Supplement to Nature
November 30, 1893

Nature

A WEEKLY

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

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A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

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THURSDAY, MAY 4, 1893.

AN AMERICAN TEXT-BOOK OF PHYSICS.

Physics, Advanced Course. By George F. Barker, Professor of Physics in the University of Pennsylvania. Pp. 902. (London: Macmillan and Co., 1892.)

THE days are nearly over when a text-book of Physics in one volume is any longer a possibility. The attempt to compress so great a mass of knowledge into small compass seems necessarily to involve the omission of anything like the full elementary explanation required by junior students, as well as the more advanced discussion suitable to seniors; it also appears necessary to curtail any approach to a mathematical investigation, and to dispense with the details of experimental appliances.

With so much omitted it may surprise those who do not know what a vast region is now cultivated under the name Physics, that there is enough left to fill a bulky volume. But there is, and this volume contains it, viz. the quiet and systematic rehearsal of the broad facts of the subject, a statement free from rhetoric and from effort, a statement which flows placidly on in a peaceful and easy flow.

The absence of friction renders the book hardly suitable for a beginner, especially one without a teacher; he could hardly manage to grip the facts as they passed him. But after a serious course of lectures, after a disjointed struggle with difficulties in this or that department, it would be a pleasant relief to a student to have a book like this put into his hands as a kind of glorified note-book, that he may leisurely revise the whole in a corrected and simple form. If a third year student is able to read this book feeling that it continually excites in him recollections of the more detailed treatment he has elsewhere acquired, he may be satisfied that he knows a good deal of Physics; if, on the other hand, he comes across pages where the matter is new and where he has any difficulty in apprehending what is said, he may feel assured that here there is something desirable for him to attend to and learn from any of the more detailed and elaborate sources open to him.

That is how the book strikes me: as one eminently suited to assist a student's revision of the subject, so as to ensure that his knowledge may be free from glaring gaps; but not as a book that could be recommended for learning from. It would probably, as I have said, be difficult to learn from, but a still more fatal objection to its use by a solitary learner is the probability that its easy flow would convey an altogether erroneous impression of the difficulties that really bristle about the subject, and would lead to only a very superficial smattering, quite incommensurate with the vast amount of information which is summarised and made more or less palatable by this genial treatise.

Having thus indicated what seems to me the general usefulness of the book I proceed to indicate its contents. It begins with fundamental units and the laws of mechanics, together with a summary of the properties of matter. Then it proceeds to treat of Energy as belonging to various bodies; masses, molecules, and the ether. This is the classification definitely adopted throughout the book—it is a treatise on the forms of energy. "Mass physics, molecule physics, and æther-physics; and the fact is significant that to the last division of the subject it has been found necessary to devote more than half of the entire work." "Radiation is considered broadly, without any special reference to those wave-frequencies which excite vision and are ordinarily called light." Modern references abound, and the subjects dwelt on are those which at the present time are most exciting attention. "The author's aim has been to avoid making the book simply an encyclopædic collection of facts on the one hand, or too purely an abstract and theoretical discussion of physical theories on the other." "He has made free use of all the sources of information at his command. . . The names of those physicists to whom the science is most deeply indebted are given in connection with the subjects on which they have worked, and in order to bring the student into more intimate contact with these great minds, the laws or principles they have formulated have frequently been given in their own words."

This free quotation is characteristic of the book, and sometimes it could be wished that a chapter and verse reference for further following up had been given, instead of only the mere name. But, after all, such reference would have been fidgeting and out of harmony with the even tenor of the text, which is about as different as it can possibly be from the productions of German authors.

I do not myself think it a good plan to incorporate formulæ in the text, so that there is nothing for the eye to catch. Such a proceeding may be convenient to the printer, but it is only permissible when the expressions are very simple and easy ones. However, all those in this book are simple and easy ones, so possibly no student need feel any inconvenience.

So far as I have observed, the statements made are usually clear and correct. There are some few exceptions; for instance, the definition of self-induction on pp. 814, 815 is not satisfactory. On p. 858 the distance apart of points, between which unit difference of magnetic potential exists, is unnecessarily specified in the definition of Verdet's constant; but this is a slip made also in Everett's "Units," and is an easy one both to make and to correct.

The account of a volume-air-thermometer given on p. 295 can hardly pass muster; and indeed this and other meagre references to the work of Regnault may be taken as typical of the absence of even the outlines of those experimental details which one is accustomed to find in the writings of French authors.

But, as I said at the beginning, the attempt to compress all physics into one volume of reasonable size and good print can only be made if one is content to omit about 90 per cent. of what might be included. As a convenient summary of a course of lectures of a particular grade the book is probably about as good as can be expected, and it may be found useful for revision-work by students in this country.

OLIVER LODGE.

BABYLONIAN COSMOLOGY.

Die Kosmologie der Babylonier. Studien und Materialen von P. Jensen. (Strassburg.)

THE thick volume of five hundred and fifty pages of closely printed matter lying before us represents what was originally intended by its author to be the first part of an exhaustive treatise upon the mythology of the Babylonians in the widest sense of the term, but he was obliged to abandon the scheme after investigating the spiritual and religious views of the Babylonians which the cuneiform texts make known to us, because he was driven by facts to admit that any such attempt would, with our present information, be premature. Prof. Jensen has then contented himself with placing in the hands of his readers a series of facts and a collection of materials for making researches into the astronomical system of the Babylonians, together with the results which he deduces from them. He is fain to admit that the present state of the study of this subject is lamentable in the extreme; for those who have worked at it in times past, and even those who still profess themselves to be devoted to the science, link idea to idea without regard to natural sequence, and draw conclusions, and invent systems, and give themselves over to traditions rather than to the serious discussion of the facts and statements of the cuneiform texts. Other writers being naturally incapable of distinguishing what is certain from that which is not, and possessing neither the knowledge necessary to control the work of Assyriologists, nor the power to work independently, reproduce the statements given doubtfully by scholars, and send them among non-experts as incontrovertible facts, and thus it comes that the greater part of the work which is current under the name of "Babylonian Mythology" must be considered base coin only.

The earliest worker in the field of Babylonian Astronomy was the famous Dr. Hincks, who published the result of his investigations of some cuneiform texts in the British Museum in the Transactions of the Irish Academy in 1856. In 1862 Sir Henry Rawlinson, the "Father of Assyriology," discovered that most important document now universally known as the "Eponym Canon," in which an eclipse of the sun was mentioned. As Dr. Hincks overlooked the fact that the greater number of the texts which he regarded as astronomical were purely astrological, this discovery by Sir Henry Rawlinson of the notice of an astronomical event recorded by the Babylonians, the accuracy of which could be demonstrated by modern mathematical calculations, must be considered as the first step towards a scientific elucidation of Babylonian astronomy, and a proof that pure astronomical science already existed in the Euphrates Valley as early as B.C. 700. In 1871 the veteran Assyriologist, Jules Oppert, published in the *Journal Asiatique* the results of his study of some syllabaries, and other texts in which the Babylonian names of the planets and other stars were given, and three years later Prof. Sayce published a lengthy paper entitled "The Astronomy and the Astrology of the Babylonians," in the Transactions of the Society of Biblical Archæology, in which he reprinted, without making a new collation, most of the astrological texts published by Rawlinson in "Cuneiform Inscriptions of Western Asia," vol. iii., to which he added English translations. On the work of these two last-mentioned Assyriologists Prof. Jensen makes some strong comments.

Passing over smaller works by Schrader and Lotz we next strike firm ground in the excellent work by Drs. Epping and Strassmaier. The former is an astronomer of no mean skill and ability, and the latter is one of the greatest experts in modern cuneiform decipherment and is thoroughly skilled in working at the tablets at first hand. In the work entitled "Astronomisches aus Babylon," Freiburg i. B. 1889, these scholars published the texts from three tablets of lunar ephemerides for the years 188, 189, and 201 of the era of Seleucus, which began B.C. 312, together with a long astronomical commentary upon them and remarks upon Babylonian ephemerides of planets in general. From these texts it was evident that the Babylonians were accustomed to tabulate the heliacal rising and setting of the planets and of Sirius, and the opposition of the planets to the sun, and it was discovered that they had in the ecliptic a number of groups of stars, twelve of which correspond roughly in nomenclature and in position with the signs of the Zodiac. When this important publication appeared Prof. Jensen had for some years been independently working at the history of the origin of the Zodiac, and a large portion of his work now before us was already in type. A careful study of the new matter and of the theories based upon it by Drs. Epping and Strassmaier convinced him of the general correctness of the results of his own investigations, at which he had arrived by a method peculiarly his own, and by many new readings of the cuneiform names of planets and stars which he was enabled to explain satisfactorily he confirmed several identifications of stars which had been pointed out by Dr. Epping by the light of mathematical astronomy. It is but fair to say that at the outset some differences of opinion existed between these distinguished scholars, but already many of them have been adjusted, and the proof of the general accuracy of the work is therefore much stronger.

Prof. Jensen divides his book into two sections. In the first he treats of the "Universe and its Parts," and in the second of the "Creation and of the Formation of the World." Under the first heading, in a series of chapters, he discusses the sky and the heavenly bodies in it, special attention being paid to the consideration of the Zodiac, the earth, the Mountain of sunrise, the abodes of the blessed dead and of the damned, and of the Okeanos; and under the second he translates and explains the Babylonian texts referring to the Creation and to the Deluge. Many of Prof. Jensen's ideas are new, and will therefore fail to be accepted by those who prefer to follow traditions and their own views in preference to results obtained directly from the cuneiform texts which are, after all, our only trustworthy authority on Babylonian cosmology. He argues his propositions in a sober manner, and he arranges his facts with clearness; he gives proof or authority for every statement, and he assumes or takes for granted little or nothing. Prof. Jensen's book is a careful statement of all the important views of the Babylonians concerning the system of the heavens and the earth as recorded by the officia astronomers and astrologers attached to the library of Assurbanipal at Nineveh about B.C. 660. His work will command the respect and earn the gratitude of all true scholars, even of those who may disagree with him, and by reason of it the scientific astronomer of to-day with his telescope and spectroscope and instruments for stellar photography will respect his predecessors on the plains of Mesopotamia, who differ from him in their calculation of the length of the average period between new-moon and new-moon by two-fifths of a second only!

OUR BOOK SHELF.

Elements of Physiography. By Hugh Dickie, LL.D. Collins Science Series. (London: Collins.)

THIS is a small manual designedly written as a text-book for the elementary stage of physiography, according to the syllabus of the Science and Art Department. All that is necessary for this stage is treated of within its pages in as concise and brief a manner as possible.

Interspersed amongst the text are upwards of 100 excellent illustrations and four coloured maps, and very good sets of questions for exercise are inserted at the end of each chapter.

The author would do well to be a little more precise and accurate in some of his statements. In Article 150, p. 138, he says: "The position of a star in the sky is fixed as follows:—(1) Its angular distance E. or W. of the line passing through the poles." Which particular one of the infinite number of lines passing through the poles is meant is not very clear. He should have "fixed" the line by adding "and the zenith." At the end of Article 154 he states that "comets and nebulæ are bodies less dense in their composition than stars, and more erratic in their movements." Surely the author should know that nebulæ do not appear to wander about amongst the stars, but keep the same relative position with respect to the latter.

Upon the whole, however, the book, which is moderate in price, can be recommended to pupils preparing for the examination in elementary physiography.

Seventh Annual Report of the Bureau of Ethnology to the Secretary of the Smithsonian Institution, 1885-86. By J. W. Powell, Director. (Washington: Government Printing Office.)

THE Report which occupies the first part of this handsome volume is too old to be read with much interest. Happily it is accompanied by papers which are of more than passing value. One of these—on Indian linguistic families of America north of Mexico—is by Prof. J. W. Powell, who, in the course of an elaborate discussion and exposition, throws much light on an intricate and most difficult subject. A paper by Mr. W. J. Hoffman on the Midē'wiwin or "grand medicine society" of the Ojibwa, will be read with pleasure by students of anthropology, and Mr. James Mooney devotes a very careful and interesting paper to the consideration of the sacred formulas of the Cherokees.

LETTERS TO THE EDITOR.

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

A Remarkable Rainfall.

I SEND a few particulars of the recent remarkable rainfall at Crohamhurst, situated on the western slope of Mont Blanc, a peak on a spur of the D'Aguilar Range, an offset from the Blackall Ranges, South Eastern Queensland. The whole of this district is watered by the Stanley River, a tributary of the Brisbane River, and hence the values given below were prominent factors in producing the terrible floods from which we have suffered. I may mention that the observer at Crohamhurst is Mr. Inigo Owen Jones, one of my specially trained assistants, and that implicit reliance can be placed on his figures.

The following are the more remarkable falls of the flood period at Crohamhurst:—For 24 hours ending 9 a.m. February 1, 10·775 inches; ditto February 2, 20·056 inches; ditto February 3, 35·714 inches; ditto February 4, 10·760 inches. The gauge is a standard of the "eight-inch" pattern, standing one foot above the ground at an altitude of about 1400 feet above mean sea level. The approximate latitude and longitude of Crohamhurst are 26° 50′ S. 152° 55′ E. The gauge was emptied every three hours, night and day, on the occasion of the greatest fall. I think meteorologists will agree that for a 24 hours' fall we have beaten the world's record.

CLEMENT L. WRAGGE,
Government Meteorologist of Queensland (late of Ben Nevis).

Brisbane, March 22.

The Cold Wave at Hongkong, January 1893.—Its After Effects.

NOW that the cold wave has completely passed away and warm weather is setting in (March 17, 1893), one can write more certainly respecting the effects upon animal and vegetable life.

With regard to the plants the effect has been disastrous, especially on the higher levels, and were it not that our rarest plants descend the hillsides, and often occur in sheltered nooks, this year's frost would have caused the extinction of several of them. Combined with the dry weather we have been enduring the frost has turned our fairly green island into a brown, desert-looking land, much of the undergrowth being dead. Most of the leaves have fallen, even new leaves that were unfolding have been shed, and only now is a fresh crop coming on. The common *Lantana Camara*, instead of being a blaze of bloom, is a ragged, almost leafless shrub, with here and there a flower-head; *Mimosa pudica* is in many cases killed outright, but some are putting out fresh leaves from the root stocks. *Rhodomyrtus tomentosa*, perhaps our commonest shrub, is quite killed on the hills, and the exquisite *Enkyanthus quinqueflorus*, with its pink bells and opal glands, that is so cherished by the Chinese at their New Year Festival (February 17) was hardly up to date. On February 28, with a party of naval officers, I ascended Lanto (3000 feet), a peak on an island near Hongkong, that is famous for Tiu Chung-fa, to give it the native name, and though I found numbers of the shrubs putting forth new red terminal leaves, only one was in flower, and the supply has been very scanty. Cocoa-nuts and bananas have suffered greatly.

At Canton Dr. Henry reports the banana plantations are ruined, and bamboos have suffered. "*Aleurites triloba* (the candle-nut) looks shrivelled up, while begonias, euphorbias, crotons, and scores of others look shrivelled up." There the plants suffered more than at Hongkong, for Mr. C. Ford, superintendent of the Botanic Gardens, reports Aleurites uninjured below an altitude of 300 feet. In his Government report he gives a list of over eighty species of exotics that have suffered, and the following effects upon indigenous plants:—

Bischoffia javanica, Blume	Killed.
Blechnum orientale, Linn.	,,
Embelia Ribes, Burm.	Leaves killed.
ovata, Scheff.	,, ,,
Evodia triphylla, A. de C.	,, ,,
Ficus retusa, Linn.	Killed.
hispida, Linn.	,,
Harlandi, Benth.	,,
Garcinia oblongifolia, Champ. ...	Leaves killed.
Itea chinensis, Hook. and Arn. ...	,, ,,
Melastoma candidum, Don	Killed.
Mœsa sinensis, A. de C.	,,
Nephrolepis exaltata, Schott	Fronds killed.
biserrata, Schott	,, ,,
Psychotria elliptica, Ker	Leaves ,,
Rottlera paniculata, Juss.	,, ,,
Rhodomyrtus tomentosus, Hassk ...	Killed.
Sponia velutina, Planch	,,
Tetracera sarmentosa, Vahl	Leaves killed.
Zanthoxylon nitidus, A. de C. ...	,, ,,

"Those which were killed were above 800 feet above sea-level."

The effect upon insect life has been disastrous. A few straggling butterflies and hymenoptera lasted a few days, and then came a blank of weeks when not an insect of any kind was seen, and the place seemed painfully still from the absence of cicadas by day and crickets by night. My friend Mr. H. E. Denson found a glow-worm at the Peak on February 6, but saw nothing else in the way of insects.

Towards the end of February the weather began to be mild, though it is still below normal, and insects began to appear, some lepidoptera emerging crippled. Butterflies are still quite rare, and generally only single specimens seen. The only species as plentiful as usual is the little pale blue *Lycæna argea*. Last year butterflies absolutely swarmed. Thus Mr. J. J. Walker, R.N., has in his diary the following notes:—February 3. "Euplœas in greater numbers than I had ever seen." And again, March 4: "The profusion of butterflies was quite bewildering."

I cannot show the difference between the two seasons better than by comparing the list of species on the wing:—

Species.	1892	1893	Remarks.
1. *Danais genutia*, Cram. ...	c	—	—
2. *similis*, Horsf. and Moore	c	—	In swarms, 1892.
3. *grammica*, Butl.	v.c	—	In swarms, 1892.
4. *tytia*, Gray	r	—	—
5. *Euplœa superba*, Herbst. ...	v.c	r	One only, 1893.
6. *lorquinii*, Feld.	v.c	—	Swarms in 1892.
7. *Melanitis leda*, Linn. ...	v.c	r	One only, 1893.
8. *Mycalesis mineus*, Linn. ...	c	—	—
9. *Ypthima*	c	—	—
10. *Clerome eumæus*, Drur. ...	v.c	—	—
11. *Vanessa charonia*, Drur. ...	c	r	A few, 1893.
12. *Junonia asterie*, Linn. ...	c	r	A few, 1893.
13. *lemonias*, Linn.... ...	v.c	r	One only, 1893.
14. *orithya*, Linn., var. *Andromeda*	c	—	—
15. *Symbrenthia hypælus*, Hub.	c	r	—
16. *Ergolis ariadne*, Linn. ...	r	—	—
17. *Neptis eurynome*, Westw. ...	v.c	r	—
18. *Athyma perius*, Linn. ...	c	r	A few, 1893.
19. *sulpitia*, Cram.	c	—	—
20. *Hypolimnas misippus*, Linn.	r	—	—
21. *Hestina assimilis*, Doub. ...	r	—	—
22. *Cupha erymanthis*, Drur. ...	c	—	—
23. *Argynnis niphe*, Linn. ...	r	r	One ♀, 1893.
24. *Pyrameio cardui*, Linn. ...	r	—	—
25. *indica*, Herbst.	r	r	One only, 1893.
26. *Zemeros flegyas*, Cram.? ...	c	r	—
27. *Abisara kausambi*, Feld. ...	c	r	—
28. *Lampides œlianus*, Fabr. ...	v.c	c	As usual in March.
29. *Polyommatus bœticus*, Linn..	r	—	—
30. *Lycæna praxiteles*, Feld. ...	c	—	—
31. *argea*?	v.c	—	—
32. *Thecla*	c	—	—
33. *Pieris canidia*, Spar. ...	v.c	r	Generally swarms.
34. *coronis*, Cram.	c	—	—
35. *Catopsilia catilla*, Cram. ...	c	—	—
36. *pyranthe*, Drur.	c	—	—
37. *crocale*, Cram.	c	r	A few, 1893.
38. *Terias hecabe*, Linn.... ...	v.c	r	A few, 1893.
39. sp.	r	—	—
40. *Ixias pyrene*, Linn.	c	r	One only, 1893.
41. sp....	r	—	—
42. *Hebomoia glaucippe*, Linn. ...	c	r	One only, 1893.
43. *Papilio memnon*, Linn. ...	v.c	r	One only, 1893.
44. *helenus*, Linn.	v.c	r	A few, 1893.
45. *polites*, Godt.	v.c	—	—
46. *dissimilis*, Linn.... ...	v.c	—	—
47. *antiphates*, Cram. ...	v.c	—	—
48. *sarpedon*, Linn.	v.c	—	—
49. *telephus*, Feld.	c	—	—
50. *agamemnon*, Linn. ...	c	—	—
51. *paris*, Linn.	c	r	A few, 1893.
52. *bianor*, Cram.	c	r	A few, 1893.
53. *Leptocircus*, sp.	c	—	—
54. *Choaspes*, sp.	r	—	—
55. *Baoris mathias*, Fabr. ...	r	—	—
56. *Telicota bambusæ*, Moore. ...	c	—	—
No. of species on the wing, March 17, 1892	56		
No. of species on the wing, March 17, 1893	21		

The paucity of species this year does not nearly represent the difference, for whereas butterflies swarmed at this time last year, they are very rare now. Mr. Walker and I make it a rule to go out every day and note the species, and I do not think we have missed one. It is not the lack of flowers, for the gardens are aglow, and rhododendrons are superb. I may mention that our unique *Rhodoleia Championi* flowered magnificently in February, producing two crops of flowers one after the other; the first were damaged and snapped off short at the base of the peduncle, carpeting the ground with carmine blossoms; the second blooms were not shed.

Bees are now active, cicadas and grasshoppers beginning to sing, but in diminished numbers. Hemiptera are waking up from their torpor, and coleoptera becoming numerous. I imagine there is not a great destruction of pupæ and eggs, but that they are delayed in emerging. To-day we have the first real soaking rain for months, and as the south-west monsoon has begun to make itself felt, I anticipate quite a burst of life during the next few weeks, and will report.

Another interesting phenomenon has occurred since I wrote my first account of the cold wave. The sea-water flowing from the north has cooled below the normal, and at the end of February was as low as 57° F., but has since recovered. Thousands of fish died, or floated about torpid, the critical temperature having just been reached. This state of things lasted about three days. The Chinese fishermen said the fish had cholera, and called attention to some alteration in a joss-house on an island in the harbour, any tampering with which causes sickness to man or beast, by interfering with the Fung Sui! They gave up fishing for a week, but the fish were not diseased so far as I could see.

I may note that since the Sanguir eruption in July last we have had perfect Krakatão sunsets, which are only just waning. They were in greatest force in the middle of December, and the fine after-glow was visible at the zenith an hour and a half after sunset. It was strong enough to overpower the zodiacal light. SYDNEY B. J. SKERTCHLY.

Kowloon, Hongkong, March 17.

P.S.—Mr. J. J. Walker, R.N., has just visited the Happy Valley after the rain. He finds the butterflies much more plentiful. *C. cumæus*, and *H. glaucippe* have appeared within the last two days.—March 23.

The April Meteors.

OF the periodical meteor showers I believe that, from an observational point of view, the April Lyrids may be regarded as one of the least interesting. The display frequently disappoints expectation, and even on the night of April 20, which usually supplies the maximum, the observer often finds his patience taxed in watching a sky which gives not more than seven or eight meteors per hour from all radiants, and not more than one-third of these from the special shower of Lyrids. This is not, however, the invariable experience. Occasionally, as, for example, in 1863 and 1884, the display is a conspicuous one, and rivals other prominent showers, such as the Perseids, Orionids, and Gemmids.

This year the circumstances were not altogether favourable for observation, the crescented moon being visible on April 19 and 20 during the first half of the night, and on April 21 her setting did not take place until 14h. The sky was however clear on April 18, 20, and 21, and the period was a remarkable one on account of its exceptional heat. The maximum shade temperature on four consecutive days was registered here as follow:—April 19, 75°, April 20, 77°, April 21, 81°, April 22, 78°. The height attained on April 21 is entitled to be regarded as a rare meteorological event. With an atmosphere so salubrious the work of recording meteors was rendered very pleasant, and reminded the observer of night-watches in July and August rather than with experiences comparatively early in the spring.

On April 18 I noted 9 shooting stars in the $1\frac{1}{2}$ hour between 11h. 30m. and 13h., and of these 2 or 3 were Lyrids. The shower was so meagre that it was not thought advisable to watch its progress through the night.

On April 19 the sky was not sufficiently clear for observations.

On April 20, between 11h. 15m. and 14h. 25m., I looked towards the eastern quarter of the sky and counted 18 meteors, of which 7 were Lyrids with a sharply defined radiant at $272° + 33°$. Several meteors were also observed from a contemporary shower at $218° + 33°$ between ϵ and γ Boötis. I saw this shower in 1887 from the same point on April 18–25.

On April 21 the sky was beautifully clear, and I recorded 29 meteors during the 4 hours between 11h. 20m. and 15h. 25m. There were 8 Lyrids which showed very exact radiation from the point $273° + 34°$ and close to the position determined on the preceding night. Several of the Lyrids were fine meteors leaving bright streaks and moving with moderate speed. A minor shower was detected from slow meteors seen on this and the previous night, at $200° + 9°$ between Virgo and Boötes. I do not appear to have noticed this radiant during my observations of the Lyrids in former years.

On April 22 clouds unfortunately prevailed, and the further progress of the display could not be watched.

Taking my observations collectively, I saw 56 meteors in watches extending over $8\frac{1}{2}$ hours on the nights of April 18, 20, and 21. Of these about 18, or one-third of the whole, belonged to the Lyrid shower. The apparent paths of the brighter meteors recorded were as follows:—

Date 1893.	G.M.T. h. m.	Mag.	Path From α δ ° °	Path To α δ ° °	Probable Radiant. ° °	Appearance.
April 18	12 50	1	$254 + 22\frac{1}{2}$	$238 + 29$	$274 + 10$	Slow. B. streak.
,, 20	11 25	1	$240 + 49\frac{1}{2}$	$232 + 54$	$218 + 33$	V. slow.
,, 20	11 56	$1\frac{1}{2}$	$289 + 53\frac{1}{2}$	$300 + 52\frac{1}{2}$	$200 + 9$	Slow.
,, 20	12 39	1	$241 + 26\frac{1}{2}$	$231 + 23$	$272 + 33$	Not swift, streak.
,, 21	12 8	♃	$270 + 44$	$268 + 49\frac{1}{2}$	$273 + 34$	V. slow, streak.
,, 21	12 24	♀	$236 + 30$	$207 + 18$	$273 + 34$	Slow, streak.
,, 21	13 26	>1	$292 + 67$	$307 + 67$	$263 + 61$	Rather swift, stk.

The Lyrid seen on April 21 at 12h. 24m. was very brilliant, and it left a long streak between α and β coronæ and slightly above Arcturus. As the meteor traversed its course of 30 degrees it exhibited three outbursts of light, and the places where these occurred were indicated by bright knots in the streak.

One of the most important questions in connection with this cometary meteor shower is as to whether the radiant shows a displacement in its position as observed on successive nights. I wrote in NATURE for May 7, 1885, to the effect that my observations on April 18, 19, and 20 of the year mentioned proved a rapid shifting to the eastwards, and even greater than that recognised in the radiant of the July and August Perseids. My later results confirm the supposed displacement, but show that it is far less extensive than that based on the figures obtained in 1885. I append a summary of all my radiants for this shower with the exception of those obtained in the years 1873 and 1874, which were certainly not very accurate owing to my inexperience in the work at that time. In comparing the various positions included in the list, it must be remembered that too much weight should not be given to any one individually, but that the general result deducible from them all will ensure the most trustworthy conclusions. The first position in the list, viz. that for April 18, 1885, is undoubtedly too far west to be consistent with the others, while that for April 19, 1877, is equally too far north. From the distribution of the radiants in right ascension there is striking evidence of displacement. Further observations will be very valuable, especially if made at the beginning and ending of the shower on say April 16, 17, and 22 and 23. But on these nights it is scarcely visible at all, so that it will be advisable to watch for it during the whole night, and perhaps to amalgamate the results for a similar date in several years.

Radiants of Lyrids observed at Bristol.

1885	April 18	260°	+33°
1887	,,	266	+33
1877	April 19	269	+37
1884	,,	269	+33
1885	,,	268	+33
1887	,,	269	+31
1878	April 20	273	+32
1879	,,	272	+33
1885	,,	274	+33
1887	,,	271	+33
1893	,,	272	+33
1878	April 21	272	+32
1893	,,	273	+34
1878	April 22	275	+31

The consistency of the positions on April 20 sufficiently shows that the radiant is sharply defined and that its place may be determined with considerable precision.

In looking over the observations I found two trifling clerical errors in my catalogue of radiants printed in the *Monthly Notices* for May, 1890. Radiant number 102 was seen on April 19, not April 20, 1884, and number 104 on April 21, not April 20, 1878.

I believe this shower lasts from April 16 to 23. On the former date in 1877 I recorded three of its meteors, and the radiant was indicated at $263° + 33°$, but not with certainty.

The very fine meteor of April 15 last, 9h. 52m., seen in many parts of the country, was not an early Lyrid, but appears to have belonged to a radiant in Cassiopeia, and possibly to the same system which furnished the fireballs of April 10, 1874, and April 9, 1876, with radiants at $19° + 57°$ and $17° + 57°$ respectively, according to Von Niessl. A fireball seen on May 30, 1877, had a radiant at $20° + 58°$, which is virtually the same position as the others. I would be glad to hear of any additional observations of the large meteor of April 15, 1893, or of any of the meteors seen at Bristol on the nights of April 18, 20, and 21 last, and referred to in the first of the foregoing tables.

W. F. Denning.

Smithsonian Institution Documents.

I do not know whether your numerous readers realise that many of the public documents published by the United States Government and the Smithsonian Institution can be obtained by direct personal application to the author, at least as long as copies remain undistributed.

The volume entitled "Mechanics of the Atmosphere," recently published by the Smithsonian Institution, was compiled in the confident hope of stimulating the study of this difficult subject by English-speaking scholars throughout the world; further volumes will follow if it becomes evident that this hope is being realised. This collection of translations appeals especially to the mathematical physicist, and I should be pleased to hear from any one who desires to study or teach this subject.

Cleveland Abbe.

Weather Bureau, Washington, April 15.

THE GENESIS OF NOVA AURIGÆ.

It is a common belief that everything is created for a beneficial purpose, and a commoner one that the chief purpose is the delectation of mankind. Without occupying the stilted position involved in the acceptation of such an idea, it can be said that all things that are made are useful for the extension of knowledge. Viewed from this standpoint, the universe is a field containing an infinite number of facts which have to be reaped and garnered before they can be threshed. In the case of the new star that appeared in Auriga last year, a rich harvest of facts has been gathered in. Astronomers from their watch-towers have scanned the celestial visitor through optic-glasses; estimated its glory; measured its place; photographed it, and caused it to weave its pattern in the spectroscope. But it is not enough to make observations and store them up in musty libraries without the proper understanding of their import. At all events, the greatest possible good should be wrung from the facts, and an attempt should be made to discriminate the theory that best explains them. For this reason the subject of Nova Aurigæ is here resuscitated. Theories galore have been propounded to account for that star's genesis, and the most important are described in this note, so that every one can judge for himself the explanation which sufficiently satisfies the phenomena.

Before the advent of the new star of 1866 the general opinion was that such objects represented new creations. Spectroscopic observations then caused a revulsion of that idea, and we find Dr. Huggins suggesting in an italicised expression, that "*the star became suddenly enrapt in burning hydrogen*" ("Spectrum Analysis," p. 28, Huggins, 1866). To quote more fully, "In consequence it may be of some great convulsion, of the precise nature of which it would be idle to speculate, enormous quantities of gas were set free. A large part of this gas consisted of hydrogen, which was burning about the star in combination with some other element. This flaming gas emitted the light represented by the spectrum of bright lines. The greatly increased brightness of the spectrum of the other part of the star's light may show that this fierce gaseous conflagration had heated to a more vivid incandescence the matter of the photosphere. As the free hydrogen became exhausted the flames gradually abated, the photosphere became less vivid, and the star waned down to its former brightness." More or less modified forms of this theory of a fiery cataclysm were afterwards put forward, to account for the formation of Nova Cygni in 1876. Mr. Lockyer, however, advanced the idea that the outburst was due to cosmical collisions (Nature, vol. xvi. p. 413). In his words, "We are driven from the idea that these phenomena are produced by the incandescence of large masses of matter because, if they were so produced, the running down of brilliancy would be exceedingly slow. Let us consider the case, then, on the supposition of small masses of matter. Where are we to find them? The answer is easy: in those small meteoric masses which an ever-increasing mass of evidence tends to show occupy all the realms of space." Practically all the theories with regard to the origin of new stars are modifications of one or the other of these; either an internal convulsion, or an external collision, is hypotheticated. Let us see how each will stand the test put upon it by Nova Aurigæ.

The discovery by Mr. Lockyer that the bright lines in the spectrum of the new star were accompanied by dark lines on their more refrangible sides seemed at once to be a striking confirmation of his views. The interpretation naturally put upon such a composite appearance was that two discrete masses were engaged in producing the body's light; one, having a spectrum of dark lines, was rushing towards the earth, while the bright-line star or nebula was running away. As Mr. Lockyer remarked in a paper communicated to the Royal Society on February 7, 1892, "the spectrum of Nova Aurigæ would suggest that a moderately dense swarm [of meteorites] is now moving towards the earth with a great velocity, and is disturbed by a sparser one which is receding. The great agitations set up in the dense swarm would produce the dark-line spectrum, while the sparser swarm would give the bright lines." In spite of its simplicity, however, and its ability to account for the observed facts, the meteoritic theory did not commend itself to the minds of some astronomers. Dr. Huggins clung to the idea that the outburst was the result of eruptions similar in kind to those upon the sun, but the acquisition of knowledge of the light changes of stars forced him to withdraw the original suggestion that the luminosity of a Nova is produced by chemical combustion (*Fortnightly Review*, June 1892, p. 827), in fact, to relinquish entirely the crude conception of a burning world propounded in 1866. In its place Dr. Huggins put the view that Nova Aurigæ owed its birth to the near approach of two gaseous bodies. "But," he admits (*Ibid.* p. 825), "a casual near approach of two bodies of great size would be a greatly less improbable event than an actual collision. The phenomena of the new star scarcely permit us to suppose even a partial collision, though if the bodies were diffused enough, or the approach close enough, there may have been possibly some mutual interpenetration and mingling of the rare gases near their boundaries."

"An explanation which would better accord with what we know of the behaviour of the Nova may, perhaps, be found in a view put forward many years ago by Klinkerfues, and recently developed by Wilsing, that under such circumstances of near approach enormous tidal disturbances would be set up, amounting, it may be, to partial deformation in the case of a gaseous body, and producing sufficiently great changes of pressure in the interior of the bodies to give rise to enormous eruptions of the hotter matter from within, immensely greater but similar in kind to solar eruptions." Serious objections to the Klinkerfues-Wilsing hypothesis are pointed out by Herr Seelinger (*Astr. Nach.*, No. 3118, and Nature, December 8, 1892). He shows that the statical theory of tides that has been applied is entirely inappropriate to the case, and also that the hypothesis involves assumptions amounting almost to impossibilities. In the first place, the pairing of the bright and dark lines makes it necessary to assume that the two bodies engaged were of similar chemical constitution, one having an absorption spectrum and the other an equivalent radiation spectrum. But even if we make this unthinkable supposition, a fatal objection has been pointed out by Mr. Maunder (*Knowledge*, June 1892). It is that the bright lines ought to have their refrangibility increased, not decreased as the spectroscopic observations show them to be. In other words, the erupted matter would approach the earth, not recede from it. This single undisputable fact effectually disposes of the chromospheric hypothesis to which reference has been made.

Another chromospheric theory in which only a single star is involved has been put forward by Father Sidgreaves (*The Observatory*, October, 1892). After describing the spectrum he says, "It is only necessary, therefore, to consider the conditions under which the blue-side shift of the Nova's lines should produce the absorption effect while the red-side parts show unclouded radiation. A great cyclonic storm of heated gases would produce this double if the heated gases were rushing towards us in the lower depths of the atmosphere trending upwards and returning over the stellar limb. In the lower positions the advancing outrush would be screened by a great depth of absorbing atmosphere, while as a high retreating current its radiation would be along a clear line to our spectroscopes." This explanation is plausible enough, but it does not go to the root of the matter. How, for instance, does Father Sidgreaves account for such a tremendous eruption as that required by his hypothesis? It is difficult to believe that internal forces could sustain, for two months, a stream of gas rushing earthwards with a velocity of about 400 miles per second, and then curving round and receding at the rate of 300 miles per second. And the idea becomes still more incomprehensible when we remember that the body possessing this marvellous store of energy was quite invisible before December, 1891. Until Father Sidgreaves explains the machinery by which the terrific whirl of chromospheric matter was started and kept up, his theory can hardly be seriously discussed.

As has already been remarked, Mr. Lockyer was the originator of the theory that Novas represent the result of the collisions of small masses. On this theory the broadened character of the lines in the spectrum of Nova Aurigæ is explained by supposing that different parts of the colliding swarms of meteorites were moving with different velocities, or with the same velocity in different directions. Several modifications of the meteoritic theory have been published. Mr. W. H. Monck has suggested that a star, or a swarm of meteors, rushing through a gaseous nebula afford the best explanation of the phenomena. The only difference between this idea and that of Mr. Lockyer's is that the nebula is supposed to consist of gaseous instead of meteoritic particles. But, from a dynamical point of view, there is no distinction between the two, for it is well known that Prof. G. H. Darwin has proved that the individual meteorites of a swarm would behave like the individual particles of a gas. Referring to the collision with a gaseous nebula, Mr. Monck says (*Journal of the British Astronomical Association*, January, 1893): "The previous absence of nebular lines, even if clearly proved, would not be conclusive as to the non-existence of such a nebula, for its temperature may not be high enough to produce these lines until raised by the advent of the star. A considerable proportion of Novæ, however, appear to be connected with known nebulæ. Irregularities in the nebulæ would produce the observed fluctuations of light, and if the relative velocity was considerable the bright gas-lines of the nebula would be distinguishable from the dark absorption lines of the star. The bright lines would be broader than usual, because the velocity of the portion of the nebula adjoining the star would be partially destroyed and the luminous gas would thus be moving with different velocities. The heating being confined to the surface of the star, the cooling would take place more rapidly than after an ordinary collision. But if the star travelled far through the nebula in a state of intense incandescence, portions of the surface would from time to time be vaporised and captured by the nebula, the mass of the moving star thus diminishing at every step. It might even end in complete vaporisation, as meteors are sometimes vaporised in our atmosphere. Herr Seelinger has worked out mathematically a theory (*Astr. Nach.* No. 3118, and NATURE, vol. xlvii. p. 137) very similar to that of Mr. Monck. He supposes that a body enters a cosmic cloud, such as Dr. Max Wolf's photographs show to be widely scattered through space. Whatever the constitution of such a nebulous mass, collision with it causes an increase of temperature, and a vaporisation of some of the constituents of the colliding body. The process is precisely similar to the entrance of a meteor into the earth's atmosphere. According to Herr Seelinger, Nova Aurigæ was produced in this wise. A dark body was rushing earthwards through space; it came to a mass of nebulosity, the light of which was so feeble that the eye could not appreciate it; the collision caused an increase of temperature and of luminosity; the heaping up of the glowing vapours in front of the colliding body produced the spectrum of dark lines, and the bright-line spectrum was given by the vapours left behind as the body moved onwards. These vapours would quickly assume the velocity of adjacent parts of the nebula, hence the dark lines would appear on the more refrangible sides of the bright ones in the manner observed.

Mr. Maunder also favours a collision theory (*Knowledge*, June 1892), his idea being that a long and dense swarm of meteors rushed through the atmosphere of a star, and produced the phenomena exhibited by Nova Aurigæ As the stream passed periastron, the spectrum of the glowing meteorites, and that of the constituents of the stellar atmosphere with which they were colliding, would appear together with the absorption spectrum of the star.

From what has been said it will be seen that none of the collision theories are substantially different from that laid down by Mr. Lockyer in 1877. It has been asserted that the meteoritic theory is not competent to explain the observed facts, but the opponents have generally omitted to specify its imperfections. One of the commonest objections is that the collision of two meteor swarms would be accompanied by a very considerable slackening of the rate of movement. Against this can be urged Seelinger's proof that the great relative velocity indicated by the spectrum could remain practically unchanged, and, in spite of this, enough kinetic energy could be transformed into heat to cause a superficial incandescence. Another objection is that it is impossible to conceive of meteor swarms of such magnitude that though rushing through one another with a relative velocity of more than seven hundred miles per second, disentanglement did not take place until two or three months had elapsed. In the light of latter-day revelations of astronomical photography, this objection becomes a mere cavil. The long-exposure photographs taken in recent years show that space is full of nebulous matter, and the "stream of tendency" is towards the idea that such masses are not gaseous but of meteoritic constitution. Now a simple calculation proves that even if Nova Aurigæ had a parallax of one second of arc, the whole of the luminosity received up to the end of April, 1892, could have been produced by the collision of two bits of nebulous matter, each of which would subtend an angle at the earth of less than half a minute of arc.

Surely it is not too much to assume the existence of meteoritic swarms of such comparatively small dimensions.

In some incidental remarks upon temporary stars, Mr. Maunder agreed with Mr. Lockyer in 1890 (*Journal of the British Astronomical Association*, vol. i. No. 1, p. 29) that they "must be stars in quite another sense to our sun. The rapidity with which their brightness diminishes is plain proof of this. Only small bodies could cool so rapidly, and since despite their vast distance (for their parallax is insensible) these Novas show themselves conspicuous, we are obliged to explain their brilliancy by considering them as consisting of aggregations of such small bodies; the total extent and mass of the swarm making up for the insignificant size of its components."

It will be seen that Mr. Lockyer's theory fits in with these observations most aptly. "New stars," he says (Roy. Soc. Proc., vol. xliii. p. 154), "whether seen in connection with nebulæ or not, are produced by the clash of meteor swarms. Clearly, as the swarm cooled down after the collision, we should find its spectrum tend to assume the nebular type." It is quite immaterial whether the chief nebular line is considered to be due to magnesium or not. According to the meteoritic hypothesis, a new star, as it diminishes in brilliancy, and presumably in temperature, must degrade towards the condition of a nebula. Accept the observations in proof of such a transformation, and the idea that nebulæ are entirely composed of glowing gas becomes untenable, unless it is believed that a Nova increases in temperature as it diminishes in brightness. On the other hand, the change of a new star into a nebula gives strong support to Mr. Lockyer's view that nebulæ are low temperature phenomena. In a paper "On the Causes which Produce the Phenomena of New Stars" (Phil. Trans., vol. clxxxii. (1891) A. pp. 397–448) Mr. Lockyer shows that the spectroscopic observations of Nova Coronæ, Nova Cygni, and Nova Andromedæ are in agreement with his hypothesis. It was therefore expected that Nova Aurigæ should assume the characteristic badge of a nebula. The expectation has been strikingly realised. In August, 1892, the star revived, and on the 19th of that month Prof. Campbell, of the Lick Observatory, wrote the following account of his observations of it (*Astr. Nach.*, No. 3133):—"The brightest line previously observed was resolved into three lines, whose wave-lengths were about 501, 496, and 486, which were at once recognised to be the three characteristic nebular lines. The same morning Prof. Barnard, using the 36-inch equatorial, observed the Nova as a nebula 3″ in diameter, with a tenth magnitude star in its centre. Thus the nebulous character of the object was independently established by two entirely different methods." Writing on the same subject, Prof. Barnard remarks (*Astr. Nach.*, No. 3143):—"I think it unquestionable that had any decided nebulosity existed about the star at its first appearance, it would have been detected in observations with the 36-inch, especially when the star had faded somewhat. So it is clearly evident that there has been an actual transformation in every sense of the word of a star into a nebula within an interval of only four months." Herr Renz has also observed the nebular character of the Nova by means of the Pulkowa refractor. On the other hand, one or two observers have been unable to detect the nebulosity, and it does not appear on Dr. Roberts's photograph of the region. It is impossible, however, to think that an observer of Prof. Barnard's calibre could have been deceived in the matter; hence the conflicting observations are probably accounted for by fluctuations in the extent and brightness of the nebulosity. The fact that Dr. Max Wolf's photographs of the Nova fail to show any haziness round the star goes for nothing, for a patch 3″ in diameter could not be distinguished from a point upon the scale of his pictures.

The spectroscopic evidence of the nebular character of Nova Aurigæ in its old age does not rest merely upon Prof. Campbell's observations. Prof. Copeland examined the spectrum on August 25 and 26, and also Mr. J. G. Lohse. From the measures obtained the mean values assigned to the two brightest lines were λ 500·3 and λ 495·3, while a fainter line was seen in the position λ 580·1, which is also the position of a bright line found in the Wolf-Rayet stars and Nova Cygni (NATURE vol. xlvi. p. 464). Mr. Fowler has also observed the two lines at 5006 and 4956 (*Ibid.* vol. xlvii. p. 399). But perhaps the most convincing of all testimonies is contained in a paper by Herr Gothard on the spectrum of the new star in Auriga as compared with the spectra of planetary nebulæ (Monthly Notices R.A.S., vol. liii. p. 55). The author has photographed the spectra of a number of nebulæ, and compared the results with his photographs of the Nova spectrum. "Each new photograph," says he, "increased the probability, which may be considered as a proved fact that the *spectrum not only resembles, but that the aspect and the position of the lines show it to be identical with the spectra of the planetary nebulæ*. In other words the new star has changed into a planetary nebula." In the face of this array of facts nothing could appear to be more satisfactorily established than the descent of the Nova to the condition of a nebula. Up to the present only one observer, Dr. Huggins, has delivered himself of a contrary conviction. His observations have led him to believe that "the bright band in the Nova spectrum is resolved into a long group of lines extending through about fifteen tenth-metres" when a high dispersion is employed (*Astr. Nach.*, No. 3153). This observation, however, has not been confirmed, hence it cannot be "implicitly accepted." It can hardly be discussed until Dr. Huggins gives a more explicit description of the number and positions of the individual lines he has seen.

Such are the theories with regard to the origin of Nova Aurigæ and new stars generally. From the survey we see that Huggins' theory of burning worlds suggested to account for the appearance of a new star has gone the way of Tycho Brahe's idea that such bodies are new creations. Any and all chromospheric theories fail to explain the transformation of the Nova into a nebula, so they should be abandoned. And finally, the whole sequence of spectroscopic phenomena is explainable on the hypothesis that the light was produced "by the clash of meteor-swarms." From the point of view of the meteoritic hypothesis things could hardly have turned out more satisfactorily than they have, yet at least one carping critic, after being forced to admit the testimony of his eyes that the Nova now exists as a nebula, has ventured to say that the fact tells against it. How, forsooth? Simply to make such a statement without backing it up reminds one very forcibly of mud-throwing. Let the blows to the hypothesis be fairly given, and as fairly met, for only by such means can the truth prevail.

RICHARD A. GREGORY.

THE ROYAL SOCIETY SELECTED CANDIDATES.

THE following fifteen candidates were selected on Thursday last (April 27) by the council of the Royal Society, to be recommended for election into the Society. The ballot will take place on June 1 at 4 p.m We print with the name of each candidate the statement of his qualifications.

WILLIAM BURNSIDE, M.A.,

Professor of Mathematics at the Royal Naval College, Greenwich. Formerly Fellow of Pembroke College, Cambridge Author of the following papers among others:—"On Deep water Waves resulting from a Limited Original Disturbance," and "On the small Wave-Motions of a Heterogeneous Fluid under Gravity" (Proc. Lond. Math. Soc., vol. xx.); "On Functions determined by their Discontinuities and by a Certain Form of Boundary Condition," and "On a Certain Riemann's Surface" (*ibid.*, vol. xxii.); "On a Class of Automorphic Functions," with a "Further Note," and "On the Forms of Hyperelliptic Integrals of the First Class, which are Expressible as the Sum of Two Elliptic Integrals" (*ibid.*, vol. xxiii.); "The Elliptic Functions of $\frac{1}{3}$ K., &c.;" "Centre of Pressure of a Plane Polygon" (*Messenger of Math.*, vol. xii.); "On Certain Spherical Harmonics" (*ibid.*, vol. xiv.); "On the Trisection of the Period for Weierstrass's Elliptic Functions" (*ibid.*, vol. xvi.); "On the Potential of an Elliptic Cylinder" (*ibid.*, xviii.); "Geometrical Interpretation of a Condition of Integrability;" "The Lines of Zero Length on a Surface as Curvilinear Co-ordinates;" "On the Propagation of Energy in the Electro-Magnetic Field" (*ibid.*, vol. xix.); "On the Addition-Theorem for Hyperbolic Functions;" "On a Case of Streaming Motion;" "A Property of Linear Substitutions;" "A Property of Plane Isothermal Curves;" "On the Differential Equation of Confocal Sphero-Conics" (*ibid.*, vol. xx.); "On the Jacobian of Two Quadratics and a System of Linear Equations," "On the Form of Closed Curves of the Third Class;" "On Linear Transformations of the Elliptic Differential" (*ibid.*, vol. xxi.); "On the Division of the Elliptic Periods by 9" (*ibid.*, vol. xxii.); "On the Partition of Energy Between the Translatory and Rotational Motions of a Set of Now Homogeneous Spheres" (Edin. Trans., 1888); "On a Simplified Proof of Maxwell's Theorem (in the Kinetic Theory of Gases)" (Edin. Proc., 1887); "On the Theory of Functions" (Camb. Phil. Proc., vol. vii.).

WYNDHAM R. DUNSTAN, M.A.,

Professor of Chemistry to, and Director of the Research Laboratory of, the Pharmaceutical Society of Great Britain. Lecturer on Chemistry in the Medical School, St. Thomas's Hospital. Author of numerous papers on Chemistry and Chemical Pharmacology, *e.g.*:—"The Action of Alkalis on the Nitroparaffins"; "The Physiological Action of the Paraffinic Nitrites" (Proc. Roy. Soc., 1891—the first of a series of papers in conjunction with Prof. Cash, F.R.S.); "Contributions to our Knowledge of the Aconite Alkaloids"; "The Occurrence of Skatole in the Vegetable Kingdom"; "The Constituents of the Artificial Salicylic Acid of Commerce and a method of producing the pure acid for medicinal use." Distinguished as an Investigator, and for the interest which he has taken in Educational Questions.

WILLIAM ELLIS,

F.R.A.S., F.R. Met. Soc., Memb. Inst. Elect. Eng., late President of Roy. Meteorol. Soc., Superintendent of the Magnetical and Meteorological Department, Royal Observatory, Greenwich. Connected with the Royal Observatory since 1841, and since 1875 has been Superintendent of the Magnetical and Meteorological Department. For eighteen years previously, in addition to astronomical work, had charge of the Chronometer and Time Signal Department. First showed how completely the long series of Greenwich magnetic observations confirmed the existence of sympathetic variation between solar spots and terrestrial magnetism, for horizontal force as well as for declination. Among other works, carried out, on the English side, the whole of the operations in the telegraphic determination of the longitude of Cairo, in which a submarine line of about 3000 miles in length was used in an unbroken circuit. His discussion of these operations is given in the British "Account of the Observations of the Transit of Venus, 1874." Applied the principle of the galvanic regulation of clocks to the regulation of a chronometer. Was formerly Observer in Durham University Observatory, his astronomical work during this time being published in the *Astronomische Nachrichten*, vols. xxxv., xxxvi., and xxxvii. Is the author of a paper in the *Phil. Trans.* "On the Relation between the Diurnal Range of Magnetic Declination and Horizontal Force, as observed at the Royal Observatory, Greenwich, 1841 to 1877, and the Period of Solar Spot Frequency." Also of papers in the *Memoirs* and *Monthly Notices* of the Roy. Astron. Soc., the *Quart. Journ. Roy. Meteorol. Soc.*, and other scientific journals.

J. COSSAR EWART, M.D.,

Professor of Natural History in the University of Edinburgh. An original investigator in various departments of Zoology and Comparative Anatomy. Author of valuable biological memoirs communicated to the Royal Society and to various scientific journals, his researches on the Locomotive System of the Echinodermata having been selected by the Council of the Royal Society as the subject of the Croonian Lecture of 1881. He was appointed in 1878 to the Chair of Natural History in the University of Aberdeen, and, subsequently, to the corresponding chair in the University of Edinburgh. This last post he now fills. He is a member of the Fishery Board of Scotland, and is at present engaged under the co-operation of the Board in important observations and experiments on the Natural History of the Herring. Author of:—"The Development of the Electric Organ of *Raia batis*"; "The Structure of the Electric Organ of *Raia circularis*"; "The Electric Organ of *Raia radiata*" (Phil. Trans., 1889); "The Structure, Relations, Progressive Development and Growth of the Electric Organ of the Skate" (*ibid.*, 1892; "The Cranial Nerves of Elasmobranch Fishes" (Trans. Roy. Soc., Edin.).

WILLIAM TENNANT GAIRDNER, M.D. (Edin.),

Hon. LL.D. (Edin.). F.R.C.P. (Edin.). Hon. M.D. (Dublin). F.K.Q.C.P. (Ireland), Physician in Ordinary to H.M. the Queen in Scotland. Professor of Medicine in the University of Glasgow. Since his graduation, in 1845, has made numerous contributions to the science of Medicine, more especially in the departments of Pathology, Public Health and Hygiene, and Clinical Medicine. He is generally recognised as one of the foremost physicians of his time, and his status in the profession is indicated by the fact that he has acted as President of the British Medical Association. For several years he acted as the first Medical Officer of Health for the city of Glasgow, and it is well known that the measures he then initiated for securing the health of the community soon materially lowered the death rate of the city, and have been largely adopted both at home and abroad. Dr. Gairdner has held the chair of Medicine in the University of Glasgow for thirty years, and he is distinguished as a teacher as well as an investigator into the phenomena of disease. Dr. Gairdner has published the following works:—(1) "Contributions to the Pathology of the Kidney" (1848); (2) "Pathological Anatomy of Bronchitis and on Bronchial Obstruction" (1850); (3) "Pathology of Pericarditis" (1860); (4) "Clinical Medicine" (1862); (5) "Public Health in Relation to Air and Water" (1862); (6) "Alcoholic Stimulants in Treatment of Fever" (1864); (7) "Study of Fever in Glasgow" (1865); (8) "On Articulate Speech and Aphasia" (1866); (9) "On Antipyretic Treatment of Specific Fever" (1878); (10) "Clinical Lectures" (1877); (11) "Angina Pectoris" in Reynolds's "System of Medicine" (1877); (12) "On the Physiognomy of Disease in Finlayson's Clinical Manual" (1878); (13) "On Insanity" (Morisonian Lectures, 1885); (14) "The Physician as a Naturalist" (1888); and many papers in medical journals, and in the transactions of pathological and medical societies.

ERNEST WILLIAM HOBSON,

D.Sc. (Cantab.). Fellow of Christ's College, Cambridge, and University Lecturer. Author of the following memoirs, paper and book:—"On a Class of Spherical Harmonics of Complex Degree with Applications to Physical Problems" (Trans. Camb. Phil. Soc., vol. xiv.); "Synthetical Solutions in the Conduction of Heat" (Proc. Lond. Math. Soc., vol. xix.); "Systems of Spherical Harmonics" (*ibid.*, vol. xxii.); "On Harmonic Functions for the Elliptic Cone" (*ibid.*, vol. xxiii.); "On a Radiation Problem" (Proc. Camb. Phil. Soc., vol. vi.); "On a Theorem in Differentiation and its Application to Spherical Harmonics" (read before the Lond. Math. Soc., and in the press); "On the Evaluation of a Certain Surface-Integral and its Application to the Expansion of the Potential of Ellipsoids" (read before the Lond. Math. Soc.); "On Fourier's Theorem" (*Messenger of Math.*, vol. xi.). Author of the article "Trigonometry," in the "Encyclopædia Britannica," Author of a treatise on "Trigonometry," including many of the higher developments.

SIR HENRY HOYLE HOWORTH,

Barrister-at-Law. Author of "A History of the Mongols, 4 vols., 1876-87; "The History of Chenghiz Khan and his

Ancestors," containing much information upon the Ethnography of Asia, &c., published in parts in "The Indian Antiquary," and about to be republished separately; "The Mammoth and the Flood," 8vo, pp. 464, 1887. Numerous papers on historical, antiquarian, anthropological, and geological subjects in Journ. Ethnolog. Soc., Journ. Anthrop. Inst. (Westerly Drifting of the Nomads, Ethnology of Germany, Spread of the Slaves, &c.), Journ. Roy. Asiat. Soc. (Northern Frontagers of China), International Congress of Orientalists, Historical Soc. (Early History and Movements of the Danes and Norsemen), Archæologia, Geological Magazine, &c. Distinguished for his literary and archæological attainments.

EDWIN TULLEY NEWTON,

F.G.S., F.Z.S. Palæontologist to the Geological Survey of England and Wales. For twenty-five years on the Staff of the Survey. Recipient of the Wollaston Donation Fund of the Geological Society, in 1884. Author of numerous papers on Palæontological and Biological Subjects, of which the following are some of the more important:—"On the Skull, Brain and Auditory Organ of a New Species of Pterosaurian (*Scaphognathus Purdoni*)" (Phil. Trans., 1888); "On a Gigantic Species of Bird (*Gastornis Klaassenii*) from the Lower Eocene" (Trans. Zool. Soc., 1886); twenty-six papers on "Cretaceous Fishes and Tertiary Vertebrata" (in *Quart. Journ. Geol. Soc.* and *Geol. Mag.*, 1876-90) "On the Structure of the Eye of the Lobster and on the Brain of the Cockroach" (*Quart. Journ. Micros. Sci.* 1873-79). Also the following Memoirs of the Geological Survey:—"The Chimœroid Fishes of the British Cretaceous Rocks" (1878); and "The Vertebrata of the Forest Bed Series of Norfolk and Suffolk."

CHARLES SCOTT SHERRINGTON,

M.B. (Camb.), M.A. Lecturer on Physiology, St. Thomas's Hospital. Author of the following and other papers:—"Secondary and Tertiary Degenerations in the Spinal Cord of the Dog" (*Journ. Physiol.*, 1885); "Degenerations in the Spinal Cord following Lesions of the Cortex Cerebri" (*ibid.*, 1889); "On two recently described Tracts in the Spinal Cord" ("Brain," 1886); "On Outlying Nerve Cells, in the Mammalian Spinal Cord" (Phil. Trans., 1890). Joint Author of the following, and other papers:—"Secondary Degeneration in the Spinal Cord of the Dog" (*Journ. Physiol.*, 1884); "Bilateral Descending Degeneration Fifty-two Days after Hæmorrhage in one Cerebral Hemisphere" ("Brain," 1886); "On the Formation of Scar Tissue" (*Journ. Physiol.* 1889); On the Regulation of the Blood Supply of the Brain" (*Journ. Physiol.* 1890); "The Influence of the Movements of the body upon the Capacity of the Cranio-Vertebral Canal" ("Brain," 1891).

EDWARD C. STIRLING,

M.D. (Camb.), M.A., F.R.C.S., C.M.Z.S., late President, Royal Society of South Australia, and Inter-colonial Medical Congress. Senior Surgeon, Adelaide Hospital. Lecturer on Physiology, University of Adelaide. Eminent for his researches in Physiology and Ethnology in South Australia. Formerly Assistant-Surgeon and Lecturer on Physiology, St. George's Hospital, London. For ten years Surgeon to the Adelaide Hospital, and now Senior Surgeon and Member of the Board of Management. For ten years Lecturer on Physiology and Member of the University Council of Adelaide. President of the First Inter-colonial Medical Congress, 1887; Vice-President of the Second, 1888. President of the Royal Society of South Australia, 1889; and of the Australian Branch of the British Medical Association in 1888. A member of the Legislative Assembly South Australia, 1883-86. First President and Organiser of the States Children Council. For seven years Hon. Director and Organiser of the South Australian Museum. Author of many papers in the St. George's Hospital Reports, Inter-colonial Congresses, the Transactions South Australian Branch Brit. Med. Assoc., Transactions of the Zoological Society, London, and Royal Society of South Australia. Discoverer of a new genus and Species of Marsupialia, *Notoryctes Typhlops*, and other species, during a journey from the north to the south of the Australian Continent, in company with His Excellency the Earl of Kintore, Governor of South Australia.

JOHN ISAAC THORNYCROFT,

M.Inst.C.E. Member of Council of the Institution of Naval Architects. Author of several papers connected with Science, as: "On the Resistance opposed by Water to the motion of Vessels of Various Forms, and on the way in which this varies with the velocity" (1869); "On the Efficiency of Guide-blade Propellors" (1883); "On the most suitable Propellor for Shallow Draughts" (1885); "On Shallow-draught Screw-steamers" (1885); "On Torpedo-boats and Light Yachts" (8vo, pp. 94, with five large diagrams, 1881). A distinguished engineer and naval architect, also most successful as a scientific naval architect in the construction of torpedo-boats, having a minimum of weight and a maximum of power and speed. Attached to science and anxious to promote its progress.

JAMES WILLIAM HELENUS TRAIL,

M.D., A.M., C.M. (Aberdeen). Regius Professor of Botany (since 1877) in the University of Aberdeen. Corresp. K.-K Zool.-Botan. Gesell., Vienna, and Soc. Nat. Sci. et Math., Cherbourg. Made, in 1874, important botanical collections in the Valley of the Amazon, in North Brazil. Author of a paper on the Palms collected on the occasion (Journ. of Bot., 1876); of a "Revision of Scottish *Discomycetes*" (Scottish Naturalist, N.S., iv., 1889); of a paper on the Gall-making Diptera of Scotland (*ibid.*, 1888), and of numerous others.

ALFRED RUSSEL WALLACE,

LL.D., D.C.L., F.L.S., F.Z.S. Author of a paper "On the Tendency of Varieties to depart indefinitely from the Original Type" (Journ. Linn. Soc., iii., 1859, Zoology), and numerous other writings.

ARTHUR MASON WORTHINGTON,

M.A., F.R.A.S. Head Master and Professor of Physics, Royal Naval Engineering College, Devonport. Distinguished as a physicist, especially for his researches on surface tension and on the stretching of liquids. Author of the following papers:—"On the Forms assumed by Drops of Liquid falling Vertically on a Horizontal Plate" (Proc. Roy. Soc., 1876–77); "On the Spontaneous Segmentation of a Liquid Annulus" (*ibid.*, 1879); "On Pendent Drops" (*ibid.*, 1881); "On Impact with a Liquid Surface" (*ibid.*, 1882); "On the Horizontal Motion of Floating Bodies under the Action of Capillary Forces" (Phil. Mag., 1883); "On the Surface Forces in Fluids" (*ibid.*, 1884), "On the Error involved in Prof. Quincke's Method of Calculating Surface Tensions from the Dimensions of Flat Drops and Bubbles" (*ibid.*, 1885); "A Capillary Multiplier" (*ibid.*); "On Tensional Stress and Strain within a Liquid" (Brit. Assoc. Sect. A., 1888): "On the Discharge of Electrification by Flames" (Brit. Assoc., Rept. Electrolysis Comm., 1889); "On the Mechanical Stretching of Liquids, an Experimental Determination of the Volume-Extensibility of Ethyl Alcohol" (read before the Roy. Soc. Feb. 4, 1892). Also of the following:—"Physical Laboratory Practice," and "The Dynamics of Rotation."

SYDNEY YOUNG,

D.Sc. (Lond.). Professor of Chemistry, University College, Bristol. Well known as a scientific chemist. Author of numerous papers on Organic and Inorganic Chemistry, and on the border-land of Physics and Chemistry. Among these are:—"Alkyl Fluorides;" "Ethyl valerolactone;" "Vapour Pressures and Specific Volumes of Halogen Compounds in relation to the Periodic Law;" "A New Method of determining Specific Volumes of Liquids and Saturated Vapours;" "The Molecular Volumes of the Saturated Vapours of Benzene, and of its Halogen Derivatives." Dr. Young is also the joint author of numerous memoirs on the thermal properties of liquids, and allied subjects, several of which have appeared in full in the Philosophical Transactions. During the last five years Dr. Young has published the following papers on chemical and physical subjects:—Preparation of Dibenzyl Ketone; Vapour-Pressures of Quinoline, Dibenzyl Ketone, and Mercury; Exact Thermometry; The Volatilisation of Ice; A Thermometer for Lecture Purposes; Relations between Boiling-Points, Molecular Volumes, and Chemical Characters of Liquids; Vapour-Pressures and Molecular Volumes of Acetic Acid, Carbon Tetra-Chloride, and Stannic Chloride; Relations between "Corresponding" Temperatures, Pressures, and Volumes of Liquids and Vapours. The last item of the series of joint papers with Professor Ramsay—"A Study of the Thermal Properties of Water and Steam"—has been published in the Philosophical Transactions. Dr. Young is also the author of the articles on "Distillation," "Sublimation," and "Thermometry" in Thorpe's "Dictionary of Applied Chemistry."

NOTES.

MR. CHARLES CHREE, Fellow of King's College, Cambridge, has been selected to fill the important office of Superintendent to the Kew Observatory. It is one for which the combination of high mathematical capacity with a practical experience of the apparatus and methods of physical research is especially needed. Mr. Chree obtained in 1884 the hitherto unequalled honour of a first class in the most advanced parts both of the Mathematical and of the Natural Science Triposes, and he has since been much engaged at Cambridge in experimental and mathematical investigations. The results of these are published in the *Cambridge Philosophical Journal*, and in the "Philosophical Transactions" of the Royal Society.

THE "James Forrest" lecture will be delivered at the Institution of Civil Engineers this evening by Mr. William Anderson, F.R.S. The subject is the interdependence of abstract science and engineering.

SIR W. H. FLOWER, F.R.S., will preside over the fourth annual meeting of the Museums' Association, which will be held in London in July. The meeting, which will last for several days, will begin on Monday, July 3.

AT the meeting of the Victoria Institute on Monday a paper by Prof. Maspero was read in the author's absence by Mr. T. G. Pinches, of the British Museum. The paper embodied the results of Prof. Maspero's investigations during the past ten years as regards the places in Southern Palestine claimed, according to the Karnac records, to have been captured by the Egyptians in the campaign under Sheshonq (Shishak) against Rehoboam.

THE report of the Council of the City and Guilds of London Institute has just been published. We are glad to note that they are "able again to point to steady and continued development in each branch of the Institute's work, as shown by the statistics of their colleges, and—what is more satisfactory—by the positions taken by their students, as the result, to a large extent, of the instruction provided."

THE tercentenary of the foundation of the Botanic Garden of Montpellier will be celebrated by *fêtes* from the 20th to the 28th of May, when the Botanical Society of France will hold its special annual session in the town. The botanists of Montpellier offer hospitality to foreign botanists who may desire to attend the *fêtes*.

SINCE the death of Dr. Prantl the editorship of the cryptogamic bi-monthly *Hedwigia* has been undertaken by Dr. G. Hieronymus, Herr P. Hennings, and Dr. G. Lindau.

UNDER the auspices of the Imperial Academy of Sciences in Vienna, Dr. E. v. Halácsy, and Prof. Hilber have undertaken a botanical and geological investigation of Mt. Pindus in Thessaly in the course of the present year.

PROF. MARTIN, on account of his serious and prolonged ill-health, has tendered his resignation of the professorship of biology, which he has held in the Johns Hopkins University since 1876.

A NEW journal of experimental and theoretical physics, called *The Physical Review*, and conducted by Edward L. Nichols and Ernest Merritt, will be published for the Cornell University by Messrs. Macmillan and Co., New York and London. The first number will appear on July 1. The new journal will be issued bi-monthly, and each number will consist of at least sixty-four pages. It will be devoted to the promotion of original work in physics.

THE Camera Club has issued a "Conference Number" of its Journal, in which an account is given of the proceedings of the Photographic Conference, held lately at the Society of Arts.

SINCE our last issue the temperature has appreciably decreased over these islands; the maxima have only reached 70° occasionally in the southern and central parts of England, while in all other districts the thermometer has seldom risen above 60°. Up to Tuesday, the 2nd inst., the rainfall had only been slight, the greater part being confined to the northern and western parts of the country, where small amounts have been of frequent occurrence. The recent drought has been probably unprecedented in some parts; at places on the south coast no rain had fallen for forty-five days, while in the neighbourhood of London there were thirty days without rain. The type of weather has recently undergone an entire change; cyclonic disturbances formed in and near our islands, while the anticyclonic conditions temporarily disappeared. With this change in the distribution of atmospheric pressure, the northerly and easterly winds gave place to those from westerly and southerly directions, unsettled and showery weather became general over the whole country, and the softer quality of the air was very perceptible. Notwithstanding the decrease of temperature, the *Weekly Weather Report* of April 29 showed that it was above the mean in all districts, the excess varying from 3° to 5° in the north and west, to 6° or 7° in most parts of England. The rainfall for the week was, of course, less than the mean in all districts, while bright sunshine was very prevalent over the entire kingdom; in the Channel Islands the percentage of possible duration was as high as 81, and in all districts it greatly exceeded the average.

DR. PAUL SCHREIBER has communicated to the *Meteorologische Zeitschrift* for April an account of some extraordinary snowballs which fell at Glashutte, in Saxony, on December 4 last. After a storm which had lasted ten minutes, a calm suddenly occurred, and light balls of snow measuring from four to five inches began to fall. The balls lay on the ground until the next day, there being from five to twelve of them to a square yard. Dr. Schreiber thinks that the phenomenon was of an electrical origin, as the preceding disturbance seemed to point to a thunderstorm.

PROF. HELLMANN, to whom meteorologists are so much indebted for many laborious investigations into the history of old observations and instruments, has recently made an important addition to early meteorological literature by the publication of *Das älteste Berliner Wetter-Buch*, containing observations made in Berlin in 1700–1701, by Gottfried Kirch and his wife, being the first part of a manuscript of over 1000 quarto pages. During the preparation of Dr. Hellmann's valuable work on the climate of Berlin he had made constant search for these observations, which were known to have been in Berlin about fifty years ago, and he at last discovered them, strangely enough, in the Crawford Library at the Edinburgh University. It is well known that Lord Crawford (then Lord Lindsay) took an interest in collecting works on comets, and these old manuscripts contained a number of such observations, in addition to meteorological data. Dr. Hellmann's account of the search for, and the discovery of, the manuscript, and of the antecedents of the Kirch family, is exceedingly interesting.

IN the *Annales* of the French Meteorological Office, recently published for the year 1890, M. Angot has discussed the observations taken simultaneously during that year at the Central Meteorological Office and on the Eiffel tower, and has arrived at some interesting results respecting the variation with height of the several meteorological elements. The reduced barometric pressure was lower every month on the tower than on the ground, the probable cause being the great difference in the velocity of the wind at the two stations. The observations made at the three stations on the tower allow of the variations of temperature with altitude being studied with great detail, and it was found that the rate of diminution was far from being proportional to the height above the ground. In all months, at the middle of the night-time, the temperature increased with altitude, the maximum difference occurring at a mean height of about 500 feet, it then decreased at first slowly, and afterwards more rapidly; at about 1000 feet the mean rate of decrease already amounted to 1°·4 per 100 metres (328 feet) During the middle of the day-time the decrease of temperature with height above 500 feet is nearly uniform in all months, being about 1°·6 for each 100 metres. Between 500 feet and the ground, however, the decrease showed a marked annual variation; during the cold season the difference was less than that observed at the higher level, while in the hot season it was much greater. The diurnal variation of vapour tension at the summit of the tower exhibited entirely different characteristics from those near the ground; generally speaking, there was only one maximum, near noon, and one minimum, between the evening and midnight. During all months the vapour tension was less at the top of the tower than near the ground. The diurnal variation of the wind exhibited a marked minimum at the top of the tower during the day-time, and a maximum at night, being the reverse of what is observed at ground stations.

THE Board of Agriculture has issued a valuable report on rust or mildew on wheat plants. It contains a complete account of the life-history of the fungus of ordinary mildew, *Puccinia graminis*, as well as of that of spring-rust and mildew, *Puccinia rubigo vera*, with a discussion of the conditions favourable for their propagation, and the best means of averting them. It is illustrated by some excellent coloured plates by Mr. Worthington Smith.

RATHER less than three years ago (NATURE, vol. xlii. p. 297) we had to record the death of Mr. W. K. Parker, and in doing so we gave some account of the main facts of his career. An excellent little biographical sketch of him by his son, T. Jeffrey Parker, has just been published by Messrs. Macmillan and Co. In an introductory letter Prof. Huxley speaks of the volume as one which "gives a presentation as accurate as it is vivid, of a man of noble and lovable character, endowed with intellectual powers of a very unusual order." Prof. Huxley says he has "never met with another such combination of minute accuracy in observation and boundless memory for details, with a vagrancy of imagination which absolutely rioted in the scenting out of subtle and often far-fetched analogies." "The genius of an artist struggled with that of a philosopher, and not unfrequently the latter got the worst of the contest."

AT the instance of some Russian meteorologists, who have frequent occasion to measure very low temperatures, M. Chappuis lately undertook a study of the spirit thermometer (*Arch. de Sciences*). He traces its anomalies to three sources. (1) Adhesion of the liquid to the walls of the capillary tube. When the instrument is brought from ordinary temperature to a lower, the sinking column leaves liquid on the tube, which for hours, and even days, continues slowly descending. (2) Irregular expansion of the spirit with the temperature. As the expansion increases with heating, the graduation should be made to correspond, the degrees for higher temperatures being longer (which is not usually the case). (3) Impurities in the spirit, and varying water-content, which affect expansion materially. M. Chappuis recognises the difficulty of getting rid of these faults, and concludes that alcohol is not to be recommended as a liquid for thermometers marking low temperatures. On the other hand, it has been shown that toluol (with a boiling point of about 110° C.) is a liquid well adapted for the purpose and free from the disadvantages referred to.

LAKE MEMPHRAMAGOG—the Loch Lomond of Canada—lies partly in the State of Vermont, but belongs to the St. Lawrence hydrographic system. It is thirty miles long, and varies from one to four miles in breadth. It lies in the lap of high hills, and is a deep-water lake, soundings in one locality indicating depths, it is claimed, of 600 ft. Mr. A. T. Drummond writes to us that from readings taken on August 10 last, at 11 a.m., under a strong sun and cloudless sky, two facts appear to be established:—(1) that Lake Memphramagog is a cold-water lake whose bottom temperatures are in August as low as 44°·75 Fahr.; (2) that the high surface temperature is only maintained for relatively a few feet, beneath which the mercury falls rapidly towards the lowest reading. There is a decided surface current at the southern end, arising from the inflowing streams there, and it is suggestive the warm waters from these streams flow, river-like, over the colder waters of the lake, just as the Gulf Stream, under a different influence, but lightly skims the surface of such a large portion of the broad Atlantic Ocean. Whilst the thermometer at twelve fathoms registered 51°, the waters of Lake Ontario, at their outlet into the St. Lawrence indicated at the same depth, and at about the same period, 67°.

THE green colour in certain oysters, localised in the gills and palps, and lost under certain conditions, is known to be due to an insoluble pigment introduced by a diatom on which the oysters feed. It has been shown lately by M. Pelseneer, of Ghent (*Rev. Sci.*), that a process of "phagocytosis" here occurs. The pigmentary granulations are an injurious product in the blood; and they are devoured by the blood corpuscles, which, thus charged, pass into the gills and palps, where the blood is separated from the outer water by a mere thin layer of epithelium. The corpuscles penetrate between the epithelial cells, where some are destroyed, and some pass right through and escape. It is thus explained how green oysters placed in water without the diatom referred to lose their colour very quickly (in thirty-six hours at most), the charged corpuscles being rapidly eliminated.

THE success of the luminous fountains at the Paris Exhibition of 1889 suggested to M. Trouvé the idea of producing the effects on a small scale and cheaply. Several forms of this small fountain are described in the *Bulletin de la Société d'Encouragement*. Instead of illuminating the water jets by lateral mirrors, M. Trouvé lights up with an incandescent lamp at the focus of a parabolic mirror a sort of inverted glass with apertures for the liquid. M. Trouvé also here describes his method of imitating lightning at one of the Paris theatres. Instead of flashing lycopodium powder behind a broken line cut in the scenery (the old plan), a long bamboo or other flexible rod is used, having a small incandescent lamp of great brilliancy at the end, with a foot commutator, enabling one to make or break the circuit at will. The rod is moved quickly down in a zigzag direction at the proper moment. The sound of the wind in a storm is imitated by means of a double-action pump and two sirens; and that of hail by throwing coarse sand against an osier screen.

A SIMPLE optical photometer, serving also to measure the degree of visual power, has been devised by Dr. Simonoff

(*Moniteur de la Photogr.*). A series of twenty-four pages is arranged, the first having a clear grey tint, the second one of double intensity, and so on to the twenty-fourth, the tint of which is nearly black, being twenty-four times more intense than that of page 1. On each page are printed a few phrases in black letters of different sizes. In a badly lit room one may estimate the amount of illumination by turning over the leaves of this little book, held about a foot from the eyes, until one can no longer read the line of letters of a selected size. With good illumination you may proceed to the twentieth or twenty-fourth page, but with poorer light you may be stopped at the tenth, or twelfth, or fifteenth. The instrument is for indoor use exclusively. In schools it might prove useful in testing the vision of children.

A PERIODICAL which will show what natives of India can do in some branches of science has been started in Bombay. It is called *The Indian Medico-Chirurgical Review*, and is edited by N. A. Choksy. We have received the third number, in which several native writers record the results of original observation, while there are many good notes on work being done in Europe. In one article the *Review* urges the necessity for the establishment of a teaching university in Bombay. As the teaching of law, medicine, and science in the presidency is practically located in the city of Bombay, and hence in touch with the existing examining University, a few professorships might, the *Review* thinks, be endowed, and eminent men invited from Europe to occupy the new chairs. The *Review* also suggests that the Government might with advantage "copy the system of the German Universities by establishing biological, physiological, pathological, bacteriological, and hygienic institutes, in connection with these professorships, and place over them professors who would go on teaching and at the same time carry on original researches."

IN the report of the Geological Survey of India for 1892 reference is made to Dr. Noetling's visit to the amber and jade mines of Upper Burma—a visit which was rendered possible by the starting of the Maingkwan column. The so-called amber turns out to be a new variety of this form of fossil resin, to which the name of Burmite has been assigned by Dr. Noetling in conjunction with Dr. Otto Helm (a distinguished authority in this line) of Danzig, to whom specimens were forwarded. The peculiarity of Burmite is a fluorescence, giving the mineral an appearance as of solidified kerosine oil: and, as far as has yet been seen, it is of darker colours than is usual with amber proper (succinite); while it is a little harder than the latter. The colour alone is, according to the present fashion in Europe, against the mineral, but some of the darker varieties of brown red colour, present on being cut deeply *en cabochon*, the flat or under face being turned to the observer, a really gorgeous ruby tint which should make the stone desirable ornamentally. The so-called jade—for the actual constitution of the mineral as worked in Burma determines it properly as *jadeite*—is worked by pit and quarry mines, the former for forty miles along the bank of the Uru river southwards from Sankha, while the latter are excavated on the top of a plateau at Tammaw, eight miles out of Sankha, in the Mogoung subdivision. The industry seems to be a thriving one, and rather promising for future more systematic and skilled development, for at least 500 men are engaged every season in working the quarries. White is the commonest colour, the green varieties being of much rarer occurrence; while, in some of the fewer boulders obtained from the laterite beds along the course of the Uru river, a "red jade" appears to have been produced by ferruginous decomposition change.

THERE are two stations in Italy for the economic investigation of the diseases of plants; one at Pavia, established in 1871 in connection with the Botanical Institute of the Royal University, and now under the directorship of Prof. Briosi; the other at Rome, established in 1887, and presided over by Prof. Cuboni. They are required to investigate the nature and cause of diseases, to test and provide remedies, and to disseminate information by lectures and publications. As might be expected, the diseases of the vine and of the olive occupy a large share of their attention.

PROF. V. DVORAK, of Agram, uses a very simple apparatus for demonstrating the oscillation of the air in sound phenomena. In an ordinary resonating sphere the short neck is replaced by a small metal plate with a conical hole opening inwards, its shortest diameter being about 2 mm. When the resonator sounds, the passage of air through the hole is strong enough to extinguish a lighted match. If a small paper wheel resembling a water-wheel is placed a little below the opening and the resonator stands about 3 cm. in front of a wall, the blowing of a horn, or the singing of the proper note, is capable of setting the wheel in rapid rotation. A very serviceable lecture apparatus for measuring the intensity of sound is illustrated in the *Zeitschrift für Physikalischen Unterricht*. A narrow glass tube bent at a very obtuse angle is half filled with alcohol. One end of the tube has a conical opening, and this is placed at a distance of 0·5 cm. from the opening of the resonator described. The whole is mounted on a board capable of adjustment to any angle. The puffs emitted from the resonator when responding to a sound affect the level of the alcohol, and the displacements are read off on a scale attached to the tube, projected, if necessary, on to a screen. Another effect of sound easily observed is that of repulsion. A light resonator of the ordinary construction is floated on water, its axis being kept horizontal by means of an attached piece of wire. On blowing the horn, the sphere will float in the direction opposite to that in which the neck is pointed. To produce continuous rotation, four resonators are attached to a light cross of wood turning on a needle point, or one resonator with four bent necks is suspended by a thread. If this acoustical reaction wheel is placed in one corner of the lecture theatre, it can be set rotating from the opposite corner by a strong tuning fork, or even by singing through a conical tube.

AT the recent exhibition of the Société Française de Physique, M. Hurmuzescu showed the following experiment:—A metallic wire, through which a continuous current is passed, is stretched horizontally in a glass tube containing gas either at the ordinary atmospheric pressure or rarefied. As soon as the wire becomes red-hot it begins to vibrate in a vertical plane, and the containing tube becomes much hotter at the bottom than at the sides. This effect has not been satisfactorily explained by its discoverer.

M. CLAUDE showed at the same exhibition an instrument for measuring the difference in phase between the current in a circuit and the impressed electromotive force. The principle of the instrument is as follows:—When a piece of soft iron, fixed to the end of a spring, is placed before the pole of an electromagnet having a permanently magnetised core and traversed by an alternating current, it is attracted and vibrates with the same period as the current. If the spring also carries a mirror from which a ray of light is reflected on to a scale, the length of the band of light produced will be proportional to the maximum displacement of the mirror. Two such electromagnets are used, acting on the piece of soft iron in opposite directions, and at such distances that they produce the same maximum deflection, one magnet being placed in series with the circuit, and the other joined to the ends of a non-inductive resistance. Under these conditions the length of the band of light is proportional to the cosine of half the angle of lag.

An interesting note by M. Birkeland appears in the *Comptes Rendus* for April 17 on the reflection of electrical waves at the extremity of a linear conductor. By an application of Prof. Poynting's theorem concerning the movement of the energy in an electromagnetic field to the case of a Hertzian oscillator, he has shown how the damping of the oscillations depends on the nature and position of the conductors in the neighbourhood. He also accounts for the fact that, when the distance between the first stationary node and the end of a wire is determined by means of a secondary circuit, the value found is smaller than that obtained by a direct measurement of the potential along the wire, by showing that the paths along which the magnetic energy travels are extended beyond the end of the wire, so that the wave has, so to speak, to make a detour round the end of the wire, and is thus retarded.

An important new series of compounds, the thionylamines, in which two new hydrogen atoms of the amido group of the primary amines are replaced by the radicle thionyl SO, have been prepared by Prof. Michaelis, and are described in the current number of *Liebig's Annalen*. It has been found that the primary amines of the fatty series when dissolved in ether react with thionyl chloride, $SOCl_2$, in a manner which is readily controlled by extraneous cooling of the vessel in which the reaction is conducted. The products are the hydrochloride of the amine employed which separates in crystals, and the new liquid thionylamine which remains dissolved in the ether, but can readily be isolated by fractional distillation. Thionyl chloride is incapable of acting upon the hydrochlorides of the amines of the fatty series, hence three molecular equivalents of the amine are required for every equivalent of thionyl chloride, according to the following equation in the case of methylamine:—$SOCl_2 + 3(CH_3.NH_2) = CH_3.N:SO + 2(CH_3NH_2.HCl)$. The thionylamines of this series are colourless fuming liquids which boil without decomposition and emit a most powerful odour. They are decomposed by water into the original amines and sulphur dioxide. The amines of the aromatic series likewise form thionylamines with thionyl chloride; and the hydrochlorides, unlike those of the fatty series, react with equal facility in accordance with the equation $C_6H_5NH_2.HCl + SOCl_2 = C_6H_5N:SO + 3HCl$. It is only necessary to cover the powdered hydrochloride of aniline with benzene, add the calculated quantity of thionyl chloride, and warm over a water bath for a short time. The lower members of the aromatic thionylamines are yellow liquids which distil without decomposition; the higher members may likewise be distilled without loss under diminished pressure. Alkalies convert them into the original amines and a sulphite, $C_6H_5N:SO + 2NaOH = C_6H_5NH_2 + Na_2SO_3$.

Thionyl-methylamine, $CH_3N:SO$, the first member of the series, is most conveniently prepared by reacting with methylamine upon a solution of thionylaniline in toluene. The latter is first prepared and cooled by a freezing mixture; the methylamine should likewise be maintained at as low a temperature as possible until the moment of adding it to the solution of thionylaniline. After agitation and standing for some time the product of the reaction may be distilled, when thionylmethylamine is obtained as a colourless fuming liquid boiling at 58–59°. Its odour is not unlike that of bleaching powder. Thionyl-ethylamine, $C_2H_5N:SO$, may be readily obtained by mixing cooled ethereal solutions of thionyl chloride and ethylamine. The reaction even at this low temperature is very violent, occurring with hissing and the evolution of white fumes as each drop of the dilute ethereal solution of thionyl chloride falls into the solution of ethylamine. Ethereal solutions of thionylaniline and ethylamine afford a better yield, and with less admixed impurity. Thionyl-ethylamine boils at 73°, and in properties closely resembles thionyl-methylamine. Several of the higher members of this and of the aromatic series have been prepared by Prof. Michaelis, and are fully described in his lengthy memoir. It is interesting that in presence of the moisture of the air, or of a small quantity of added water, the thionylamines are converted into compounds of the amines with sulphur dioxide. Those of the aromatic series usually consist of two molecules of the original amine with one molecule of sulphur dioxide. The first few members of the fatty series form compounds consisting of equal molecules of the amine and sulphur dioxide, and the higher members appear capable of forming both classes of compounds.

During the Easter vacation the Port Erin Biological station has been full. The Liverpool Marine Biological Committee organised a dredging expedition, and the steamer *Lady Loch* was hired for some days, during which a trip was made to the deep water lying west of the Isle of Man, and the shallower ground round the Calf Island and off Spanish Head was also explored. On one of the days the calm sea and low tide enabled the wonderful caves near Spanish Head to be visited in a boat from the steamer. The exposed sides, parts of the roof, and as far down as can be seen in the clear water, are closely covered with rounded red ascidians adhering together in masses, black and white sponges, and tufts of *Tubularia*, forming altogether a most striking sight. The sponges are mostly *Pachymatisma johnstoni*, and the ascidians are Alder's *Polycarpa glomerata*, a somewhat variable species solitary specimens of which have been sometimes referred to *Styela rustica* (a species which probably does not occur at all in British seas). Amongst the more noteworthy animals obtained on these recent dredging expeditions were *Virgularia mirabilis*, *Corynactis viridis*, *Depastrum cyathiforme*, *Amphiura chiajii*, *Palmipes placenta*, *Porania pulvillus*, *Stichaster roseus*, *Luidia ciliaris*, *Brissopsis lyrifera*, *Thyone fusus* and *T. raphanus*, *Hyalinœcia tubicola*, *Calocaris macandrewœ*, *Pasiphœa sivado*, *Xantho tuberculatus*, *Ebalia tuberosa* and *E. tumefacta*, *Hippolyte spinus*, a new species of *Metopa*, *Munida* sp., *Isocardia cor*, *Lyonsia norvegica*, *Spirialis retroversus*, *Fissurella grœca*, *Capulus hungaricus*, *Pleurobranchus plumula*, *Lamellaria perspicua*, *Dendronotus arborescens*, *Tritonia hombergi*, *Eolis tricolor*, *Eolis angulata*, *Actœonia corrugata*, *Scaphander lignarius*, and a new species of the compound ascidian *Glossophorum*, allied to *G. humile*, Lahille, but differing in the colour of the colony and also in minute structure. Prof. Brady and Mr. Thompson obtained a number of interesting Copepoda, including a new *Dactylopus*, and a new and very large *Lichomolgus*, which is found inhabiting *Pecten maximus*, just as *L. agilis* inhabits the common cockle. Since the L. M. B. C. Easter dredging party left Port Erin the following have been working at the station:—Prof. M. C. Potter, Prof. F. E. Weiss, Mr. W. J. Beaumont, Mr. E. T. Browne, and Mr. J. H. Vanstone. Another dredging expedition will be organised for the Whitsuntide vacation.

Notes from the Marine Biological Station, Plymouth.—Last week's captures include the rare Polyclad *Prostheceræus vittatus* and Macruran *Gebia stellata*, and a remarkable haul of the Nudibranch *Hero formosa* whose first capture on our southern coasts was recorded a few weeks ago. The investigation of the floating fauna is much impeded by the continued abundance of gelatinous algæ, which clog the meshes of the townets at all depths. The Leptomedusa *Irene pellucida* is still fairly common, and the pelagic larvæ of *Cereanthus* (*arachnactis*) have now reached a high grade of development. The following animals are now breeding:—The Hydroids *Clava multicornis*, *Gonothyrœa Loveni*, *Sertularia pumila* and *Plumularia pinnata*; the Nemertine *Cephalothrix bioculata*; and the Decapod Crustacea *Eupagurus bernhardus* and *Portunus pusillus*.

THE additions to the Zoological Society's Gardens during the past week include a Crowned Gibbon (*Hylobates pileatus*, ♀) from Borneo, presented by Mr. Leicester P. Beaufort; a Bengalese Cat (*Felis bengalensis*) from India, presented by Captain F. Whistler; a White-bellied Hedgehog (*Erinaceus albiventris*) from Somaliland, presented by Mr. H. W. Seton-Karr, F.Z.S.; five Weasels (*Mustela vulgaris*) British, presented by Mr. George Long; a Festive Amazon (*Chrysotis festiva*) from Guiana, presented by Mrs. Hills; a Chinese Lark (*Melanocorypha mongolica*) from China, presented by Mrs. Pollard; two Serin Finches (*Serinus hortulanus*) from south-west Spain, presented by Mr. J. A. Crawford, F.Z.S.; an Undulated Grass Parrakeet (*Melopsittacus undulatus*) from Australia, presented by Mast. W. D. Savory; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, presented by Mr. E. P. Ramsay; two Hawfinches (*Coccothraustes vulgaris*) British, presented by Mr. A. Klosz; a Magpie Tanager (*Cissopis leveriana*) from south-east Brazil, presented by Mr. H. A. Astlett; two Great Cyclodus (*Cyclodus gigas*) from Australia, presented by Captain Clarke; a Common Viper (*Vipera berus*) British, presented by Mr. Briton Rivière, R.A., F.Z.S.; a Poë Honey-Eater (*Prosthemadera novæ-zealandiæ*) from New Zealand, a Malabar Green Bulbul (*Phyllornis aurifrons*), a Red-eared Bulbul (*Pycnonotus jocosus*) from India, a Cape Coly (*Colius capensis*), two Derbian Zonures (*Zonurus derbianus*) from South Africa, two American Blue Birds (*Sialia wilsoni*) from North America, two Great Eagle Owls (*Bubo maximus*) European, deposited; two Black-necked Swans (*Cygnus nigricollis*, ♂ ♀) from Antarctic America, two Madagascar Love-birds (*Agapornis cana*, ♂ ♀) from Madagascar, a Red-sided Eclectus (*Eclectus pectoralis*, ♂) from New Guinea, purchased; a Red Kangaroo (*Macropus rufus*, ♂) a Great Wallaroo (*Macropus robustus*, ♂), seven Satin Bower Birds (*Ptilonorhynchus violaceus*) from Australia, two Maugés Dasyures [(*Dasyurus maugæi*, ♂ ♂), a King Parrakeet (*Aprosmictus scapulatus*), two Diamond Snakes (*Morelia spilotes*), a Water Lizard (*Physignathus lesueuri*) from New South Wales, received in exchange.

OUR ASTRONOMICAL COLUMN.

SOUTH POLAR CAP OF MARS.—During the opposition of Mars in 1892 Prof. George Comstock made a series of determinations of the position angles of the south polar cap of Mars, of its angular extent, and of its polar and equatorial diameter. In the first-mentioned measurements he placed the micrometer thread tangent to the planet's disc, and so rotated it that it was symmetrically situated about the point of tangency; one observation included five settings of this kind, with a determination of the parallel from a neighbouring star, and for the majority of the observations these measurements were made both with telescope east and west. The angular dimensions of the caps were measured by placing the thread tangential to the disc of the planet at the extremities of the cap. The coordinates of the centre of the spot, where θ represents the areographical longitude and λ the south polar distance, together with the diameter of the cap and the adopted corrections to the position angle of the axis of Mars as given by Marth's ephemeris, may be gathered from the following table:—

1892.	Diam. of Cap.	λ	θ	Ephem.
	°	°	°	°
July 26	44	0·47	341	−2·26
Aug. 18	35	2·95	311	−3·06
Sept. 19	22	2·95	336	−2·66

Prof. Campbell finds the correction to the position angles, as given by Marth's ephemeris as −0°·16, while Prof. Hall's correction amounts to +1°·24, both of which vary considerably from the values given above. These differences, as Prof. Comstock points out, may arise from the systematic errors affecting the three methods employed.

The measures of the diameter as made at opposition were as follows:—

Date.	Eq. diam.	Polar diam.
	″	″
Aug. 5	26·06	25·19
,, 6	25·80	25·36
,, 7	26·25	25·67

THE BRIGHTNESS OF THE MAJOR AND MINOR PLANETS.—The latest publication issued from the Astrophysical Observatory at Potsdam (No. 30) contains all Dr. G. Müller's determinations of the brightnesses of both the major and some of the minor planets. These observations extend over a period of about eight years, but the majority were made during the years 1883–85. The first chapter is devoted to a tabulation of the different stars used throughout the work for purposes of comparison. In the second are brought together all the planetary observations, while the third consists of a discussion of the whole number of observations, each planet being independently treated. To state briefly some of the results that these determinations have brought to light we may say: (*a*) That with the exception of the planets Jupiter, Uranus, and Neptune, the variations in brightness are found to be directly dependent on the phase differences, which can be plotted out in simple curves. (*b*) That from the observations of each planet the "Lichtschwankungen" accord with no theory, and that near opposition the variations in brightness are found to be larger than those which should be the case as regards the theoretical values. (*c*) The form of the light curves, when one expresses the brightnesses in stellar magnitudes, approaches very nearly, except in the case of Venus, a straight line, and the variations in magnitude are also very nearly proportional to the corresponding phase-differences. (*d*) The observations give no indication of the dependency of the "Lichtstärke" on the rotation of the planets. And lastly (*e*) that by taking series of observations of the largest planets, obtaining the mean values from different years, differences are found which, as Dr. Müller says, cannot be due to the inaccuracy of the measures or to the fact that the same instruments were not always used. The following table shows clearly the relative brightnesses that result from the above determinations:—

Name of Planet.	Brightness. Distance 1.	App. radius. Distance 1.	Reduced Brightness.	Relative Albedo.	Zöllner's Albedo.
		″			
Mercury	−0·003	3·23	−0·808	0·64	0·43
Venus	−4·004	8·78	−2·638	3·44	2·33
Mars	−1·297	4·68	−1·297	1·00	1·00
Jupiter	−8·932	94·23	−2·412	2·79	2·34
Saturn	−8·685	77·63	−2·586	3·28	1·87
Uranus	−6·858	36·67	−2·388	2·73	2·40
Neptune	−7·053	43·15	−2·229	2·36	1·74

METEOR SHOWERS.—Of the important meteor showers which occur during the present month that which occurs on the sixth exceeds all others in brilliancy. On the evening before and after this date there are also two other showers, but they are much fainter. The positions of the radiant points are, according to Mr. Denning:—

Date.	Radiant. R.A.	Radiant. Decl.	Meteors.
		°	
May 5	254	−21	Slowish
,, 6	338	−2	Swift; streaks
,, 7	224	+7	Slow; bright

ASTRONOMY POPULARISED IN AMERICA.—There seems to be no doubt that the interest taken in astronomy in America is rapidly on the increase, and the demands for large telescopes there have played no small part in helping to stir up in many minds the desire for enlightenment in this fascinating science. Increase in the number of students and amateurs, and rapidly growing demands for small telescopes are signs that cannot be misconstrued, indicating as they do the vast interest that even to-day is shown in the oldest of sciences. To satisfy and further these favourable omens, or in other words to bring together those who can instruct into close relations with those who are to be instructed, the editors of *Astronomy and Astrophysics* propose, assuming they get a sufficient number of subscribers, to issue a monthly publication entitled "Popular Astronomy." The idea of this project is that it should serve as a guide for self-instruction, and supply a medium for queries and answers for methods of work, facts, books, &c. They propose to commence with a series of topics for observation, the stars, moon, planets, &c., assuming that the readers are supplied only with an opera glass or small telescope. It is to be in no sense professional, "except to be accurate in statement of fact and principle without being technical in terms." The first number can be ready by September of this year if the subscribers are forthcoming.

OPTICAL TESTS FOR OBJECTIVES.—In a small pamphlet entitled "Optische Untersuchung von Objectiven," by Dr. Ludwig Mach of Prague, the contents of which have appeared in the *Photographischer Rundschau*, the writer describes a very simple means of obtaining photographs of objectives showing defects in the glass. After first referring shortly to the methods adopted by Schröder, Alvan Clark, &c., giving some excellent small photographs of some of the results obtained by these means, he decribes his method of making small optical errors visible. He casts, by means of an achromatic lens, an image of the sun on a screen in which is a small hole. Behind this screen, at some distance from it, he places the object glass to be tested, together with the camera at its focus, and it is found that in all places where the object glass is not perfect a system of interference marks or rings is formed. Experimenting with an object glass of 10·2 cm. aperture and 143 cm. focal length, by Sir Howard Grubb, the writer shows a photograph taken after this means.

PHOTOGRAPH OF A BOLID.—Although on fine nights many telescopes carrying with them photographic plates are turned towards the starry heavens for special objects, none, except a very few exceptions, have had the good luck to record the passage of a bright meteor. M. Lewis, at Ausonia (Connecticut) seems to have been very fortunate in this respect (*Bulletin Astronomique*, tome x., March), for on January 13 of this year, while photographing the comet Holmes, a very bright meteor crossed the field of view. An examination of the plate showed that the trail commenced at about 1h. 38m. R.A., and + 33° 40′ declination, terminating at 0h. 8m. R.A., and + 32° 12′ declination. Under the microscope he says that the centre of the trail is crossed by a very dark axis, clearly defined, while the other part is bounded by fringes of very irregular forms, indicating that fragments of matter had been detached from the meteorite: signs of rotary movement during its passage before the sensitised plate were also visible. For orbit determinations, photographs such as these, if they could be more often obtained, would be very valuable, for one could then fix the different points of the trajectory with far greater accuracy than is now done by the necessarily very approximate method of naked eye estimations.

GEOGRAPHICAL NOTES.

AN amusing instance of newspaper science occurred in a morning paper last week. A note on the salinity of the North Pacific, published in this column (vol. xlvii. p. 590), was reproduced without acknowledgment, but with annotations. After the quotation, "a tongue of considerably fresher water stretches nearly across the ocean about 10° N." came the interpolation, "caused no doubt by the dilution of the sea by the melting snow and ice of the northern regions," a far-fetched hypothesis, which ignores the rainy belt of calms. A worse error was to say that the curves of equal salinity "run through Behring Strait," when the original said Bering Sea. The use of a map would probably have prevented the blunders.

THE *Mouvement Géographique* publishes a useful *résumé* with route-maps and portraits of the officers of the various expeditions of the Katanga Company from May, 1890, to April, 1893. In July, 1890, the expedition of M. A. Delcommune left Europe for the Congo, went by the Lomami, discovered Lake Kassali, and reached Bunkeia, in Katanga on October 6, 1891. This expedition spent a year in exploring the upper Lualaba and the western side of Lake Tanganyika, then descended the Lukuga, crossed the Congo basin in a west-by-north direction to Lusambo, and arrived in Brussels on April 15, 1893. An expedition under Le Marinel left Lusambo on December 23, 1890, reached Bunkeia on April 18, 1891, and after taking possession of Katanga, returned to Lusambo in August of the same year. On July 4, 1891, Captain Stairs left the east coast, and travelling by Lake Tanganyika reached Bunkeia in December, but the leader died on the Zambesi on his way home on June 8, 1892. In September, 1891, Captain Bia's party left Stanley Pool, ascended the Sankuru, discovered Lakes Kabele and Kabire, near the Lualaba, and reached Bunkeia in January, 1892. Thence in June they reached Lake Bangweola, and after Captain Bia's death, Lieutenant Francqui led the expedition through the upper regions of the Lualaba, and in January, 1893, joined Delcommune at Lusambo, returning with him to Europe. The discoveries made by these four expeditions are of great importance; they fill in much of the detail of the Congo basin hitherto very lightly sketched on the maps.

A RUMOUR has been current that Dr. Nansen's polar expedition is likely to collapse at the last moment for lack of funds; but it is satisfactory to learn that this is not the case. The *Fram* is practically ready for sea, and the party will embark in the month of June, as originally intended.

THE recent advance in Arctic navigation is strikingly shown in the announcement by a Norwegian firm of a pleasure-trip to Spitzbergen, planned for this summer, with a vessel strengthened for ice-work and fitted with every comfort.

MM. FOUREAU AND MERY have during the past year carried out some important journeys in the Sahara. They have succeeded in reaching the country of the Tuaregs, which has not been visited by Europeans since the Flatters' mission was massacred in 1881, and they have induced the chiefs to acknowledge French protection. The French officials are diligently extending the cultivable area of the oases in the northern Sahara by sinking artesian wells and securing artificial irrigation.

THE USE OF HISTORY IN TEACHING MATHEMATICS.[1]

I HAVE ventured to make some suggestions to this Association as to the use of history in teaching mathematics, and the restrictions and limitations under which it may be advantageously employed. It will be perhaps the most convenient course to begin with the restrictions and limitations.

The three most important of these are:—

(1) The history of mathematics should be strictly auxiliary and subordinate to mathematical teaching.

(2) Only those portions should be dealt with which are of real assistance to the learner.

(3) It is not to be made a subject of examination.

Unless these conditions are observed, it is to be feared that the effect of the introduction of new matter for instruction would be injurious rather than beneficial. The ordinary schoolboy or schoolgirl now takes in hand quite as many subjects as he or she can satisfactorily study, and nobody wants the number to be increased.

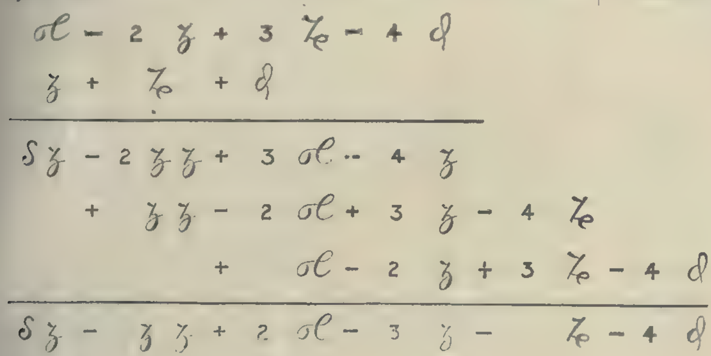
When men look back on their school days, they constantly feel some things they have always remembered and often applied came to them from their masters not as part of the regular course or as included in the work done for examination. It is just this outside illustrative position that I propose history should occupy in respect to mathematics. I want at the outset to free myself from any imputation of desiring to add one grain's weight to the heavy burden boys and girls have to bear in these days of competitive examination.

Coming now to the main question, which is in what ways history makes mathematical study easier, clearer, or more interesting, it may first of all be remarked that it gives us stereoscopic views instead of pictures and diagrams. A particular subject may be looked at from many sides, each aspect suggesting a different mode of treatment. Thus, although we do not want to go back to the method in Whewell's Mechanical Euclid, where the main truths of elementary statics were all derived from the fundamental axiom that a ruler would balance if its middle point were supported; it is yet a good thing for the pupil to know that such a method was successfully adopted. We do not want in arithmetic to go back to the old-fashioned rules of single and double false position, but the student is all the better for knowing what they were, and what could be effected by their means. Possibly some of us might really like to go back to the proof of Euclid I. 47 in the "Vija Ganita," depending only on the almost obvious truth that triangles of the same shape have their sides proportional, but at all events a student should know about this proof, even if he were to be warned of the objections to using it.

In some instances there is a further direct advantage in recalling old methods that are now superseded. Though the change

[1] Abstract of a paper by Mr. G. Heppel, read before the Association for the Improvement of Geometrical Teaching.

has been wisely made, yet it may happen that some important particulars have become comparatively obscured under the new treatment, that were in full light when the older plan was in vogue. Since Harriot introduced into England the grand and powerful improvement of making letters of the alphabet stand for unknown quantities, school boys have been for the most part regularly trained to look on algebra as a game of hide and seek, where x is concealed under conditions, and has to be dragged out into the light. The idea of some undetermined radix of a scale of notation, which was the very essence of the algebra of Stifel and Stevin, has not been brought prominently before them. It may be of interest to give four successive stages by which a process of multiplication in algebra has arrived at its present form. The first, originated by Stifel and adopted by Recorde, made use of very strange signs with very odd names. In the product, beginning from the right, the first term was called the *absolute*, the second the *root*, the third the *square*, the fourth the *cube*, the fifth the *zenzizenzike*, and the sixth the *sursolide*. In the second stage, Stevin's notation, adopted by Briggs, is self-explanatory. The third system is Vieta's, adopted by Harriot.



$$
\begin{array}{l}
③ - 2\,② + 3\,① - 4 \\
② + ① + 1 \\
\hline
⑤ - 2\,④ + 3\,③ - 4\,② \\
\quad + ④ - 2\,③ + 3\,② - 4\,① \\
\quad\quad + ③ - 2\,② + 3\,① - 4 \\
\hline
⑤ - ④ + 2\,③ - 3\,② - ① - 4
\end{array}
$$

$$
\begin{array}{l}
aaa - 2aa + 3a - 4 \\
aa + a + 1 \\
\hline
aaaaa - 2aaaa + 3aaa - 4aa \\
\quad + aaaa - 2aaa + 3aa - 4a \\
\quad\quad aaa - 2aa + 3a - 4 \\
\hline
aaaaa - aaaa + 2aaa - 3aa - a - 4
\end{array}
$$

$$
\begin{array}{l}
a^3 - 2a^2 + 3a - 4 \\
a^2 + a + 1 \\
\hline
a^5 - 2a^4 + 3a^3 - 4a^2 \\
\quad a^4 - 2a^3 + 3a^2 - 4a \\
\quad\quad a^3 - 2a^2 + 3a - 4 \\
\hline
a^5 - a^4 + 2a^3 - 3a^2 - a - 4
\end{array}
$$

As another example, a boy can use logarithms and understand what they are, directly he has mastered the law of indices, but in order to calculate them he imagines that he must know the Binomial and Exponential Theorems. Surely it would aid him to comprehend the relations of logarithms to numbers, if he knew that they were originally calculated when the Binomial and Exponential Theorems were unknown, and if he were given some slight sketch of the means by which they were then determined.

In the *Daily News* of December 16, 1892, a verse was quoted as being often found written in a schoolboy's Euclid or Algebra:—

> "If there should be another flood,
> Hither for refuge fly,
> Were the whole world to be submerged,
> This book would still be dry."

The schoolboy's charge of dryness must be met by showing him how the progress of the arithmetic, geometry, algebra, and trigonometry that he is learning has gone on in answer to the needs that men have felt, and the desires they have formed.

There have been periods in which men, under the influence of some widely-spread motive, have called for the aid of the theorists to help them on their course, and the endeavour to supply the great want of the time has brought about a great advance in theoretical knowledge. As we look at the course of these great movements, we find that it is the practical men that supply the stimulus to exertion, that set the few thinking for the advantage of the many. Three instances of these great wants of life—one of them now dead, the other two in ever-increasing life and vigour, stand out prominently beyond the rest—astrology, commerce, and navigation. The influence of astrology extended over such a vast period of time that we cannot trace its progress step by step from the ancient Chaldeans to the Doctor Dee of the reign of Elizabeth, who was the last eminent English mathematician of the astrological sort, and at the same time one of the great promoters of mathematics in its more modern applications. We can see, however, what has been left to us as the result of the attention that was paid to astrology. The works of Bhascara, himself an astrologer, show the extent to which the Indian arithmetic and algebra had gone, and what stock was in hand to be turned to the new purpose of facilitating European commerce. We had also from these ancient scholars the elements of trigonometry and tables of sines and cosines.

The old astrologers were maintained and were enabled to carry on their researches by the wealth of princes: Alphonso, King of Castile; Frederick II., Emperor of Germany; Matthias Corvinus, King of Hungary, are instances of monarchs who had astrologers in their train, filling recognised positions in their courts. Some of these were men of real learning; others, like Galeotti, introduced with the romance writer's licence as to place and time in Scott's "Quentin Durward," and Lilly, who successfully deluded the Parliamentary leaders in the Civil War, were not much better than quacks.

When we leave the astrological age and proceed to the commercial, the history is much more complete and more interesting. The whole story of the introduction of Indian arithmetic into Europe by means of the Arabians, first as the result of the Moorish conquests in Spain, and then, after a long interval, as a result of the commercial enterprise of Italy, is full of romantic interest. It is curious to notice how strongly the commercial element comes out in the algebra of Mahommed ben Musa. It is all about questions of money, partnerships, and legacies. When the practical objects for which mathematics were studied became different, there was a corresponding alteration in the mode by which such researches were encouraged and maintained. There still remained the patronage of great princes and nobles, but a new class of promoters arose among the great merchants and trading communities. A great wave of public enthusiasm seems to have borne along with it all classes of society, engaging them in the advancement of the new learning. Benedetti held the office of mathematician to the Duke of Savoy, with a good salary; Torricelli was mathematician to the Duke of Tuscany; Harriot received £300 a year regularly from the Earl of Northumberland, and while his noble patron was for fifteen years in prison for complicity with some of the ambitious plots of his friend Sir Walter Raleigh, Harriot, Hues, and Warner bore him company, and were generally spoken of as the Earl's three magi. As showing the interest taken by the traders of great cities, it may be noticed that some of the most important treatises of the time were written at the instigation of the merchants of Florence, and published at their expense. In our own country, the first English translation of Euclid was made by a citizen of London. Recorde dedicates the first English algebra to the company of Merchant Adventurers trading to Muscovia.

Important advances in mathematics were made by the professors at the college in London, founded by Sir Thomas Gresham. This feeling among the trading classes produced results in Italy which Libri tells us were unparalleled in any previous time. We all know of the Floral Games of Toulouse, and the athletic contests of the Greeks at Olympia and Corinth. But Libri tells us that just this interest, just this popular excitement was felt in Italy when Ferrari or Bombelli had made a step in advance in the solution of cubic and biquadratic equations. There were public challenges to contests of skill, proclamations by heralds, wagers to be decided. There is a collection of answers given by Tartaglia to questions submitted to him for solution by men from all ranks in society, princes, monks, doctors, ambassadors, professors, architects, and merchants, and a large proportion of them had to do with cubic and biquadratic equations. It may seem rather strange that this particular portion of Algebra should have excited so much interest, but it must be remembered that it is not possible to determine beforehand what researches into abstract truth will afterwards lead to the greatest practical benefits. There was a widespread belief that the new powers of calculation would bring about material advantage.

I trust that I may be pardoned for thus bringing forward matters which are no doubt very familiar to most of the members of this Association; but the object has been to give a sample of the kind of facts that would be likely to appeal to the minds of young learners, and to attach some human interest to the abstract subjects they are studying. This human interest is to be found in the history of navigation not less than in that of commerce. The relation between the commercial impulse and the navigation impulse was not exactly one of succession. The former was the earlier, then the two for a time went on together, and afterwards the latter was supreme as a ruling motive for promoting mathematics.

The two great problems in navigation were first, if you knew where you were, to find how you could best get somewhere else; and secondly, if you did not know where you were, to find this out by astronomical observation. The solution of the first was mainly dependent on maps and charts, and consequently for a long time men were hard at work making these for the use of sailors. The first great promoter of this work in modern times was Prince Henry of Portugal, called the Navigator, and after his death in 1460 to the close of the century, Portugal, eagerly engaged in the exploration of the coast of Africa, continued to be the great chart-producing country. Later on it was to the Netherlands that we were principally indebted for improvements in this direction, and in the long list of those thus engaged a prominent place is taken by Stevin. Mercator's projection is so called from Kauffman, who invented it in 1566, but did not clearly show the principles on which it is founded, a task that was afterwards accomplished by an Englishman, Edward Wright, whose great services to science have been but scantily recognised.

The second great problem—to find out where you are by astronomical observation—was a pressing question in the sixteenth and seventeenth centuries. The chief instrument the Elizabethan mariner had at his command was the astrolabe. This was made in very various forms. For use at sea, of course the simplest form was chosen. There is a plate in Hutton's Mathematical Dictionary of one, consisting of a graduated circle held up by a ring, and so keeping a vertical position by its own weight, furnished with an arm and two sights, by which the altitude of the sun, moon, or stars could be estimated. The astrolabes in use on land were fitted up with much greater refinement.

An instrument perhaps more frequently used, easier to work with than the astrolabe, but less accurate, was called the cross-staff or fore-staff. It was composed of a graduated wooden rod, about three feet long, with cross pieces sliding along it of different heights, and the angle was observed in the same way that a volunteer uses the sights on his rifle. This fore-staff could be applied to roughly determine the distance between two stars.

To determine with any accuracy a ship's place at sea, three things are requisite. First, a theory that is true and workable as far as it goes; secondly, means of observation; thirdly, means of calculation. A defect in any one of these requisites renders comparative excellence in the other two o small use. Now, the mariners of Drake's time had scanty theoretical knowledge, poor instruments, and very deficient means of calculation. They could, in a rough fashion, find out in about what latitude they were; the longitude remained a mystery.

It was at the beginning of the seventeenth century that the first great improvement took place. The invention of logarithms, by Napier, placed the calculating power at one bound far in advance of either the theoretical knowledge or the means of observation. His system, further developed by Briggs, the Gresham professor, so completely supplied the want previously existing, that any improvements made between then and the present time are mere matters of detail.

The improvements in theory and in instruments went on gradually and together. Tycho Brahe did much to advance the efficiency of instruments, and every step in this direction gave the means of correcting or developing previous defective theory, and each theoretical advance suggested or rendered possible some new instrument of observation. It is no proper part of my subject to trace the steps of this progress. It is sufficient to say that now the shipmaster, often a man of no great scientific attainments, generally accustomed to work by rules, the reasons for which he does not know, has in his cabin a chronometer and a book of navigation tables, which represent in a material form the genius and the toil of the master minds that have arisen during the centuries of the past.

In the application of pure mathematics to navigation, as well as to many other purposes, it is curious to notice the changes in the relations between graphic methods and calculation methods. At first the former greatly predominated. The quantities of straight lines and curves engraved on Drake's astrolabe, the profusion of scales on old sun dials, that but few thoroughly understand, were originally intended and were accepted as the most simple means of determining practical problems. They gradually gave place to numerical calculation, but not very quickly. Fifty years ago a boy's training in the elements of navigation was conducted far more on the lines of geometrical construction than it is at present. In quite recent times there has been a revival of graphic methods in a somewhat different aspect. Besides the value they have always had for illustration and explanation, it has been seen that there is a special field for them in cases where calculation would be long and troublesome, and this special field is being clearly marked off.

The correspondence between the practical aims of men and the progress of theoretical knowledge and of means of calculation does not stop with navigation. In recent times the need for more powerful or more exact machinery, the employment of steam and electricity, our increased knowledge of what is meant by heat and light have had the effect of demanding fresh advances in mathematical methods; or, perhaps, more exactly of selecting from the mass of abstract truth acquired for its own sake the particular portion suited to the special purpose. These influences have had, however, nothing to do with the schoolboy's elementary programme, and are, therefore, outside the immediate subject of this paper.

In conclusion, I would urge that if there is any sound foundation for the views that have been expressed, we ought not in England to be without some elementary primer of the History of Mathematics.

FOGS AND HORTICULTURE.

PROF F. W. OLIVER'S second report on the effects of urban fog upon cultivated plants has been presented to the scientific committee of the Royal Horticultural Society, and is now printed in the Society's Journal. The following is the passage in which he deals with possible remedial measures:—

There is very little of what I can say likely to be consoling to the horticulturist. We must recollect that in the employment of measures directed towards mitigating the injuries incident to fog, two factors—the presence of poisons in the atmosphere and the reduction of light—have to be considered. To counteract these the urban cultivator is asked to construct air-tight houses, with definite openings where the admitted air can be filtered; whilst to compensate for the loss of light due to the absorption which the rays undergo in traversing a stratum of dense fog, he must provide a generous installation of electric light. Without doubt, the entire preservation of vegetation in foggy weather is only a matter of *£ s. d.* But it is for the cultivator to sit down and count the cost. Representative growers agree in advising me that although horticulture, under these conditions, would be very interesting from a scientific point of view, it would hardly be commercially desirable. The necessity for the reconstruction of glass-houses upon valuable urban land must of necessity suggest to the horticulturist the alternative of decamping into the country, where the cultural conditions are more favourable. The enhanced value of urban sites has, apart from other inducements, no doubt been a factor in determining an increasing number of growers to settle well outside the suburbs. If, then, any idea of reconstruction is raised, it would in all probability prove to be the last straw. Considerations of this sort lead me, in making a few remarks upon cultural precautions, to limit my suggestions to such as are possible of realisation—things being as they are.

If we could eliminate atmospheric contamination, I do not think the reduction of light alone would be a very serious cause of complaint. Now and then it might be so to some extent, though it would hardly be a grievance of the first magnitude. It is when we have superadded aërial contamination that the mischief is done. Many very common injuries to flowers—injuries which impress the cultivator and catch his attention—have no casual relation with diminished illumination. The inflorescences of rhododendrons, which become so characteristically glued up in their bud-scales and fail to open, will expand perfectly in total darkness. So also will the flower-buds of most orchids. Since, however, the application of artificial light, in a manner likely to be effective, would be an unduly heavy burden on the grower, we will dismiss this aspect of the question, and proceed to discuss whether atmospheric contamination can be cheaply remedied.

And, first of all, can fog be neutralised or absorbed after it has entered a plant house? I have experimented with several things, but my results do not justify me in basing any recommendations upon them. The sluicing or syringing of liquid chemicals about a house has little to recommend it, even when attended with some success. To solids the objection is not so great. But I have not found that carbonate of ammonia, for instance, exerts any noticeably beneficial action as a neutraliser of the acid vapour of fog. But fog is a complex product, and anything which might neutralise one constituent would probably leave the others free to do their damage. I have never felt that anything could be done inside the house towards mitigating fog except the taking of certain precautions as regards watering and heating. And I am of this opinion still.

The scope of this report does not extend to a discussion of the big question of the abolition of fog. Even the most sanguine of the present generation can hardly hope to enjoy any abatement of the fog-nuisance. So that I shall be more practically discharging my mission in discussing how fogs may be excluded from plant-houses than in attacking the greater problem. Stoves, within certain limits, can be covered in with sheets of canvas, and this has been tried with encouraging results. I first heard of this method being systematically and successfully applied from Mr. C. Davies, of the Mote Park Gardens, Maidstone. Even the fogs of limited duration which are experienced there are sufficient to destroy the blossoms of a whole houseful of orchids. But they have been successfully combated by covering in the house with canvas sheets. Elsewhere I have seen this done, sometimes at my suggestion, with beneficial results. Still, at the best, it is but an expedient. Immunity obtained in this way is only partial. Severe fogs of short duration, or longer ones of only moderate density, may be filtered through canvas, so that the damage caused is lessened; but a persistent dense fog generally prevails in the end.

If plant-houses were constructed rather less leaky than is the case at present, something definite could no doubt be done towards filtering the air. I confess to holding serious doubts as to whether the admission of air to plant-houses, as in vogue just now, is based on sound physiological principles—and this quite apart from the fog-nuisance. During the course of my inquiries into fog, a device for ventilating conservatories—the "patent fog-annihilator" of Mr. Charles Toope—came prominently under my notice; and as I have been frequently asked what I think of it, I will take this opportunity of stating what I know. The system is as follows: A number of boxes, situated on the floor under the staging, communicate directly with the exterior by means of aperatures which can be readily closed if desirable. These boxes contain several open-work trays, upon which sticks of charcoal are loosely placed. The air entering a box from outside is led through these trays, coming into close contact with the charcoal. As the air leaves the box it impinges upon the hot-water pipes, and is thus warmed before it reaches the plants in cultivation. The entrance of air is promoted by simple contrivances known as "exhaust-caps" placed on or near the ridge of the house. These caps are so constructed that practically, under all conditions, an out-draught of air obtains. Should the draught be too great, it can be regulated by means of valves. By this system a constant circulation of air throughout the house is brought about. The air enters the charcoal-box at once from outside. It passes through this and is warmed by the hot-water system of the house, and ultimately escapes by means of the "exhaust-caps." Excepting for the apertures mentioned the house is air-tight. It is by means of the charcoal that Mr. Toope claims that the air admitted is purified. As the air circulates between the sticks of charcoal it gives up the products of coal-combustion with which it may be contaminated, as in foggy weather.

Charcoal undoubtedly possesses remarkable properties as an absorbent, and Mr. Toope is by no means the first to call attention to its properties in this respect. Forty years ago the chemist Stenhouse[1] made observations on these properties, and it may not be without interest to call attention to what he said about it. In the paper referred to, Stenhouse describes and illustrates the remarkable property of charcoal as an absorbent and oxidiser of the products of decomposition of organic matter. He describes how the carcases of dogs were kept covered with a thin layer of powdered charcoal—but otherwise exposed—without any nuisance arising therefrom. He adds that he has devised a respirator on this principle, to be used in districts smitten with cholera or yellow fever. He found, further, that with such a respirator he could breathe with impunity air containing large amounts of ammonia, sulphurrtted hydrogen, and other hurtful gases. Finally, he suggested the application of charcoal for purifying the air of houses located in infected districts—all air admitted to be passed through thin canvas bags containining crushed charcoal. Were such precautions taken, many regions at that time fatal to Europeans could be, he was sanguine, dwelt in with impunity.

In a later paper[2] Stenhouse describes his experiments, showing how the absorbent property of charcoal could be greatly increased. From this paper I venture to make the following extract, as charcoal seems to have fallen into desuetude as an absorbent:—

"The lighter kinds of wood charcoal, owing to the nine volumes of oxygen gas contained in their pores, possess a considerable power of oxidising the greater number of easily alterable gases and vapours. The absorbent power of charcoal is comparatively much greater than its capacity for inducing chemical combination. In this respect charcoal presents a remarkable contrast to spongy platinum, which, though inferior as an absorbent for some gaseous substances—such, for instance, as ammonia, of which spongy platinum absorbs only thirty volumes, while charcoal absorbs ninety—is, nevertheless, immensely more effective both as an oxidiser and as a promoter of chemical combination generally. As it is desirable, for some purposes, while retaining the absorbent power of charcoal unimpaired, to increase its oxidating influences, it struck me that this important object might be easily effected by combining the charcoal with minutely divided platinum. In this way a combination is produced to which I have given the name of platinised charcoal, which possesses the good properties of both of its constituents. In order to platinise charcoal, nothing more is necessary than to boil the charcoal, either in coarse powder or in large pieces, in a solution of bichloride of platinum, and when the charcoal has become thoroughly impregnated with the platinum, which seldom requires more than ten minutes or a quarter of an hoar, to heat it to redness in a closed vessel—a capacious platinum crucible being very well adapted for this purpose. When 150 grains of charcoal were impregnated with nine grains of platinum, by the process just described, the charcoal was found to have undergone no change in its external appearance, though its properties had been very essentially altered. . . . I find that two per cent. of platinum is sufficient

1 J. Stenhouse, "Ueb. die entfärbenden und disinficirenden Eigenschaften der Holzkohle, nebst Beschreibung eines Kohle-Respirators zur Reinigung der Luft durch Filtration," *Annalen der Chemie und Pharmacie*, Bd. xc. 1854, p. 186.

2 J. Stenhouse, "On Platinised Charcoal," *Journ. Chem. Soc.* viii. 1856, p. 105.

to platinise charcoal for most purposes. Charcoal containing this small amount of platinum causes a mixture of oxygen and hydrogen to combine perfectly in about a quarter of an hour, and this is the strength of platinised charcoal that seems best adapted for charcoal disinfectant respirators . . . . Platinised charcoal seems likely to admit of various useful applications; one of the most obvious of these is its excellent adaptability to air-filters and respirators for disinfectant purposes." So much for the properties of charcoal. My colleague, Prof. Corfield, of University College, assures me that "charcoal is now very little used for the purification of foul air. It was formerly employed in sewer ventilation, but it was found that it soon became damp and was then useless.

I was anxious to test Mr. Toope's application, and to see how far the sulphurous acid of fog might be absorbed as the foggy air passed through the charcoal trays. Mr. Toope, therefore, at my request, furnished me with a sample box, so arranged that I could aspirate air throught it. I was frequently in the habit of aspirating fog through 25 c.c. of potassium permanganate of such strength that the aspiration of $2\frac{1}{2}$ to 3 cubic feet of an ordinary fog would decolorise the solution, whilst $1\frac{1}{2}$ to 2 cubic feet sufficed in the case of very severe fogs. I have repeatedly aspirated air, in all sorts of foggy weather, through the charcoal box. But even in the most severe instances I have never noticed anything more than a slight discoloration of the permanganate after the passage of as much as 25 cubic feet. I have also placed the box in a chamber into which an atmosphere of strong sulphurous acid was introduced—an atmosphere of which $\frac{1}{10}$ cubic foot sufficed to entirely decolorise the permanganate. When drawn through the charcoal, however, 3 cubic feet could be drawn without perceptibly affecting the colour of the fluid. When kept in an atmosphere of strong sulphurous acid the charcoal becomes in time charged, and, for the time being, incapable of further absorption. In this charged condition I left the box for some eight or ten weeks, and found that by the expiration of that time it was as good an absorber as ever. With ordinary fogs there seems little fear of anything of this kind happening; nor have I observed any tendency in the charcoal to get choked in this way in long spells of foggy weather. That other impurities are also absorbed I have no proof, though I consider it most probable.

In order to demonstrate the advantages of his system to horticulturists, Mr. Toope has constructed a small conservatory at his offices in Stepney. Here he cultivates, in an unfavourable atmospheric environment, a collection of orchids and other stove plants. The results I regard as distinctly favourable to his system, though they were not by any means convincing. This arose, not necessarily, from any defect in the filtering apparatus, but rather from faulty cultural methods. Mr. Toope is a busy man, and the charge of his plants falls to the lot of others. Many plants very sensitive to atmospheric impurities, which he obtained at my suggestion, received a severe check in transit before they reached him. Others, again, which he raised from seed for observation were liable to neglect from time to time. So that a casual visitor unacquainted with the facts might easily have carried away an unfavourable impression of the utility of the system. But, taking everything into consideration, I incline to take a distinctly favourable view of charcoal as a filter for contaminated air—so much so that I believe it might be adopted with advantage by our urban cultivators. The charcoal undoubtedly absorbs a very large percentage of the sulphurous acid, and this can only have a beneficial result. The adoption of the system to old plant-houses does not involve any very serious reconstruction. The charcoal-boxes and exhaust-caps are easily fixed; whilst it is only very old and leaky houses that cannot be rendered reasonably airtight. In this way the toxic action of fog will, I am confident, be mitigated to an appreciable extent.

As regards cultural precautions to be observed in foggy weather, experience indicates that a low temperature and a moist atmosphere are conducive to the well-being of the plants, though they, of course, afford no absolute protection. This aspect of the question has been clearly put in the following note from the *Gardeners' Chronicle* by Mr. Thiselton-Dyer, which I venture to quote *in extenso*:—

"The Kew practice of keeping the winter temperature of the houses as low as we dare is based on the result of practical experience. I do not dogmatise for other people who want to solve their own problems, and find out what is best for their particular requirements for themselves. But, as Mr. Henslow has pointed out, the theory of the subject has been stated clearly by Lindley; and it may not be amiss to quote a few words from his classical 'Theory and Practice of Horticulture' on the subject.

"The point of the whole matter is that in winter, with a low external temperature and nocturnal radiation, it is practically impossible, in a large glasshouse, to keep the internal atmosphere humid with a high temperature. I quote from Lindley, p. 207:—

"'Another source of dryness is the coldness of the glass roof, especially in cold weather, when its temperature is lowered by the external air, in consequence of which the moisture of the artificial atmosphere is precipitated upon the inside of the glass, whence it runs down in the form of "drip."'

"Again, 'It is evident that the mode of preventing this drying of the air by the cold surface of a glass roof will be either by raising the temperature of the glass, which can only be effected by drawing a covering of some kind over our houses at night, so as to intercept radiation, or by double glass sashes; or else by keeping the temperature of the air as low as possible, consistently with the safety of the plants, and so diminishing the difference between the temperature of the external and internal air.'

"In large glasshouses it is obviously impracticable to adopt the expedients which Lindley suggests. The only alternative is to do what we do at Kew—lower the temperature as much as possible, and so secure the highest possible relative humidity, with the double result of keeping the plants at rest and of checking their desiccation."

I hope shortly to issue a third report dealing with the fog question from its purely local aspect, including lists of plants which suffer and the area around the metropolis to which these special injuries are observed.

In due time I shall prepare a very detailed report or monograph, illustrated from the large series of drawings which I have accumulated. It will only be in such a detailed monograph that I shall be able to justify many of the statements which occur in the body of this, the second report.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—Mr. Pendlebury, of St. John's College, has been reappointed a University Lecturer in Mathematics, for five years, from Lady Day 1893. Prof. Macalister, President of the Anthropological Institute, has given three lectures this term on Physical Anthropology as follows: April 27, "The Races of Australia;" April 29, "The Ancient Egyptians;" May 2, "The Prehistoric Races of Britain."

The Professor of Pathology announces a practical course of instruction in bacteriology, to be given during the ensuing long vacation, by Prof. Adami, Dr. A. A. Kanthack, Dr. Wesbrook, and Mr. L. Cobbett.

Mr. J. Y. Buchanan, F.R.S., will deliver the second part of his course of lectures on oceanography at noon on Tuesdays during the present term.

The Smith's Prizes are this year awarded to three mathematicians, who are bracketed, namely, C. E. Cullis, B.A., of Caius, for an essay "On the Motion of Perforated Solids in an Incompressible Liquid"; D. B. Mair, B.A., "On the Continuous Deformation of Surfaces"; and R. H. D. Mayall, B.A., of Sidney, "On Certain Forms of Current Sheets." Mr. Mair and Mr. Mayall were bracketed Second Wranglers, and Mr. Cullis bracketed Seventh Wrangler in the Mathematical Tripos of 1891.

SCIENTIFIC SERIAL.

American Meteorological Journal, April.—Ice columns in gravelly soil, by Prof. C. Abbe. During spring and autumn little slender columns of ice are found at the surface of gravelly soils in moist places after a clear cool night, and the surface layer is found to be raised up an inch or two. Prof. Abbe offers an explanation of the phenomenon, which differs from that given by Leconte and others. The subject is of some importance to agricultural soil physics.—The diurnal variations of barometric pressure, by C. J. Lyons, of the Hawaiian Weather Bureau. The author takes into account the expansion of the air both upwards and laterally, caused by the apparent motion of the sun, and he considers that it is the *lateral* pressure that causes the barometer to rise to a maximum about half way between local sunrise and local maximum of temperature. He states that an advancing area, which is increasing in the temperature of its lower strata, will cause a high barometer area at a considerable distance in front of itself, and that the reverse occurs during the advance of an area which is diminishing in the temperature of its lower strata. The evening maximum he takes to be a reactionary wave from the afternoon minimum.—Recent foreign studies of thunderstorms, by R. de C. Ward. The author has collected the literature of the subject from the time that Mr. G. J. Symons commenced his observations, in 1856, down to the close of 1892, and gives a general summary of the results of each discussion. The present paper refers entirely to Great Britain.—The Chinook wind, by H. M. Ballou. Comparatively little has yet been written about the Chinook wind; its name is derived from that of the tribe of Chinook Indians living near Puget's Sound. During the prevalence of the wind the thermometer often rises from below zero to 40° or 45° in a few hours. It is analogous to the Föhn in Switzerland, and similar winds are reported from various parts of the world. All that is needed to produce them are high and low pressure areas, whereby the air is caused to pass over the mountains, depositing its moisture during the ascent, and descending on the leeward side. The author gives a list of works bearing upon the subject.—The North Atlantic hurricane of December 22, 1892, by E. Hayden. The paper is accompanied by a map showing the great size and severity of the storm. It is estimated that the area embraced was fully four million square miles, and the author considers that this storm is accountable in some degree for the subsequent very cold weather in North America and Europe.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 9.—"Preliminary Account of the Arrangement of the Sympathetic Nervous System, based chiefly on Observations upon Pilo-motor Nerves." I. By J. N. Langley, F.R.S., Fellow of Trinity College, Cambridge. In the cat, the spinal nerves which contain pilo-motor fibres in their nerve-roots, are usually the 4th thoracic to the 3rd lumbar inclusive. The spinal pilo-motor fibres run into the sympathetic trunk, there they become connected with nerve-cells; on leaving the sympathetic chain, they run to their peripheral endings in cranial or spinal nerves. The fibres to the body accompany those dorsal cutaneous branches of the spinal nerves, which supply the skin over and close to the vertebræ. Broadly speaking, the pilo-motor fibres run from the sympathetic chain to the cranial and spinal nerves in the grey rami, but a few fibres may run out in the white rami. Broadly speaking, the fibres issuing from any one ganglion are connected with nerve-cells in that ganglion and with no other sympathetic nerve-cell. In some cases a certain number of such fibres are connected with nerve-cells, not in the ganglion from which they issue, but in the ganglion immediately above or below it. The fibres, before and after they have joined nerve-cells, may be called respectively pre-ganglionic and post-ganglionic. Each ganglion, by its post-ganglionic fibres, supplies, in any one individual, a definite portion of skin. The areas supplied by the ganglia from above downwards, starting with the superior cervical ganglion, are, apart from a variable amount of overlapping, successive areas. The cranial rami of the superior cervical ganglion supply the skin of the dorsal part of the head, except a posterior portion, beginning about 1½ cm. behind the anterior level of the ears; this unaffected region we may call the occipital region. The cervical rami of the superior cervical ganglion supply the skin of the occipital region of the head by fibres running in the great occipital (2nd cervical) nerve, and the skin over the first three or four cervical vertebræ by fibres running in the 3rd cervical nerve. The ganglion stellatum, by its cervical rami, supplies the skin from the 3rd and 4th cervical vertebræ to some point between the spine of the 2nd and 3rd thoracic vertebræ. Often its area extends upwards to join the occipital region. The areas supplied by the post-ganglionic pilo-motor fibres of the 3rd, 4th, 5th, and 6th cervical nerves vary in relative size in different individuals; roughly we may take the 3rd nerve as supplying the skin over the first three and a half vertebræ, and the others as supplying successive strips of about two vertebræ each. In the fore leg region, one, two, or three spinal nerves send no cutaneous branches to the mid-line of the back. These are the 7th and 8th cervical, and the 1st thoracic, nerves. Sometimes the 7th, sometimes the 1st, thoracic has such a cutaneous branch; corresponding to the presence or absence of these cutaneous branches is the presence or absence of pilo-motor fibres in the rami which pass from the ganglion stellatum to the respective nerves. The ganglion stellatum also sends pilo-motor fibres to the first four thoracic nerves. From the 5th thoracic nerve downwards (and sometimes from the 4th) there is a ganglion and ramus for each nerve. The distribution of all these rami down to the 4th lumbar may be considered together. The area of the second thoracic ramus (or of the 1st, as mentioned above) follows on the area of the lowest effective cervical ramus. The 4th lumber ramus supplies either the skin over the 7th lumbar vertebra and a small piece of sacrum or the skin over the sacrum. Between the limits just given for the 2nd thoracic and the fourth lumbar the areas follow on each other, the length of each area being about that of a vertebra.

Below the 4th lumbar nerve is the hind leg region, which is like that of the fore leg already mentioned, in so far as one, two, or three nerves have no dorsal cutaneous branches to the mid-line, and the corresponding rami have no pilo-motor fibres. These nerves are the 5th, 6th, and 7th lumbar.

About the end of the sacrum appears to be the dividing line between the areas of the rami which come from above and those which come from below the ineffective ramus or rami. Thus the skin over the lower part of the sacrum may be supplied by the 4th, 5th, or, perhaps, the 6th lumbar ramus, the skin over the upper coccygeal vertebræ by the 7th lumbar or 1st sacral. The second sacral ramus, as a rule, supplies the hairs of the tail just above the level of the anus and over it; the 3rd sacral ramus supplies the hairs for about an inch and a half below the level of the anus. The coccygeal ganglion gives off rami to the several coccygeal nerves, and these supply different lengths of the tail.

It is easily shown that the area of the skin supplied with pilo-motor fibres by the dorsal cutaneous branch of any given spinal nerve is also supplied by it with sensory fibres. And there is good reason for believing that the fibres of the grey ramus of a nerve, *i.e.* the post-ganglionic sympathetic fibres of a spinal nerve, have in the main the same distribution in the skin as the sensory fibres of the nerve.

Each spinal nerve, from the 1st cervical to the 3rd lumbar, sends fibres to 7 or 8 sympathetic ganglia. For the details of this connection we must refer to the figure appended to the paper.

March 23.—"On the Variation of Surface Energy with Temperature," by William Ramsay, Ph.D., F.R.S., and John Shields, B.Sc., Ph.D.

It is shown that a close analogy exists between the equation for gases,

$$pv = \mathrm{RT},$$

and an equation expressing the relation of surface energy to temperature,

$$\gamma s = \kappa\tau,$$

where γ is surface tension; s, surface; κ, a constant; and τ, temperature measured downwards from a point about 6° below the critical point of the fluid. As the origin of T in the gaseous equation is where $p = 0$, so the origin of τ should be where $\gamma = 0$. Correcting the above equation so that τ shall represent the number of degrees measured downwards from the critical point, the equation becomes

$$\gamma s = \kappa(\tau - d).$$

But even this equation does not express the whole truth. For at temperatures less than 30° below the critical temperature, the relation between surface energy and temperature is not a rectilinear one; a correction is therefore introduced in the form of a second term, which becomes insignificant at temperatures more than 25° or 30° τ; it is

$$\gamma s = \kappa\tau - \kappa d(1 - 10^{-\lambda\tau}).$$

The liquids examined were: ether, methyl formate, ethyl acetate, carbon tetrachloride, benzene, chlorobenzene, acetic acid, and methyl and ethyl alcohols; in fact, the only ones for which data are available. For, in order to calculate γ from the rise in a capillary tube, it is necessary to know the density of the orthobaric liquid and gas; and trustworthy data exist only for these liquids and for a few others which resemble them closely, *e.g.* fluorobenzene, bromobenzene, &c. Also to calculate *s*, *i.e.* *molecular* surface, it is necessary to know the molecular volume of the liquid, and to raise it to the ⅔rds power. Hence $v^{\frac{2}{3}} = s$, or molecular surface; *i.e.* it is possible to compare different liquids on the surfaces of which equal numbers of molecules lie.

Measurements were made at $-89°\cdot8$, the boiling point of nitrous oxide under atmospheric pressure, with ether, methyl formate, ethyl acetate, and the two alcohols; the other substances are solid at that low temperature. These observations confirmed the rectilinear relation with the first three; but in the case of the two alcohols evidence was obtained of molecular association, as also with acetic acid. It is possible to calculate the amount of association at any temperature in such cases. For, as κ is approximately constant for the molecular surface of the "normal" liquids, the equation

$$\kappa/d = x^{\frac{2}{3}},$$

where d is the differential coefficient of an associating liquid, and x is the molecular aggregation, gives the number of simple molecules which have united to form a compound at the temperature chosen. For the alcohols at $-90°$, and for acetic acid a $20°$, the association of molecules approximates to $(C_2H_4O_2)_4$, $(CH_4O)_4$, and $(C_2H_6O)_4$.

We have thus a method by which it is possible to ascertain the molecular complexity of undiluted liquids. The results with the alcohols are shown to agree within resonable limits with those indicated by experiments with strong solutions by Raoult's method.

It is incidentally shown in the course of the paper that there is no angle of contact between liquid and glass, when the liquid surface is in contact only with its own vapour. Ordinary measurements of capillarity give inconstant, and probably inaccurate, results, for it is not the surface tension of the liquid which is measured, but that of a solution of air in the surface film of the liquid.

The paper contains tables and curves exemplifying and illustrating the statements given.

Chemical Society, March 16.—Dr. W. H. Perkin, Vice-President, in the chair.—The following papers were read:—The limits of accuracy of gold bullion assaying and the losses of gold incidental to it, by T. K. Rose. Assays of gold bullion by the ordinary method may be rendered more accurate by the use of a more sensitive balance than is usually employed. The amount of copper or silver contained in the assay piece very considerably influences the "surcharge" or difference in weight between the gold originally present in the assay piece and the cornet finally obtained. The presence of antimony, zinc, tellurium, iron, or nickel reduces the surcharge by quantities which the author has determined. It therefore follows that to ensure accuracy check assays must be made on alloys of the same composition as those under examination. Variations in the surcharge are also caused by changes in temperature of the muffle furnace used in cupellation; a rise of $5°$ in the temperature usually worked at, viz. about $1064°$, is accompanied by a reduction in the surcharge of about $0\cdot01$ per 1000. If attention be paid to the points enumerated above, the gold in bullion of a high degree of purity can be determined within $\pm\ 0\cdot02$ per 1000, the limits of accuracy having been previously considered to be $\pm\ 0\cdot10$ per 1000. The author has estimated the losses of gold in bullion assays. These are due to absorption by the cupel, volatilisation in the muffle and dissolution in the parting acid.—The volatilisation of gold, by T. K. Rose. The author has determined the loss of gold incurred on heating test pieces of the pure metal or its alloys at temperatures between $1045°$ and $1300°$ under various conditions. The loss of gold increases as the temperature rises, pure gold losing four times as much at $1245°$ as at $1090°$. A large amount of gold is volatilised in an atmosphere consisting mainly of carbonic oxide, whilst a small amount only is lost in coal gas. A comparatively small amount of gold is carried away by the more volatile metals, copper appearing to exert an exceptional influence. Metals which are easily volatilised do not appear to be completely driven off at the highest temperatures attained. A larger proportion of gold is lost by alloys which form flat buttons on the cupel than by those which form spherical buttons; it would hence seem that the conditions which lower the surface tension of the gold button also raise the vapour pressure of the metal.—Note on the boiling-point of nitrous oxide at atmospheric pressure, and on the melting-point of solid nitrous oxide, by W. Ramsay and J. Shields. Nitrous oxide boils at $-89°\cdot8$, and melts at $-102°\cdot3$.—The isomerism of the paraffinic aldoximes, by W. R. Dunstan and T. S. Dymond. The importance of the author's discovery of the existence of two acetaldoximes in connection with the theory of the isomerism of oximes is pointed out. The behaviour of the isomerides towards reagents is very similar, the acetyl derivatives prepared from the liquid and solid modifications appearing identical. Both acetaldoximes are converted by hydrogen chloride into the same hydrochloride. The action of phosphoric chloride on the crystalline aldoxime in ethereal solution at a low temperature yields a product which on hydrolysis gives ammonia and acetic acid, as well as methylamine and formic acid; the same products are obtained in almost the same proportion from the liquid aldoxime at a a high temperature. The two isomerides yield only ammonia and acetic acid when treated with phosphorous chloride. Propionaldoxime, Et.CH : NOH, has hitherto been known only as a liquid boiling at $132°$; the authors find, however, that it may be obtained in two forms, the one a liquid and the other a solid melting at $22°$. The solid modification is converted into the liquid one by heating, and the liquid form changes slowly into the solid one on cooling; this behaviour is quite similar to that of the isomeric acetaldoximes. The action of reagents on the acet- and propion-aldoximes is also analogous. It would appear from the above results that further study is needed to establish criteria of stereochemical isomerism in the case of these oximes; the authors are therefore still engaged upon the subject.—The mineral waters of Askern, in Yorkshire, by C. H. Bothamley. The author gives analyses of the waters of four wells or springs at Askern. These waters are accredited with considerable therapeutic value.—Note on the distribution of acidic and alkalinic radicles in a solution containing calcium, magnesium, carbonates, and sulphates; and on the composition of mineral waters, by C. H. Bothamley. The author concludes that if the question of ionic dissociation in solution be put on one side, and mineral waters and solutions of calcium, magnesium, and the carbonic and sulphuric acid radicles, be represented as containing salts as such, the sulphuric radicle must be regarded as combining by preference with magnesium and not with calcium, as is generally supposed.—A magnesium compound of diphenyl, by W. R. Hodgkinson. Magnesium has no action on dry aniline, toluidine, form- and acet-anilid and phthalanil; phenylhydrazine begins to act on magnesium at about $150°$, and at higher temperatures the reaction becomes very violent. Aniline, benzene, ammonia, and nitrogen are evolved and a solid whitish substance containing the metal remains in the retort; on heating this residue an oil is obtained which contains diphenyl. These results suggest the presence of magnesium diphenyl.—Note on acetanhydrocitric acid, by F. Klingemann. The author criticises the recent work of Easterfield and Sell on this acid.—The dissolution of gold in a solution of potassium cyanide, by R. C. Maclaurin. The author shows that the dissolution of gold in potassium cyanide solution is conditioned by the presence of oxygen, and that the amounts of oxygen absorbed and of gold dissolved are in the proportion indicated by Elsner's original equation—

$$4Au + 8KCN + O_2 + 2H_2O = 4AuCN, KCN + 4KHO.$$

Furthermore, it is shown that the rate of dissolution varies with the strength of the solution and that it passes through a maximum in passing from dilute to concentrated solutions; this variation is traced to a decrease in the solubility of oxygen in solutions of potassium cyanide as the concentration increases.

March 27.—Annual General Meeting.—Prof. Crum Brown, F.R.S., President, in the chair.—The President delivered an address in which he discussed the history of the phlogistic theory and its gradual displacement by more modern views. The balance-sheet for the past year was then presented, and the usual votes of thanks passed. A ballot was then taken for the election of officers and Council for the present year.

Mathematical Society, April 13.—Mr. A. B. Kempe, F.R.S., President, in the chair.—The President, calling attention to the title of a paper he had read at the January meeting on the application of Clifford's graphs to ordinary binary quantics (*ante*, p. 382), said that the subject being there regarded from Prof. Clifford's point of view, he had, following the precedent set in a paper by the late Mr. Spottiswoode on Clifford's graphs, associated the name of Clifford only with the graphs in the title. He had, however, on further consideration come to the conclusion that by such exclusive association an impression might be created which would operate unjustly towards the unquestionable originality of the paper by Prof. Sylvester on the application of the new atomic theory to the graphical representation of the invariants and covariants of binary quantics published in the *American Journal of Mathematics*, vol. i. p. 64. By permission of the council he proposed therefore to alter the title of his paper by referring therein to the graphs as "the Sylvester-Clifford graphs."—The following communications were made:—Toroidal functions, by A. B. Basset, F.R.S. The object of this paper is to develop the theory of toroidal functions from a point of view which brings out its connection with the associated functions

$$P_n^m(\nu),\ Q_n^m(\nu),$$

which occur in spherical and spheroidal harmonic analysis. A toroidal function is an associated function of degree $n-\frac{1}{2}$ and order m, where n is zero or any positive integer, and m is zero or any positive integer not greater than n. The paper commences by showing that these functions may be expressed in terms of the definite integrals—

$$P_n^m(\nu)=\frac{(-)^m\Gamma(n+\frac{1}{2})}{\Gamma(n-m+\frac{1}{2}}\int_0^\pi\frac{\cos m\phi d\phi}{\{\nu+(\nu^2-1)^{\frac{1}{2}}\cos\phi\}}n+\tfrac{1}{2},$$

and

$$Q_n^m(\nu)=\frac{(-)^m\Gamma(n+\frac{1}{2})}{\Gamma(n-m+\frac{1}{2})}\int_0^\infty\frac{\cosh m\phi d\phi}{\{\nu+(\nu^2-1)^{\frac{1}{2}}\cosh\phi\}}n+\tfrac{1}{2}.$$

It can easily be proved that these definite integrals satisfy the differential equations for toroidal functions, and the advantages of this method of procedure are twofold. In the first place these integrals lead to certain difference and mixed difference equations connecting functions of different orders and degrees; and in the second place the whole of the analysis and the results will apply when n is changed into $n+\frac{1}{2}$, in which case the integrals become ordinary associated functions. In physical investigations connected with circular vortex rings, functions of degree n and order unity occur, whose properties may be more simply deduced from those of the zonal functions; also $\nu=\cosh\eta$, when η is very large. If, therefore, $\epsilon^{-\eta}=k$, k will be small, and appropriate series can be obtained in terms of k. The latter part of the paper is occupied with the investigation of these series, and it is shown that

$$Q_n=k^{n+\frac{1}{2}}\sum_0^\infty A_s k^{2s},$$

whilst

$$P_n=k^{-n+\frac{1}{2}}(\phi_n\log 4/k+\psi_n),$$

where ϕn, ψn are infinite series of powers of k^2.—Note on the problem to inscribe in one of two given triangles a triangle similar to the other, by Mr. J. Griffiths. The writer discusses the following propositions: (1) A triangle DEF inscribed in a given triangle ABC, so as to be similar to another given one A′B′C′, belongs to some one of twelve systems of similar in-triangles, each system having a centre of similitude of its own. (2) The centres of similitude of the twelve systems in question can be formed into two groups of six points which lie respectively on two circles, inverse to each other with respect to the circumcircle ABC. (3) The centre of similitude of any system of similar triangles inscribed in ABC and having a common Brocard angle equal to that of A′B′C′ will lie on one or other of the above circles. (4) As a particular case of the problem the different systems formed by a triangle DEF inscribed in ABC, so as to be either directly or inversely similar to it are noticed.—The singularity of the optical wave-surface, by J. Larmor, F.R.S. It is shown that two sheets of a wave-surface cannot intersect along a curve. As the elastic quality of a crystalline medium is gradually altered, the separate sheets of its (mechanical) wave-surface may draw together, and may finally come into contact at one or more conical points; but any further alteration in the same direction produces instability. The existence of the abnormality of conical refraction would thus be, on a purely elastic theory, an indication of the immediate approach of instability.—On a problem of conformal representation, by Prof. W. Burnside. The paper deals with those cases in which a rectangular polygon can be represented conformally on a circle or half plane by means of an integral equation between two complex variables. It is formally proved that whenever the polygon can be formed by the juxtaposition of equal and similar figures either

(i) triangle $\frac{\pi}{2}\cdot\frac{\pi}{3}\cdot\frac{\pi}{6}$

(ii) triangle $\frac{\pi}{4}\cdot\frac{\pi}{4}\cdot\frac{\pi}{2}$

(iii) any rectangle

the representation is possible by such an integral equation, and that it is not possible in any other case. A general method for finding the equation carrying out the representation is given, and a few special cases are worked at length. The paper finishes by considering shortly the case in which the polygon is not simply connected, and one or two other allied points.

Linnean Society, April 20.—Prof. Stewart, President, in the chair.—In view of the approaching anniversary meeting the election of auditors took place, when Dr. Meiklejohn and Mr. E. A. Batters were nominated on behalf of the Council, and Messrs. Thomas Christy and W. F. Kirby on behalf of the Fellows.—The President took occasion to notice the retirement of Mr. F. H. Kingston after thirty-six years' service as lodge-keeper, and presented him with a testimonial in the shape of a cigar case containing five and thirty pounds in bank-notes, which had been subscribed on his behalf by all the societies in Burlington House. After a suitable response on the part of the recipient, attention was directed to some photographs of Burlington House with the gateway as it existed before the rebuilding in 1868, and showing the old colonnade which had since been demolished and was lying still uncared for in Battersea Park.—On behalf of Mr. C. Chilton of Dunedin, N.Z., Mr. W. Perry Sladen gave an abstract of a paper on the subterranean crustacea of New Zealand, with remarks on the fauna of caves and wells. The paper contained a *résumé* of previous publications on the subject with additional information from the author's own observation, and an expression of his views on certain controversial points in connection therewith. His remarks were criticised by the President and by Prof. Howes, Dr. Henry Power and Mr. G. Fookes.—A paper was then read by Mr. H. M. Bernard on the anatomy, physiology, and histology of the *Chernetidæ*, with special reference to the rudimentary stigmata, and to a new form of trachea, on which an interesting discussion ensued, and Mr. Bernard replied to the criticisms which were offered.—The society adjourned to May 4.

PARIS.

Academy of Sciences, April 24.—M. Lœwy in the chair.—On the observation of the partial solar eclipse of April 16, made at the Paris Observatory, by M. F. Tisserand. From a measurement of six photographs obtained by MM. Henry, the instants of contact were calculated to have been 3h. 59m. 51s. and 4h. 27m. 59s.—Recent researches on the nitrogen-fixing micro-organisms, by M. Berthelot. From a series of experiments upon samples of earth taken from the Botanic Garden of the École de Pharmacie, it appears that the micro-organisms capable of fixing free nitrogen from the air belong to widely varying species, but that the chief agents are certain bacteria of the soil, seven species of which were isolated. The carbon and hydrogen contained in the atmosphere does not appear capable of supporting the life of these bacteria, and their nourishment is chiefly derived from the decomposition of sugar, tartaric acid, and other hydrocarbons supplied by higher organisms. If there is an abundance of combined nitrogen at hand, the bacteria flourish more profusely, and their absorption of free nitrogen, though placed beyond doubt, has certain definite limits. On the whole, it seems that the carbon-fixing and the nitrogen-fixing organisms fulfil mutually supplementary functions.—On the order of successive appearance of the vessels in the parallel formation of the leaves of certain *Compositæ* (*Tragopagon*, &c.), by M. A. Trécul.—Physiological and therapeutic effects of a liquid extracted from the male sexual gland, by MM. Brown-Séquard and d'Arsonval. Samples of the orchitic liquid for subcutaneous injection were offered to all medical men willing to report upon its effects. Over 1200 physicians availed themselves of this offer, and their results are very encouraging. The malady showing the most striking effect of the remedy was locomotor ataxy, of which 314 out of 342 undoubted cases were cured or considerably improved. Another almost incurable disease which proved very amenable to this treatment was shaking paralysis, of which 25 out of 27 cases were much improved. It appears that the orchitic liquid, though not possessing any direct curative influence upon the various morbid states of the organism, is capable on subcutaneous injection of curing or decidedly ameliorating a great variety of affections, organic or otherwise. This action is due to two kinds of influence. By the one, the nervous system gains in vigour, and becomes capable of improving the dynamical or organic state of the diseased parts; by the other, which depends upon the entrance into the blood of new materials, the liquid contributes to the cure of morbid states by the formation of new cellules and other anatomical elements.—Observation of the solar eclipse of April 16, 1893, at the Lyon Observatory, by M. Ch. André.—Observation of the solar eclipse of April 16 at the Algiers Observatory, by M. Ch. Trépied.—Additional note, by M. Spée.—Spectro-photographic method for the study of the solar corona, by M. George Hale.—On the reduction of any differential system to a linear form and integrable completion of the first order, by M. Riquier.—Verification of the steam counter and its application to the measurement of supersaturation and superheating, by M. H. Parenty.—On the tension of saturated water-vapour, by M. Antoine.—On the measurement of large differences of phase in white light, by M. P. Joubin.—On rational systems of expressions in dimensions of electric and magnetic quantities, by M. E. Mercadier.—Measurement of the difference of phase of two sinusoidal currents, by M. Désiré Korda.—Effect of colouring matters upon actino-electric phenomena, by M. H. Rigollot.—Study of ferric chloride and ferric oxalate solutions; distribution of the ferric oxide between the hydrochloric and the oxalic acid, by M. Georges Lemoine.—On some derivatives of licareol, by M. Ph. Barbier.—On the constitution of gallic blue or tannine indigo, by M. P. Cazeneuve.—On the chloramines, by M. A. Berg.—On bromal bornylates, by M. J. Minguin.—Qualitative and quantitative analyses of formaldehyde, by M. A. Trillat.—On dioptase deposits on the French Congo, by M. Alfred Le Chatelier.—On a zirkoniferous felspathic enclosure in the basaltic rocks of the Puy de Montaudou, near Royat, by M. Ferdinand Gonnard.—On a new mineral species discovered in the copper deposits of Boleo (Lower California, Mexico), by M. E. Cumenge.—On the rocks of the porphyritic series in the French Alps, by M. P. Termier.—On the discovery of the Marine carboniferous in the valley of Saint-Amarin (Haute-Alsace), by M. Mathieu Mieg.—Biological conditions of lacustrine vegetation, by M. Ant. Magnin.—Acclimatisation in France of new Salmonidæ, by M. Daguin.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—Vertebrate Embryology: Dr. A. Milnes Marshall (Smith, Elder, and Co.)—Chemistry for All: W. J. Harrison and R. J. Bailey (Blackie).—Unités et Etalons: C. E. Guillaume (Paris, Gauthier-Villars).—Principes de la Machine a Vapeur: E. Widmann (Paris, Gauthier-Villars). Smithsonian Institution, Report of U.S. National Museum, 1890 (Washington).—The Soil in Relation to Health: H. A. Miers and R. Crosskey (Macmillan).—Wm. Kitchen Parker, F.R.S.: T. Jeffery Parker (Macmillan).—Types of Animal Life: St. G. Mivart (Osgood).—Advanced Physiography: R. A. Gregory and J. Christie (Hughes).—Gun and Camera in Southern Africa: H. A Bryden (Stanford).—Alembic Club Reprints; No. 1, Experiments upon Magnesia Alba, Quicklime, &c.: Dr. J. Black (Edinburgh, Clay).

Pamphlets.—Vererbungsgesetze und ihre Anwendung auf den Menschen: S. S. Buckman (Leipzig, Günthers).—City and Guilds of London Institute; Report to the Governors, April (London).—The Stæchiological Cure of Consumption, &c.: Dr. J. F. Churchill (Stott).

Serials.—Quarterly Journal of Microscopical Science, April (Churchill).—Bulletin of the New York Mathematical Society, vol. 2, No. 7 (New York).—Ergebnisse der Meteorologischen Beobachtungen, Jahrgang 2 (Bremen).—Seismological Society of Japan, vol. 1, 1893 (Yokohama).—Geological Magazine, May (K. Paul).—Natural Science, May (Macmillan).

DIARY OF SOCIETIES.

London.

THURSDAY, May 4.

Royal Society, at 4.30.—On the Thickness and Electrical Resistance of Thin Liquid Films: Prof. Reinold, F.R.S., and Prof. Rücker, F.R.S.—Organic Oximides; a Research on their Pharmacology: Dr. H. Pomfret.—On the Alleged Increase of Cancer: Geo. King and Dr. Newsholme.—Further Experimental Note on the Correlation of Action of Antagonistic Muscles: Dr. Sherrington. On the Differential Co-variants of Plane Curves, and the Operators Employed in their Development: R. F. Gwyther.

Linnean Society, at 8.—Nervous System of Myxine glutinosa: Alfred Sanders.—On Polynesian Plants collected by J. J. Lister; W. B. Hemsley, F.R.S.

Chemical Society, at 8.—Ballot for the Election of Fellows.—Hydrates of Potassium, Sodium, and Lithium Hydroxides: S. U. Pickering, F.R.S.—Notes on Marsh's and Renich's Tests for Arsenic: Dr. J. Clark.—The Formation of Hydrogen Peroxide in Organic Liquids: Dr. A. Richardson.—The Supposed Saponification of Linseed Oil by White Lead: J. B. Hannay and A. E. Leighton.—Notes on the Capillary Separation of Substances in Solution: L. Reed.

Institution of Civil Engineers, at 8.—The First James Forrest Lecture—The Interdependence of Abstract Science and Engineering: Dr William Anderson, F.R.S.

Royal Institution, at 3.—The Atmosphere: Prof. Dewar, F.R.S.

FRIDAY, May 5.

Chemical Society, at 8.—Hofmann Memorial Meeting.—Address by Right Hon. Lord Playfair, F.R.S.; Sir F. A. Abel, F.R.S.; W. H. Perkin, F.R.S.

Royal Institution, at 9.—Fogs, Clouds, and Lightning: Shelford Bidwell, F.R.S.

SATURDAY, May 6.

Royal Institution, at 3.—Johnson and Milton: Dr. Henry Craik, C.B.

MONDAY, May 8.

Aristotelian Society, at 8.—G. F. Stout.

Royal Institution, at 5.—General Monthly Meeting.

TUESDAY, May 9.

Institution of Civil Engineers, at 8.—Mining and Ore Treatment at Broken Hill, New South Wales: M. B. Jamieson and John Howell. (Discussion.)

Anthropological Institute, at 8.30.—Note on the Skull of an Aboriginal Australian: C. Dudley Cooper. (Communicated by Prof. G. D. Thane.)—On Borneo: C. Hose.—On the Natives of Tonga: R. G Leefe.

Royal Institution, at 3.—Modern Society in China: Prof. R. K. Douglas.

WEDNESDAY, May 10.

Geological Society, at 8.—On the Felsites and Conglomerates between Bethesda and Llanllyfni, North Wales: Prof. J. F. Blake.—The Llandovery and Associated Rocks of the Neighbourhood of Corwen: Philip Lake and Theodore T. Groom.

Entomological Society, at 7.—Dicranota, a Carnivorous Tipulid Larva: Prof. L. C. Miall, F.R.S.—On a Lepidopterous Pupa (Micropteryx purpurella) with Functionally Active Mandibles: Dr. T. Algernon Chapman.

Institution of Civil Engineers, at 8.—The Introduction of Rubble Blocks into Concrete Structures: J. Wilson Steven.

THURSDAY, May 11.

Mathematical Society, at 8.—On some Formulæ of Codazzi and Weingarten in Relation to the Application of Surfaces to each other: Prof. Cayley, F.R.S.—On the Expansion of Certain Infinite Products: Prof. L. J. Rogers.

Institution of Electrical Engineers, at 8.—On the Prevention of Sparking, Compound Dynamos without Series Coils or Magnets; and Self-exciting Dynamos and Motors without Winding upon Field Magnets: W. B. Sayers.

Royal Institution, at 3.—The Atmosphere: Prof. Dewar, F.R.S.

FRIDAY, May 12.

Physical Society, at 5.—The Drawing of Curves from their Curvature: C. V. Boys, F.R.S.—The Foundations of Dynamics: Oliver Lodge, F.R.S.

Royal Astronomical Society, at 8.

Royal Institution, at 9.—Isoperimetrical Problems: Lord Kelvin, Pres. R.S.

SATURDAY, May 13.

Royal Botanic Society, at 3.45.

Royal Institution, at 3.—Johnson and Swift: Dr. Henry Craik, C.B.

CONTENTS.

THURSDAY, MAY 11, 1893.

A BOOK ON PHYSIOGRAPHY.

"*A. E. Brehm. Les Merveilles de la Nature.*" *La Terre, les Mers, et les Continents; Géographie Physique, Géologie et Minéralogie.* Par Fernand Priem. (Paris: J. B. Baillière et Fils, 1892.)

THE wonders of nature! The book would be worth having that would help us to realise, however imperfectly, what it is that underlies this hackneyed phrase. But the book that shall create and satisfy a craving for this result will not be easy to build up. It must be encyclopædic, but (need it be said?) not an encyclopædia. It must be accurate to the last degree of accuracy, but must have nothing of the pedant about it. Human interests must, wherever an opportunity offers, be interwoven with its narrative. The narrative itself must be, not the heavy didactic prosing of an old-fashioned schoolmaster, but the congenial living talk of a friend. Sound judgment must pick out what is to be told and what left unsaid. So far from looking upon all facts as of equal value, the utmost care must be exercised to present those only which are within the grasp of the lay mind; all that has significance for the specialist only will be out of place. Nothing will be inserted merely because it is curious or marvellous, for the object will be not to make the reader gape like an astonished clown at something which looks very extraordinary because he does not understand it; rather to use the emotion of wonder as a means to something beyond, as an inducement to look below the surface and find out how results so startling have been brought about. The right book must be neither shallow nor deep; fascinating as a poem, but sound as a scientific treatise; and it will be well if there run through all of it some one leading idea, which will serve to give it unity and string together into a connected whole the sections of which it is made up.

Under the title of "Les Merveilles de la Nature" a series of works is being published which seem to be intended for what is usually known as the "general reader." The preceding volumes have dealt with animal life, the volume now before us is devoted to Erdkunde. It will be possible, without pretending to deal with the whole of the bulky volume, to inquire how far it appears likely to meet the requirements of those readers for whom it seems intended. The work opens with "Données générales de la Géologie," and the commencement is promising; the treatment is broad, and illustrations are supplied of the general truths enunciated. But already, on p. 5, we see how little judgment has been exercised in the selection of materials. Of what interest or of what educational value to the general reader can be such technical details as a description of the way of measuring dip and strike in the field, and a figure of a pocket compass? A few pages further on we have a compressed summary of the succession and life of the main geological epochs, and some well-executed figures of their fossils. The account is far too meagre to be of any real use, and it is difficult to see what principle has guided the selection of the fossils. There is a "casualness" too about some statements calculated to mislead; as when we find no mention of Brachiopods in the Silurian and Carboniferous, but the emphatic assertion that the Devonian fauna is specially characterised by the presence of numerous Brachiopods. Again it is true enough that the Triassic fauna "diffère notablement de la fauna paléozoïque;" but the fact that it contains a mixture of palæozoic and mesozoic forms is at least of equal importance. These instances, picked at random, show how much of a compilation and how little of a masterly abstract is offered to the reader. A history of the progress of geology is one of those things specially suited to such a work as the present. We have one here interestingly written, though perhaps the salient points do not stand out as boldly as could be wished.

Further on, under the heads of mineralogy and petrology, we have a vast array of facts of very unequal interest or value for ordinary readers. What good can it be to any one to be told that there are six or seven systems of crystallisation, when he is never told what is meant by a "system"? Symmetry, which lies at the base of crystallographic classification, is barely mentioned, and most imperfectly explained. But what an attractive and instructive story may be made about crystals! Some of the more elementary facts about their symmetry and probable molecular structure are not hard to grasp, and furnish fascinating illustrations of law and harmony. Looked at in this light, these flowers of the inorganic world cease to be mere glittering gauds, and tell a tale that all would follow with delight. Out of Ruskin, checked by Miller, such might be constructed in place of this dull assemblage of barren and imperfectly explained facts. When we come to the microscopic examination of rocks there is much that is too detailed for the general public and not full enough for the specialist.

The nationality of the book must be the excuse for the survival of such statements as the following:—"Le granite est la roche éruptive la plus ancienne. . . . Ses éruptions se sont faites pour la plupart avant le dépôt des roches sédementaires: le plus récentes paraissent dater du cambrien." "Les porphyres pétrosiliceuse sont charactéristiques de l'époque permienne." But surely any one whose knowledge went beyond a few books would have thought it fair to say that these views were not universally adopted, though they are held by some of the most distinguished of his countrymen.

Turning to other branches of knowledge, the critic is still compelled to take serious objection to much that he meets with. Solar and stellar physics are scarcely up to date, though perhaps there is enough for a book of this class. It will be hard for any one who depends upon this book alone to gather how the shape of the earth is ascertained. It is all very well to copy out of a book that an arc of 1° is so long in Peru and so long in Lapland, but there is no word said as to how astronomers find out that they have travelled over 1° of latitude, nor of the trigonometrical survey requisite to measure the length of the arc. These points are easy enough of explanation, and if in place of the misleading cut on Fig. 64 a figure had been given with the necessary explanation, we should have had something of educational value instead of a mere transcript. Statements are made with great confidence about the time of rotation of Mercury and the inclination of the axis of Venus and of the prodigious height of the mountains on these two planets; they certainly ought not to have been put down as well-ascertained matters of fact. Figs. 67 and 68 I confess are beyond me.

These samples, culled from different parts of the book, are enough to give a fair idea of its general character, and the impression made on my mind by a general perusal is that it is by no means an ideal performance. But there is much that is attractive about it. It is crowded with illustrations, many of them artistic and apposite, though in the case of some it is hard to see upon what they are intended to throw light. With children it will be deservedly a favourite. I think I know a boy, of some eight or nine years, not much addicted to reading, who will devour the "pictures" and render the life of his elders a burden by the countless questions they suggest. And the elders will, many of them, find in it much interesting matter; and if what they read is not always quite sound and here and there a little dismal, there is much that is lively and stirring and to which no exception can be taken on the score of accuracy. We may wish the book good speed till something better of its kind displaces it.

A. H. Green.

SIR W. BOWMAN'S COLLECTED PAPERS.

The Collected Papers of Sir William Bowman, Bart., F.R.S. Edited for the Committee of the "Bowman Testimonial Fund," by J. Burdon Sanderson, M.D., F.R.S., and J. W. Hulke, F.R.S. In two volumes. (London: Harrison and Sons, 1892.)

No more fitting record of a well-spent life could have been given to the world than these two volumes, containing "The Collected Papers" of the late Sir William Bowman.

In July, 1888, the "Bowman Testimonial Fund" was inaugurated. Its design was to make to Sir William Bowman some acknowledgment of the appreciation in which he was held on account of his high personal character and of his professional and scientific attainments. This took first the form of a portrait of himself by Mr. Ouless, R.A., and further of a republication at least in great measure of his various scientific memoirs. These memoirs have been edited, with the assistance of the author, by Prof. Burdon Sanderson and Mr. Hulke.

The first volume contains the whole "of the epoch-making researches which were accomplished by Sir William Bowman between forty and fifty years ago in the field which he himself designated as that of 'Physiological Anatomy,'" for he regarded the discovery and uses parts as the main purpose of anatomical investigation. This volume has been edited by Prof. J. Burdon Sanderson, and contains three memoirs from the "Philosophical Transactions" on the minute structure and movements of voluntary muscle; on the contraction of voluntary muscle in the living body; and on the structure and use of the Malphigian bodies of the kidney, with observations on the circulation through that gland; also the author's contributions to "The Physiological Anatomy and Physiology of Man." This work was published between 1839 and 1856, by Drs. Todd and Bowman, and we learn the interesting details that out of a total of 298 illustrations to the two volumes, 120 of these were from the drawings of Bowman. This volume concludes with four contributions to the "Cyclopædia of Anatomy and Physiology" on Mucous Membrane; on Muscle; on Muscular Motion; and on the Pacinian Bodies.

The second volume comprises a selection of "reprints," together with some papers, now first printed, under the headings miscellaneous, surgical, and ophthalmological. These have been selected from a large amount of material, and arranged with the assistance of the author. This volume has been edited by Mr. J. W. Hulke, who writes that, "read from the standpoint of the time when each was written, these memoirs, in addition to their intrinsic merits, have, as marking the views and opinions then prevalent, a distinct value for the student interested in the history of modern medicine."

The work is prefaced by a brief memoir by Henry Power, in which he reminds us that this man of many parts and much learning "had a clear idea of the relative value of the different branches of knowledge associated with medicine, and that he recognised the futility of any endeavour on the part of the student to make himself a profound chemist, botanist, or physiologist, believing that such an attempt necessarily leads to the neglect of the practical subjects which are the occasion for which these foundation sciences are studied. No one knew better than he that 'ex libris nemo evasit artifex,' the scene of the labours of the student, was, in his opinion, at the bed-side of the patient." These ideas of Bowman are of especial importance in these days, when the tendency of the teaching in our medical schools is for each teacher to try to make his subject the one alone necessary, instead of its being but a small part of an important whole. The sketch, which is all too short, is appreciative and sympathetic. One little trait we miss; while the great physiologist's love of country life is hinted at, his love for and knowledge of flowers is passed over, and yet those who were privileged to know him in his days of well-earned rest and leisure will remember what a delight his garden was to him. Two portraits are given; both are photographs. One is of the painting by G. F. Watts, R.A., of Bowman when forty-eight years of age. This hardly does justice to the original painting, and one is of the painting by W. W. Ouless, R.A., which was done for the "Testimonial Committee Fund," in 1889, when Bowman was in his seventy-third year. This is an excellent and pleasing likeness.

OUR BOOK SHELF.

Aids to Biology. By Joseph W. Williams. (London: Baillière, Tindall and Cox.) (Students' Aids Series.)

This little volume of 142 pages, small octavo, is the second work which has reached us written up to the standard of the first examination of the Conjoint Board of the Royal Colleges of Physicians and Surgeons. The information which it contains is transcribed from the best sources available, and the author has woven the excerpts into a very presentable whole, written in good, clear style, and exceptionally free of gross errors. The pages of the volume are enlivened by thirty-nine small woodcuts and a well-chosen epilogue from Broca, and there are added a useful "index glossary," and a series of "test questions," largely culled from examination papers of the past. The work is by no means destitute of small incongruities and an occasional misuse of technical terms; and the most serious errors which it contains, contrary to the general rule, involve leading rather than subsidiary topics. The description of "living matter" as existing in the "colloidal condition" and (two pages further on) as "a semi-fluid granular substance . . . unable to absorb colouring matters when living"; the alleged origin of the cœlome of "all animals above the cœlenterata" by "the splitting of the mesoblast"; the assumption that the contractile vacuole of the protozoa is a respiratory organ "pumping in oxygenated water," and "furnishing oxygen to the animal by means of its rhythmical dilatations"; the confusion under the term "paraplasm" between modified portions of the cell-protoplasm and products of its living metabolism, with the correlated description of the protoplasm of the egg cell as a "vitellus, or yolk"; and the description of sclerenchyma as "stony tissue," are cases in point. We note with satisfaction the prominence given to the physiological and more purely chemical aspects of the subject, too often neglected in minor works on general biology. Conspicuous among leading dogmas formulated is the assertion that with the exception of ascidians and some infusorians the animal "does not contain cellulose," with the implication that certain animals form chlorophyll. We venture to think that the time has now arrived when the investigations of Beyerinck, Famintzin, Von Graff, and Haberlandt, Ambronn, and others, which have lately revolutionised our knowledge on these vitally important topics, should find expression in the elementary class-book. The author remarks in his preface that "it must be remembered that biology can be learnt in no other way than with the scalpel and the microscope," and that his volume is intended "simply and solely for the purpose of revising" a practical knowledge which the student has gained under the guidance of his teachers, "especially during the few weeks previous to the time when he intends to cross the threshold of the examination hall." If this line of conduct can be ensured, the work will fulfil a good purpose; but it may be doubted whether the overtaught medical student of to-day will regard the book as anything but a cram one. It has been compiled at considerable pains and with marked success; but as the dispensation which it seeks to further cannot possibly endure, we wish we could congratulate the author upon a devotion to some more permanent and desirable object.

Public Health Problems. By John F. J. Sykes. Illustrated. (London: Walter Scott)

THE author of this volume—which forms one of the Contemporary Science Series—has sought "to bring to a focus some of the essential points in evolution, environment, parasitism, prophylaxis, and sanitation, bearing upon the preservation of public health." It was impossible for him to deal fully in the space at his disposal with any particular part of so vast a subject, but he has contrived to give a very clear and interesting idea of the main lines of inquiry with which workers in the public health service are chiefly concerned. First he treats of internal and external influences affecting health, these influences being heredity, physical influences (light and heat), chemical media, and biological agents. Then he discusses the following aspects of communicable diseases—causation, parasitism, dissemination, and modifications. Afterwards there are series of chapters on defensive measures against communicable diseases, and on the urban dwelling. Mr. Sykes, as medical officer of health for St. Pancras and honorary secretary of the Incorporated Society of Medical Officers of Health, has had ample opportunity for the study of the questions on which he discourses, and his book ought to be of good service in disseminating sound ideas as to the conditions on compliance with which the attainment of a higher standard of public health depends.

Galenic Pharmacy. By R. A. Cripps. (London: J. and A. Churchill, 1893.)

THE student of pharmacy will, no doubt, find plenty of instructive information in this book. It does not, however, call for an extended notice in this journal, as the author does not attempt a scientific treatment of the subject, but confines himself to dealing with it on the old lines. The various pharmaceutical operations of solution, infusion, &c., are fully described, but no attempt is made to arrange the facts on any than an empirical basis. The time has arrived, however, when pharmacy should be expounded in a more scientific manner, and many barbaric and obsolete processes excluded or re-modelled in the light of our present chemical and pharmacological knowledge.

LETTERS TO THE EDITOR.

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

Mr. H. O. Forbes's Discoveries in the Chatham Islands.

IN a paper read before the Royal Geographical Society on March 12th, and again in an article on "The Chatham Islands and their Story" in the *Fortnightly Review* of this month, Mr. H. O. Forbes has described his very interesting discoveries in these islands, and has founded thereon certain conclusions as to the past history of the New Zealand group. The most startling new fact is the proof of the recent existence on the Chatham Islands of two birds whose nearest allies inhabited the distant group of the Mascarene Islands within the historical period. These are a flightless rail very closely allied to the Aphanapteryx of Mauritius, and a coot which is hardly different, except in its somewhat larger size, from the extinct *Fulica newtoni* of the same island.

It is on the flightless rail that Mr. Forbes mainly dwells in his deductions of past changes which it is supposed to imply, and it is on these deductions only that I wish to make a few remarks. He quotes Prof. A. Newton and his brother as stating that the solitaire of Roderiquez and the Dodo of Mauritius, being evidently of one stock, and there being analogous facts in the adjacent islands, they are compelled to believe that "there was once a time when Roderiquez, Mauritius, Bourbon, Madagascar, and the Seychelles were connected by dry land"; and he then argues that there must also have been a continuous land surface between this land and the ancient land comprising New Zealand and the surrounding islands. This connecting land he supposes to have been the Antarctic continent during a mild period and with great extensions over the southern ocean. When the Antarctic ice age came on the inhabitants of this continent had to migrate northwards, and some, "such as the genus Aphanapteryx, would seem to have split into parties, which, travelling by divergent roads, finally arrived in regions so far apart as Mauritius and the Chatham Islands, unaffected by the varying climates and surroundings they experienced, being of an ancient dominating type."

It is this tremendous hypothesis which appears to me to be not only quite unnecessary to explain the facts, but also to be inadequate to explain them. If one thing more than another is clear, it is that these comparatively small flightless birds were developed, as such, in or near to the islands where they are now found, since they could not possibly have arisen on any extensive land inhabited by carnivorous mammals and reptiles, and, if introduced into such a country, could not long survive. So far as I am aware, no doubt has ever been expressed on this point, the evidence for it being so clear and its explanation on the theory of evolution so complete; and I hardly think that Prof. Newton would now maintain that the affinities of the flightless birds of Mauritius, Bourbon, and Roderiquez implied the former union of these truly oceanic islands. Allied forms of ancestral flying birds may have reached the islands without such union;

and, owing to the total absence of terrestrial enemies and the abundance of food, may have developed into the allied flightless birds whose remains are found there.

But Mr. Forbes speaks of the genus Aphanapteryx itself, presumably therefore flightless, inhabiting the Antarctic continent, and migrating northwards by two routes of about 2000 miles each, in which case, this enormous extent of land must have been as free from all carnivorous land mammals and reptiles as New Zealand and Mauritius are now. If however, the birds in question lost their powers of flight in or near the islands where their remains are found, all difficulties of this kind disappear. The Aphanapteryx belongs to a family, the Rallidæ or rails, of world-wide distribution, while many of the component genera are also almost cosmopolitan, and are represented by closely allied species in distant regions. What difficulty, therefore, is there in the same or closely allied species of this widespread group finding their way at some remote epoch to Mauritius and the Chatham Islands, and, from similar causes in both islands, losing their power of flight while retaining their general similarity of structure? To put the matter briefly: if the common ancestors of the Aphanapteryx of Mauritius and the Chatham Islands were flightless, they could not have reached those islands from the Antarctic continent owing to the length of route and the presence of enemies; while if they possessed the power of flight no important change in land-distribution is required.

I have discussed this one point only, because it illustrates the very common practice of explaining each fresh anomaly of distribution by enormous changes of physical geography, when a much more satisfactory explanation can be given involving no such vast and unsupported revolutions in the earth's surface. I am aware that Mr. Forbes adduces many other facts and considerations in support of his view as to the former extension and habitability of the Antartic continent, some of which appear to me to be valid and others the reverse. On most of these I have already expressed an opinion in my "Island Life"; and I only write now in order to point out that the very remarkable and interesting facts, whose discovery we owe to Mr. Forbes's energy and perseverance, do not add anything to the evidence already adduced for that view, but may be best explained in a far simpler manner, and without requiring any important changes in the geography of the southern hemisphere.

Alfred R. Wallace.

Swarms of Amphipods.

Once last winter on entering the laboratory here after it had been shut up for a few days, we found the floor, tables, shelves, window-ledges, and even dishes on the highest shelves, covered with great numbers of dead amphipods. These were found to be *Orchestia gammarellus* (the shore-hopper). About ten days ago an unusually high tide occurred, and the curator and others who were working in the biological station noticed that the steps leading to the beach were swarming with amphipods. On investigating further it was found that the amphipods were coming up in great numbers from high-water mark, that they jumped up the steps, and that they climbed the vertical concrete wall surrounding the station to a height of several feet. Many of them were found about twelve feet above the sea, having come nearly all the way on artificial ground (concrete steps and wall), and they were so abundant on the platform outside the laboratory door that it was impossible to put a foot down without treading on many. Specimens were kept, and Mr. A. O. Walker, who is here with me now, finds that these also are *Orchestia gammarellus.* This species lives normally at or about high-water mark, and it is abundant here under stones at that line, but Mr. Walker tells me that he has taken it on the one hand nearly at low-water mark, and on the other hand under stones on grass, along with beetles, and we have found it near here far above high-water mark at the side of the road. However, these last are probably exceptional cases, and we are both inclined to think that the two amphipod invasions noticed here have been caused by the Orchestias being driven from their usual haunts by exceptionally high tides. But whether a panic arises on the flooding of their homes, or they lose their way on our concrete, the fact remains that whereas the sea was only a couple of feet higher than an ordinary high tide the amphipods ascended on the one occasion to about twelve and on the other to perhaps twenty feet above their usual level.

Port Erin, April 29. W. A. Herdman.

A Difficulty in Weismannism Resolved.

Weismann's essay "On the Significance of Sexual Repr duction in the Theory of Natural Selection," published in 188 enunciates the thesis that the object of sexual reproduction is " create those individual differences which form the material out which natural selection produces new species." This thesis w developed in the essay, "On the Number of Polar Bodies a Their Significance in Heredity" (1887), and still further "Amphimixis," published late in 1891.

While "Amphimixis" must have been nearly ready, I wro to Nature (vol. xliv. p. 613), under the heading, " Difficulty in Weismannism," pointing out *a posteriori* the co plete insufficiency of sexual reproduction, by merely shuffli ancestral germ-plasms, to effect indefinite specific variation the lines adopted by Weismann. My friend, Mr. Poulton, wro (vol. xlv. p. 52) accepting my summary of Weismann's vie "as fair statements," but criticising the deductions is not allo ing for the effect of different groupings of the ancestral plasms the germ-cells, and regretting that I had not awaited the pu lication of "Amphimixis," as "Prof. Weismann tells me," wrote, "that the points raised by Prof. Hartog are consider in this treatise." Mr. Trow also wrote (vol. xlv. p. 102), urgi that I had not allowed for the simultaneous action of natu selection or for the combinations of germ-plasms. In reply my rejoinder of the same date, Mr. Trow again urged that I h not taken natural selection into account, and that I had m understood Weismann's position. The controversy was th closed.

However, neither the German edition of "Amphimixis," n the authorised English translation published about six mont later, contained the solution of my difficulty that was anticipat by Mr. Poulton. There runs through the book like a red thre the conception of 1886, that sexual reproduction is the creat of the variations on which natural selection acts. A referen of mine to the inadequacy of this, Weismann's Theory Variation, contained in an article in the *Contemporary Revi* for July, 1892 ("Problems of Reproduction"), passed witho answer or comment, so far as I know.

In "The Germ Plasm, a Theory of Heredity" (189 Weismann devotes chapter xiv. to the consideration of heredi Herein I find the following theses, in which I preserve t italics of the original (English edition):—

1. "*It* [sc. amphimixis] *is not the primary cause of he ditary variation,*" p. 414.

2. "*The cause of hereditary variation must lie deeper th this* [amphimixis]. *It must be due to the direct effect of extern influences on the biophors and determinants*" [sc. of the ge plasms or ids], p. 415.

3. "*The origin of a variation* is equally independent selection and amphimixis, and is due to the constant occurre of slight inequalities of nutrition in the germ plasm," p. 431.

Obviously the position of 1886–91 has been abandoned untenable. If we ask why, the answer is probably contain in the following passage and annexed note ("Germ Plasm pp. 434–5):—

"It has recently been maintained that as a consequence my theory I must adopt one of two alternatives, and assu either that the germ plasm of the higher animals consists of of the primitive protozoan ancestors, or that every id is co structed in accordance with the existing character of t species; my real view, however, is intermediate between th two." The note runs: "Compare Marcus Hartog, Natu vol. xliv. p. 102." The reference omits my letter of Octo 31, 1891. The deductions made by this author from my form views are logically correct, but are no longer justifiable, sinc myself have gained further insight into the problems co cerned.

It follows from the above—

1. That Weismann has withdrawn his whole theory of spec variation as created by sexual reproduction.

2. That my account of his views on the point at issue in 18 was both full and fair.

3. That in 1891 no one else, not even Prof. Weismann, h perceived that "logically correct" deductions from his gene theory of the germ plasm were fatal to his theory of variatio

4. That the Weismannism of to-day regards the action external forces as the one essential cause of variation, so approximates to the teachings of the older evolutionists.

As no reference is made in the preface to this matter, even in the index (for which Prof. Weismann is not responsib

. wish to draw attention to it—all the more since so competent . writer as "D. H. S." seems in a review in NATURE (April :7) to be unaware that the theory of variation by amphimixis [1] ias ceased to exist as a "Difficulty in Weismannism."

Cork, May 1. MARCUS HARTOG.

Medical Biology.

G. B. H. HAS, I am glad to see, criticised effectively the yllabus of Elementary Biology put forth by the Conjoint Board NATURE, vol. xlvii. p. 530). A less fortunate course of study could iardly have been devised. The students who take the course nclude a number whose previous education, energy and ambition .re not sufficient to encourage them to attempt a university ;ourse, and the average quality is therefore not very good. They vork through a number of unicellular types, which give no raining for the hands, though they are no doubt useful in other ways. Then come Hydra and the Leech. Hydra is of course a good subject. The Leech is not instructive to a student who ias no knowledge of similar animals, and the untrained man cannot possibly dissect it for himself. The rest of the course consists of parasitic worms and certain generalities. The parasitic worms commonly have the nervous system, heart, and sometimes even the alimentary canal absent or poorly developed, while the reproductive organs are of extraordinary complexity. From these the student has mainly to derive his notions of the plans of structure which are found among animals. Such a course of study looks practical, but it is almost pure waste of ime. It does not teach the student to dissect, nor does it ntroduce him to those problems of Nature which are most accessible to a beginner. In fact, the whole course may be expected to evaporate shortly, leaving behind nothing more valuable than a recollection of the outward appearance of certain parasitic worms.

When the teacher attempts to introduce more instructive subjects, the class, solely bent upon satisfying the Conjoint Board, are too apt to scamp the work, with this excuse, that their prescribed course cannot have aroused any interest in Biology. Educationally, the syllabus of the Conjoint Board is a sin.

L. C. M.

Afterglows in Spain.

I HAVE read Mr. Backhouse's note in NATURE (vol. xlvii. p. 582) on the afterglows as seen by him in Spain during February last, and the doubts he expresses on the question whether this phenomenon has always occurred when the sun has been near the horizon. I have observed for many years the setting of the sun in Cadiz on the sea horizon with the purest sky, and never remarked the pink tint, but always the rosy tint in the west and the purple, or *Cegensghein*, in the east. After the Krakatão eruption, in the clear sky of Madrid, the pink colour of the segment was always more or less visible; and it has been more marked in these later afterglows. The phenomenon is of the same character as that of 1883, but much less brilliant. The apex of the segment rises frequently to 40°.

I have also many times observed the *green ray* (rayon vert) in very different conditions of the atmosphere, but nearly always with calm air; this is not precisely a ray, but a flash of green light that has a very perceptible duration of some tenths of a second. AUGUSTO ARCIMIS.

Madrid, April 24.

Soot-figures on Ceilings.

THE phenomenon noted by Mr. Poulton in NATURE (vol. xlvii. p. 608) is a matter of very common observation; except in the detail of the nail-heads it has been often noticed. The explanation is, I fancy, simpler than that suggested by Prof. Lodge. It is probably a simple case of *sifting of air*, as it passes by upward diffusion through the porous plaster, where its passage is not barred by contact of the plaster with the wood on the upper side. The plaster acts as the plaster of Paris plug does in the classical researches of Graham on the diffusion of gases, and as the plug of cotton-wool does in the common process of sterilising air in biological work. That warm air does stream up through a plaster-ceiling in this way is a matter of experience to every householder, when in the winter a bedroom over a sitting-room in which a fire is kept burning all day and a lamp or gas-flames for some hours in the evening, is always found to be drier and warmer than another room in the same house not so situated. We can scarcely classify dry wood and iron together as conductors of heat. A. IRVING.

Wellington College, Berks, April 29.

THE soot-figures on ceilings described by Mr. Poulton remind me of the appearance of very similar figures brought out by hoar-frost. The first time I noticed this effect was on the surface of a smoothly-boarded gate, where the parts behind which the bars of the framing ran were marked out by a much thicker coating of hoar-frost than the rest. Subsequently I noticed the same effect on a wooden pier where the planking was crossed by broad belts of white, exactly outlining the timbers to which the boards were nailed. On another occasion thick hoar-frost had formed on the roof of the after-cabin of the steam yacht *Medusa*, composed of a close pile of fine needles of ice about one-eighth of an inch high, inclined at various angles. At first the places where the thin teak boards were nailed to the cross-beams were covered only a little more thickly than the rest, but as the warmth of the day increased the ice spicules disappeared—evaporated rather than melted—from the unsupported parts, but remained in a broad band outlining each beam except above the nail-heads, over each of which a small clear space had melted.

At the time I satisfied myself that the phenomena were due to peculiarities of melting rather than of deposition. Supposing the whole surface to have been coated uniformly, the thicker parts would take longer to heat up by the sun, and so tend to prolong the life of the ice spicules resting on them. If this were so, conversely the thickened parts of the structure, cooling more slowly, should have received a lighter coating to begin with, but this I was never fortunate enough to observe. Is the similarity to the soot-figures accidental? HUGH ROBERT MILL.

1, Savile-row, April 28.

AS this subject has been under discussion lately in NATURE, it seems worth while recording a striking instance which must be well known to many who have been in the large mess room of the Royal Engineers at Chatham. This room has a lofty, highly ornamented ceiling, which was for many years bordered with a deep cornice with a plain moulding either in plaster or papier maché, mostly stuck on one simple template, and coloured either white or some very pale tint. The room was lit by three sunlights in the roof, containing about 190 gas jets. In the course of time the whole of the white moulded cornice became grey with soot-deposit *marked at intervals with light bars*, which were apparently the outline of the wooden ribs carrying the mouldings. This pattern was fairly conspicuous, and was often a subject of discussion at mess (1885 to 1890). Dr. A. Lodge's explanation of the cause seems to be the true explanation. ALLAN CUNNINGHAM.

Kensington, April 28.

THE mapping out of the heads of nails driven into the joists of the ceiling at Felixstowe seems to be inexplicable by the theory of filtration, although this may very probably account for the more common cases of a deposit between but not upon the joists of a ceiling. I am endeavouring to get a photograph of the best part of the Felixstowe ceiling. Dr. Mill's observation seems to be due, as he suggests, to a different process.

E. B. POULTON.

THE APPRECIATION OF SCIENCE BY GERMAN MANUFACTURERS.

RECENTLY, when giving evidence before the Gresham University Commission, I had occasion to speak of the attention devoted in German chemical laboratories to higher studies, and when asked what were the results of this instruction I drew attention to an article published a short time before in that most enterprising of chemical periodicals, the *Chemiker-Zeitung*, edited by Dr. Krause. In this article a description is given of the research laboratory provided to accommodate *six and twenty skilled chemists*, attached to the works of the Farbenfabriken,

[1] As regards the origin of new species, the author, like Prof. Weismann, attributes the greatest importance to sexual reproduction, and especially to cross fertilisation" (see ante, p. 606).

vormals F. Bayer and Co., of Elberfeld, who are manufacturers of dye-stuffs and other products derivable from tars. I told the Commissioners that if, at the present time, it were desired to fit up a research laboratory for chemical purposes in London, we could not do better than take these plans and reproduce them in their entirety, and that we should then, I believed, have reason to congratulate ourselves on possessing the best-appointed public research laboratory in the world.

In addition to the two dozen skilled chemists in the research department at the Elberfeld works, a large number are engaged in other departments, the total number employed being, I believe, over *sixty !*

The Elberfeld works do not stand alone: the world-renowned Badische Anilin and Sodafabrik probably has in the aggregate far more laboratory accommodation than is provided even at Elberfeld. I learn from my friend Dr. Caro, that of the *seventy-eight* chemists in the employ of this firm fifty-six have the Ph.D. degree.

At many other works equally ample provision is made—in fact the colour works throughout Germany are simply laboratories on a very large scale.

As an antithesis, I may add that I told the Gresham Commissioners that I did not think that any English colour works had six skilled chemists in its employ; at all events six was the maximum number.

Is it then surprising that, notwithstanding that a very large proportion of the coal-tar used is of English origin, and that both the "aniline-colour" and the alizarin industry were first established here, according to a statement in the Chicago Exhibition Catalogue of the German Section, about nine-tenths of the total quantity of artificial colouring matters now produced is manufactured in Germany? Whatever the proportion, in 1891, Germany exported aniline-colours of the estimated value of no less than 44,269,000 marks, and alizarin valued at 12,906,000 marks—or little short of three millions sterling—a very large proportion of these manufactured colouring matters being sent to the East Indies, where they are fast displacing those of natural origin. Dr. Caro in a comprehensive monograph just published in the *Berichte* in which the gradual development of the coal-tar colour industry is fully traced out, speaks of it as a German *national industry. Manufactured in Germany* is certainly now the recognized trade mark for chemicals throughout the world.

Not many years ago Wurtz wrote, with reference to the origin of the science, "La chimie est une science française;" at the present day we may say, without fear of contradiction, that, whatever its origin, it is now a German science; that it is to this fact that the Germans owe their supremacy; and that it is to our failure to feel the pulse of the times, and to educate ourselves up to the proper point that we owe our downfall. It is to be feared, moreover, that unless we realise this without further loss of time, and hasten to fit ourselves to do our fair share of the work, other industries in which chemistry plays an important part, ere another twenty years are past, will also have quitted our shores. To do this we must put aside the idea that University extension and County Council lectures, or even polytechnics and technical schools for the multitude, are to bring about the necessary reform; and we must rise above the belief that a degree given for text-book knowledge and an acquaintance with the ordinary methods of analysis is evidence of competency. A true conception of what a chemist is—what he is called on to do and to know in this age of progress—must arise in high quarters and especially among our manufacturers.

FIG. 1.—Laboratory as seen from the street; Works on right, Offices on left.

Our children must be properly taught at school and trained to work as well as to play, and we must cease to worry their lives at college by insisting on the study of a multiplicity of subjects, and no longer attempt to develope a Chinese system of examinations. Surely it is time that we realised that our examination system is a fraudulent failure. In Germany the victory has been gained wholly and solely through the agency of the Universities—here we are still dominated by influences which had their origin in the monkish cell, and our ancient Universities do nothing to help us. The intolerant individuality which has enabled us to conquer and to govern where other nations have failed is of little use in an industrial war against the most systematically instructed people in the world, whose weapons are scientific research and scientific method, and who have been careful to "organise victory," to use Huxley's expression in his remarkable letter to the *Times* at the time that the proposal to establish the Imperial Institute was under discussion. Huxley warned us six years ago of the fate that awaited our industries if we did not organise victory. I fear that so far as chemistry is concerned our insular conservatism still leads us to turn a deaf ear to all such warnings, and that the only change is that we are six years nearer to our fate.

The following particulars are mainly taken from the number of the *Chemiker-Zeitung* above referred to. I am indebted to the Farbenfabriken, vormals F. Bayer and Co., for photographs from which the illustrations to this article have been prepared. I may add that I have had the very great pleasure of inspecting the laboratory.

The opening passage of the *Chemiker-Zeitung* notice is very significant, and is as follows :—

In any industry at the present day standing still involves retrogression, and this is especially the case in the colour industry, which has developed to such an extent in our country during recent years, and which owes its development in the first instance to the extreme attention paid to chemical science in Germany at the universities and technical schools. Whereas formerly, however, the colour industry owed its progress almost entirely to the schools and their celebrated leaders, of late years knowledge in this great field has become so specialised that a determining influence can be exercised only by one who is within the industry. Since the colour works have begun to pay attention to derivatives of coal and wood tar not only in the dyers' interest, but have also placed them at the service of medical science; and since it has been recognized that the protection afforded by a patent does not retard, but, on the contrary, promotes an industry, and is therefore to the general good, and patent laws have been introduced into Germany, of which, in comparison with those of other countries, we have reason to be proud, competition has so increased that all the works concerned are forced to make every effort to prevent their destruction in the struggle for existence. Consequently all the larger colour works within recent years have erected laboratories in which a large number of disciples of chemical science are unceasingly engaged in the endeavour to meet the growing wants of the dyer by adding to the already large number of artificial coal-tar colours, not only with the object of producing colours of increased beauty, but also to meet the growing desire for colours of greater fastness, and especially with the object of entirely displacing the natural dye stuffs which were formerly exclusively used. These technical laboratories are necessarily arranged with special reference to the requirements of the industry, and therefore differ in many respects from the laboratories at the universities and technical schools which are used for teaching purposes.

The laboratory of the Farbenfabriken, vormals Friedr. Bayer and Co. at Elberfeld, opened towards the close of 1891, is the newest institution of its kind.

Fig. 1 is from a photograph of the building taken from the street. The object in view was to provide all necessary rooms for twenty-six chemists. In order to make full use of the site, however, rooms for certain other purposes were also included. The laboratory adjoins the offices of the firm and the dye house, and also the physiological laboratory. The new building is 35·66 m. long and 16·14 m. deep.

A large portion of the basement is fitted up as a store for apparatus, &c., and is connected with the laboratories above by a stairway and lift. Luxurious provision is made here for the comfort of the staff, two rooms being provided in which they can change their clothes, along one side of each of which there are twelve clothes cupboards, and a bench with cupboards for boots underneath extending along the opposite side; and also of twelve separate bath rooms with hot and cold water, and a lavatory with twenty-four basins. The heating apparatus for the baths, and a low pressure steam heating apparatus, are placed next to the wall at one end of the building, and here also niches are constructed for autoclaves—*i.e.* vessels in which materials can be heated under pressure.

The ground floor is 6 m. high from floor to floor, excepting at the eastern end, where it is 1·28 m. deeper. The eastern higher portion is divided by a floor into two low apartments fitted up for experimental dyeing. Next to this and beyond the stairway on either side of a corridor are two rooms, 2·96 × 5·61 m., one of which is a combustion room, the other containing balances and other physical apparatus. The whole of the remaining space, 24·18 m. long by 14·6 m. deep, is fitted up as a laboratory for twelve chemists, and comprises twelve separate working places, and two for large operations for common use. This arrangement has the advantage that each chemist has had placed at his disposal a separate laboratory for his own use without the room having been deprived of its uniform character. Fig. 2 is from a photograph of the laboratory, Fig. 3 representing one working place.

The first floor includes a room 8·13 m. by 3·21 m. for the use of the director of the laboratory; a room 9·82 m. by 5·61 m. used as a library;[1] a room 5·61 m. by 2·96 m. for special use; and a large laboratory corresponding to that on the ground floor with places for thirteen chemists. A gallery carried on iron brackets is constructed along the side of this room on the outside of the building, in which experiments involving the production of specially unpleasant odours can be made. This gallery is approached through a glazed doorway constructed in one of the window places, but experiments going on in it can be overlooked from the laboratory within, through the windows.

The second floor is divided into two by a partition wall, one part being occupied by the printers engaged in preparing the various labels, notices, &c., required by the firm; the other being used by the bookbinders who make up sample-books, &c.

The attics are used as store rooms.

The building is simply constructed of brick, stone being used only for the window-sills; in fact, it is characterised throughout by simplicity and solidity of construction. The basement floor is cemented; the remaining floors are covered with antilaeolith, a clay asphalt which withstands hot strongly acid liquids.

The drainage water is carried away in open channels constructed in the floor.

The electric light is used throughout, the large laboratories being each illuminated by means of four arc lamps, and the other rooms by glow-lamps.

It has not been thought necessary to introduce any

[1] Probably there are few, *if any*, libraries attached to educational institutions so fully provided with the current literature and works of reference as are the libraries at the chief colour works.

FIG. 2.—Laboratory for twelve chemists, six on either side of main passage.

mechanical system to secure general ventilation. Air is admitted through openings in the upper part of the windows, the foul air finding sufficient means of escape up a shaft in which there is a spiral staircase, at the end of the large laboratories, and which terminates in a large opening in the western gable. Special care, however, is taken to remove fumes evolved in the chemical experiments. For this purpose a large number of earthenware pipes, 15 ccm. in diameter, are built into the walls between the windows in the large laboratories and elsewhere; these are carried up and connected with asphalted flues, which eventually terminate in a large air shaft carried out above the roof; the necessary draft is secured by means of a large fan placed at the base of the shaft, and driven by the engine in the printing department. At right angles to the walls at both sides of the rooms, between the windows, hollow walls are built out about 2·5 m., on either side of which draft closets are constructed (see Fig. 2), flue pipes such as have been referred to being let into these walls.

Passing over numerous interesting details of construction, the arrangement of the laboratories may now be referred to. Each place is so arranged as to constitute a complete laboratory with every necessary provision, while at the same time there is nothing to prevent the various chemists working together or to hinder the general supervision of the laboratory. The arrangement is best understood by reference to Figs. 2 and 3, of which the latter shows a single working place. The two side benches are connected by the window bench, so that each chemist has command of a bench about 15 m. long! The bottles on the shelves of each place contain 180 different agents—among these being all the substances in use or produced in the works, so that, if desired, any combinations tried in the laboratory may at once be effected on the large scale in the works. The pipes for gas, water, compressed air and vacuum are carried in a space behind the shelving, and can be easily got at for repairs, the shelving being made removable. The benches, except at the windows, are covered with lead. Under the bench there are numerous drawers and cupboards, containing all apparatus that can possibly be required, and also chemicals such as salt, potassium chloride, sodium acetate, &c., which are used in large quantities. Thus in Fig. 3 a sliding stand will be seen projecting from a cupboard on the right-hand side, carrying measuring cylinders inverted over pegs. Each drawer or cupboard, in fact, has its special purpose, and is carefully labelled, the same arrangement being maintained throughout the laboratory, so that the attendants are able to see that each chemist is supplied with all necessary apparatus. On either bench next the window there is a closed draft-closet, and next to it a hood, it being possible to connect these by a moveable window. In one of the closets there is a large copper water bath, in which steam, previously cleaned from rust, condenses and can be drawn off as boiling distilled water; this bath has the usual openings above with rings, &c., and has within it a drying oven surrounded by boiling water, a wooden drying closet being placed below in which things can be dried by heat radiated from the water bath above. The waste water and steam pass away through the hollow wall at the back of the closet, in which there is a channel communicating with the drain.

FIG. 3.—Working place of one chemist.

On either side of the window a pipe connected to the general ventilation system is let into the wall, to which a funnel-shaped hood can be attached, so that experiments involving the evolution of fumes can be carried on at the window-bench. This bench, however, is chiefly used for titration work, and therefore shelves are affixed to the wall some distance above it on either side, on which large bottles are placed containing the standard solutions.

It will be seen from Figs. 2 and 3 that a sink is placed at the end of the bench on the one side, and that there is a desk on the opposite side; adjoining this desk is an ice cupboard let into the bench, on the cover of which a balance for weighing out substances used in the experiments is placed. By the provision of such an ice cupboard at every place a great saving of ice has been effected: it is not only available for the storage of ice—nowadays an indispensable laboratory agent—but things can be kept cool in it even over long periods, over Sunday for example.

Four differently coloured pipes for water, gas, compressed air and vacuum run along the ceiling, and from these branch pipes are carried down the columns to the benches; taps are provided in a convenient situation, so that, if necessary, the supply of water, &c., to a bench may be at once shut off. The water pipes are covered with flannel to prevent the water which condenses on them from dropping down. Each working place is provided with 4 taps for compressed air, 4 vacuum taps, 11 water taps, 14 gas taps for heating purposes, and 9 gas burners in case of a failure of the electric light. A steam pipe runs along the wall, from which there are branch pipes connected with "purifiers," conveying steam to each of the large water baths before referred to, and to a valve under the hood adjoining the closet.

A shower bath depends from the ceiling at either end of each of the large laboratories for use in case of the clothes of any of the chemists or laboratory attendants catching fire.

Every bottle on the shelves is not only clearly labelled, but is also numbered, so that it is easy for the lad who has to keep the place clean and in order, however ignorant he may be, to arrange them properly, and moreover, each particular chemical occupies the same position in the row of bottles in every place in the laboratory.

Each chemist has a lad to assist him who washes all vessels, keeps the benches clean and the apparatus in order; in fact, does generally what he is told, even helping in the experiments. In addition, there are three lads under the supervision of an older laboratory servant in each laboratory, who at once avail themselves of any opportunity offered by the absence of the staff to "tidy up" in regions not specially committed to the charge of the young assistants. The order and cleanliness—extending even to keeping the leaden bench tops polished—thus secured is most remarkable.

Each chemist is so completely screened from his neighbour "next door," that he is not only able to work undisturbed, but practically in secret; he is only open to observation from the place on the opposite side of the main gangway, and the chemists are usually so placed that of the two working at these benches either the one is a junior under the direction of the other, or they are working in co-operation.

As a further illustration of the perfection of the arrangements I may quote from an account before me of a visit to the laboratory a description of the steps taken to put out a fire. A crack is suddenly heard and flames and a dense cloud of smoke are seen to ascend from one of the benches; all the chemists in the room at once rush to the spot. The particular chemist is found to be unhurt, but the clothes of his laboratory boy are on fire; instantly he is dragged to the shower bath, and the fire is at once put out. Meanwhile the laboratory servant has given the alarm by means of the electric fire alarm provided in the room, and within two minutes the twelve men on duty of the twenty-four members of the works fire brigade appear in full uniform. Those present, however, by turning on all the water taps in the neighbourhood of the fire and directing the water on to the burning bench had already extinguished the flames. The room is filled with a dense black fog, but by opening the windows and a valve in the main ventilation system near the ceiling this is very soon got rid of. The origin of the accident was simple enough: a young chemist, fresh from the University, unaccustomed to work with large quantities, had allowed his laboratory boy to heat a couple of litres of the hydrocarbon toluene, which he was using in recrystallising a substance, in a glass flask, over a bare flame.

Another striking feature in the large laboratories is a series of brass valves arranged along the wall under a hood opposite the bench for general use; the labels under these valves bear the names oxygen, carbon dioxide, chlorine, sulphur dioxide, phosgene, methyl chloride, hydrogen and ammonia. These various gases, compressed in cylinders enclosed in cupboards in the basement, can be used at any time by communicating through a speaking tube to the man in charge of the store department, who then opens the valve on the cylinder containing the required gas, so that it only remains for the chemist to open the valve in the laboratory.

In the lower laboratory one place only is distinguished from all the others, being fitted up for electro-chemical work with the necessary current-measuring instruments, a series of about fifty glow lamps being arranged as resistances.

In the balance-room, besides balances, there is a large arc lamp with special lenses designed by Prof. von Perger, of Vienna, used in ascertaining the effect of light on colours—in these days sunlight can no longer satisfy the needs of German industrial enterprise! Colorimeters, spectroscopes, and other apparatus are also to be found in this room. Colour chemists are not fond of making analyses if it be possible to characterise substances by any other means; the combustion furnaces are therefore but little used, and a number of ovens in which pressure tubes are heated have supplanted most of them.

Adjoining the research laboratories there is a "technical laboratory" full of apparatus exactly like that in use in the works, but of much smaller size. Here experiments are carried out on a somewhat larger scale than in the laboratory prior to the processes being effected on the large scale in the works; and the staff in this laboratory are also engaged in making many of the chemicals required to replenish the stores for use in the research laboratories.

The stores are in charge of two superintendents, one of whom is educated as a glass-blower. It is worth mentioning also that all thermometers, prior to their issue from the store, are there compared with a normal thermometer.

The laboratory was designed by my friend Dr. C. Duisberg, the director, the necessary architectural assistance being afforded by Herr Bormann, architect to the works.

The foregoing is but a very imperfect account of this marvellous works research laboratory. A more typical and concrete illustration of the appreciation of the value of science by German manufacturers, however, could not possibly be found, but yet it is only one of many that might be brought forward. Personally I can only say, that while lamenting the criminal short-sightedness of my countrymen, I am lost in admiration of the enterprise displayed by their foreign competitors: it cannot be denied that they deserve to succeed!

HENRY E. ARMSTRONG.

ELECTRO-OPTICS.

THE experimental and theoretical investigations of the last twenty years have lent a new interest to what, I venture to think, is one of the most fascinating branches of physical optics, namely, the action of an electromagnetic field upon light. The discoveries which have hitherto been made may be classified under four heads: (1) Faraday's experiments, which show that when plane polarised light is transmitted through a *transparent* magnetised medium, a rotation of the plane of polarisation is produced; (2) Kerr's experiments, which show that the effect of electrostatic force on a *transparent* medium is to convert it into one which is optically equivalent to a uniaxal crystal whose axis is in the direction of the force; (3) Kerr's experiments on the reflection of plane polarised light at the surface of a magnetised iron reflector, which show that a rotation of the plane of polarisation of the reflected light takes place, which in certain cases is in the same and in others in the contrary direction to that of the amperean current which may be conceived to produce the magnetic force; (4) Kundt's experiments on the reflection of light from magnetised iron, cobalt, and nickel, and also on the transmission of light through thin magnetised films of these metals. There is also another series of experiments by Kundt, in which polarised light is refracted at the upper surface of a plate of glass, is then reflected at the lower surface, and again refracted at the upper surface. The results of these experiments show that the plane of polarisation of the ultimately emergent light is rotated in the *contrary* direction to that produced by an iron reflector.

There seems to be a fair amount of evidence to lead to the conclusion that Hall's effect is intimately connected with the action of a magnetic field upon light, but further evidence is required before it can be asserted that both phenomena are due to the same ultimate cause. Up to the present time Hall's effect has, I believe, only been detected in conducting media; but if it be assumed to be capable of existing in transparent media, theory furnishes results which, as far as they have been worked out, are in agreement with experiment. Hall's effect is capable of explaining the experiments of Faraday, and it also gives a result in accordance with Kundt's experiments on reflection and refraction from a plate of magnetised glass in the case in which the magnetisation and incidence are normal. It would be quite possible to apply this theory to the case of oblique incidence, but the work would be laborious and the final results complicated. The experiments of Prof. Dewar on liquid oxygen would seem to provide a more promising way of testing this theory, for, on account of the high susceptibility of this substance to magnetic action, it is possible that an effect might be observed in the case of *direct* reflection.[1] According to theory, Hall's effect ought to be positive in the case of glass and gaseous oxygen, and negative in the case of a solution of perchloride of iron; and a repetition of Kundt's experiments, in which the latter liquid is employed in the place of glass, ought to show that the rotation takes place in the *same* direction as that produced by metallic iron. Such experiments would be valuable as a further test of the theory, but they do not appear to have been made.

A paper recently communicated to the Cambridge Philosophical Society (May 1) still further confirms the view which I have put forward. In this paper I have transformed the formulæ for reflection at a magnetised *transparent* medium by assuming that the refractive index is a complex quantity. The resulting formulæ for the amplitudes of the reflected vibrations agree very well with Kerr's experiments so far as qualitative results are concerned, provided the values and signs of certain quantities are supposed to be determined by optical, as distinguished from electromagnetic methods. They are, moreover, the same *as regards their form* as those deducible from Maxwell's theory by taking into account the conductivity combined with Hall's effect; but unfortunately the values of certain constants, when expressed in terms of electrical quantities, differ from the values which are required by optical experiments, in a manner which prevents a perfectly satisfactory electromagnetic theory being constructed in this way, and I doubt whether it will be possible to attain the end in view until a theory based upon the mutual reaction of ether and matter has been discovered in which quantities, upon which the motion of matter depends, enter into combination with electromagnetic quantities.

Although the sign of Kerr's effect in nickel is the same as in iron and cobalt, the sign of Hall's effect is different. This difficulty is apparent rather than real, for a theory based upon the mutual reaction of ether and matter might very well introduce a factor containing the free periods of the vibrations of the matter which would change the sign of the magnetic terms. Some light might be thrown on this point by determining the principal incidence and azimuth for nickel and cobalt.

The generally received theory, that reflection and refraction are materially influenced when any of the free periods of the vibrations of the matter fall within the limits of the visible spectrum, suggests that the sign of Kerr's effect may be different in the case of the ultra-violet and the infra-red portions of the spectrum from what it is in the luminous portion. Experiments on this branch of the subject are needed, and possibly the employment of a fluorescent substance, such as quinine, in the case of the ultra-violet waves, or of a solution of iodine in disulphide of carbon, in conjunction with Prof. Langley's bolometer,[2] when the infra-red waves are experimented upon, might furnish important information on this point.

The experiments of Kerr on the effect of electrostatic force suggest that if light were reflected from a strongly electrified metallic conductor, certain peculiarities would be observed. In the absence of experiments, which do not appear to have been made, it would be impossible to predict with certainty what these effects are likely to be; but it would seem probable that an electrified metallic reflector would behave like a doubly-refracting metallic medium having a *single* optic axis which is perpendicular to the reflecting surface. When light is reflected from the surface of a uniaxal crystal which is cut perpendicularly to the axis, the component vibration at right angles to the plane of incidence is reflected in the same manner as if the medium were isotropic. Under these circumstances we should anticipate that in the case of an electrified metallic reflector, the component vibration *in* the plane of incidence would be much more strongly affected by electrification than the component at right angles to this plane. If this speculation should be verified by experiment, it would follow that the principal incidence and azimuth, and also the difference between the changes of phase of the two components, would be affected by electrification in a manner which could be observed.

In conclusion I would point out that further experiments are required of the following nature:—

(1) Experiments on the reflection of light from magnetised *transparent* media, such as glass, perchloride of iron, and also if possible from liquid oxygen.

(2) Experiments on reflection from and transmission through magnetised metals, special attention being paid to the effects produced by the non-luminous portion of the spectrum.

(3) Experiments on reflection from *electrified* metallic reflectors.

A. B. BASSET.

[1] The effect produced by a *single* reflection from magnetised glass would be too feeble to be detected; but Dr. Kerr suggested to me that an effect might possibly be observed by employing the method of multiple reflections.

[2] I do not know whether the bolometer is more sensitive to heat than a pair of average eyes are to light; if it is, experiments on the infra-red waves ought to be easier than experiments on luminous waves.

NOTES.

The annual meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers, 25, Great George Street, London, on Wednesday and Thursday, May 24 and 25. On Wednesday business will be transacted; the Bessemer Gold Medal for 1893 will be presented to Mr. John Fritz, of Bethlehem, Pa., U.S.A.; and the president-elect, Mr. E. Windsor Richards, will deliver his inaugural address. The following papers will afterwards be read and discussed: "On the elimination of sulphur from iron and steel" (second paper), by J. E. Stead; "On the Saniter process of desulphurisation," by E. H. Saniter. On Thursday the following papers will be read and discussed:—"On the basic process of Witkowitz," by F. Kupelwieser; "Notes on puddling iron," by John Head; "On a recording pyrometer," by Prof. Roberts-Austen, F.R.S.

The Royal Society *soirée* was being held as Nature went to press yesterday evening.

A dinner will be given by the Master and Fellows of Gonville and Caius College, Cambridge, on Wednesday, June 21, in the College Hall, to celebrate the tercentenary of the admission of William Harvey to the college.

The annual dinner of the Royal Geographical Society will take place on Saturday, May 13, at the Whitehall Rooms, Hôtel Métropole, Sir M. E. Grant Duff, President of the Society, in the chair.

The second annual Robert Boyle Lecture of the Oxford University Junior Scientific Club will be delivered in the University Museum on Tuesday, the 16th inst., at 8.30 p.m., by Lord Kelvin, P.R.S. His subject will be, "The Molecular Tactics of Crystals."

The Geologists' Association has made arrangements for a geological excursion to Farnham on Saturday, May 13. During Whitsuntide there will be an excursion to Bradford-on-Avon and Westbury, in Wiltshire.

The late Lord Derby has left by will to the Royal Society a sum of £2000. He has also bequeathed £2000 to the Royal Institution.

The Royal Society of New South Wales offers its medal and £25 for the best communication sent in not later than May 1, 1894, containing the results of original research or observation upon each of the following subjects:—(1) On the timbers of New South Wales, with special reference to their fitness for use in construction, manufactures, and other similar purposes; (2) on the raised sea-beaches and kitchen middens on the coast of New South Wales; (3) on the aboriginal rock-carvings and paintings in New South Wales.

The Royal Hungarian Academy of Sciences at Buda-Pesth has devoted the sum of 2000 fl. to the promotion of botanical investigations during the year 1893.

The Committee of the Kew Observatory has issued its report for the year ending December 31, 1892.

The Council of the Durham College of Science has resolved to offer to each county council in England the right of nominating a scholar who shall attend the course of instruction in the agricultural department of the college without the payment of fees, on condition that the county council pay to the scholar not less than £30 towards the cost of his board and lodging in Newcastle or the neighbourhood, and of such books or appliances as he may require for his study. The scholarships will be tenable in the first instance for one year, but may be renewed for a second year by the college council if the progress o the student is satisfactory. The object of the college council is twofold: to bring before the notice of county councils and others the advantages offered by its agricultural department, and to make some acknowledgment to the country generally for the contributions it has received from imperial sources through the Board of Agriculture.

The Yorkshire Naturalists' Union is making a great effort to double its membership, and ought to have little difficulty in accomplishing its purpose, as it is one of the most vigorous of the provincial scientific societies. Its funds are at present insufficient to justify it in publishing all the important works it has in hand.

Mr. M. A. Veeder writes to us from Lyons, New York, that Lieut. Peary, of the United States Navy, during his coming expedition to the northernmost Greenland, will record observations of the aurora, upon a plan that will enable comparisons to be made in detail with records from other localities. "The plan," Mr. Veeder says, "is already in operation, upon an international basis, and the results are proving to be important. Numerous observers widely distributed are desirable, and inasmuch as even those who have no special technical knowledge may make entries that will be of value any who feel so disposed may co-operate." Further information and supplies of blanks may be obtained from Mr. Veeder, who will be glad to receive also, any records of observations of the aurora whatever, for purposes of comparison.

Moderate rains occurred in the north and west, in the early part of last week, owing to the advance of depressions from the Atlantic, and a small amount of rain fell in the midland counties, but over the southern and eastern parts of England there was no measurable quantity. The drought has continued with great persistency over the southern part of the kingdom, the period without rain, up to Tuesday the 9th inst., being fifty-three days at some of the stations reporting to the Meteorological Office. An anticyclone embraced the greater part of western Europe throughout the past week, and spread westwards over the British Islands, causing high atmospheric pressure, while in northern Scandinavia the barometer rose to nearly 31 inches. The temperature has been irregular; although high for the time of year, it has been lower generally than some weeks ago; in a few instances the daily maxima have exceeded 70°, but in parts they have been little above 50°. The *Weekly Weather Report* of the 6th instant showed a general decrease of bright sunshine. The percentage of possible duration ranged from 18 to 27 in Ireland, from 22 to 30 in Scotland, and from 41 to 57 in England; in the Channel Islands the high percentage of 81 was recorded.

At the meeting of the French Meteorological Society on April 4 Dr. Fines presented a note on the violence of the storms which are occasionally experienced in the province of Roussillon (Eastern Pyrenees). On five occasions between 1860 and 1867 railway trains have been overturned on the line from Narbonne to Perpignan. A storm of great violence occurred from January 15 to 24 last, in which at one time the velocity amounted to 85 miles an hour. A large number of trees were uprooted and some loaded railway trucks were overturned on this occasion.

The annual general meeting and *conversazione* of the Selborne Society were held at the rooms of the Royal Society of British Artists yesterday evening. The objects of this excellent society are: to preserve from unnecessary destruction such wild birds, animals, and plants as are harmless, beautiful, or rare; to discourage the wearing and use for ornament of birds and their plumage, except when the birds are killed for food or reared for their plumage; to protect places and objects of interest or natural beauty from ill-treatment or destruction; and to promote the study of natural history. Many good writers on natural history contribute to the society's journal, *Nature Notes*.

A CAPITAL paper on the manufactures of India was read by Sir Juland Danvers before the Indian Section of the Society of Arts on April 24, and is published in the current number of the Society's Journal. Sir Juland is of opinion that, if all legitimate means are taken for opening the markets of the world to Indian commerce and for stimulating enterprise and energy by developing the country itself, India may become a large manufacturing as well as an agricultural country, and thus be enabled not only to support but to improve the condition of her vast population. The reading of the paper was followed by a most interesting discussion, in the course of which several high authorities expressed their cordial agreement with the views stated by Sir Juland Danvers. Sir C. E. Bernard said that short of vast discoveries of workable gold within her borders India's true and only way out of the silver difficulty that threatens her with bankruptcy is the rapid development of her home industries, especially her cotton and iron manufactures.

THE Trinidad Field Naturalists' Club prints in its Journal for April a valuable preliminary list of the mammals of Trinidad, by Mr. Oldfield Thomas, of the British Museum (Natural History). Mr. Thomas explains that he has prepared the list as a basis on which a complete scientific list of the mammals inhabiting Trinidad may be founded, and to show members of the society how extraordinarily little is definitely known of the mammals of the island. By known, of course, he means scientifically known in the sense of being published to the world, for he has no doubt whatever that many members of the society could off-hand add to the list many animals well-known to them and other inhabitants, but neither hitherto mentioned in scientific publications nor represented by specimens in the British Museum. He earnestly begs that all persons interested in the natural history of Trinidad will do what they can to obtain specimens and to send them home for identification. Every collection made at present is sure, he says, to contain species new to the island, even if not—as in the case of two bats recently received from Trinidad—altogether new to science.

A PAPER on "Recreation," read by Mr. William Odell before the Torquay Natural History Society, has been printed separately. It contains some very interesting letters from the head masters of public schools as to the effect of athletics on school work.

MR. FREDERICK J. HANBURY and the Rev. E. S. Marshall are engaged in the preparation of a Flora of Kent, which should prove an exceptionally rich county flora, though some districts have as yet been but imperfectly searched. Any assistance will be gladly received by the Rev. E. S. Marshall, Milford Vicarage, Godalming.

MR. A. T. DRUMMOND has been investigating the colours of flowers in Ontario and Quebec in relation to the time of flowering, and has contributed to the *Canadian Record of Science* an interesting paper on the subject. He finds that April, May, and even June and July are remarkable for the prevalence of white flowers, July and especially August of yellow, and September and October of purple and blue.

GOOD illustrations of the difficulty of determining plants or vegetable productions by popular or local names are given in a letter by Mr. B. B. Smyth, of the Kansas Academy of Science, published in the current Quarterly Record of the Royal Botanic Society of London. "The name Nightshade," he says, "is applied here to *Solanum nigrum* and *S. triflorum*; the name Woody Nightshade is applied to *S. Dulcamara*; the name Bittersweet is applied to *Celastrus scandens*, a twining woody plant with clusters of showy scarlet berries; the name Laurel is applied to the different species of Kalmia; the names Mock Orange and Syringa are applied (of course misapplied) to Philadelphus; the name Sarsaparilla is (mis)applied to Aralia; the name Snakeroot is applied to a dozen different species in half as many different orders; the name Mouse-ear is applied to Gnaphalium, Antennaria, and Cerastium."

WE have repeatedly called attention to the fact that the German publisher Engelmann is issuing an important series of small volumes consisting of papers which have marked an era in the history of science. A series of much the same kind has been begun, we are glad to note, by Mr. W. F. Clay, Edinburgh, and Messrs. Simpkin, Marshall and Co., London. The volumes in this series are to be known as "Alembic Club Reprints.' The first volume consists of Joseph Black's paper, entitled, "Experiments upon Magnesia Alba Quicklime, and other Alcaline Substances."

THE Natural History Society of Marlborough College has issued its report for the year ending Christmas, 1892. The high standard of work in the sections is said to have been, on the whole, well maintained; but an exception is made in the case of the zoological section, the members of which showed "little disposition to exert themselves in work conducted on scientific lines." The library of the society is rapidly increasing. Among the works added to it during the year were the four splendidly illustrated volumes (privately printed) on excavations and archæological discoveries in or near Wilts, by General Pitt-Rivers. These were presented by the author, to whom special thanks are accorded for his "peculiarly interesting and valuable gift."

ARISTOTLE, it seems, knew almost as much about field voles as is known by those who have lately been studying the mischief done by these creatures in Thessaly and Scotland. In a passage quoted in the current number of the *Zoologist* from his "Natural History of Animals" he speaks of their power of destruction as "so great that some small farmers, having on one day observed that their corn was ready for harvest, when they went the following day to cut their corn, found it all eaten." "The manner of their disappearance also," he continues, "is unaccountable; for in a few days they all vanish, although beforehand they could not be exterminated by smoking and digging them out, nor by hunting them and turning swine among them to root up their runs. Foxes also hunt them out, and wild weasels are very ready to destroy them; but they cannot prevail over their numbers and the rapidity of their increase, nor indeed can anything prevail over them but rain, and when this comes they disappear very soon." This passage is quoted in the *Zoologist* by Mr. A. H. Macpherson. The editor adds a note showing that Aristotle was by no means the only ancient writer to whom the facts were familiar.

MR. G. LEWIS contributes to the current number of the *Entomologist* a list of coleoptera new to the fauna of Japan, with notices of unrecorded synonyms. Some of the list are well-known European species; others have hitherto been known from Siberia only. Mr. Lewis says that some years will elapse before the collection gathered by him in Japan can be completely worked out.

AN interesting paper on mining and ore-treatment at Broken Hill, New South Wales, was read at the meeting of the Institution of Civil Engineers on May 2, the authors being Mr. M. B. Jamieson and Mr. J. Howell. From this mine silver and lead of the value of over £8,250,000 sterling had been taken within seven years; and it continued to yield about

220,000 ounces of silver, and between 600 and 800 tons of lead per week. Speaking of the products of the refinery, the authors said they were thus disposed of:—The pure silver was sold in the colonies by tender at stated intervals, in parcels of between 100,000 ounces and 150,000 ounces, and was purchased by the banks usually at a price somewhat above the price current in London. The soft lead was shipped either to England or to China; the latter country was becoming gradually a larger buyer of the company's lead. The matte and other compound products were shipped to England. The small amount of gold in the ore was recovered in the refinery. It amounted to about 3·4 dwt. per ton of bullion.

Mr. C. Hedley has contributed to the Proceedings of the Linnean Society of New South Wales (Second Series, vol. vii.) an interesting paper on the range of *Placostylus*, which he describes as a more fruitful subject of study than any other molluscan genus inhabiting the same area. Their large and handsome shells have attracted the attention of the most superficial and unscientific collectors, so that an extensive series has been brought to the knowledge of investigators from remote localities. In the summary of his results, Mr. Hedley remarks, first, on the essential unity of the *Placostylus* area as a zoological province, embracing the archipelagoes of Solomon, Fiji, New Hebrides, Loyalty, New Caledonia, Norfolk I. (?), Lord Howe, and New Zealand; a unity explicable, he thinks, only on the theory that they form portions of a shattered continent and are connected by shallow banks formerly dry land. This continental area he proposes to call the Melanesian plateau. He holds, secondly, that this Melanesian plateau was never connected with, nor populated from, Australia, but that its fauna was probably derived from Papua *viâ* New Britain. The presence of genera common to Australia and New Zealand he believes to be explicable on the ground that they migrated, not from the one territory to the other, but each from a common source, New Guinea. Thirdly, he thinks that New Zealand and New Caledonia were early separated from the northern archipelagoes and ceased to receive overland immigrants therefrom. Fourthly, the Fijis, according to Mr. Hedley, remained to a later date in communication with the Solomons, but were severed from that group before the latter had acquired from Papua much of its present fauna.

The "Year Book of Australia" for 1893 has been published. It includes an interesting account of scientific work done in the various Australian colonies during 1892. This has been compiled from information supplied by the scientific societies of Australia.

Some valuable reports on the Victorian coalfields, by Mr. James Stirling, of the Geological Survey of Victoria, have been issued by the Department of Mines in that colony. They are fully and most carefully illustrated.

A French translation of Lord Kelvin's "Popular Lectures and Addresses" has been published by Messrs. Gauthier-Villars et Fils. The translator is P. Lugol, who has added some notes. Translations of extracts from recent memoirs by Lord Kelvin, with notes, have been contributed by M. Brillouin.

A fresh instalment of the Proceedings of the American Academy of Arts and Sciences (New Series, vol. xix.) has just been published. It covers the period from May 1891 to May 1892. Among the contents are some considerations regarding Helmholtz's theory of consonance, by C. R. Cross and H. M. Goodwin; a note on the dependence of viscosity on pressure and temperature, by C. Barus; what electricity is: illustrated by some new experiments, by W. W. Jacques; on a theorem of Sylvester's relating to non-degenerate matrices, by H. Taber; researches on the volatile hydrocarbons, by C. M. Warren; descriptions of new plants collected in Mexico by C. G. Pringle in 1890 and 1891, with notes upon a few other species, by B. L. Robinson; on some experiments with the phonograph, relating to the vowel theory of Helmholtz, by C. R. Cross and G. V. Wendell, and other papers.

A paper entitled "Further Studies of Yuccas and their Pollination" has been contributed by Mr. W. Trelease to the fourth annual report of the Missouri Botanical Garden, and is also published separately. It is well illustrated.

The new number of the *Quarterly Journal of the Geological Society* includes the text of the anniversary address of the President, Mr. W. H. Hudleston, F.R.S. He deals with the work brought before the Society in the course of the last seven years, during which he has served the Society in one official capacity or another.

A fourth edition of "Practical Physics," by R. T. Glazebrook and W. N. Shaw, has been issued by Messrs. Longmans, Green, and Co. The authors have taken advantage of this opportunity to make some alterations and additions suggested by their own experience or that of their successors at the Cavendish Laboratory.

In a recent number of the *Comptes Rendus*, M. Rigollot gives a further account of his experiments on the electrochemical actinometer. He finds that the electromotive force developed when light falls on a plate of oxydised copper immersed in a solution of a metallic iodide, bromide or chloride can be considerably increased if it has previously been dipped in some colouring matter, such as eosine or safranine. This increase of sensitiveness is different for rays of different wave lengths, and those rays which produce the maximum effect, for any one colouring substance, depend on the position of the absorption band in the light which is transmitted by that substance.

M. Chassagny has a note in the current number of the *Comptes Rendus* on the influence of longitudinal magnetisation on the electromotive force of an iron-copper thermo-electric junction. Two couples were used, one being in the axis of a long magnetising helix, so joined together that they acted in opposite directions. The results obtained were:—(1) The effect of longitudinal magnetisation is always to increase the electromotive force. (2) This increase is independent of the direction of magnetisation. (3) For increasing fields the increase is at first very nearly proportional to the strength of the field, and attains a maximum value of 6·1 microvolts for a field of 55 C.G.S. units. After this it slowly decreases till for a field of 200 units it is 3·2 microvolts.

At the meeting of the Société Française de Physique, held on April 21, M. P. Curie gave some of the results of his experiments on the magnetic properties of bodies at different temperatures. The body to be experimented on was placed in a non-uniform magnetic field and the force acting on it measured by the torsion of a metallic wire. An electric heater capable of raising the temperature of the body to 1400° C. was used, together with one of Le Chatelier's thermo-elements to measure the temperature. In the case of oxygen, the magnetic permeability is constant for magnetising forces of from 200 to 1350 units, and for pressures of from 5 to 20 atmospheres. The law of variation of the permeability with temperature is very simple, since between 20° and 450° it varies inversely as the absolute temperature. In the case of air, the permeability at a temperature t is given by the formula $10^6\mu_t = 2760/t^2$, which can be used to correct observations made in air at any temperature.

A NEW reaction, of wide general application and of considerable practical utility, by means of which the important organic compounds known as nitriles may be readily prepared in a state of purity, has been discovered by Prof. Michaelis and Dr. Siebert, and is described by them in the current number of *Liebig's Annalen*. As stated in our chemical note of last week, Prof. Michaelis has recently been studying the action of thionyl chloride, $SOCl_2$, upon the primary amines, and has shown that the product of the reaction is a thionylamine, a compound formed by the replacement of the two hydrogen atoms of the NH_2 group of the amine by the radical thionyl, SO. In seeking to ascertain whether a similar kind of compound to the thionylamines is formed when thionyl chloride is allowed to act upon the amides of the acid radicles, Prof. Michaelis and Dr. Siebert have discovered the new mode of preparing the nitriles. Instead of a compound of such a nature being produced, a nitrile is the main product, with sulphur dioxide and hydrochloric acid as bye products. As the two latter are gaseous substances, it is at once evident that the reaction must afford a particularly convenient mode of preparing the nitriles in a state of purity. The reaction, moreover, is quite general, and is applicable both in the fatty and in the aromatic series. When thionyl chloride is brought in contact with acetamide, $CH_3 . CO . NH_2$, a violent reaction occurs, with considerable rise of temperature. After a few minutes, however, the violence diminishes, and the liquid eventually becomes quiescent. In order to complete the interaction, the product should then be heated over a water-bath for a few hours, the reaction flask being provided with a reflux condenser. When the fumes of hydrochloric acid and the odour of sulphur dioxide are no longer perceptible, the reaction is completed in accordance with the equation—

$$CH_3 . CO . NH_2 + SOCl_2 = CH_3 . CN + SO_2 + 2HCl.$$

The dark-coloured liquid is then decanted from a small quantity of resinous products of decomposition and distilled, when pure acetonitrile, clear and colourless, passes over it at its boiling point, 82°. The yield of pure nitrile is about half the weight of acetamide employed. The violence of the reaction between thionyl chloride and acetamide is very much diminished by the addition of benzene; but owing to the difficulty of separating the resulting nitrile from the benzene by fractional distillation, it is preferable not to employ it. With care, the direct addition of the thionyl chloride may be made without loss. Propionamide reacts in a very similar manner with thionyl chloride, and almost the whole of the liquid product distils over quite colourless at the boiling point of propionitrile (98°). In like manner, pure benzonitrile may be obtained by the action of thionyl chloride upon the amide of benzoic acid. It is preferable, however, in case of such higher boiling nitriles which can be readily separated from benzene by fractional distillation, to conduct the operation in presence of benzene, the reaction then proceeding much more regularly and without the violence of the direct action. Upon subsequent distillation, the thermometer at once rises to 190° after the distillation of the benzene, and remains constant at that temperature until almost the whole of the benzonitrile has passed over.

NOTES from the Marine Biological Station, Plymouth.—Last week's captures include the Hydroid *Hydractinia echinata*, the Polychæta *Eunice Harassii* and *Siphonostoma uncinatum*, the Polyzoan *Pedicellina cernua*, the Opisthobranchs *Runcina coronata* and *Polycera Lessonii*, the Crustacean *Hyas araneus*, and the Echinoderms *Cucumaria Planci* and *Luidia ciliaris*. The quantity of gelatinous algæ in the Channel waters at length exhibits signs of diminution. Medusæ of the remarkable Hydroid *Corymorpha nutans* (of Allman) have been taken in the tow-nets on several occasions. The medusæ of *Aurelia aurita* are growing rapidly in size, and have now attained an average diameter of 1¼ inches. The *Megalopæ* of *Carcinus* are no longer commonly taken in the tow-nets, but are chiefly to be found in especial haunts at the sea-bottom. The following animals, not hitherto noted, are now breeding: the Hydroids *Plumularia setacea* and *Antennularia ramosa*, the Decapod Crustacea *Crangon fasciatus* and *Hippolyte Cranchii*, the Ophiurid *Amphiura elegans* (= *squamata*), the Ascidian *Styelopsis grossularia*, and several species of Amphipoda and Pantopoda.

THE additions to the Zoological Society's Gardens during the past week include two Mozambique Monkeys (*Cercopithecus pygerythrus*, ♀ ♀) from East Africa, presented respectively by Mr. Arthur James and Miss Maude Parkinson; a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Miss G. Lloyd; a Bonnet Monkey (*Macacus sinicus*, ♀) from India, presented by Mr. R. Hughes; a Macaque Monkey (*Macacus cynomolgus*, ♀) from India, presented by Mr. F. Byfield; an Indian Buffalo (*Bubalus buffelus*, ♀) from India, presented by H.H. The Maharaja of Bhoonagar; a Common Hedgehog (*Erinaceus europæus*) British, presented by Mrs. E. Austen-Leigh; a West African Love-Bird (*Agapornis pullaria*) from West Africa, presented by Lady Theodora Guest; two Herring Gulls (*Larus argentatus*) British, presented by Mr. W. H. Aplin; two Egyptian Mastigures (*Uromastix spinipes*) from Egypt, presented by Mr. Edmund Lamb; a Moorish Tortoise (*Testudo mauritanica*) from North Africa, presented by Mr. T. W. Bayley; seven Green Tree Frogs (*Hyla arborea*) South European, presented by the Rev. C. D. Fothergill; a Silvery Gibbon (*Hylobates leuciscus*) from Malacca, a Roseate Cockatoo (*Cacatua roseicapilla*) from Australia, twenty Green Tree Frogs (*Hyla arborea*) South European, deposited; two Amherst Pheasants (*Thaumalea amherstiæ*, ♀ ♀) from Szechuen, China, a Swinhoe's Pheasant (*Euplocamus swinhoii*, ♂) from Formosa, three Cat Fish (*Amiurus catus*) from North America, purchased; a Common Crowned Pigeon (*Goura coronata*) from New Guinea, received in exchange; a Yak (*Poëphagus grunniens*), ♀), a Water Buck (*Cobus ellipsiprymnus*, ×), an Angora Goat (*Capra hircus. var.* ♂,), a Bennett's Wallaby (*Halmaturus bennetti*, ♂) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

MERIDIAN CIRCLE OBSERVATIONS.—At the meeting of the Royal Astronomical Society, held on April 14 last, the proceedings of which are recorded in the current number (No. 201) of the *Observatory*, the paper prepared by Messrs. Turner and Hollis (and read by the former) entitled, "Comparison of the Greenwich Ten-year Catalogue (1880) with the Cape Catalogue (1880)," was the means of instigating an interesting discussion with reference to questions relating to systematic error of meridian observations. The questions thus raised are of great importance, for, as Dr. Gill remarks, they "affect the objects for which public observatories were founded." Generally speaking the comparison of the catalogues above mentioned seems to have given very satisfactory results, but the series of differences obtained from the north-polar-distances, arranged in order of north polar distance, showed signs of small divergences. The source from which these differences could have arisen seems—since the accuracy of the N.P.D. places depends on the coefficient of refraction—to be at first sight apparent, and Mr. Stone's opinion is that this quantity is "practically mixed up with the question of refraction," his firm conviction being that in the Cape observations there are no systematic errors possible to account for 0″·4. Dr. Gill, in referring to the discussion generally, made some very striking remarks about meridian observations, and was of opinion that at the Cape there were sources of systematic error amounting possibly to half a second of arc. The differences obtained from the reflex and direct observations at the Cape, he says, have led him to the conclusion that they are caused by the fact that, "since the walls of the transit room are about three feet thick, they retain for a long time the heat which they absorb during the day. The result is that there are layers of air of different temperature in the room at night." To improve fundamental astronomy, half a second of arc, he says, must be seriously taken into account, and this can only be done by employing a sound instrument and a properly-constructed observing-room, "and we have neither the one nor the other at the Cape nor at Greenwich. If we are going to fight for two-tenths or three-tenths of a second, we must set to work *de novo* with better instruments, better housed, for the determination of constant error."

The Lunar Atmosphere.—Various are the methods that can be adopted for observing whether the moon has an atmosphere or not, but some of them, such as those that depend on solar eclipses, have been the least often attempted, since they are of an extremely delicate nature. In eclipses, whether partial or total, if the moon really had a moderately dense atmosphere, we should be able, by photographing the sun when partially covered by the moon, to note whether the delicate details on the solar surface in the region of the lunar limb had suffered any slight alterations in their forms. To note such variations it is needless to say that photography must be employed, and further that the photographs must be on a moderately large scale, for if indeed there be changes of form they will by no means be necessarily *very* apparent. For such observations as these no better scale could be used than that adopted by M. Janssen in those wonderful solar pictures that have done much to help us in extending our knowledge of the sun's surface. In fact M. Janssen, in *Comptes Rendus* for April 17 (No. 16) tells us that in order to try this method again several plates were exposed during the recent eclipse of the sun, but owing to the state of the sky the conditions were not very favourable, as these large photographs require a perfectly pure atmosphere. He mentions at the end of his note that he has already made some progress towards the solution of this question from the photographs that were taken at Marseilles during the partial eclipse of July, 1879.

GEOGRAPHICAL NOTES.

The Berlin Geographical Society has awarded the Humboldt medal, the highest honour it can bestow, to Dr. John Murray, editor of the *Challenger* reports, in recognition of the great advances in physical geography which are associated with his name.

The Paris Geographical Society has also awarded one of its gold medals to a foreigner, Dr. Fridjof Nansen. Other gold medals given by the Paris Society went to Captain Monteil, for his great journey to Lake Chad, M. Dybowski, for exploration on the Shari, and M. Lentheric for his monograph on the Rhone.

Mr. Guy Boothby has recently crossed Australia from north to south. He started from Normanton on the Gulf of Carpentaria in March, 1892, travelled leisurely on horseback or in a waggon to Bourke, and then descended the Darling in a boat, and later a river-steamer to Morgan, thence by rail to Adelaide. The journey occupied rather more than a year, and so far as appears little or no new country was traversed.

The May number of the *Scottish Geographical Magazine* contains a paper on the people of the Lake Nyasa region, by Mr. D. J. Rankin, in which he makes some serious charges against Mr. H. H. Johnston, the British Commissioner. Mr. Rankin considers the rule of the commissioner to be too severe, and finds fault with his knowledge of the native tribes and their claims to the land.

Mr. E. A. Floyer has a long paper in the *Geographical Journal* on the Eastern Desert of Egypt, illustrated by some very characteristic pictures and a new map, the result of his surveys. The expedition of which he was the leader was sent out by the Egyptian Government in 1891, and surveyed 23,000 square miles of mountainous desert. The region is crossed by a ridge of high ground in the higher peaks of which a few shepherds find a precarious pasture for their flocks, which feed on the comparatively thick growth of acacias. The water-supply is in the form of natural reservoirs of rain, in many cases contained in limestone cavities which keep the wells supplied.

The Columbus *fête* held in Paris on April 15, the 400th anniversary of the return of Columbus is reported at length in the current number of the *Revue de Géographie*, the main feature being an address by M. Ludovic Drapeyron, who presided. The novelty of such celebrations has passed, and it is difficult to see how the celebration of the fourth centenary of each episode of the life of Columbus after 1492 can be made serviceable to geography or of special interest to the public.

THE RECENT SOLAR ECLIPSE.

We have already printed a number of telegrams relating to observations of the solar eclipse of April 16 in various parts of the world, and now reproduce from the *Nottingham Daily Guardian* of May 9 an article on the work of the British party in West Africa. This article is contributed by a special correspondent of that journal, who writes from H.M.S. *Blonde*, Las Palmas, April 28. It contains the first detailed information which has appeared on the subject. The writer says:—

The expedition left Liverpool on March 18 by the British and African Company's steamer *Teneriffe*, the company having most generously contracted to convey them to the Gambia at greatly reduced rates. Bathurst, near the mouth of the Gambia, was reached on March 31, when the observers and their instruments were at once transferred to H.M.S. *Alecto*, which had been kindly placed at the disposal of the expedition by the Admiralty. The *Alecto*, being specially designed for service on the West African rivers, was eminently adapted to the purposes of the observers, and, indeed, without some such aid the expedition would have been impracticable. On the afternoon of April 2 the *Alecto* proceeded with the observers to the Salum River, which lies some distance to the north of the Gambia, and Fundium was reached on the following morning. The village, by the way, is called Goundiougne by the French. The chief occupation in this part of Africa is the raising of ground nuts for export. On arrival it was found that M. Deslandres and a small staff from the Paris Observatory had already been at Fundium a fortnight, and had got most of their instruments into position. A neighbouring site, kindly offered to the British party by the Administrator, was at once accepted as satisfying all requirements. It had the advantage of being partially enclosed, and was quite near to one of the wharves, so that the instruments could be put ashore without difficulty. The land around Fundium is very flat, and a perfectly clear horizon was therefore obtained. The site having been selected, plans for the arrangement of the various instruments were at once drawn, and the concrete bases were laid down, the necessary cement having been brought from Liverpool. Huts for the instruments, which had likewise been brought from England, and the instruments themselves were also erected with the least possible delay. In this preliminary work Lieutenant-Commander Lang and his staff, with the readiness characteristic of the British Navy, gave the party all needful assistance.

As eclipse work was new to all the observers, with the exception of Prof. Thorpe, who was in charge of the expedition, the instrumental equipment was such as not to overtax any of them. Prof. Thorpe, assisted by Mr. P. L. Gray, was in charge of a 6-inch equatorial telescope, belonging to Greenwich Observatory, with the necessary accessories for determining the intensity of the light at different points of the corona. The photometer used was of the form in which the amount of light from a glow lamp necessary to cause the disappearance of a grease spot on a piece of paper was determined by measuring the strength of the electric current which illuminates it. A number of such spots were so arranged in the photometer that the image of the corona formed by the telescope fell upon them, while on the other side they were illuminated by a glow lamp, the whole, of course, being inside a dark box. I myself, representing Prof. Norman Lockyer, had the management of a 6-inch photographic telescope, provided with a large prism in front of the object glass for the purpose of determining the chemical constitution of the corona and prominences. With this method of work a separate image of each position of the corona or prominences is obtained corresponding to each kind of light which it emits, and this gives the clue to its chemical character. A duplex telescope for photographing the surroundings of the eclipsed sun was in charge of Sergeant J. Kearney, R.E., who has had the advantage of a long and varied experience in photographic matters.

The instrument was provided with two object glasses of 4-inch aperture, the tube carrying them having a partition down the middle. The image formed by one of the lenses was received directly on the photographic plate, but in the other case it was magnified about three times by one of Mr. Dallmeyer's new telephotographic lenses. The dark slides carrying the photographic plates were ingeniously arranged so that by a single operation two plates were exposed. Lieutenant Hills, R.E., one of the volunteer observers was in charge of two spectroscopes of the ordinary form provided with slits. These were mounted on an equatorial stand, and were each provided with a 3-inch condensing lens. Here, again, photographic plates replaced the eye. A piece of apparatus for determining the total light of the corona was in the hands of Mr. Forbes, the other volunteer observer. Lieut.-Commander Lang undertook to make a drawing of the faint outlying parts of the corona by following the plan initiated by the American astronomer Newcombe in 1878. This consists in erecting a wooden disc in line with the eye and the eclipsed sun, and at such a distance that it appears to cover all the bright inner corona. The eclipse itself is thus eclipsed, and the observer has an opportunity of studying the more delicate parts of the corona, his eye being protected from the brighter light by the wooden disc.

The weather, fortunately, was magnificent during the whole tay of the observers at Fundium, and almost cloudless skies were experienced both day and night. By April 10 the instruments had all been carefully erected and adjusted by observations of the stars, and all was in readiness for the eclipse. Rehearsals of the operations which were to be gone through during the eclipse were now begun, and continued daily. It was arranged that the commencement of totality should be announced by pistol shot, Prof. Thorpe giving the signal to fire. Quartermaster Hallet was then to record in a loud voice the lapse of the 250 seconds of totality by reading the 15 seconds sandglass, which is so commonly used with the ship's log. Several rehearsals were gone through at dusk, when it was estimated that the light was about equal to that which might be expected during totality.

At last the day of the eclipse arrived, and everything was in complete order. The morning was a little more hazy than usual, but all felt confident of obtaining at least a moderate view of the eclipse. The observers themselves were at their posts soon after noon, and driving clocks and other details were attended to. At five minutes past one the moon was seen to have encroached on the south-western limb of the sun, and as it gradually passed over the disc the temperature of the air as gradually fell. At two o'clock the officers of the *Alecto*, who were kindly assisting the observers, also took their places. The light now waned very rapidly, and the breeze felt cold. In appearance the light of day at these stages very much resembled that which precedes an English thunderstorm. All the observers were now in perfect readiness for the pistol shot. "Five minutes" was announced by Prof. Thorpe, and I began my spectrum photographs, exposing six plates before totality. Amidst almost breathless silence the sound of the pistol shot was awaited. Eventually a similar pistol signal adopted in the French camp was clearly heard, and that moment the shadow of the moon went sweeping past. Prof. Thorpe's signal to fire, however, was not given until at least 10 seconds later. As the last trace of bright sunlight disappeared out flashed a magnificent corona of silvery light, together with numerous red and white prominences. The corona was very evenly distributed round the dark moon, that is to say, there were none of the great extensions along the Equator which were seen in 1878 and 1889. The light of the corona was very bright, and the lamps which had been provided for the use of the observers during totality were quite unnecessary—indeed, the sky light was so bright that no stars became visible at all, but Jupiter and Venus, which happened to be quite near the sun, shone out most distinctly. At Bathurst, however, the sky appears to have been clearer, and some of the brighter stars were also seen. The various observations were made and the photographs taken with no hitch whatever beyond the loss of about 10 seconds at the beginning of totality. This caused me to lose three exposures during totality, and reduced the number of Sergeant Kearney's photographs from 12 to 10. To err on the right side, Lieutenant Hills very fortunately closed his dark slides soon after "25 seconds" had been called by the quartermaster. In this case the slightest flash of sunlight would have been disastrous. Five minutes after totality was over I exposed my last plate, and the actual work of the expedition was at an end. What was more, all were confident of success.

Now, as to the results of the observations and photographs. Though it is much too early to attempt to state all that we may, except to learn from them, one point is clear. The general distribution of the corona is exactly what was expected, seeing that the sun is now in a very disturbed state. The sun spots, it is well known, have an eleven yearly period, and at the present time they are nearly at a maximum. This, in fact, made the recent eclipse one of the highest importance. It has been observed in previous eclipses that when the spots are at a minimum the corona is very much extended in the direction of the sun's equator, while, on the other hand, when the spots are at a maximum the corona is very much more evenly distributed. This supposed periodicity of the general form of the corona has received further confirmation by the recent observations. No unusual equatorial extension is shown on the excellent photographs taken by Sergeant Kearney, and none was observed by Lieut.-Commander Lang, who was specially looking for it. At Prof. Thorpe's suggestion Dr. Prout, the colonial surgeon at Bathurst, also erected a similar wooden disc, and his observations confirm those of Captain Lang. The prominences also follow the sun spots with regard to frequency, and, as already stated, a large number of them were seen. These are shown on Sergeant Kearney's photographs, and a complete record of the spectrum of each one is shown on the photographs taken by myself. The latter have the further advantage of showing the forms of the prominences as well as the spectra. Some of them chiefly show lines of hydrogen and calcium, while others again are almost crowded with lines of various metals. A complete record of the prominences has therefore been secured. With regard to the spectrum of the corona it seems doubtful at present whether our knowledge has made any great advance by the recent observations. The spectrum appears to have been very largely continuous, such as would be given by a mass of incandescent solid particles. One green line, which has previously been observed to be very prominent in the coronal spectrum, and the bright yellow line of the unknown substance, which is called helium, however, are shown in my photographs, and subsequent detailed examination may lead to the discovery of others. Lieut. Hill's photographs, which were specially exposed for the coronal spectrum, show a large proportion of continuous spectrum, and several lines which require further investigation. Much is to be hoped for, however, in another direction. The question of the constitution of the layers of the vapour which lie closest to the photosphere is one of the first importance to solar physicists. I had made arrangements to take two successive instantaneous spectrum photos as nearly as possible after the commencement of totality, but, as already stated, the opportunity was lost by reason of the lateness of the signal. The photos taken immediately after totality, however, promise to throw considerable light on the subject. Only two of these have been developed at present, and in addition to the ordinary spectrum of the uneclipsed part of the sun, they show large numbers of bright lines in the spectrum of those portions of the sun's atmosphere which were still left exposed by the moon. These, of course, also require a very detailed examination before any conclusion can be drawn. Of the thirty plates which I exposed only eleven have been developed so far, the facilities at Fundium not being very great. These were selected here and there from the whole series, and little doubt is entertained as to the good quality of the remaining plates. The photographic work was undertaken with the view of investigating the laws of variation in the brightness of the corona (1) according to the distance from the photosphere; (2) from one eclipse to another. Prof. Thorpe and Mr. Gray were successful in securing observations of the intensity of the light at sixteen different points of the corona, while Mr. Forbes made eleven measurements of the total light at as many different stages of the eclipse. All these observations were considered to be of a high degree of accuracy, but reduction to former standards and comparisons with measures at former eclipses have still to be made.

M. Deslandres' equipment consisted chiefly of spectroscopes of various forms, but in addition he was provided with instruments for photographing the eclipsed sun, one on a large and the other on a small scale. The haze somewhat interfered with his work, but he appears to have been fairly successful with such plates as were developed before the British expedition left.

The natives at Fundium were by no means alarmed during the eclipse, and there was fortunately no call for the guard of bluejackets, which Captain Lang had taken the precaution to place in the immediate neighbourhood of the instruments; indeed both here and at Bathurst the natives were sufficiently well informed to watch the progress of the eclipse through smoked glass. The cause of the eclipse seems to have been ascribed to the Almighty, and not in any way associated with the presence of the astronomers. The members of the expedition themselves had no opportunity of studying the effect of the eclipse upon the brute creation, but trustworthy observers in Bathurst report that the usual state of alarm prevailed amongst fowls, cats, and other animals. Immediately after the eclipse the huts were partly dismantled, and the observers and their instruments were photographed by Prof. Thorpe, exactly as during the operations, the astonished natives meanwhile gathering in large numbers. After a short rest, the work of dismounting and packing the instruments was begun, and before sunset considerable progress had been made. By the evening of April 17, all was packed and safely aboard the *Alecto*, and the only material remnants of the expedition were waste paper and a slab of cement, prepared and inscribed by Lieutenant Hills, with the words, "British Eclipse Expedition, April 16, 1893." It is impossible to speak too highly of the assistance rendered to the expedition by the officers and men of the *Alecto*. As already stated, Lieutenant-Commander Lang made independent observations, with the assistance of Lieutenant Colbeck. Prof. Thorpe and Mr. Gray were assisted by Mr. Pym, and myself by Lieutenant Shipton and Chief Artificer Milligan, Lieutenant Hills by Dr. Moore, Sergeant Kearney by Sergeant Williams, and Mr. Collick and Mr. Forbes, by Mr. Willoughby, the engineer, and Mr. Murphy, one of the artificers.

The expedition left Fundium on April 18, and arrived at Bathurst on April 19, where H.M.S. *Blonde* was waiting under orders to convey the party to Grand Canary. Without this convenient arrangement, the expedition could not have left Bathurst before May 3 or 4. The homeward journey to England will be completed by a passage in the first available steamer.

THE ORIENTATION OF GREEK TEMPLES.[1]

THIS investigation is supplementary to Mr. Lockyer's examination of the orientation of the Egyptian temples, in the course of which he has cited passages translated from hieroglyphics, showing most distinctly that there was a connection between the foundation of those temples and certain stars. He has also shown that the structure of the temples demonstrates that the light from these stars must have been admitted at their rising or setting along the axis of the temples through the doorways, and that in certain temples the doorways have been altered in such a way as to follow the amplitude of the star as it changed, owing to the precession of the Equinoxes, and that in some cases a new temple had been founded alongside of an older one for the same purpose.

Although there does not seem to be any historical or epigraphical record of such a nature in Greece, the architectural evidence is not wanting. On the Acropolis of Athens there are two temples, both dedicated to Minerva, lying within a few yards of one another, both apparently oriented to the Pleiades, the older temple to an earlier position of the star group, and the other to a later one. At Rhamnus there are two temples almost touching one another, both following (and with accordant dates) the shifting places of Spica. In a temple at Ægina a doorway placed excentrically in the west wall of the cella was adapted for the observation of a setting star.

A clue is given for finding out the dates of the foundations of temples oriented to stars by means of the changes produced upon them by the precession of the Equinoxes; a movement which induces a divergence between the latitudes and longitudes of stars, and their places reckoned in declination and right ascension; so that after the lapse of 200 or 300 years a star which rose or set in the direction of the axis of a temple would have passed to a different amplitude, so as to be no more available for observation, as before, from the adytum.

In the earlier ages of Greek civilisation the only accurate measure of time by night was obtained by the rising or setting of stars, and these were more particularly observed when heliacal, or as nearly as possible to sunrise. For the purpose of temple worship, which was carried on almost exclusively at sunrise, the priests would naturally be very much dependent for their preparations on the heliacal stars as time warners.

The orientation of temples may be divided into two classes, solar and stellar. In the former the orientation lies within the solstitial limits; in the latter it exceeds them. In Greece there are comparatively few of the latter class.

In the lists of temples which follow, all the orientations were obtained from azimuths taken with a theodolite, either from the Sun or from the planet Venus. In almost every case two or more sights were observed, and occasionally also the performance of the instrument was tested by stars at night. The heights subtended by the visible horizon opposite to the axes of the temples were also observed.

The first list comprises twenty-seven intra-solstitial temples:

7	examples from	Athens.	1	example from	Sunium.
3	,,	Olympia.	1	,,	Corinth.
2	,,	Epidaurus.	1	,,	Bassæ.
2	,,	Rhamnus.	1	,,	Ephesus.
2	,,	Ægina.	1	,,	Platæa.
1	,,	Tegea.	1	,,	Lycosura.
1	,,	Nemea.	1	,,	Megalopolis.
1	,,	Corfu.	1	,,	Argos.

For all these the resulting solar and stellar elements are given, with the approximate dates of foundation, similarly to the following specimen, namely, that of the Temple of Jupiter at Olympia.

Olympia, lat. 37° 38′ *N.*

Temple of Jupiter	Orientation angle.		Stellar elements.	Solar elements.	Name of star.
	262° 37′ 46″	Amplitude, star or sun	8° 38′ 0″ N.	7° 22′ 14″ N.	
		Corresponding altitude	3 0 0 E.	1 42 0 E.	
		Declination	+8 40 0	+6 52 22	
		Hour angles	$6^h\ 11^m\ 37^s$	$7^h\ 34^m\ 52^s$	
		Depression of sun	...	14° 12′ 0″	
		Right ascension	$23^h\ 40^m\ 0^s$	$1^h\ 3^m\ 5^s$	
		Approximate date	B.C. 740	Apr. 6.	

This example has been selected from the rest of the list because this temple has been chosen for the purpose of showing the method of procedure in working out the elements from the observations, those, namely, of the orientation angle, and of the height of the visible horizon.

A few general remarks, however, seem required respecting the Sun's and star's altitude, and the Sun's depression when the star is to be observed.

For a star to be seen heliacally, it is necessary that the Sun should be just sufficiently below the horizon for the star to be recognised. According to Biot, Ptolemy, speaking of Egypt, has recorded this to be about 11°. But where, as generally in Greece, there are mountains screening the glow which at such times skirts the true horizon, it seems fair at any rate for a first magnitude star to consider 10° as sufficient. I have myself seen Rigel in the same direction as the Sun when elevated 2° 40′ above the sea horizon, the Sun being less than 10° below. Obviously an observer looking from a dark chamber in a well known direction would be more favourably situated.

It is proper to allow about 3° of altitude for a star to be seen above low clouds and the hazy glow which skirts the horizon. The Sun's light, however,, seems to be very effective at a lower altitude, and when he appears over a mountain of 2° or 3° altitude the angle may properly be reduced by 20′ or 25′, partly for refraction, and partly because a small segment only of the disc is sufficient for illumination.

The method I have pursued in working out the example of the Temple of Jupiter at Olympia is as follows.

The orientation angle, measured from the south point round by way of west and north, is 262° 37′ 46″, which is equivalent to an amplitude of + 7° 22′ 14″. The eastern mountain subtends an angle of 2° 4′. For reasons above given, the solar altitude

[1] Abstract of a paper (read before the Royal Society on April 27), "On the Results of an Examination of the Orientation of a number of Greek Temples, with a view to connect these Angles with the Amplitudes of certain Stars at the time these Temples were founded, and an endeavour to derive therefrom the Dates of their Foundation by consideration of the changes produced upon the Right Ascension and Declination of the Stars arising from the Precession of the Equinoxes." By F. C. Penrose, F.R.A.S. Communicated by Prof. J. Norman Lockyer, F.R.S.

may be taken as $1° 42'$, but that of the star, $3°$. Combining these values with the latitude, viz., $37° 38'$, and using the formula

$$\sin \delta = \cos \text{zen. dist.} \times \cos \text{colat} + \sin \text{zen. dist.} \times \sin \text{colat} \times \sin \text{ampl.},$$

we obtain for the star a declination of $+7° 40'$, and for that of the Sun $+6° 52' 22''$. This latter, with the ecliptic obliquity of about 800 years B.C., determines the Sun's right ascension to have been 1h. 3m. 15s.

The next step is to inquire if there be any bright star or star group which, at a date consistent with archæological possibility, would have had a declination near to the above-named place, and would also have been heliacal.

Such a star would have required about 6h. 8m. to pass from $3°$ altitude to the meridian, and it would have required to have been about $1\frac{1}{2}$h. in advance of the Sun to allow it to be seen. The approximate R.A. of such star would therefore be about 23h. 40m., and its declination, as already stated, must be about $7° 40'$ N.

For trials I have used a stereographic projection of the sphere taken on the pole of the ecliptic, but showing also R.A. hours and parallels of declination. Any place on this projection may be chosen and marked on a superimposed sheet of tracing paper, and then if the tracing paper is turned round upon the pole of the ecliptic as a centre, so that the straight line drawn upon it, which in the first instance joined the two poles marked on the projection is carried round to an angle equal to the amount of precessional movement under consideration, if there be a suitable star marked on the projection the point selected for trial will pass over it or near it, and after the star has been thus roughly pointed out the more exact calculations may be proceeded with. By this process in the case before us the tracing-paper mark coincided almost exactly with the place of α Arietis, and for this star the particulars were carefully computed which have been given in the list of elements.

It should be noticed that there are in every case of intra-solstitial temples four possible solutions of this step. The Sun's amplitude may be due either to the vernal or the autumnal place, and the star might have been heliacal either at its rising or setting. In every instance all these four alternatives have been tried by the preliminary search method, and in every case in temples of old foundation an heliacal star has resulted from one or other of the trials, but never more than one.

The star which has been found as above for the Temple of Jupiter is no other than the brightest star of the first sign of the Zodiac, and therefore peculiarly suited to that god. The same star is connected with the early temple of Jupiter Olympius at Athens.

In intra-solstitial temples, by the nature of the case, the stars are almost entirely confined to the Zodiacal constellations, and consequently suitable stars are very much limited in number.

Another very great limitation arises from the consideration that, to have been of any service as a time warner, the star must have been heliacal, and when these two limitations are taken into account it becomes improbable to the greatest degree that there should always have been a suitable star unless it had been so arranged by the builders of the temple.

In about two-thirds of the cases which I have investigated the dates deduced from the orientations are clearly earlier than the architectural remains now visible above the ground. This is explained by the temples having been rebuilt upon old foundations, as may be seen in several cases which have been excavated, of which the archaic Temple of Minerva on the Acropolis of Athens and the Temple of Jupiter Olympius on a lower site are instances. There are temples also of a middle epoch, such as the examples at Corinth, Ægina, and the later temples at Argos and at Olympia (the Metroum at the last named), of which the orientation dates are quite consistent with what may be gathered from other sources.

Besides the list of intra-solstitial temples already given I have particulars of five for which I have been unable to find an heliacal star. They are all known to be of recent foundation, when other methods of measuring time had been discovered. The solar axial coincidences were no doubt in all these cases connected with the great festivals of these temples. It was clearly the case in two of them.

At the Theseum at Athens the date was either October 10 or March 2. The *Thesea* festival is reckoned to have been on October 8 or 9. For the later Erechtheum the day would have been April 8 or September 3. The great festival of this temple is put down for September 3.

Leaving the solar temples, we find that the star which was observed at the great Temple of Ceres must have been Sirius, not used, however, heliacally—although this temple is not extra solstitial—but for its own refulgence at midnight. The date so determined is quite consistent with the probable time of the foundation of the Eleusinian Mysteries and the time of year when at its rising it would have crossed the axis at midnight agrees exactly with that of the celebration of the Great Mysteries.

It is reasonable to suppose that when, as in the case of Sirius at Eleusis, brilliant stars were observed at night, the effect was enhanced by the priests by means of polished surfaces.

Herodotus, speaking of a temple at Tyre (B. II, 44), says:—

"*Καὶ ἐν αὐτῷ ἦσαν στῆλαι δύο, ἡ μὲν χρυσοῦ ἀπέφθου, ἡ δὲ σμαράγδου λίθου, λάμποντος τὰς νύκτας μέγαθος.*"

(Two shafts, one of pure gold, the other of emerald, which shone remarkably at night.)

Of a list of seven extra-solstitial temples which are named, five are more particularly noticed, viz. :—

A temple at Mycenæ and one near Thebes, which are built nearly north and south, but which probably, as was the case at Bassæ, had eastern doorways. The star, α Arietis, which suits the first, seems to point out the dedication of this temple to Jupiter. The other is very remarkable, and connects the Bœotian Thebes with the great Egyptian city; the star was γ Draconis. Thebes was called the City of the Dragon, and tradition records that Cadmus introduced both Phœnician and Egyptian worship. Three of the temples lay more nearly at an angle bisecting the cardinal points; these are Diana Propylæa at Eleusis, a small temple (not yet named) lately discovered at Athens, and the Temple of Venus at Ancona, recovered by means of the walls of a church built upon its traditional site. In these temples the star observed at the first seems to have been Capella, the time of the year when it shone axially at midnight agreeing with that of the celebration of the Little Mysteries, and in the other two the star was Arcturus.

EXPLORATIONS IN THE KARAKORAM.

MR. W. M. CONWAY gave an account of his recent exploring expedition in the Karakoram mountains at the last meeting of the Royal Geographical Society. The paper was illustrated by lantern slides, and a series of paintings by Mr. McCormick, who accompanied the expedition, was also exhibited. Mr. Conway said:—We left Srinagar on April 13, 1892, and came to Gilgit. Arrived at Gilgit we found the condition of the mountains, from a climber's point of view, too backward for our purposes. We therefore spent a month in mapping and exploring the fine Bagrot Valley, which slopes southwards from Rakipushi and its immediate neighbours along the main ridge. We hoped to be able to force a passage over this ridge into Nagyr; but the persistent bad weather baulked our efforts when they were on the point of succeeding. When the traveller has emerged from the inhospitable defiles which sunder the valley of Hunza Nagyr from Gilgit, and has climbed the vast ancient moraines near Tashot, which form the final rampart of the fertile basin (fertile, of course, only by reason of artificial irrigation of admirable complexity and completeness), he stands surrounded by an astonishing view. The bottom of the valley is, as usual, deeply filled by *débris*, whose surface is covered by terraced fields, faced with cyclopean masonry, and rich with growing crops and countless fruit trees. The mountains fling themselves aloft on either hand, with astounding precipitancy, as it were into the uttermost heights of heaven; so steeply, in fact, that a spring avalanche falling from the summit of Rakipushi on the south must almost reach the bottom of the valley. Rakipushi is 25,500 feet high; the Hunza peak is about 24,000 feet high. Their summits are separated by a distance of 19 miles. Both mountains are visible from base to summit at one and the same time from the level floor of the valley between them, which is not more than 7000 feet above the sea. No mountain view that I saw in the Karakorams surpasses this for grim wonder of colossal scale, combined with savage grandeur of form and contrast of smiling foreground.

Having been beaten back on June 24 from an attempt to reach the Bagrot Pass from the north, we returned to Nagyr, and started inwards towards the wholly-unknown region. We left Nagyr behind on June 27, and in a mile or two came to the foot of the Hopar Glacier. This glacier was once joined by the Hispar Glacier, and their united moraines were deposited at Nagyr, the town being actually built upon their crest. Now the foot of the Hispar Glacier has retreated some twenty miles into the mountains. The Hopar Glacier is greatly shrunken in width, and in its shrinkage it has left a fine, almost level area, beside its left bank, which is covered by the fields of Hopar.

We were delighted to find an enormous and almost unsuspected series of glacier basins above Barpu. In order to get some idea of them we spent a day mounting to the crest of the ridge north of our camp, which divides Barpu from the Hispar Valley. The view was of peculiar interest to us, for we looked for the first time into the Hispar Valley and beheld the long avenue of peaks that lined the way up the Hispar Glacier towards the unknown snowy regions through which lay our intended route into Baltistan. We reached the summit of the Hispar Pass on July 18, and Askole on the 26th, our slow progress being caused by the exigencies of the survey in weather that was oftener bad than fair.

We left Askole on July 31 and returned to it again on September 5, the intervening time having been spent over our expedition up the Baltoro Glacier and the ascent of Crystal and Pioneer Peaks. On September 10 we embarked on a skin raft, which carried us down the Shigar River to the Indus. We landed, and in half an hour reached the scattered villages of Skardo, capital of Baltistan. Of our journey from Skardo to Leh to verify our instruments, and from Leh back to Srinagar, it is unnecessary to speak. We reached Abbottabad on October 28, exactly seven months from the day on which we left it.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Oxford.—During this term Prof. Clifton is lecturing on the optical properties of crystals, and other lectures and practical instruction are given by Mr. Walker and Mr. White at the Museum, by Mr. Baynes at Christchurch, by Sir J. Conroy at Balliol, and Mr. F. J. Smith at Trinity. In chemistry, Mr. Fisher and Mr. Watts are lecturing on inorganic and organic chemistry respectively, and Messrs. V. H. Veley and J. E. Marsh are demonstrators at the Museum. Mr. Vernon Harcourt is lecturing on inorganic chemistry at Christchurch, and Mr. D. H. Nagel at Trinity.

The professor of geology announces a course of lectures on economic geology and geological excursions. Prof. Ray Lankester is giving two courses, on embryology, and on the protozoa, rotifera, and urochorda; and supplementary lectures are given by Dr. Benham, Mr. J. Barclay Thompson, Mr. Bourne, and Mr. Minchin.

Prof. Burdon Sanderson is lecturing on the central nervous system, and has the assistance of Dr. Haldane and Mr. Pembury.

Prof. Vines is lecturing on outlines of classification, and has appointed Mr. P. Groom, of Cambridge, as demonstrator.

At the end of last term a sum of £3500 was voted by Convocation towards the renewal of a portion of the buildings and hothouses in the Botanic Garden. Prof. Vines made a full report on the condition of the houses at the end of last year, showing that all were old, of faulty construction, and so dilapidated as to entail a heavy annual expenditure for repairs. At the same meeting of Convocation a sum of £1000 was placed to the credit of the delegates of the University Museum, to be employed at their discretion for the maintenance and improvement of the collections in the Museum.

At a meeting of the Ashmolean Society on Monday, May 1, under the presidency of Mr. E. B. Poulton, Prof. A. W. Rücker, F.R.S., gave an interesting lecture on the electrical conductivity of thin films, which was largely attended.

On the 16th inst. Lord Kelvin will give the annual Boyle lecture to the Junior Scientific Club, and on the 18th the Romanes lecture will be given in the Sheldonian theatre by the Right Hon. T. H. Huxley.

Cambridge.—The term for which Mr. J. Y. Buchanan, F.R.S., was appointed to the University Lectureship in Geography expires at the end of the present term. The Committee of Selection for the appointment of a Lecturer to hold office for the next five years, will meet at Gonville and Caius Lodge on May 31. The stipend of the Lecturer is £200 a year, and he is required to deliver courses of Lectures in Geography during two terms at least, and to give informal instruction and assistance to students attending his lectures, and to promote the study of his subject in the University. The retiring lecturer is re-eligible. Candidates are to send their names and testimonials to the Master of Gonville and Caius College, on or before May 27.

The first Arnold Gerstenberg Studentship, of the value of £90 a year for two years, will be competed for in May, 1894, by men or women who have obtained honours in either part of the Natural Science Tripos, and whose first term of residence was not earlier than the Easter term 1888. The subjects of examination are Logic and Psychology, and the successful candidate must undertake to pursue a course of philosophical study.

Applications for permission to occupy the University's tables at the Zoological stations of Naples and Plymouth are invited; they should be addressed to Prof. Newton, and reach him on or before May 25.

The names of Prof. John Couch Adams, and of William, seventh Duke of Devonshire, have been inserted in the list of Benefactors of the University, recited at the annual Commemoration Service.

The plans for the Sedgwick Memorial Museum of Geology, prepared by Mr. T. G. Jackson, A.R.A., were approved by a large majority, in the Senate on Thursday last. The work of construction cannot however be begun until the finances of the University, which this year show a deficit of some £4000, are in a more satisfactory state. A proposal to raise funds, by increasing the capitation-fee paid by undergraduates from 17s. to 40s. a year, is now before the Senate.

Alfred Eichholz, B.A., first class in both parts of the Natural Science Tripos 1891–92, with distinction in physiology, has been elected to a Fellowship at Emmanuel College. Mr. Eichholz has already published papers of interest on physiological and anatomical subjects, and his election reflects great credit on his college.

SCIENTIFIC SERIAL.

Bulletin of the New York Mathematical Society, vol. ii. nos. 5, 6 (New York, 1893).—The earlier number opens with an account of the theory of substitutions (pp. 83–106), by Prof. Oskar Bolza. This is a warmly appreciative notice of Dr. F. N. Cole's translation of Netto's "Theory of Substitutions and its Applications to Algebra," to which attention has recently been drawn in our columns (see Nature, pp. 338, 339).—Dr. M. Bôcher in a bit of mathematical history (pp. 107–109) calls attention to a remarkable memoir by Euler ("De motu Vibratorio Tympanorum," 1764).—No. 6 contains a paper read before the New York Mathematical Society by Dr. T. Craig on some of the developments in the theory of ordinary differential equations (pp. 119–134). This is likely to be useful to students. Another paper read before the same Society is one entitled "On a General Formula for the Expansion of Functions in Series," by Prof. Echols (pp. 135–144), which is intended to be a brief exposition of a general theorem which forms the basis of a series of papers on certain determinant forms and their applications.—A short note follows by Dr. E. McClintock on the early history of the non-euclidian geometry (pp. 144–147), in continuation and part correction of his previous note in No. 2 of this volume. It discusses the claim to priority, brought forward recently by Prof. Beltrami, of Saccheri (1733) in his "Euclides ab omni nævo Vindicatus" as against Lobatschewsky.—"Notes" and "new publications" complete each number.

SOCIETIES AND ACADEMIES.

London.

Royal Society, February 16.—"On a Portable Ophthalmometer." By Dr. Thomas Reid, Glasgow. Communicated by Lord Kelvin, P.R.S.

The object of this instrument is to measure the curvature of the central area of the cornea, the polar or optical zone, and as this polar zone is the part of the cornea utilised for distinct vision, the instrument furnishes all the data practically requisite for the diagnosis and measurement of corneal astigmatism. Its use may be extended to the measurement of convex and concave reflecting surfaces within the limits of this instrument, *i.e.* from 6 to 10 mms. of radius.

The theory of its construction is based on a particular application of the following well-known optical law:—that when two centred optical systems are so combined that their principal foci coincide, the ratio of the size of the object to the size of the image formed by the combined systems is equal to the ratio of the principal foci of the two optical systems adjacent respectively to object and image. The two optical systems in this case are a convex lens and the cornea as a reflecting surface, the object being in the principal focus of the convex lens.

The instrument is composed of the following parts: an aplanatic lens of 26 mms. focus, a rectangular prism neutralised in the visual axis by a smaller prism, one side of the rectangular prism being adjacent to the lens and an iris diaphragm being opposite to the other side in the principal focus of the lens. Behind the prism is a telescope with a double image prism fixed in front of the object glass of the telescope, which has precisely the same focus as that of the aplanatic lens. Cross wires at its principal focus are viewed by a Ramsden eye-piece.

Before using the instrument it is essential that the cross wires should be distinctly seen at the punctum remotum of the observer. The adjusted instrument is held in the observer's left hand, which rests on the forehead of the patient, the diaphragm being directed to a luminous source to the right of the observer. When the observed eye is directed to the central or fixation point of the instrument, the image of the diaphragm in the cornea can only be distinctly seen, when the principal focus of the lens coincides with the principal focus of the cornea, the point of coincidence of the principal foci being found by moving the instrument to and fro. The image of the diaphragm by means of the double image prism appears as two images in the centre of the field, when the visual line of the observer's eye is perpendicular to the surface of the cornea, through which it passes. If these images are not seen in the centre, their position indicates the direction of the angle *a*. The size of the corneal image being constant (2 mms.) the images are brought into exact contact by suitable variations of the iris diaphragm. By using a circular object, the circular, elliptical or irregular form of the image reveals at once the condition of the surface. When the images are elliptical, the minor axes of the two images are to be brought into the same straight line by a rotation of the telescope, and similarly with the major axes.

Equal differences in the size of the diaphragm correspond to equal differences in dioptric power, each millimetre of difference in diameter corresponding to three dioptres. The amount of astigmatism in dioptres can thus be read off on a graduated scale fixed to the instrument.

This instrument reads certainly to within half a dioptre, which between 7 and 8 mms. of radius of curvature is equivalent to $\cdot 08\dot{8}$ mms. of difference of radius.

April 20.—"The Potential of an Anchor Ring," by F. W. Dyson, Fellow of Trinity College, Cambridge, Isaac Newton student in the University of Cambridge. Communicated by Prof. J. J. Thomson, F.R.S.

This paper is a continuation of some researches on rings published in the Phil. Trans. 1893. A system of solutions of Laplace's equation applicable to space *inside* an anchor ring is found. By means of these and the value of the potential at external points found in the previous paper, the potential of a ring at internal points is found. The stability of the annular form of rotating gravitating fluid is discussed; the ring form is shown to be stable for fluted and twisted disturbances, but unstable for long beaded ones. The potential of a ring of gravitating matter whose cross section is elliptic is obtained. Applying the result to Saturn's system, it is shown that for his ring to be continuous fluid its density would have to be 100 times that of the planet. The steady motion of a single vortex-ring of finite cross section in an infinite fluid is discussed, and also the motion of a number of vortex rings on the same axis. Numerical calculations are entered into for the particular cases of a vortex ring followed by another of equal strength, a vortex ring approaching an infinite plane, and one passing directly over a spherical obstacle.

Physical Society, April 28.—Prof. W. E. Ayrton, F.R.S., Past-President, in the chair.—Adjourned discussion on the viscosity of liquids, by Prof. J. Perry, J. Graham, and L. W. Heath. Prof. Perry read a communication he had received from Prof. Maurice Fitzgerald on the subject, in which the latter discusses the corrections necessary for reducing the results obtained by circular motion to the corresponding motion in plane layers. He shows that in addition to the circular motion, the effect is complicated by radial flow due to "centrifugal head," which causes the liquid to pass outwards near the bottom of the trough and inwards across the edge of the suspended cylinder, with continuations along the sides of the trough and cylinder. Taking this motion into account the formula $v = Ar^{1+\frac{c}{\mu}} + \frac{B}{r}$ is deduced, where v is the velocity, μ the viscosity, A and B arbitrary constants, and c a constant depending on the radial flow. When $c = 0$ the formula reduces to equation (5) of the paper, whilst if $c = -2\mu$ it becomes $v = \frac{C}{r}$. The subject of critical velocities in non-turbulent motion is referred to, and some probable effects of the anomalous variations of density and viscosity of sperm oil noticed by the authors of the paper are pointed out. Prof. Perry, in further reply to Prof. Osborne Reynolds' comments, said he understood Prof. Reynolds to have proved that friction was proportional to velocity when the motion was steady. Experiments he (Prof. Perry) had made with discs of iron and glass in revolving mercury seemed to show that this was not the case. On replacing the mercury by sperm oil he found that up to a certain speed friction was strictly proportional to velocity, whilst above that speed friction varied as $v^{1\cdot 25}$. Coloured streaks in the liquid remained unbroken even at the highest speeds. He therefore concluded that continuity of the streaks was not necessarily accompanied by a linear law of friction.—Mr. E. C. Rimington read a paper on luminous discharges in electrodeless vacuum tubes. The luminous rings produced in exhausted bulbs and tubes by discharging Leyden jars through coils surrounding them, had, he said, been attributed by Mr. Tesla (*Elec. Eng. of New York*, July 1, 1891) to the electrostatic action of the surrounding wire rather than to the rapidly varying magnetic induction through the rarefied gas. The present paper describes several experiments bearing on this point which lead the author to conclude that varying magnetic induction is the chief cause of the luminous rings. They also show that a superposed electrostatic field greatly assists the production of the luminosity. Most of the experiments described were performed before the meeting, some of the effects being particularly brilliant. In one experiment an exhausted bulb was placed within a coil connecting the outside coatings of two Leyden jars and placed between two metal plates, which could be connected at will with the outside of either jar. The spark gap between the inner coatings was then arranged so that no luminosity was seen in the bulb. On connecting one or both the metal plates with the jars in such a way as to increase the electrostatic field through the bulb, bright rings immediately appeared. An electrostatic field produced by a small induction coil connected to a piece of tin-foil on the bulb caused the rings to form at irregular intervals when the discharge of the jars and coil happened to be properly timed. In another experiment two loops of wire in series were used, and when put on the bulb in such a way as to produce a large magnetic effect but small electrostatic field, bright rings appeared, but if the magnetic effects of the coils opposed each other, whilst the electrostatic field was increased, no rings were seen. The subject is treated mathematically at some length in the paper, the times at which the maximum values of the current, the potential difference between the outside of the jars and the rate of change of current occur, as well as the values of their successive maxima being determined. The influence of size of jars is next considered, and the time-integral of rate of change of current on which the effect on the eye depends, expressed as a geometrical series. Taking an approximation the author shows that the time-integral is roughly proportional to the fourth root of the capacity. Large jars are therefore theoretically only slightly better than small ones, and this agrees with observation. On the subject of apparently unclosed discharges, such as are seen when discharges pass through a coarse spiral wound on an exhausted tube, the author said he had observed that the discharges were really closed, but the return part much diffused and of feeble intensity. Experiments were exhibited showing that under some circumstances an exhausted bulb acted like a closed metallic circuit, whilst under other conditions dissimilar effects were produced. Another experiment was shown in which a faint luminous ring, produced by a single turn of insulated wire round a bulb, was apparently repelled on touching the wire with the finger. The author also showed that fan-shaped luminosities could be produced by rotating an exhausted tube in the electrostatic field produced by a charged ebonite or glass rod. Dr. Sumpner, speaking of the apparently unclosed discharges, pointed out that they might be closed through the wire forming the primary circuit, in the same way as the coil of a transformer might be arranged to act partly as primary and partly as secondary. Mr. A. P. Trotter, after referring to Dr. Bottomley's researches, said it was important in discussing such experiments to distinguish between electrostatic and electromagnetic effects. In Mr. Campbell Swinton's experiments the luminosity always appeared to get as far away from the wire as possible and to be at right angles to it, whereas in Mr. Rimington's the luminous portions were close to the wire. With a view to puzzling the discharge in Mr. Swinton's tubes he had made a right-angled bend in the spiral surrounding the tube, the result of which was to make the luminosity discontinuous, one end of the break being bifurcated. In all Mr. Swinton's experiments brush discharges surrounded the wire. Prof. S. P. Thompson thought an electrostatic field would aid a discharge even if its direction was not the same as the E.M.F. due to varying magnetic induction. Planté had found that vacuum tubes through which 800 cells were insufficient to produce a discharge, immediately allowed a discharge to pass when a rubbed ebonite rod was brought within about 10 feet distance. This effect was found to be independent of the direction of the disturbing field. Analogous effects had also been observed by Prof. Schuster, and described in his Bakerian lecture. Mr. E. W. Smith regarded the stresses set up in the medium as cumulative, a very slight cause acting on a substance already strained nearly to breaking point, being sufficient to cause breakdown. Mr. Blakesley inquired if the effects were the same if the induction coil, used in one of the experiments, was replaced by an electric machine, and whether the direction of the field so produced influenced the result. Mr. W. R. Pidgeon said closed circuits were necessary, and he had found it very difficult to produce discharges in tubes unless the ends of the primary wire were brought together. In his reply Mr. Rimington said each turn of the luminous spiral formed a complete circuit of itself. The phenomena observed by Mr. Campbell Swinton were quite different to those he had shown, and due to different causes. Mr. Swinton's spirals were reversed, and were due to phosphorescence of the glass.

Zoological Society, April 18.—Sir W. H. Flower, F.R.S., President, in the chair.—The Secretary read a report on the additions that had been made to the Society's menagerie during the month of March, and called special attention to three White-tailed Gnus (*Connochætes gnu*) from the Transvaal (a male and two females), obtained by purchase March 7, and to three Springboks (*Gazella euchore*) from South Africa, deposited by H.R.H. the Prince of Wales.—Mr. Sclater exhibited and made remarks on a specimen of a curious variety of the Pig-tailed Monkey (*Macacus nemestrinus*) from the Baram River, Sarawak, lately living in the Society's menagerie.—Mr. Sclater read a communication received from General Sir Lothian Nicholson, Governor of Gibraltar, respecting the Barbary Apes (*Macacus inuus*) living on the Rock of Gibraltar, which were stated to have increased of late years, and were now supposed to be nearly sixty in number.—Mr. W. L. Sclater made some remarks on the principal animals noted in the Zoological Gardens of Antwerp and Amsterdam, which he had lately visited.—A communication was read from Mr. A. E. Shipley containing an account of the anatomy and histology of two Gephyrean worms of the genus *Sipunculus* from Zanzibar, together with a few observations on Sipunculids in general.—Mr. Oldfield Thomas gave an account of a small collection of Mammals obtained in Central Peru by Mr. J. Kalinowski. Amongst several species represented in this collection, either new or of such interest as to deserve a record was especially noted a new form of Rodents of the family, Muridæ, proposed to be called *Ichthyomys stolzmanni*.—Mr. H. J. Elwes read a communication from Mr. W. Warren describing a large number of new species and new genera of Moths of the family Geometridæ in Mr. Elwes's collection, from Sikkim and other districts of India. Notes on the localities and on other points were added by Mr. Elwes.

Geological Society, April 26.—W. H. Hudleston, F.R.S., President, in the Chair.—The following communications were read:—The origin of the crystalline schists of the Malvern Hills, by Dr. Charles Callaway. This paper was the third of a series of three. In the first of these, published in the *Quarterly Journal* in 1887, the author contended that many of the gneisses and schists of Malvern were formed out of igneous rocks. In the second, which appeared in the Journal in 1889, he discussed the origin of secondary minerals at shear-zones in the Malvern rocks, and arrived at the conclusion that all the mica and much of the felspar, to say nothing of quartz and other minerals, were of secondary origin. In the present paper the author first pointed out that some of the most important mineral changes described in his second communication—such, for example, as the conversion of chlorite into biotite—had since been confirmed by independent investigators. He held that, as a whole, the gneisses and schists of Malvern had been formed by the crushing and shearing of consolidated igneous rocks; but he did not deny the possibility that here and there the foliated structure might have been produced in a fused mass. In the first stage of metamorphism the diorite or granite was crushed and decomposed. This slightly compressed rock could be traced step by step into a typical gneiss or schist. The signs of pressure progressively increased, and the mineral and chemical changes became proportionately greater. Reconstruction set in. The process of metamorphism did not always follow the same lines. Felspar was sometimes crushed into seams of fragments, and these, by partial re-fusion and pressure, were converted into gneissose lenticles of quartz and felspar. Intervening chlorite was changed to biotite, or even to muscovite or sericite. Thus a typical gneiss, consisting of quartz-felspar lenticles in a felt-work of mica, was formed out of a diorite. Sometimes the felspar was reconstituted without becoming fragmental; and it was then deposited on, or it included, idiomorphic mica. Or a soda-lime felspar might, by a process of corrosion, be converted into quartz, or a soda-felspar, or both. In an early stage of metamorphism, the rock was often dirty and rotten through the abundance of chlorite and disseminated iron oxide. The former being changed to mica, and the latter being either absorbed in the production of biotite, or reconstituted in a crystalline form, a sound clear gneiss was the result. In the completed product, the signs of crushing and shearing were often entirely wanting. Even strain-shadows were rare in it. The metamorphism, however, was demonstrated in numerous localities by tracing the gradations inch by inch, and by the subsequent study of large numbers of microscopic slides, in which the transition was still more clearly seen than in the field. The classification of the Malvern schists originally proposed was somewhat enlarged, the injection-schists being subdivided into —(1) Schists of primary injection, in which one rock was injected into another, and (2) Schists of secondary injection, formed by the infiltration of secondary minerals along shear-planes. One of the most important of the chemical changes produced in the conversion of a diorite into an acidic schist was the elimination of magnesia. This was proved by analysis. The recent researches of Mr. Alexander Johnstone had shown that even in the laboratory, and at the ordinary temperatures, carbonated waters were able to remove magnesia from certain of its combinations with silica. The reading of this paper was followed by a discussion, in which the President, Prof. Bonney, Mr. Harker, Mr. Rutley, Prof. Hull, and the author took part.—Supplementary notes on the metamorphic rocks around the Shap Granite by Alfred Harker, and J. E. Marr, F.R.S. This paper contains some additions and corrections to the work submitted to the Society by the authors on a previous occasion (see *Quart. Journ. Geol. Soc.* vol. xlvii. p. 266). In the present communication special attention is paid to the alteration of a group of basic volcanic rocks by the granite. Some remarks were made on this paper by the President, Mr. Rutley, Mr. Teall. Mr. Harker and Mr. Marr replied.

Linnean Society, May 4.—Prof. Stewart, President, in the chair.—Dr. R. B. Sharpe exhibited some new and rare birds from Borneo, and made remarks upon the singular distribution of the genera to which they belonged. On behalf of Miss E. M. Sharpe he also exhibited both sexes of the larvæ and cocoons of a rare silkworm moth, *Gonometa fascia* from Lagos. Prof. J. B. Farmer exhibited under the microscope some preparations showing attraction spheres in Hepatic spores, and gave the result of his recent researches on the subject.—Mr. Thomas Christy exhibited some curious variations in foliage in plants of a *Sterculia* from Brazil, reared from the same pod, and showed also a specimen of *Erythroxylon Coca* in fruit.—Mr. W. B. Hemsley showed two British plants which were interesting on account of the localities, namely *Empetrum nigrum* from Dorset (where Mr. C. B. Clarke had seen it growing on Poole Harbour Spit though it had not been included hitherto in the county flora), and *Scilla nutans* with prolonged bracts, usually regarded as an introduced garden form, which had been found growing apparently wild in a wood near Ashford, Kent. —Mr. Alfred Sanders then read a paper on the nervous system of *Myxine glutinosa*, a fish allied to the Lampreys.

DUBLIN.

Royal Dublin Society, April 19.—Prof. A. A. Rambaut, Astronomer Royal for Ireland, in the chair.—Dr. J. Joly, F.R.S., described a method of detecting the existence of variable stars by continuous photometric observations from night to night on groups of stars, by receiving the image of the group upon a photographic plate having a slow eccentric circular motion within the telescope, so that the images of the individual stars appear as circular traces upon the plate. Variations in the intensity of any trace, not common to all the linear images, indicate a variability of luminosity in the particular star describing the trace.—Prof. A. A. Rambaut read a paper on the distortion of photographic star images due to refraction.—The usual formulæ of refraction by which the relative position of one star with regard to another may be corrected for this effect, such as those published lately by the author in the *Astronomische Nachrichten*, No. 3125, are strictly applicable only to one definite instant of time. It is possible to keep only one star absolutely fixed on the plate by means of the slow motions in R.A. and declination, and the changes in the amount of the differential refraction will cause any other star to alter its position on the plate if the exposure is continued for any considerable time. The effect of this change is that all stars on the plate, except that used to guide by, are more or less distorted. The paper contains tables giving the amount by which the refraction changes at various declinations and hour angles, and from these the amount by which a star image on the plate is distorted in passing from any hour angle to any other can be readily computed. For instance, it is shown that an equatorial star whose distance and position angle from the guiding star are 1400″ and 45° would, in passing from an hour angle of 4h. to one of 5h., be distorted in R.A. by 5″·86 and in declination by 7″·98. It appears, however, that if the zenith distance does not exceed 60° and the exposure is limited to a quarter of an hour, the distortion will not exceed 0″·2, and that if the corrections are computed for the middle of the exposure and the measures made from the middle of the slightly distorted image no error will arise.—Prof. T. Johnson, exhibited *Gomontia polyrhiza*, Born. et Flah., a green alga, perforating the shells of various molluscs. Specimens were collected at different localities on the west and east coasts of Ireland; Galway (April, 1891) being the first locality in which the plant was observed.

PARIS.

Academy of Sciences, May 1.—M. Loewy in the chair.—The motion of liquids studied by chronophotography, by M. Marey. The water whose motion was to be studied was contained in a long tank bent into an elliptic shape and returning upon itself. One of the branches had both sides closed by panes of plate-glass, behind which was placed a screen of black velvet. A centimetre scale was fixed to the inner pane, and the tank was illuminated by sunlight reflected from below. The camera was placed at a distance in front of the glass, screens being arranged so as to keep off all light except that coming from the water. When the water was clear, the only thing photographed was the meniscus formed by its surface against the glass, which appeared as a bright straight line. When the surface was disturbed by waves, the nature of the disturbance was indicated by the successive shapes assumed by the meniscus. To study the internal motions of the liquid, small globules were constructed of wax and resin, silvered like certain pills, and so proportioned as to be slightly heavier than water, so that they could be made to float in neutral equilibrium by adding salt water. Stationary waves were then produced by rapidly changing the immersion of a solid cylinder on the opposite side of the tank, when the meniscus was thrown into the species of trochoidal curve already deduced from hydrodynamical theory. This curve appears in the photographs in great perfection. A wave of translation was also photographed fourteen times per second, and its velocity, as calculated by the scale, was 2·24 m. per second. Streams and eddies were also produced in the tank, and traced by means of the bright balls. On letting the water flow past an obstacle in the form of a fish, more obtuse on one side than on the other, it was proved that no perceptible eddies were formed if the water first encountered the obtuse side, but that it was greatly disturbed if the acute end was presented to the stream.—Determination of the specific heat of boron, by MM. Henri Moissan and Henri Gautier.—On mineral phosphates of animal origin, and on a new type of phosphorites, by M. Armand Gautier.—On the sanitary system adopted by the Dresden Conference for establishing common measures to safeguard the public health in times of epidemic cholera, without placing useless obstacles in the way of commercial transactions or the movements of travellers, by M. Bronardel.—Observations of the comets, Brooks (1892, VI.), Holmes (1892, III.), and Brooks (1893, I.), made with the great equatorial of Bordeaux, by MM. G. Razet, L. Picart, and F. Courty.—On a general case where the problem of the rotation of a solid body admits of uniform integrals, by M. Hugo Gyldén.—On the displacement of the temperature of maximum density of water by pressure, and the return to the ordinary laws under the influence of pressure and temperature, by M. E. H. Amagat.—Researches to establish the bases of a new method of recognising the adulteration of butter by margarine employed either singly or mixed with other fatty materials of vegetable or animal origin, by M. A. Houzeau.—Observation of the solar eclipse of April 16, 1893, at the observatory of the Société Scientifique Flammarion at Marseilles, by M Léotard.—On a class of differential equations, by M. Vessiot.—On the structure of finite and continuous groups, by M. Cartan.—On the ordinary differential equations which possess a fundamental system of integrals, by M. A. Guldberg.—On the reduction of the problem of tantochronics to the integration of a partial differential equation of the first order and the second degree, by M. G. Kœnigs.—On the densities and molecular volumes of chlorine and of hydrochloric acid, by M. A. Leduc.—On the diminution of the coefficient of expansion of glass, by M. L. C. Baudin.—On the systems of dimensions of electrical units, by M. E. Mercadier.—On the influence of longitudinal magnetisation upon the electromotive form of a copper-iron couple, by M. Chassagny.—Optical phenomena presented by secondary wood in thin sections, by M. Constant Houlbert.—Decomposition of oxalic acid by the ferric salts under the influence of heat, by M. George Lemoine.—Contribution to the study of the Leclanché cell, by M. A. Ditte. On the fluorides of the alkaline earths, by M. C. Poulenc.—On the quantitative determination of phosphoric acid, by MM. A. Villers and Fr. Borg.—On licarene derived from licareol, by M. Ph. Barbier.—On a vegetable nucleine, by M. P. Petit. On an earthquake shock felt at Grenoble on April 8, by M. Kilian.—The month of April, 1893, by M. E. Renou.—On the emission of a sugar-containing liquid by the green parts of the orange-tree, by M. E. Guinier.—On a new genus of conifers found in the Albian of the Argonne, by M. Paul Fliche.—Discovery of two skeletons at Villejuif and at Thiais, their age and ethnic character, by M. Zaborowski.—Periodic form of the doriferous power in the fatty series, by M. Jacques Passy.—Researches on the employment of tree leaves in the feeding of cattle, by M. A. Ch. Girard.

BERLIN.

Physiological Society, April 7.—Prof. du Bois Reymond, President, in the chair.—Dr. Engel gave an account of the outcome of his researches on the development of blood corpuscles. By using appropriate staining reagents, and fixation of the corpuscles by drying, he had found, in the embryos of mice in various stages of development and in leukhæmic children, that at first spheroidal nucleated cells make their appearance, metrocytes, which subsequently divide karyokinetically into daughter-metrocytes. From the latter some non-nucleated cells containing hæmoglobin are developed, as also some red-coloured cells, from which are then formed the red corpuscles, the nucleated white corpuscles and platelets. In the discussion which ensued Prof. Ehrlich confirmed the above results from personal observations, but regarded the origin of white blood-corpuscles from the red cells as not yet definitely established. Prof. Kossel spoke on a new saccharine substance called Dulcin, describing its chemical constitution and its effect on rabbits and dogs. Dulcin is two hundred times as sweet as sugar. Rabbits were unaffected by daily doses of 2 grm. (= 400 grm. sugar), but dogs were found to lose their appetite by prolonged taking of the above dose, recovering it soon when the drug was no longer administered.—Prof. Ewald had tried the effect of dulcin upon both healthy and sick people, observing no ill effect with doses equal to the amount of sugar ordinarily consumed. Prof. Heymans, of Ghent, reported that employing Golgi's method he had observed numerous branching nerves in the muscles of the wall of the cardiac ventricle, and particularly in the apex of the heart. Dr. Lilienfeld had studied the relationship of cell-elements to certain colouring matters, and exhibited a mixture of the latter, which appeared of an equally brownish-violet colour, both in aqueous and alcoholic solution. On shaking up in this crystals of nucleinic acid, the chief constituent of the nucleus, they were at once coloured bright green, whereas white of egg assumed an intense red colour.

April 21.—Prof. du Bois Reymond, President, in the chair.—Dr. Goldscheider reported upon experiments on the sense of touch in the blind, as made by Hocheisen on eight individuals, of whom some were born blind, while others became blind in early youth. The results obtained showed that the muscular sense of the blind is far more acute than of those who can see, being more acute in the youthful blind than in those who are older; in the latter the sense is scarcely more acute than that of those who can see. Similarly the power of localising was more acute in the young than in those who are older, and did not differ appreciably from that of those who can see. By practice both the above senses can be so sharpened in those who possess sight that they are ultimately as acute as for the blind.—M. Krüger spoke on the chemical constitution of adenin and hypoxanthin, and described the reactions which led to the establishing of their constitutional formulæ.

Physical Society, April 28.—Prof. Kundt, President, in the chair.—Prof. Neesen spoke on a new mercurial pump he had constructed on the principle of a Sprengel pump. Dr. Fröhlich developed his views on the theory of the electromagnet, which by bringing Hopkinson's theory into accord with conceptions of magnetic resistance and ideas on saturation had led to a considerable advance in generalisation. The discussion which ensued was chiefly taken up by Dr. Du Bois, who urged that the views propounded were rather of technical than scientific interest.

[*Note.*—In the report of the Physical Society (see NATURE, April 27, p. 624), in line five from the top, for "pressure" read "thickness," and in line six from the bottom for "Wren" read "Wien."]

DIARY OF SOCIETIES.

LONDON.

THURSDAY, MAY 11.

MATHEMATICAL SOCIETY, at 8.—On some Formulæ of Codazzi and Weingarten in Relation to the Application of Surfaces to each other: Prof. Cayley, F.R.S.—On the Expansion of Certain Infinite Products: Prof. L. J. Rogers.—A Theorem for Bicircular Quartic Curves and for Cyclides Analogous to Ivory's Theorem for Curves and Surfaces of the Second Degree: A. L. Dixon.—On the Linear Transformations between Two Quadrics: H. Taber.—The Collapse of Boiler-flues: A. E. H. Lowe.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—On the Prevention of Sparking, Compound Dynamos without Series Coils or Magnets; and Self-exciting Dnamos and Motors without Winding upon Field Magnets: W. B. Sayers.

ROYAL INSTITUTION, at 3.—The Atmosphere: Prof. Dewar, F.R.S.

FRIDAY, MAY 12.

PHYSICAL SOCIETY, at 5.—The Drawing of Curves from their Curvature: C. V. Boys, F.R.S.—The Foundations of Dynamics: Oliver Lodge, F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 8.

ROYAL INSTITUTION, at 9.—Isoperimetrical Problems: Lord Kelvin, Pres.R.S.

AMATEUR SCIENTIFIC SOCIETY, at 8.—Geological Time (with Special Reference to Mr. Mellard Reade's Paper in the *Geological Magazine* for March): W. H. Davis.

SATURDAY, MAY 13.

ROYAL BOTANIC SOCIETY, at 3.45.

ROYAL INSTITUTION, at 3.—Johnson and Swift: Dr. Henry Craik, C.B.

TUESDAY, MAY 16.

ZOOLOGICAL SOCIETY, at 8.30.—On the Atrium and Prostate of the Oligochætous Worms: F. E. Beddard, F.R.S.—Descriptions of Fifteen New Species of Pleurotomidæ: G. B. Sowerby.—List of Mammals inhabiting the Bornean Group of Islands: A. H. Everett.—On a Second Collection of Mammals sent by Mr. H. H. Johnston, C.B., from Nyassaland: O. Thomas.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Monthly Ballot for Members.—Reception by the President and Council.—Wreck-raising in the River Thames: C. J. More.

ROYAL INSTITUTION, at 3.—Modern Society in China: Prof. R. K. Douglas.

WEDNESDAY, MAY 17.

ROYAL METEOROLOGICAL SOCIETY, at 7.—Mean Daily Maximum and Minimum Temperature at the Royal Observatory, Greenwich, on the Average of the Fifty Years from 1841 to 1890: William Ellis.—Suggestions, from a Practical Point of View, for a New Classification of Cloud Forms: Frederic Gaster.—Notes on Winter: Alex. B. MacDowall.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Exhibition with the Projection Microscope: Sir David L. Salomons.—Notes on Rotifers: C. Rousselet.

THURSDAY, MAY 18.

ROYAL SOCIETY, at 4.30.

CHEMICAL SOCIETY, at 8.—Observations on the Production of Ozone during Electric Discharge through Oxygen: W. A. Shenstone and M. Priest.—The Relative Strengths or Avidities of some Weak Acids: Dr. Shields.—The Boiling Points of Homologous Compounds, Part I.: Dr. James Walker.

ROYAL INSTITUTION, at 3.—The Geographical Distribution of Birds: Dr. R. Bowdler Sharpe.

FRIDAY, MAY 19.

ROYAL INSTITUTION, at 9.—Poetry and Pessimism: Alfred Austin.

SATURDAY, MAY 20.

ROYAL INSTITUTION, at 3.—Johnson and Wesley: Dr. Henry Craik, C.B.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Future of British Agriculture: Prof. Sheldon (W. H. Allen).—The Nests and Eggs of British Birds: C. Dixon (Chapman and Hall).—Theorie der Optischen Instrumente: Dr. S. Czapski (Breslau, Trewendt).—Practical Astronomy, 2nd edition: P. S. Michie and F. S. Harlow (K. Paul).—An Analytical Index to the Works of the late John Gould, F.R.S.: Dr. R. B. Sharpe (Sotheran).—The New Technical Educator, vol. 1 (Cassell)

PAMPHLETS.—Determinations of Gravity with Half-second Pendulums on the Pacific Coast, in Alaska, and at Washington, D.C., and Hoboken, N.J.: T. C. Mendenhall (Washington).—The Photoscope (Liverpool, Sanders).

SERIALS.—Medical Magazine, May (Southwood).—Quarterly Journal of the Geological Society, vol. xlix. Part 2, No. 194 (Longmans).—Journal and Proceedings of the Royal Society of New South Wales, vol. xxvi. (K. Paul).—Verhandelingen der Koninklijke Akademie van Wetenschappen te Amsterdam, Erste Sectie, Deel. 1, Nos. 1, 2, 4, 5, 6; Tweede Sectie, Deel. 1, Nos. 1, 4, 10 (Amsterdam, J. Müller).—Journal of the Chemical Society, May (Gurney and Jackson)—Proceedings of the Royal Society of Edinburgh, vol. xix. pp. 193-295 (Edinburgh).—Himmel und Erde, May (Berlin, Paetel).—Jahrbuch der k.k. Geologischen Reichsanstalt, Jahrg. 1892, xlii. Band 3 and 4 Heft (Wien).—Journal of the Scottish Meteorological Society, third series, No, ix. (Blackwood).—Proceedings of the American Academy of Arts and Sciences, new series, vol. xix. (Boston, Wilson).—Report of the Marlborough College Natural History Society, No. 41 (Marlborough).

CONTENTS.

THURSDAY, MAY 18, 1893.

OSTWALD'S GENERAL CHEMISTRY.

Lehrbuch der Allgemeinen Chemie. Von Dr. Wilhelm Ostwald. Band I. 1891, Band II. Theil I. 1893. Zweite Auflage. (Leipzig: Wilhelm Englemann.)

THE conception of molecule is essential in explaining the phenomena of both chemistry and physics. Porosity and compressibility point to the conclusion that matter does not entirely fill space, to account for the dispersion of light requires that matter should have a grained structure; these and countless other physical facts find an explanation in the conception of molecule. Moreover, from various observations, more especially on the properties of gases and the phenomena of surface tension, the size of molecules can be approximately calculated, and in terms of the idea of molecule deduced in ways such as these physical properties are explained.

The chemist, on the other hand, has arrived at the need of the conception of molecule from totally different considerations. In the early days of his science, when the laws of combining proportions and of chemical equivalents were taking definite shape, the revival of the conception of atom was of immediate service in furthering the progress of chemistry. It was not long in becoming apparent, however, that the conception of atom alone was insufficient to meet the facts.

The relative numbers of atoms entering into the composition of compounds was a matter of doubt until Avogadro's hypothesis was accepted, and until it was granted that definite groups of atoms—chemical molecules—were concerned in chemical processes.

The chemist has thus built up his conception of molecule in accordance with chemical facts; he regards it as a structure composed of parts, and in order to explain the existence of isomers, he has to assume definite relative arrangements of the atoms within a molecule.

From the fact that the two conceptions of molecule have been derived independently of one another, it has come about that physical properties are discussed more or less apart from the chemical nature of the substances examined, and for this reason within recent times there has arisen a fascinating field of inquiry on the borderland of chemistry and physics. For it has been urged, "Is it not possible to trace the cause of physical phenomena beyond the physical molecule?" If, as the chemist has shown, the molecule is a structure composed of parts, is it not possible that these parts of molecules are the units to be dealt with? In short, "Is not the ultimate cause of physical as well as of chemical phenomena to be ascribed to the chemical atoms and their mutual relationships?"

Already this question has been answered in several ways, and in none more striking than by those investigations which are concerned with the physical constants of substances and their chemical nature. Here it has been shown that the magnitudes of many physical constants are conditioned by the nature, number, and arrangement of the atoms which compose molecules and that frequently definite changes in chemical nature bring about definite quantitative changes in the magnitude of physical constants.

Books dealing with such investigations as these are but few, indeed the first volume of the book before us is practically the only one which gives a comprehensive view of what has been done in this direction. If we exclude those parts which are purely physical and which are concerned with familiarising the reader with the physical properties to be treated, the volume may in the main be taken as linking on the chemical to the physical conception of molecule, in so far as to show that the magnitudes of physical constants are functions of molecular weight and molecular structure.

The general arrangement of the contents of this volume is pretty much as it was in the previous edition, although very few pages remain as they were, and the introduction of recent investigations has increased the size of the volume by about one-third. The atomic hypothesis and the laws upon which it is based are first treated, then follows a useful summary of the various atomic weight estimations, from which are deduced the probable values of those fundamental constants, values which are already finding their way into current literature. The numerical relations existing between the atomic weights of the elements constitute the concluding portion of this the first of the six books into which vol. i. is divided. Succeeding books deal respectively with the physical properties of gases, liquids, solutions, and solids, and with the relations existing between the physical properties and the chemical nature of the substances.

Solutions are, in this edition, for the first time treated in a separate book, which with certain additions has been translated into English by Mr. Pattison Muir, and has already been noticed in these columns (NATURE, vol. xlv. p. 193). Electric conductivity and electrolysis now find a place in vol. ii. under electro-chemistry. The sixth and last book of vol. i. deals with chemical systematics—the criteria by which atomic weights are chosen, the periodic law and the relations between the physical constants of the elements and their atomic weights, and the molecular theory and the structure of chemical compounds in which the doctrines of valency, isomerism, &c., are discussed.

The peculiar interest which attaches to connections between the physical constants of substances and their chemical nature lies in the fact that an idea is thereby obtained of the constitution of the substances as they actually exist. Structure as deduced from purely chemical methods is founded upon reaction. The compound has to be decomposed before its constitution can be determined, and occasionally such methods lead to ambiguous results. Examples are steadily multiplying of compounds which in one reaction appear to correspond with one formula, while in another reaction a different formula better represents their chemical behaviour. Already measurements of physical constants have been applied to some such cases and have served to indicate that the structure of a pure substance may be conditioned by its temperature. At high temperatures, for example, acetyl acetone would appear to exist in the ketonic condition, $CH_3CO.CH_2.CO.CH_3$, while as temperature falls it would seem as if a gradual transition to the alcoholic conditions,

$CH_3.C(OH):CH.CO.CH_3$ and $CH_3.C(OH):C.C(OH)CH_3$, took place.

But physical methods can be applied to the study of the phenomena of chemical change as well as to those of chemical structure. Change of any kind taking place in material substances is to be sought in the nature of the energy associated with those substances, and chemical change has therefore to be sought in the nature of chemical energy. Of the nature of chemical energy, however, we know but little. Although it is the source of most of the energy turned to practical account in the arts and manufactures, and indeed, directly or indirectly, of all vital energy, it cannot be directly measured, and its nature is, as yet, but a matter for speculation.

Part 1 of vol. ii. of the "Lehrbuch" is concerned with making clear the present position of knowledge on this subject of chemical energy. To begin with, energy in general is discussed, the various forms under which it is known to us, and the units in which they are measured. Particular attention is directed to the factors which enter into the expressions denoting several of the types of energy, and more especially to the intensity factor. In the case of heat, for example, the intensity factor is temperature, and temperature, of course, determines whether heat energy shall be transferred from one body to another. A heat change between two bodies is conditioned by their temperature, and if the factors entering into the expression for chemical energy could be ascertained, the cause of chemical change might be traced in a similar way.

But although chemical energy cannot be directly measured, it can be transformed into other kinds of energy, and in turn other kinds of energy may pass into chemical energy. The amounts of these other kinds of energy which are thus involved in chemical processes are often capable of accurate measurement, and from such measurements alone can an insight into the nature of chemical energy be at present obtained. With such measurements the rest of the part is concerned.

During chemical change, chemical energy passes most readily and most completely into heat, and hence thermo-chemistry is first dealt with. A general historical discussion of the subject is succeeded by chapters on the non-metals, salt formation in aqueous solutions, the metals, and organic compounds. The concluding chapters deal with the "energetics" of heat, wherein is to be found the material which can be grouped around the second law of thermodynamics and the nature of heat energy in general, and with "chemical energetics" which treats of such attempts as have been made to arrive at the nature of chemical energy and its relations to heat energy. Where possible, connections between the chemical nature of substances and the heat energy to which they give rise during chemical change are pointed out, and the general application of thermal results to problems in chemical structure is kept well to the front.

The subject of electro-chemistry, which has been entirely recast, now occupies some 500 pages, as compared with little more than 100 in the first edition. It consists of a historical introduction, and of chapters on electrical energetics, Faraday's law, the migration of the ions, the conductivity of electrolytes, the constitution of electrolytes and the properties of ions, electromotive force, the differences of potential in cells, and on electrolysis and polarisation. In this section the author has collected and generalised the mass of communications which have recently been brought into existence by the fruitful hypothesis of electrolytic dissociation, and has connected them up with previous knowledge on the electrical properties of solutions. In conjunction with other portions of the "Lehrbuch" on the stoichiometry of solutions, this section gives the only full and systematic account of the new theory of solutions which is available to the general reader.

The third and last book of this part takes up the subject of photo-chemistry. The nature of radiant energy, which plays so important a part in the economy of nature and its relations to chemical energy, are first discussed. Then follow chapters on actinometry, the law of photochemical action, and on special photo-chemistry, which deals with the assimilation of carbon by plants, and the action of light on various chemical substances.

Enough has been stated to show that the work is unique. There is no other book which even attempts to cover the same ground. No chemical library can be regarded as complete without a copy of Ostwald's "Lehrbuch." It contains an enormous amount of information, both theoretical and practical, which is simply indispensable to the chemist and to the physicist. It is, indeed, difficult to overestimate the value of such a work.

But at the same time, mainly for the reason that it touches upon so many subjects, its usefulness in certain directions may to some extent be interfered with. One cannot fail to notice that the character of the work frequently savours more of a dictionary than a handbook. In the chapters on solutions and electro-chemistry there is, perhaps, not much room for this objection, for there the author has a definite purpose in view—the elucidation of the "new theory"—and writes around it, moulding his information and shaping the issues in a way that leaves little to be desired, if his standpoint be granted. Contrasted with the treatment of these sections we have on the other hand, that of the book generally. Here are set out short abstracts, in many cases but fragmentary, of the more important researches on the subject under discussion, but little attention being paid however to generalising the results or smoothing down the discrepancies, or indeed the contradictions which occasionally arise. For example, under the subject of the molecular volumes of liquids Kopp's work comes first, and his method of obtaining atomic volumes is given, the values of carbon and hydrogen being derived by the comparison of aromatic and fatty compounds. In due course Horstmann's conclusion that the ring-grouping of atoms exerts a marked effect on molecular volume finds a place, and the author passes on to other researches. But if Horstmann's conclusion is justified the whole superstructure of Kopp's calculated atomic volumes is subject to modification, as the effect of ring-grouping is ignored in the derivation of his atomic constants. Again, here as elsewhere, the author gives Schröder's work the prominence which has been more or less denied it in the past. Schröder's method, however involves different atomic constants to those of Kopp, and it is left almost entirely to the reader to assess the relative worth of the two systems. On one page of this chapter, too, Schiff's rule relating to the boiling points and molecular volumes of isomers is given, while two pages later are set out the results of Städel, which lead to the opposite conclusion, a conclusion which is much more generally true than that of Schiff, as the reader may verify by referring to the tables of physical constants given towards the end of the chapter.

The author may purposely have left matters in this condition, his idea being merely to indicate the gist of what has been done on the different questions. Indeed the present condition of subjects like molecular volume is so unsatisfactory as to prevent any very definite conclusions being stated. Nevertheless, if such abstracts as are given had on various occasions been supplemented by a statement of opinion as to the nett upshot of the whole discussion, there is little question that the average student would have found the mastering of several portions of the "Lehrbuch" a task of less difficulty than at present it is.

On p. 387, lines 2, etc., a volume-change due to oxygen is attributed to hydrogen: typographical errors are somewhat numerous, as could hardly be otherwise in a work of this kind.

To complete the second edition of the "Lehrbuch," Part 2 of the second volume, which treats of chemical affinity, has still to be published. Its appearance will serve to complete a work which goes further than any other to show how chemistry and physics must be united in the endeavour to arrive at the real nature of material phenomena.

J. W. Rodger.

CLARK ON THE STEAM ENGINE.

The Steam Engine: a Treatise on Steam Engines and Boilers. By Daniel Kinnear Clark, M.Inst.C.E. (London, Glasgow, Edinburgh and New York: Blackie and Sons, Limited, 1892.)

THE author of this book holds the first place among those who many years ago made the locomotive an object of scientific study. His famous work on railway machinery is still of prime importance, holding as it does an honoured place in many drawing offices. The present work consists of two ponderous volumes of some 800 pages each, and claims to be a comprehensive, accurate, and clearly written text-book, fully abreast of all the recent developments in the principle, performance, and construction of the steam engine. This no doubt is a very large claim to make for any work, but when one remembers who the author is, one is bound to admit that no one is more capable of carrying out so important a scheme.

Besides the author's many researches in locomotive engineering particularly, we notice that the numerous published records of investigation and practice have been made use of. This is certainly as it should be, and having been judiciously done adds greatly to the value of the work as a book for reference.

The work is divided into four main sections:—(1) The principles and performance of steam boilers; (2) the principles and performance of steam engines; (3) the construction of steam boilers; (4) the construction of steam engines. These main sections are again subdivided into many chapters.

The vast amount of information to be gathered from these pages may be imagined when it is noted that the first section alone takes up some 373 pages. Most of this space is absorbed by descriptions of experiments with special types of boilers, mechanical and other means of stoking, the prevention of smoke and the relative efficiency of various kinds of coal. Besides this the properties of steam are discussed, and the question of the economical combustion of fuel is very thoroughly gone into. The second section is an excellent treatise on the general behaviour of steam in the cylinder, and here we find evidence of the great experience of the author in this subject, particularly in the handling of the indicator diagram and the many lessons to be learnt from it when properly understood. The third section deals with the construction of steam boilers and concludes the first volume. Here we find a collection of reports and original matter of a valuable description embracing the whole subject. It is a pity that the classical researches of the late Mr. P. W. Willans find no place in the volume, because he, of all engineers, studied the thermodynamics of steam thoroughly, and his contributions to science on this subject are invaluable. It may be noted that his central valve high-speed engines find no place in the work. This also is to be regretted, because this type of engine is rapidly coming to the front, both as an economical machine and a trustworthy motor particularly for electric lighting by direct driving, the Glasgow Corporation Electric Lighting Station being among the latest to be fitted with these engines.

The first volume may be roughly said to contain most of the theoretical part of the subject, and the second volume the description of many types of stationary, marine, and locomotive engines. This volume begins with a very complete description of the various valve gears in use and the distribution of steam by ordinary and other slide valves, also the construction and modes of working of the many governors in use. Further on stationary engines for general purposes are described and very fully illustrated. We miss from these excellent examples the many types of high-speed engines used for driving dynamos, centrifugal pumps, fans, &c. Many of these have reached a high state of efficiency and might have been included with advantage.

Chapter lx. deals with British and foreign types of locomotives. We are not surprised to find that the many chapters on the locomotive are by far the best in the whole work. The author may be said to have grown up with the locomotive and to have made it his own particular study; to this day the plucky man who rode on the buffer beams of the old Edinburgh and Glasgow four-wheeled engines taking indicator diagrams is often quoted on that line, now part of the North British system.

The paper read by the late Mr. William Stroudley on the construction of locomotive engines, &c., before the Institution of Civil Engineers contains probably the most recent and trustworthy information at present available on this subject. The author has done well in making the quotations he does from this source. Of the British locomotives illustrated all are of most recent design. The table of types of American engines made by the Baldwin locomotive works is interesting, and the illustrations are good; but what is the use of giving the reputed weight of trains hauled without quoting the average speed? Surely the one can be of little service without the other. Continental locomotive practice is well represented in the types in use on the St. Gothard railway. Of peculiar types of locomotives perhaps the six-coupled double bogie Fairlie engine is a good example. This engine, designed by Sir Alexander M. Rendel for the Mexican Railway Company, is stated to be able to haul a train weight of 3600 tons on the level. The engine when fully charged carries 2850 gallons of water, and has 300 cubic feet of room for coal, and weighs 92¼ tons. On regular duty the engines run on a section of road which, for a length of fourteen miles, has many gradients of 1 in 25, with curves of 350 feet radius. More recent Fairlie engines supplied to this company weigh 93 tons 16 cwt. in running order, and are reported to do their work admirably.

We now come to the description of the different types of compound locomotives in use. These are practically all included in the Webb and Worsdell types in use in this country. Of the Webb type we find the Dreadnought class, and, in the appendix, the Greater Britain, thoroughly described and well illustrated.

At the present time the London and North-Western Railway Company have eighty-three compound locomotives of Mr. Webb's design at work, the total mileage of which since 1882 up to the end of December, 1892, was 22,854,037 miles, with an average consumption of 35·1 lbs. of coal per mile. This includes not only the fuel consumed in actually working the train, but also 1·2 lbs. used in raising steam and all fuel consumed whilst the engine is standing or shunting. The description of the Worsdell type of compound is equally clear, and is well illustrated by the Great Eastern and North Eastern locomotives. Why, however, are the Worsdell intercepting and starting valves alone described and illustrated? when this type of valve is seldom if ever used outside the North-Eastern Railway, the Worsdell Von Borries, Lapage, disc automatic valve being generally adopted in its place. Sixty Worsdell compound goods engines of the Mogul type have recently been sent to India, the cylinders being respectively 20 inches and 28 inches in diameter, stroke 26 inches, and the coupled wheels 5 feet 1½ inches in diameter. These engines and tenders weigh about 95 tons in running conditions.

In the addenda to the second volume there is some interesting information in reference to the construction of American locomotives and boilers, and details are freely illustrated. Following this is a description of the Vauclain compound locomotive as made by the Baldwin locomotive works. Then comes a short description of the Westinghouse brake—a very good break no doubt; but why should not the Vacuum brake find a place in the volume?

These volumes cannot of course be appreciated without careful study. They are a perfect mine of information, partly original, partly derived from contributions to the proceedings of various technical institutions and societies. The illustrations are excellent, and the typography remarkably clear. The work should be welcomed, both by the student and the engineer, as the best text-book on the steam engine and boiler yet published.

N. J. LOCKYER.

A LIFE OF LOUIS AGASSIZ.

Louis Agassiz: his Life and Work. By Charles Frederick Holder, LL.D., &c. (Leaders in Science.) (G. Putnam's Sons, New York and London.)

WITHOUT a Life of Louis Agassiz a series of histories of leaders in science would be incomplete. Fortunately materials are not lacking, for in addition to the "Life and Correspondence" edited by his widow, there are numerous sketches and accounts of particular aspects of the man. The present volume tells the main incidents of his life and work, pleasantly and succinctly, and presents us with a clear outline of a remarkable personality. The book is well printed and the illustrations are not few. Some are good, others are not specially connected with the text, two are failures. Both relate to Switzerland. One is a sensational picture of Agassiz' "descent into the heart of a glacier," where he is being lowered down into a crevasse, while the text clearly shows that he descended a *moulin*. The other represents "Agassiz on the pinnacle of the Jungfrau." We think that this must be a studio composition, for the "pinnacle" is not very like what we have seen, and the topography of the view is incomprehensible.

Agassiz was a sturdy Swiss lad, uniting, as became a Neuchâtelois, something of French versatility with German tenacity of purpose; a close and keen observer delighting in every aspect of nature, happily neither "crammed" nor forced as a boy. When only twelve years old he was an omnivorous collector, and was more than this, a close student of his treasures.

Intended for commerce, he prevailed upon his parents to let him attend a course of classes at the University of Lausanne, then to proceed to Heidelberg and Munich as a student of medicine. At the age of twenty-three he had obtained the degree of doctor in that faculty as well as in philosophy. By this time, however, he had determined to devote himself to science, having already made his mark by his work on fresh-water fishes. After some stay in Paris a professorship was ultimately created for him at Neuchâtel, which he held until a visit to America ended in his accepting a post at Cambridge, Massachusetts, and settling down in the United States. But before leaving his native land he had become famous also by his studies of glaciers; still it was in the New World that the most important part of his life's work was done. Apart from the immense impulse which he gave to the progress of science in the United States, his explorations along the coast of Florida, in Brazil, on both coasts of South America, all supplied abundant material for study, which was worked up with unflagging industry.

The book, in short, is a marvellous record of work accomplished. We read in it of incessant labours in the lecture-room, the laboratory, and the field, yet the list of his books and scientific papers appended to this volume is perfectly appalling. Of the former there are thirty-nine, large and small; the list of the latter occupies twenty-two and a-half pages, each containing about ten entries, on the average. But this incessant activity, mental and physical, wore out even the sturdy Switzer, careful as he had always been in exercising the body. Cuvier's last words to him, "Be careful, and remember that work kills," had been, perhaps of necessity, neglected. The day after they were spoken the great naturalist had been stricken to death by paralysis. They were equally prophetic in the case of Agassiz, for by his sixty-seventh year even his vigorous constitution was worn out.

Agassiz was a born teacher. As one of his admirers says, "His greatest work in science was his influence upon other men." Surely this is one of the best of epitaphs. This memoir contains some pithy sayings worth remembering in our generation. These are a few samples—"It is a false idea to suppose that anybody is competent to learn or to teach anything;" "The mind is made strong not through much learning but by the thorough possession of something;" "Learn to read the book of Nature for yourself;" "Train your pupils to be observers;" "It is better to have a few forms well known than to teach a little about many hundred species;" "The study of Nature is an intercourse with the highest mind." A remark, also of his, has a lesson for this age of many books, when he said, commenting on his early difficulties in obtaining them, that "he believed it had been really an advantage, for it prevented him from relying too much on them, their absence forcing him to investigate for himself."

Dr. Holder compares the influence of Agassiz in America with that of Darwin in England. It was in many respects very different, as were the men; yet they had much in common: the same intense love of nature, the same thirst for knowledge, the same indomitable energy in the pursuit of it. They were alike in being seriously hampered: Agassiz by poverty, at any rate in the earlier part of his life, for many a time his mind had to be fed at the expense of his body; Darwin by ill health in the larger and later part. Yet they were very different: the one in constant intercourse with his fellow men, the enthusiastic leader of a band of students, the centre of a society; the other compelled to lead a recluse life. They looked also upon nature from different standpoints. Agassiz was unable to accept Darwin's views as to the origin of species, though it is curious to see what concessions he was prepared to make in regard to a progression from an embryonic stage to one of high development. This, however, must be by successive creations, not by evolution. In regard to the latter he apparently shared the fears of not a few other religious men, and failed to see that the vision of Mother Carey in Peacepool, "making things make themselves," may be as full an expression of the operation of a Divine Mind as any scheme of creation.

Agassiz, though he had a hard struggle, was fortunate in many respects: in the possession of good parents, a vigorous frame, and a sound constitution; above all, in acquiring the friendship of such men as Cuvier and Humboldt at the age when their help was most needed. He was happy, like Darwin, in his family life, with a wife who was a helpmate, and a son who followed his footsteps, and still does honour to the name. Like Darwin also, he was *felix opportunitate vitæ et mortis*. Both had their obstacles to overcome, and their difficulties to conquer, but they would have found these more formidable, because more insidious, in the present generation. Is an Agassiz or a Darwin any longer a possible product? Natural science is now sometimes in danger of becoming a department of literature or a branch of physics. These men went to nature for their teaching rather than to books: now they would find it hard to avoid being smothered with "the literature of the subject," and being choked with the dust of libraries. To read the life of the genuine lover of out-door nature such as Agassiz or Darwin, is like a breath from a glacier in the valley of the Rhone; to study the record of a life so simple, so earnest, so pure, so reverent, is a lesson for all time.

T. G. BONNEY.

OUR BOOK SHELF.

Beiträge zur Biologie und Anatomie der Lianen, im Besonderen der in Brasilien einheimischen Arten. Von Dr. H. Schenck. Zweiter Theil. Beiträge zur Anatomie der Lianen. 8vo. pp. 271, tt. 12. (Jena: Gustav Fischer, 1893.)

IN a brief notice of the first part of Dr. Schenck's "Beiträge" (NATURE, vol. xli., p. 514), the fact that it was only the first part was overlooked; hence the remark that all the plates of that part were devoted to the illustration of the external morphology of chiefly woody climbers loses the force it would have had, had it referred to the whole work. The second part has now appeared, and this treats of the anatomy, whilst the first treats of the biology of this class of plants. The two volumes form a valuable book of reference on this subject; and the illustrations include examples of the anatomy of the stems of climbing plants belonging to about twenty-five natural orders. There are twelve large folded plates containing 178 figures, all very laboriously and carefully drawn. The Sapindaceæ and Leguminosæ are most numerously represented, and present some highly curious structures.

W. B. H.

LETTERS TO THE EDITOR.

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

The Late Solar Eclipse.

IN his account of the work of the Eclipse Expedition at Fundium Mr. Fowler seeks to explain his inability to obtain the photographs at the moment of totality by the assumption that he received the signal of the beginning of totality at least ten seconds too late, and he bases this assumption on his own estimate of the difference in time which elapsed between my signal and that of M. Coculesco, one of the French observers at Fundium.

I did not hear M. Coculesco's signal, as my head was necessarily enveloped in the dark cloth of my photometer at the moment, but M. Deslandres, the chief of the French party, with whom I returned to Europe, tells me that he estimated the interval at about two seconds, with which estimate M. Coculesco concurs.

There would seem to be good reason to believe that the actual time of the total phase was several seconds less than we had been led to expect. The chronometer observations at Fundium (lat. 14° 7′) gave 243 seconds. M. Bigourdan, who was specially charged by the Bureau des Longitudes to make accurate observations on this point at Joal, which is a few miles to the west of Fundium, and in lat. 14° 9′, informs me that the total phase there was 241 seconds.

It is possible, therefore, that Mr. Fowler's estimate of 10 seconds may not only have been erroneous in consequence of the known difficulty of accurately estimating a time interval

during the exciting conditions of an eclipse, but may also have arisen from the fact that the actual eclipse was shorter than the calculated one.
T. E. THORPE.

Daylight Meteor, March 18.

THIS meteor, reported to NATURE by Dr. Rorie of Dundee, was also seen by Mr. A. G. Linney at Ackworth, near Pontefract. Careful comparison of their records gave a probable path from just S.E. of Lanark to 30 or 40 miles W. of Mull. Notes received later from the Fort William Low Level Observatory make it probable that the end was nearer there, say just N. of Mull. The former gives an actual path of 180 miles, from a height of 140 to 42 miles; the latter, 140 miles, ending at a height of 40 miles or less. If Dr. Rorie's time is correct, it travelled at a rate of 36 or 28 miles per second, both being rapid. This accounts for the magnificent streak. As this floated across to Dundee in three quarters of an hour, the central part must have in that time travelled 95 or 85 miles at a height of 100 to 90 miles above the earth, and in an E.N.E. direction. Thus its velocity seems to have exceeded 100 miles an hour. The Krakatão dust reached us in the same direction, its greatest height being 30 to 40 miles, and speed 72 miles per hour. A greater speed at greater altitude quite agrees with theoretical probabilities, although the increase seems very great.
J. EDMUND CLARK.

Roche's Limit.

A LETTER has been addressed by Mr. D. D. Heath to the Editor of NATURE on the statical problem involved in "G. R.'s" approximate method of finding Roche's limit. This letter has been submitted to me, and I have thus been led to look more closely into "G. R.'s" proof, which I adopted in a recent letter to NATURE (April 20, 1893, p. 581). Mr. Heath shows that both "G. R." and I have omitted the factor 2 from our result, and I now see besides that a statical solution is insufficient for the problem in question.

The problem may be stated thus :—To find at what distance two equal spheres in contact can revolve in a circular orbit round a third, the centres of the three spheres being in a straight line.

Take the following notation :—The single sphere of density σ and unit radius; the two spheres each of unit density and radii r; c, the distance from the centre of the single sphere to the point of contact of the two; and ω the angular velocity of the system.

The problem may be rendered statical by introducing the conception of centrifugal force estimated from the centre of inertia of the system, which is also the centre of rotation. The distance of the centre of inertia from the point of contact of the two spheres is $c\sigma/(\sigma+2r^3)$.

Then the three equations, only two of which are independent, which express the equilibrium of the spheres are :—

$$\omega^2\left(\frac{c\sigma}{\sigma+2r^3}+r\right)=\frac{\frac{4}{3}\pi\sigma}{(c+r)^2}+\frac{\frac{4}{3}\pi r^3}{(2r)^2},$$

$$\omega^2\left(\frac{c\sigma}{\sigma+2r^3}-r\right)=\frac{\frac{4}{3}\pi\sigma}{(c-r)^2}-\frac{\frac{4}{3}\pi r^3}{(2r)^2},$$

$$\omega^2\left(c-\frac{c\sigma}{\sigma+2r^3}\right)=\frac{4}{3}\pi r^3\left(\frac{1}{(c+r)^2}+\frac{1}{(c-r)^2}\right).$$

Adding the first two of these and dividing by $\frac{2}{3}\pi\sigma$, and then subtracting the second from the first and dividing by $\frac{2}{3}\pi r$, we have

$$\frac{3\omega^2}{\pi}\left(\frac{c}{\sigma+2r^3}\right)=\frac{4(c^2+r^2)}{(c^2-r^2)^2},$$

$$\frac{3\omega^2}{\pi}=1-\frac{8c\sigma}{(c^2-r^2)^2}.$$

Eliminating ω^2 we have

$$c(c^2-r^2)^2-8c^2\sigma=4(c^2+r^2)(\sigma+2r^3),$$

or

$$c^5-2c^4r^2-c^2(12\sigma+8r^3)+cr^4-4r^2(\sigma+2r^3)=0,$$

a quintic for determining c, the approximation to Roche's limit. If the two spheres are infinitely small compared with the single one, this reduces to

$$c^3=12\sigma.$$

Thus the factor 16 (which, as Mr. Heath shows, should have been 8) of "G. R.'s" and of my previous letter must be replaced by 12, when the rotation is taken into account. In the notation used before, we therefore have as the approximation to Roche's limit

$$2{\cdot}29\text{R}\times\left(\frac{\text{D}}{d}\right)^{\frac{1}{3}}.$$

Proceeding further, as I did before, to find when three homogeneous spheres are in contact, so that $\sigma=1$ and $c=2r+1$, we have—

$$22r^5-25r^4-60r^3+14r^2+38+11=0.$$

Unity is a solution of this, so that three equal spheres are in contact—an obviously correct solution.

There is another root with $r=2{\cdot}08$, so that the two spheres are each much larger than the third.

These solutions of course give no approximation to that of the problem to which the latter part of my letter referred.

May 3.
G. H. DARWIN.

The Use of Ants to Aphides and Coccidæ.

MR. COCKERELL is not quite accurate in saying that I have "adduced the production of honey-dew by aphides as a difficulty in the way of the Darwinian theory" (NATURE, vol. xlvii. p. 608). In the passage to which he alludes I have said, that the relationship which in this matter subsists between ants and aphides is one of the very few instances where it can be so much as suggested that the structures or instincts of one species have exclusive reference to the needs of any other species. Therefore, even if this suggestion were not thus opposed to all the analogies of organic nature, "most of us would probably deem it prudent to hold that the secretion must primarily be of some use to the aphis itself, although the matter has not been sufficiently investigated to inform us of what this use is" ("Darwin and after Darwin," p. 292).

But my object in now writing is to corroborate Mr. Cockerell's explanation. For, on looking up my references, I find a letter from the Rev. W. G. Proudfoot, dated March 26, 1891, in which he communicates the following observations :—

"On looking up I noticed that hundreds of large black ants were going up and down the tree, and then I saw the aphides. . . . But what struck me most was that the aphides showered down their excretions independently of the ants' solicitations, while at other times I noticed that an ant would approach an aphis without getting anything, and would then go to another. I was struck with this, because I remembered Mr. Darwin's inability to make the aphides yield their secretion after many experiments. A large number of hornets were flying about the tree, but seemed afraid of the ants; for when they attempted to alight, an ant would at once rush to the spot, and the hornet would get out of its way."

From this it seems probable that, but for the presence of the ants, the aphides would have been devoured by the hornets. It also appears that Darwin's explanation is likewise true, viz. that the aphides are bound to get rid of their excretions in any case, and therefore that "they do not excrete solely for the benefit of the ants."
GEORGE J. ROMANES.

Christ Church, Oxford, May 6.

MR. COCKERELL'S letter (NATURE, vol. xlvii. p. 608) suggests the possibility that the following fact bearing on the connection between a coccid and another member of the Aculeate Hymenoptera may be interesting. I have a quantity of *Cotoneaster microphylla* covering a long sunny bank, and this shrub is much infested by a coccid, *Secanium ribis*. The queen wasps (usually early in June, but this year they are beginning now) are attracted in great numbers by the secretion from the coccid and may be taken with a common ring net and destroyed, to the great advantage of my garden. As to the visits of the wasps being of any advantage to the coccid I am somewhat sceptical, though no doubt they are to the wasps—when they are not caught!
ALFRED O. WALKER.

Nant y Glyn, Colwyn Bay, May 5.

ON THE EARLY TEMPLE AND PYRAMID BUILDERS.

I HAVE in previous articles discussed the orientation of many temples in various parts of Egypt. It will have been seen that it has been possible to divide them into solar and stellar temples, and that in the case of the former both solstices and equinoxes have been in question.

I have also referred to the very considerable literature which already exists as to the pyramids, and shown how the most carefully constructed among them are invariably oriented truly to the four cardinal points, and further that it is possible that some parts of their structures might have served some astronomical purpose, since astronomical methods must certainly have been employed in their construction.

It has also been suggested that the fundamental difference between solstitial and equinoctial worships indicated by the solstitial temples and the pyramids required nothing less than a difference of race to explain it. I propose now to inquire if there be any considerations which can be utilised to continue the discussion of the question thus raised on purely astronomical grounds. It is obvious that if sufficient tradition exists to permit us to associate the various structures which have been studied astronomically with definite periods of Egyptian history, a study of the larger outlines of that history will enable us to determine whether or not the critical changes in dynasties and rulers were or were not associated with critical changes in astronomical ideas as revealed by changes in temple-worship. If there be no connection the changes may have been due to a change of idea only, and the suggestion of a distinction of race falls to the ground.

In a region of inquiry where the facts are so few and difficult to recognise among a mass of myths and traditions, to say nothing of contradictory assertions by different authors; the more closely we adhere to a rigidly scientific method of inquiry the better. I propose to show, therefore, that there is one working hypothesis which seems to include a great many of the facts, and I hope to give the hypothesis and the facts in such a way that if there be anything inaccurately or incompletely stated it will be easy at once to change the front of the inquiry and proceed along the new line indicated.

I may begin by remarking that it is fundamental for the hypothesis, that the temples of On or Heliopolis, as stated by Maspero and other high authorities, existed before the times of Mini (Menes) and the pyramid builders, whatever may have been the date of the original foundation of Thebes.

Before Mini, according to Maspero, "On et les villes du Nord avaient eu la part principale dans le développement de la civilisation Égyptienne. Les prières et la hymnes, qui formèrent plus tard le noyau des livres sacrés, avaient été ridigés à On."[1]

The working hypothesis is as follows :—

1. The first civilisation as yet glimpsed in Egypt, represented by On or Heliopolis, was a civilisation with a solstitial solar worship associated with the rise of the Nile. A northern star was also worshipped.

2. Memphis (possibly also Sais, Bubastis, Tanis, and other cities with east and west walls) and the pyramids were built by an invading race from a land where the worship was equinoctial. A star rising in the east was worshipped at the equinox.

3. The blank in Egyptian history between the sixth and eleventh dynasties was associated with conflicts between these races, which were ended by the victory of the representatives of the old worship of On. After them pyramid building ceased and solstitial worship was resuscitated; Memphis takes second place, and Thebes, a southern On, so far as solstitial solar worship is concerned, comes upon the scene as the seat of the twelfth dynasty.

[1] "Histoire ancienne," p. 41.

4. The subsequent historical events were largely due to conflicts with intruding races. The intruders established themselves in cities with east and west walls, and were on each occasion driven out by solstitial solar worshippers who founded dynasties (eighteenth and twenty-fifth) at Thebes.

1.—*On.*

I have taken another occasion of remarking how the various worships at Thebes were reflected in the orientation of the temenos walls. The so-called "symmetrophobia" of the Egyptians was full of meaning, which in this case, at all events, is no longer hidden. If we note this reflection, as we can over and over again, where both temples and walls still stand, it is fair to assume that where the walls alone remain the temples which they once enclosed, long since destroyed, had the same relation. These considerations, alas, have to be appealed to in the case of Heliopolis, to say so far nothing of Abydos and Memphis.

At Heliopolis the so-called "symmetrophobia" as indicated by the trend of the mounds given in Lepsius's plan, is so strong that in spite of the fact that only one obelisk of one temple remains, it is easy to show that both solstitial solar worship and star worship were carried on, if walls had the same relation to the included temples at On as they had at Thebes.

The solar temple at On has entirely disappeared. As may be gathered from the remains of the mounds, it lay in the line of the solstices. As the gods included Rā, Atmu, and Osiris, probably like the temple of Amen Rā at Thebes there were two temples back to back. At Thebes the temples were directed north-west—south-east, at On south-west—north-east.

My observations of the orientation of the obelisk show that the temple of which it formed part may have possibly been the first of the series which includes the temple of Mut at Thebes, and other temples, there and at Abydos; that is the worship of Set was in question, to speak generically. Now, according to Maspero,[1] Sit or Set formed one of the divine dynasties, being associated with the sun and air gods at On, *i.e.* with Rā, Atmu, Osiris, Horus, and Shou.

At Abydos, as also can be determined by the orientation of the walls, one of the oldest temples was probably a solstitial one. The stellar temples sacred to Set were built much later than the solar temple.

Like On, Abydos was a sacred city.[2]

"C'est comme ville sainte qu'elle était universellement connue. Ses sanctuaires etaient célèbres, son dieu Osiris vénéré, ses fêtes suivies par toute l'Égypte; les gens riches des autres nomes tenaient à honneur de se faire dresser une stèle dans son temple."[3]

If it be found that the references to "ancestors," and "divine ancestors," occur after the eleventh dynasty, the race represented by On may be referred to (see the articles on the Egyptian year), and it may be that so often referred to as the Hor schesu.

Only one star temple, as I have said, is still represented at On; those at Abydos are known to be late. The term, then, of Sun-worshippers was highly distinctive, and there is reason to believe that the stellar observations were connected with the solar worship.

2.—(*a*) *The East and West Walls and Pyramid Builders.*

On the hypothesis these came from a country where the worship was equinoctial.

We are justified from what is known regarding the rise of the Nile as dominating and defining the commencement of the Egyptian year that other ancient peoples placed under like conditions would act in the same way.

Now what the Nile was to Egypt the valleys of the

[1] *Op. cit.* p. 33.
[2] Maspero, *op. cit.*, p. 21.
[3] It is important to inquire if this took place after the advent of the eleventh dynasty.

Tigris and the Euphrates were to the early Chaldæan empire. Like the Nile, these valleys were subject to annual inundations, and their fertility depended, as in Egypt, upon the manner in which the irrigation was looked after.

But unlike the Nile, the commencement of the inundation of these rivers took place near the vernal equinox; hence the year, we may assume, began then, and, reasoning by analogy, the worship in all probability was equinoctial.

A people entering Egypt from this region, then, would satisfy one condition of the problem, but is there any evidence that this people built their solar temples and temple walls east and west, and that they also built pyramids?

There is ample evidence, although, alas! the structures in Chaldæa, being generally built in brick and not in stone, no longer remain, as do those erected in Egypt. Still, in spite of the absence of the possibility of a comparative study, research has shown that in the whole region to the north-east of Egypt the temenos walls of temples and the walls of towns run east and west; and though at present actual dates cannot be given, a high antiquity is suggested in the case of some of them. Further, the temples which remain in that region where stone was procurable, as at Palmyra, Baalbec, Jerusalem, all lie east and west. But more than this, it is well known that from the very earliest times pyramidal structures, called ziggurats, some 150 feet high, were erected in each important city. These were really observatories; they were pyramids built in steps, as clearly shown from pictures found on contemporary tablets; and one with seven steps and of great antiquity, it is known, was restored by Nebuchadnezzar about 600 B.C. at Babylon.

A second condition of the hypothesis is therefore satisfied.

But did this equinox-worshipping, pyramid-building race live at anything like the time required? Prof. Sayce showed in the Hibbert lectures which were delivered in the year 1887 that recent finds have established the existence of a King Sargon I. at Agade in Chaldæa 3800 B.C. Hence it seems that a third condition of the hypothesis is satisfied by this recent discovery. There was undoubtedly an equinox-worshipping, pyramid-building race existing in Chaldæa at the time the Egyptian pyramids are supposed to have been built.

Hommel, in a recent paper on the Babylonian origin of Egyptian culture, shows that the names of the gods corresponded in many cases with the names of deities mentioned in the oldest Egyptian pyramid texts. . . . The names were represented by exactly the same signs in both Babylonian and Egyptian hieroglyphics . . . the name and signs of Osiris the Babylonian Asari are represented in both countries by an eye. He contends that there had been a direct communication between the two civilizations, and that the Babylonian was the older of the two.

Next let us return to Egypt.

We find at Memphis, Sais, Bubastis, and Tanis east and west walls which at once stamp those cities as differing in origin from On, Abydos, and Thebes, where, as I have shown, the walls trend either north-west—south-east or north-east—south-west.

For Memphis, Sais, and Tanis, the evidence is afforded by the maps of Lepsius. For Bubastis it depends upon the statement of Naville, that the walls run "nearly from east to west," and with the looseness too often associated with such statements, it is not said whether true or magnetic bearings are indicated.

Associated with these east and west walls there is farther evidence of great antiquity. Bubastis, according to Naville,[1] has afforded traces of the date of Cheops and Chephren, and it is stated by Manetho to have existed as early as the second dynasty.

[1] "Bubastis," preface, p. iv.

It is also generally known that the pyramids in Egypt are oriented east and west. Nor is this all.

One of the oldest, if not the oldest, pyramid known, is a step pyramid modelled on the zuggurat pattern: the so-called "step pyramid of Sakkarah." The steps are six in number, and vary in height from thirty-eight to twenty-nine feet, their width being about six feet. The dimensions are (352 north and south) × (396 east and west) × 197 feet. Some authorities think this pyramid was erected in the first dynasty by the fourth king (Nenephes of Manetho, Āta of the tablet of Abydos.) The arrangement of chambers in this pyramid is quite special.

The claim to the highest antiquity of the step pyramid is disputed by some in favour of the "false pyramid" of Mêdûm. It also is really a step pyramid 115 feet high; its outline, which conceals some of the steps, shows three stages, seventy, twenty, and twenty-five feet high; but in its internal structure it is really a step pyramid of six stages.

This pyramid must, according to Petrie, be attributed to Seneferu; but De Rougé has given evidence to the contrary.[1] Seneferu was a king of the fourth dynasty.

We have at Dashour the only remaining abnormal pyramid called the blunted pyramid, for the reason that the inclination changes at about one-third of the height. This pyramid forms one of a group of four, two of stone, and, be it carefully borne in mind, two of brick; their dimensions are 700 × 700 × 326 feet; 620 × 620 × 321 feet; 350 × 350 × 90 feet; and 343 × 343 × 156 feet.

One of these pyramids was formerly supposed to have been built by Seneferu; if any of them had been erected by King Ousertsen III. of the twelfth dynasty, as was formerly thought, the hypothesis we are considering would have been invalid.

Only after Seneferu, then do we come to the normal Egyptian pyramid, the two largest at Gizeh built by Cheops and Chephren (fourth dynasty) being, so far as is accurately known, the oldest of the series. (According to Mariette the date of Mini is 5004 B.C., and the fourth dynasty commenced in 4235.)

Associated with the cities with east and west walls are temples facing due east, fit, therefore, to receive the rays of the morning sun rising at an equinox.

Associated with these pyramids carefully oriented east and west, we find on their eastern sides some distance away, and on a line passing through their centres at right angles to a meridian line, temples facing due west, the clearest possible indication of equinoctial worship. At sunset at the equinox the sepulchral chamber and the sun were in line from the adytum. The priest faced a double Osiris.

In the case of the pyramid of Chephren, not only have we, as I hold, such a temple of Osiris, but the Sphinx granite temple was most probably the crypt of a temple of Isis, its relation to the south face of the pyramid being borne in mind. If this were so Osiris was a name both for the solstitial and equinoctial sun.

Other pyramids were built at Sakkarah during the sixth dynasty, but it is remarkable that such a king as Pepi-Meri-Rā should not have imitated the majestic structures of the fourth dynasty. He is said to have built a pyramid at Sakkareh, but its obscurity is evidence that the pyramid idea was giving way, and it looks as if this dynasty were really on the side of On,[2] for the authority of Memphis declined, and Abydos was preferred, while abroad Sinai was reconquered, and Ethiopia was kept in order.[3]

The sphinx (oriented true east) must also be ascribed to the earliest pyramid builders; it could not have been built before their intrusion. The Colossi of the plain at

[1] Maspero, *op. cit.* p. 59. [2] Maspero, *op. cit.* p. 80.
[3] Further, it is known that there was some connection between Pepi-Meri-Rā and the eleventh dynasty of Thebes. Maspero, *op. cit.* p. 91.

Thebes was a subsequent reply of the On solstitial worship to it.

(b) The Worship of the Bull by the Pyramid Builders.

There is a subsidiary point in connection with the pyramid builders and equinoctial worship.

The worship of Apis preceded the building of pyramids. Mini is credited by Elian with its introduction,[1] but at any rate Kakau of the second dynasty issued proclamations regarding it,[2] and a statue of Hapi was in the temple of Cheops.[3]

It is stated that the first month of the Chaldæan year was dedicated to the "propitious bull," and that the figure of a bull constantly occurs on the monuments as opening the year. Now the sun *at the vernal equinox* 4500 B.C. was in the constellation Taurus. Biot has shown that the equinox occurred with the sun near the pleiades in 3285 B.C. We seem driven to the conclusion that the constellation of the bull dates from this time, and that Hapi represented it.[4]

(c) The Art of the Pyramid Builders.

Another connecting link is found in the diorite statues found in the temple of Chephren, at the pyramids, and at Tell-loh (ancient Sirgalla) by M. de Sarzec in 1881.

This last find consisted of some large statues of diorite, and the attitude chosen was that of Chephren himself as represented in the Museum of Gizeh.

This indicates equality in the arts and the possession of similar tools in Chaldæa and Egypt about the time in question.

(d) The Star Worship of the Pyramid Builders.

I have given before the gods of Heliopolis, and have shown that with the exception of Sit none are stellar; and that the temple of Sit is still represented. But we find in pyramid times the list is vastly changed; only the Sun gods Ra, Horus, Osiris, are common to the two. As new divinities we find[5]:—

Isis.
Hathor.
Nephthys.
Ptah.
Selkit.
Sokhit.

Of these the first two and the last two undoubtedly symbolised stars, and there can be no question that the temple of Isis at the pyramids was built to watch the rising of some of them.[6] Of Iris and Hathor I have already written at length, and I think the stars are now known. The others are more doubtful, but it may be that Ptah = Capella and Selkit = Antares.

But it is also stated that at Memphis[7] [time not given] there were temples dedicated to Soutekh and Baal. Now this is of great importance, for I suppose there is now no question among Egyptologists that the gods Set, Sit, Typhon, Bes, Soutekh, Soutkhou are identical. It is also equally well known that Soutekh was a god of the Canaanites[8] that the hippopotamus, the emblem of Set and Typhon, was the hieroglyph of the Babylonian god Baal,[9] and Bes is identified with Set in the book of the dead.[10]

[1] Maspero, *op. cit.* p. 44, note. [2] Maspero, *op. cit.* p. 46.
[3] Maspero, *op. cit.* p. 64.
[4] Not only the bull; there is evidence in favour of the view that the goddess Selk = Antares. If so, the scorpion constellation had also been established, and *both* equinoxes marked by constellations in the time of Cheops. [5] Maspero, *op. cit.* p. 64.
[6] The temple of Saïs, as I have said, had east and west walls, and so had Memphis, according to Lepsius. The form of Isis at Saïs was the goddess Neith, which, according to some authorities, was the precursor of Athene. The temple of Athene at Athens was oriented to the Pleiades.
[7] Maspero, *op. cit.* p. 357.
[8] Maspero, *op. cit.* p. 165. [9] Pierret, p. 4. [10] *Idem*, p. 48.

Jensen in his "Kosmologie der Babylonier," p. 16, points out that Bīl was the name for the pole of the equator. If this be the Baal referred to by Pierret, we get the most marvellous coincidence between the Egyptian and Babylonian star-worship and suggestion of a common origin among an astronomically-minded people.

This suggests that the founders of On and Memphis had a common origin, and the Memphitic intrusion took place after solar solstitial worship had been introduced at On. This worship could not have been brought into Egypt from any other country, bordering on Chaldæa, and its ultimate predominance is the origin of the myth of Horus slaying the hippopotamus. Nay, it may be also suggested that the predominance was brought about by men and ideas reaching On from the south, so that the myth had a single celestial and a double terrestrial side.

The Hawk God of Edfû, Harhouditi, had for servants a number of individuals called Masniou or Masnitiou = blacksmiths, just as the Hawk God of the Delta, Harsiisit, has for his entourage the Shosou Horou. Maspero in a most interesting paper[1] has recently called attention to some customs still extant among the castes of blacksmiths in Central Africa, which have suggested to him that the followers of the Edfû Horus may have come from that province.

He writes: "C'est du sud de l'Égypte que les forgerons sont remontés vers le nord, leur siège primitif était le sud de l'Égypte, la partie du pays qui a le plus des rapports avec les régions centrales de l'Afrique et leurs habitants."

Then after stating the present conditions of these workers in equatorial Africa, where they enjoy a high distinction, he concludes:—

"Je pense qu'on peut se représenter l'Horus d'Edfou comme étant au début, dans l'une de ses formes, le chef et le dieu d'une tribu d'ouvriers travaillant le métal, ou plutôt travaillant le fer. On ne saurait en effet se dissimuler qu'il y a une affinité réelle entre le fer et la personne d'Horus en certains mythes. Horus est la face céleste (horou), le ciel, le firmament, et ce firmament est de toute antiquité, un toit de fer, si bien que le fer en prit le nom de ba-ni-pit, métal du ciel, métal dont est formé le ciel: Horus l'aîné, Horus d'Edfou, est donc en réalité un dieu de fer. Il est, de plus, muni de la pique ou de la javeline à point de fer, et les dieux qui lui sont apparentés, Anhouri, Shou, sont de piquiers comme lui, au contraire des dieux du nord de l'Égypte, Ra, Phtah, etc., qui n'ont pas d'armes à l'ordinaire. La légende d'Harhouditi conquérant l'Égypte avec les masniou serait-elle donc l'écho ointain d'un fait qui se serait passé au temps antérieurs à l'histoire? Quelque chose comme l'arrivée des Espagnols au milieu des populations du Nouveau Monde, l'irruption en Égypte de tribus connaissant et employant le fer, ayant parmi elles une caste de forgerons et apportant le culte d'un dieu belliqueux qui aurait été un Horus ou se serait confondu avec l'Horus des premiers Egyptiens pour former Harhouditi. Ces tribus auraient été nécessairement d'origine Africaine et auraient apporté de nouveaux éléments Africains à ceux que renfermait déjà la civilisation du bas Nil. Les forgerons auraient perdu peu à peu leurs privilèges pour se fondre au reste de la population: à Edfou seulement et dans les villes où l'on pratiquait le culte de l'Horus d'Edfou, ils auraient conservé un caractère sacré et se seraient transformés en un sorte de domesticité religieuse, les masniou du mythe d'Horus, compagnons et serviteurs du dieu guerrier."

3.—The Work of the Eleventh and Twelfth Dynasties.

We have next to consider what happened after the great gap in Egyptian history between the sixth and twelfth dynasties, 3500 B.C.–2851 B.C. (Mariette), from

[1] *L'Anthropologie*, July-August, 1891, No. 4.

Nitocris to Amenemhat I. We pass to the Middle Empire.

Amenemhat I. built no pyramids, he added no embellishments to Memphis; but he took Heliopolis under his care, and now we first hear of Thebes.[1]

Usertsen I. built no pyramids, he added no embellishments to Memphis, but he also took Heliopolis under his care, and added obelisks to the temples, one of which remains to this day. Further, he restored the temple of Osiris at Abydos, and added to the temple of Amen-Rā at Thebes.[2]

Surely it is very noteworthy that the first thing the kings of the twelfth dynasty did was to look after the only three temples in Egypt of which traces exist, which I have shown to have been oriented to the solstice.

It is right, however, to remark that there seems to have been a mild recrudescence of pyramid building towards the end of the twelfth dynasty, and immediately preceding the Hyksos period, whether as a precursor of that period or not.

Usertsen's views about his last home have come down to us in a writing by his scribe Mirri:[3]—

"Mon maître m'envoya en mission pour lui préparer une grande demeure éternelle. Les couloirs et la chambre intérieure étaient en maçonnerie et renouvelaient les merveilles de construction des dieux. Il y eut en elle des colonnes, sculptées, belles comme le ciel, un bassin creusé qui communiquait avec le Nil, des portes, des obélisques, une façade en pierre de Rouou."

There was nothing pyramidal about this idea, but 150 years later we find Amenemhat III. returning both to the gigantic irrigation works and the pyramid building of the earlier dynasties.

The scene of these labours was the Fayyûm, where, to crown the new work, two ornamental pyramids were built, surmounted by statues, and finally the king himself was buried in a pyramid near the Labyrinth.

4.—*The Work of the Eighteenth Dynasty.*

The blank in Egyptian history between the twelfth and eighteenth dynasties is known to have been associated with the intrusion of the so-called Hyksos. It is supposed these made their way into Egypt from the countries in and to the west of Mesopotamia. It is known that they settled in the cities with east and west walls. They were finally driven out by Aahmes, the king of solstitial solar Thebes, who began the eighteenth dynasty.

In (*a*) I have shown what happened after the first great break in Egyptian history—a resuscitation of the solstitial worship at On, Abydos and Thebes.

I have next to show that precisely the same thing happened after the Hyksos period (Dyn. 13 (?), Mariette, 2233 Brugsch; Dyn. 18, 1703 B.C., Mariette) had disturbed history for some 500 years.

It is known from the papyrus Sellier (G.C. 257) that Aāhmes, the first king of the eighteenth dynasty, who re-established the independence of Egypt, was in reality fighting the priests of Soutekh in favour of the priests of Amen-Rā, the solstitial solar god, a modern representative of Atmu of On.

Amen-Rā was the successor of Menthu, the successor of Atmu of On. So close was the new worship to the oldest at On, that at the highest point of Theban power the third priest of Amen took the same titles as the Grand Priest of On, "who was the head of the first priesthood in Egypt."[4] The "Grand Priest of On," who was also called the "Great Observer of Rā and Atmu," had the privilege of entering at all times into the *Habenben* or Naos. The priest Padouamen, whose mummy was found in 1891, bore these among his other titles.

[1] Maspero, *op. cit.*, p. 112. [2] Maspero, *op. cit.* p. 112.
[3] Maspero, *op. cit.* p. 113. [4] Virey, New Gizeh Catalogue, p. 263.

The assumption of the title was not only to associate the Theban priesthood with their northern *confrères*, but surely to proclaim that the old On worship was completely restored.

5.—*The Work of the Twenty-fifth Dynasty.*

There was another invasion from Syria, which founded the twenty-second dynasty, and again the government is carried on in cities with east and west walls (Sais, Tanis, and Bubastis). The solstitial solar priests of Thebes withdraw to Ethiopia. They return, however in 700 B.C., drive out the Syrian invaders, and, under Shabaka and Taharga, found a dynasty (the twenty-fifth) at Thebes, and embellish the solstitial solar temples there.

6.—*Anthropological Evidence.*

It will be seen then that a general survey of Egyptian history does suggest conflict between two races, and this of course goes to strengthen the view that the temple building phenomena suggest two different worships, depending upon race distinctions.

We have next to ask if there is any anthropological evidence at our disposal. It so happens that Virchow has directed his attention to this very point.[1]

Premising that a strong race distinction is recognised between peoples having brachycephalic or short, and dolicocephalic or long, skulls, and that the African races belong to the latter group, I may give the following extract from his paper:—

"The craniological type in the Ancient Empire was different from that in the middle and new. The skulls from the Ancient Empire are brachycephalic, those from the new and of the present day are either dolichocephalic or mesaticephalic; the difference is therefore at least as great as that between the dolichocephalic skulls of the Frankish graves and the predominantly brachycephalic skulls of the present population of South Germany. I do not deny that we have hitherto had at our disposal only a very limited number of skulls from the Ancient Empire, which have been certainly determined; that therefore the question whether the brachycephalic skull-type deduced from these was the general or at least the predominant one cannot yet be answered with certainty, but I may appeal to the fact that the sculptors of the Ancient Empire made the brachycephalic type the basis of their works of art too."

It will be seen, then, that the anthropological as well as the historical evidence runs on all fours with the results to be obtained from such a study of the old astronomy as the temples afford us.

J. Norman Lockyer.

NOTES.

On Monday, May 29, the Duke of Connaught will open the new engineering and electrical laboratories at University College, London.

A general meeting of the members of the Federated Institution of Mining Engineers will be held in the rooms of the Institution of Civil Engineers, 25, Great George Street, Westminster, on Thursday, June 1, at 12 noon, and on Friday, June 2, at 10 a.m.

The Niederrheinische Gesellschaft für Natur- und Heilkunden at Bonn, proposes to celebrate its seventy-fifth anniversary on July 2. A scientific meeting will be held in the forenoon in the music hall of the University of Bonn, and at one o'clock the members will dine together at the hotel "Zum Goldenen Stern." In the afternoon there will be an excursion to Rüngsdorf.

[1] Prof. R. Virchow: "Land und Leute im alten und neuen Aegypten." *Verhandlungen der Gesellschaft für Erdkunde zu Berlin*, pp. 434-436, Band xv. No. 9.

CAPTAIN E. C. HORE, who was for many years in command of the mission steamer on Lake Tanganyika, and received in 1890 one of the Royal Geographical Society's awards for his observations on the physical geography of the lake, has arranged an interesting little exhibition at 48, Pall Mall, which will be formally opened tomorrow, May 19, at 4 p.m., when a number of distinguished African explorers and administrators will be present. The exhibition contains a number of African curios collected by Captain Hore, and models illustrating native life and industries in a very realistic manner. It will only be open for a few weeks, and is well worthy of a visit from all interested in the geography or in the future development of the region marked out by Nature as the future highway through the continent of Africa.

THE annual dinner of the Royal Geographical Society was held at the Whitehall Rooms, Hôtel Métropole, on Saturday, Sir M. E. Grant Duff in the chair. Among the toasts of the evening was that of "The Medallists Designate." In proposing this, the Chairman explained that the dinner usually took place on the evening of the anniversary meeting, but the rooms could not be obtained for that day, and therefore the medals had not yet been conferred. All would agree that the choice of the council had fallen upon very worthy recipients. The first was Mr. Selous, whom they welcomed that evening. The second medallist designate was Mr. Woodville Rockhill, an American diplomatist, who had made himself famous by his explorations in Western China and North-eastern Tibet. Mr. Selous, in responding, said that at a very early period of his African travels he had made sketch maps, and he had never ceased to do so in all the countries through which he had travelled. He had been able to make a pretty correct survey of Mashonaland, and he looked with the most intense pride and satisfaction to the fact that he had seen a British colony spring up in that country, which he was one of the first to explore. Lord Kelvin responded for "The Allied Sciences," proposed by Mr. Seebohm. Mr. W. T. Thiselton Dyer proposed "The Royal Geographical Society." The Chairman, in replying, said he looked back with pleasure upon the almost unclouded prosperity which the Society had enjoyed for the four years during which he had been President. Their numbers this year had sprung forward again, and their total number was close upon 3700.

THE *Botanisches Centralblatt* has published a full description of the newly established Biological Institute at Heligoland, which is now at full work. The Director is Prof. Heincke, with Dr. Hartlaub as assistant for zoology, and Dr. Ehrenbaum for the high-sea fisheries, while Dr. P. Kuckuck superintends the botanical investigations. Donations to the library are especially asked for.

M. DUCHARTRE has been elected President of the Botanical Society of France for the current year, with MM. Guignard, Clos, Poisson, and Zeiller as Vice-presidents.

THE greater part of the Kew Bulletin for February and March, which has just been issued, consists of an account of the known habits and the economic treatment of the insect commonly known as the palm weevil, which during the last five or six years has been doing enormous injury to the industry of cocoa-nut palm growing in British Honduras. The paper cannot fail to be of service to planters engaged in this industry. The number contains also, besides miscellaneous notes, the fifth decade of new orchids.

THE London Botanical Field Class, which was established in 1891, will make seven field excursions during the present summer, the first of them taking place on May 27. The director is Prof. G. S. Boulger.

DURING the past week the day temperatures have generally been considerably above the average for the season, the readings at some of the central and southern stations exceeded 70°, and reached from 75° to 80° over our south-eastern and south-midland counties; but in some parts of the north and north-west the daily maxima have not reached 60°. During the first part of the period barometric depressions approached the north of Scotland and spread southwards, bringing light rains to the northern and western parts of the country; but the fall was below the average amount, while in the south and east of England no rain fell until the 15th inst. The long drought, which in many places was brought to a close on Monday by the advance of a subsidiary depression over the southern portion of the kingdom, had lasted in parts of Kent and Hampshire for fifty-eight days, during which time absolutely no rain fell there. Towards the close of the period the type of weather became very unsettled, and thunderstorms occurred in many parts, accompanied by rain or hail, but, with few exceptions, the fall up to Tuesday, the 16th inst., was not heavy. The *Weekly Weather Report* of the 13th inst. showed that the amount of bright sunshine was much above the average. In London it was 76 per cent. of the possible amount, which is higher than any percentage previously recorded in the metropolis since sunshine instruments were established in 1880. In the Channel Islands the percentage was as high as 88, and over England generally it ranged from 60 to 78 per cent.

THE report of the Kew Committee for the year 1892, the publication of which was noted in our last issue, states that the principal magnetic disturbances were recorded on February 13 and 14, March 6 and 12, April 26, May 18, July 16 and 17, and August 12. The most marked disturbance was that which commenced on February 13; the oscillations were of a more extended and violent character than any which have been recorded during the last ten years. The tabulations of the meteorological traces and other observations have been transmitted to the Meteorological Office, and detailed information of all thunderstorms has been forwarded to the Royal Meteorological Society. Sketches of sun-spots were made on 178 days; on no occasion during the year, when observations have been taken, has the sun's surface been found free from spots, and the number of new groups enumerated has largely increased. The number of instruments verified during the year was nearly 21,000, the great majority being clinical thermometers, and, in addition, a large number of watches have been examined.

THE Meteorological Council have just issued a summary of rainfall and mean temperature for the first quarter of the twenty-eight years 1866 to 1893, based upon the observations published in the *Weekly Weather Report*. The figures show some interesting details of the weather in each of the twelve districts into which the country is divided for the purpose of weather forecasts. In every district except the north of Scotland and the east of England there was a deficiency in the amount of rainfall. In the principal wheat-producing districts the greatest deficiency was in the Midland Counties, being 1·1 inch, and the east of Scotland 1·3 inch, while in the principal grazing, &c., districts the deficiency was still larger, being 2·0 inches in the south-west of England, and 2·7 inches in the north-west of England. The deficiency for the whole of the British Islands (omitting the Channel Islands and the North of Scotland) was 1·3 inch. The temperature in every district exceeded the mean, except the north of Scotland, where it just equalled it. The largest excess was 1°·3 in the north of Ireland, and 1°·2 in the north-east of England. The excess for the British Islands generally was 0°·8; the mean temperature for the last quarter, notwithstanding the severe cold experienced at the beginning of the year having been only just exceeded once in the last nine years.

THE first part of Prof. Newton's "Dictionary of Birds" which has long been announced as in preparation will be published next month. It is based upon the articles contributed by him to the ninth edition of the "Encyclopædia Britannica," but contains large numbers of others by himself and Dr. Gadow, the Strickland Curator at Cambridge, together with contributions by Mr. Lydekker, Prof. Roy, and Dr. Shufeldt. The work is to consist of four parts, and when complete will form a demy 8vo volume of about 1000 pages, copiously illustrated, and the publishers Messrs. Adam and Charles Black, promise the second part in October next.

IN the current number of the American *Journal of Science* Mr. Pupin gives the second part of his paper on electrical oscillations of low frequency and their resonance (see NATURE, April 20, 1893). This portion consists chiefly of a theoretical investigation of the rise of potential in a circuit which is in resonance with a periodical impressed electromotive force. This rise was shown in a very striking manner by connecting two large choking coils and a condenser in series with the secondary of a transformer, a Thomson electrostatic voltmetre being connected to the terminals of the condenser, and the core of one of the choking coils consisting of a movable bundle of solf iron wires. The frequency of the impressed electromotive force being about 100 per second, the capacity of the condenser was adjusted until the removal of the plug was accompanied by bright sparks, showing that resonance was near. Then the movable iron core was adjusted till the voltmetre gave the longest deflection obtainable. In this way a rise from 60 volts (generated in the secondary and indicated by a Cardew voltmetre) to about 900 volts was easily obtained. The rise of potential is practically confined to the condenser, there being, however, a large and rapid increase in the current on the approach of resonance, which increase can be studied in a rough way by the pull which the choking coil exerts on the movable iron core when this is being adjusted to give resonance.

THE question as to the cause of earth currents is one of considerable interest, and has not yet been satisfactorily answered. A paper read before the Institute of Electrical Engineers by Mr. O. E. Walker, giving a further account of his observations made in India seems to show, however, a clear connection between the variations in the earth currents and those of the atmospheric pressure. On account of the long periods of settled weather experienced in India, that country is particularly well suited for the investigation of any such relation. Observations were made on four lines, and show, in almost every case, that in the morning the current flows from the inland place of observation to the coast, while in the afternoon the direction is reversed. The maximum current in one direction occurs at 10 a.m. local time, this also being the time of the morning maximum reading of the barometer, while the maximum current in the opposite direction occurs at 3 p.m., the time of the afternoon minimum of the barometer. Another point of interest is that the maxima of the earth currents occur when the diurnal variation of the declination is zero.

ON a clear, cold, winter afternoon, about half an hour before sunset, a peculiar phenomenon of refraction of light can be witnessed on a fresh field of snow, which is described by Mr. Albert W. Whitney in the *American Journal of Science*. Two roughly V-shaped paths, of especial, though not exclusive brilliancy, open away from the observer and towards the sun. The apex of one is perhaps six feet away, its angle 90°; the apex of the other is perhaps fifteen feet away, its angle 60°. The light is not diffused, but made up of many separate brilliant points, glowing with prismatic colours. The paths are broad, several degrees in width, their inner margin being more sharply defined than their outer limit. Measurements with a sextant have shown that all the glowing points lie in the surfaces of two cones, whose axes pass through the sun and the eye of the observer, and whose angles are approximately 22° and 46°. Hence the paths are hyperbolas, and their visibility depends upon the altitude of the sun above the horizon. Mr. Whitney explains the phenomenon as analogous to that of halos. It is largely, perhaps mostly, due to frost crystals. They form more slowly, hence more regularly, than snow crystals. The fact that snow hyperbolas are usually more conspicuous in the late afternoon than in the early morning, may be explained by the frost crystals needing a certain amount of clearing up by sun and wind of minute secondary accumulations of frost upon themselves, to make them fit for transmitting light. Another interesting fact concerns the relation of the other limb of the hyperbola to that upon the snow. If the observer walks so as always to keep one certain point in the path of light, his track will be an hyperbola; if now, from the apex of the hyperbola which he has traced, he advances a distance equal to his height multiplied by the cotangent of the altitude of the sun plus half the vertical angle of the cone, the figure which he now sees and the figure which he has traced upon the snow are the two limbs of the same hyperbola.

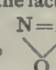
THE determination of the refractive index of the atmosphere has until recently been confined to the visible spectrum. Messrs. Kayser and Runge, in a communication to the Berlin Academy, describe a method of obtaining it for every portion of the photographic spectrum. If a prism is introduced between a Rowland concave grating and the sensitive plate, the rays are deflected, and the spectrum appears displaced on the plate. From the amount of this displacement and the distance of the prism from the plate it is easy to deduce the angle of deflection of the rays in question, and the refractive index of the prism. The prism used was hollow, made of copper and closed by quartz plates. The prism was filled with air under a pressure of about ten atmospheres Since the investigations of Mascart, Benoit, and Chappuis and Rivière have shown that the index of deviation of gases varies as the density, the refractive indices for air at zero and atmospheric pressure could be calculated from the results. Measurements were taken at seven different places along the spectrum, between wave lengths 563 and 236$\mu\mu$. The refractive indices for some of the Fraunhofer lines thus obtained are the following:—

A	1·0002902
D	1·0002919
F	1·0002940
G	1·0002959
H	1·0002975
N	1·0003000
$\lambda = 236\mu\mu$	1·0003217

These values are for air under normal temperature and pressure but not for dry air. To correct for moisture the last decimal place must be increased by 3, thus giving for D, for instance, the value 1·0002922. In the hands of previous workers, the last two figures have varied between 11 (Lorenz) and 47 (Ketteler).

NO fewer than six volumes containing French translations of writings by Mr. T. H. Huxley are now included in the "Bibliothèque Scientifique Contemporaine," issued by J. B. Baillière et Fils. The latest of these six volumes is a series of essays, entitled "Science et Religion."

A volume embodying the meteorological results deduced from observations taken at the Liverpool Observatory during the years 1889-90-91 has been published by order of the Mersey Docks and Harbour Board.

THE atomic refraction of nitrogen, in the free state as gas and in the various types of nitrogen compounds, forms the subject of a communication to the *Berichte* by Prof. Brühl, of Heidelberg. The refractive power of free gaseous nitrogen has been determined with the highest attainable accuracy by Biot and Arago, Dulong, and other later observers, and the value of the atomic refraction, calculated from the mean of all these determinations, is 2·21. As the simplest type of nitrogen compound ammonia gas is next considered, in which the three affinities of the nitrogen are attached by single linkage to the three hydrogen atoms. The molecular refraction of ammonia calculated from its refractive index is 5·65. Now, if it is admitted that the hydrogen in this simple compound possesses the same atomic refraction (1·05 for sodium light) as in the free state and in other ordinary combinations, an admission in support of which Prof. Brühl has previously adduced a considerable amount of experimental evidence, then the atomic refraction of the nitrogen in ammonia is 2·50. The compounds of nitrogen with oxygen are next discussed. The atomic refraction of oxygen for sodium light is 2·05, the molecular refraction of the free gas O_2 being 4·09. If one calculates the molecular refraction of nitric oxide, NO, by adding together the atomic refractions of the gaseous elements 2·21 and 2·05, the number 4·26 is obtained. It is interesting to find that the molecular refraction of nitric oxide, calculated from the values obtained experimentally by Dulong and by Mascart for the refractive index of the gas, is very nearly the same, 4·47. Hence in nitric oxide both elements retain about the same refractive power as in the free state. The case of nitrous oxide, N_2O, however, is quite different and leads to an interesting conclusion. Its molecular refraction calculated from the observed refractive index of the gas is 7·58. The value, however, obtained by summation of the values of its components, 2 × 2·21 and 2·05, is only 6·47. The very considerable increase of 1·11 is due to the fact that we are here dealing with a case of double linkage, , the two nitrogen atoms being mutually attached by two of their affinities. Indeed the increase is probably more than this, for the atomic refraction of oxygen in organic compounds of this type has been found by Prof. Brühl to be less than the value above ascribed to it. The atomic refraction of the nitrogen in N_2O is therefore at least 2·77. It is thus found that nitrogen as singly linked in ammonia possesses an atomic refraction of 2·50, when doubly linked, as in nitrous oxide, 2·77, and when trebly linked, as it probably is in the free gas, 2·21. The value therefore increases with double linkage, but curiously enough diminishes again with treble linkage, unlike that of carbon, which still further increases with treble linkage, and showing that there is some very essential difference between the nature of the two elements. Prof. Brühl concludes his interesting paper by discussing the various values of nitrogen when combined with carbon. When it is attached with only one of its valencies to a carbon atom, as in the tertiary amines, its atomic refraction is found to be 2·90, a very high value, higher than that of the diazo nitrogen in nitrous oxide. When doubly linked to carbon, C : N, as in the oxims, there is a much larger increase still, the exact amount of which Prof. Brühl prefers to state after carrying out further determinations on a larger number of compounds. In case of cyanogen gas, N ⋮ C · C ⋮ N, where triple linkage of nitrogen occurs, there is also a very considerable increment (1·52) in refraction. In the case of hydrocyanic acid, however, the molecular refraction corresponds almost exactly with that calculated from the empirical formula HCN, showing that the cyanogen in this compound and in cyanogen gas are quite different in molecular structure, a point which Prof. Brühl hopes further to elucidate by observations of the refraction of the nitriles and other allied organic nitrogen compounds.

Erratum.—In our chemical note of last week (p. 39) $SObl_2$ and Hbl should read $SOCl_2$ and HCl.

NOTES from the Marine Biological Station, Plymouth.—Last week's captures include the Anthozoa *Gorgonia verrucosa* and *Caryophyllia Smithii*, the Nemertine *Drepanophorus rubrostriatus*, the Mollusca *Sepia rupellaria* (= *biserialis*), *Galvina tricolor* and *Antiopa cristata*, and the Ascidians *Corella larvæformis* and *Fragarium elegans*. Several swarms of the medusa *Obelia lucifera*, full-grown and mature, were taken in the townets during the latter half of the week. Polychæte larvæ, so abundant earlier in the year, are now very scarce. Zoææ of *Porcellana*, on the other hand, have increased in numbers, and every townetting contains a variety of Decapod larvæ in different stages of development. The Hydroids *Eudendrium capillare* and *Antennularia antennina*, and the Polychæte *Sabellaria spinulosa* are now breeding.

THE additions to the Zoological Society's Gardens during the past week include two Red-winged Parrakeets (*Aprosmictus erythropterus*, ♀ ♀) from Australia, presented by Mr. H. Goodchild; two Ravens (*Corvus corax*) British, presented by Mr. Philip A. Wilkins; a Ducorp's Cockatoo (*Cacatua ducorpsi*) from the Solomon Islands, presented by Mr. R. Armitage; a Changeable Lizard (*Calotes versicolor*) from Ceylon, presented by Mr. H. L. Gibbs; a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, a Common Peafowl (*Pavo cristatus*, ♂) from India, deposited; a Yellow-cheeked Lemur (*Lemur xanthomystox*) from Madagascar, eleven Green Lizards (*Lacerta viridis*) South European, purchased; a Senegal Touracon (*Corythaix persa*) from West Africa, received in exchange; a Japanese Deer (*Cervus sika*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE GREATEST BRILLIANCY OF VENUS.—Dr. G. Müller, whose work on the brightness of the major and some of the minor planets we referred to in this column two weeks ago (p. 15) contributes to *Astronomischen Nachrichten*, No. 3162, some interesting results with reference to the greatest brilliancy of Venus. That this planet does not appear brightest at the time of conjunction, but some days before or after, has been shown by the work of Halley, Lambert, &c., and the values, as obtained from their formulæ, are:—

Formula used.	The greatest brilliancy occurs at Angle of phase.	Elongation.	No. of days before or after inf. conj.	Greatest brilliancy.
	° ′	° ′		
Halley	117 56	39 43	36	4·263
Lambert	103 46	44 38	51	2·126
Bremiker	115 15	40 52	39	2·772
Seeliger	116 0	40 33	38	3·018

Referring to the curves of the observed and computed brightnesses, as here set forward by Dr. Müller, several important points may be noticed. In the former the maximum brightness takes place at a phase angle of 119°, decreasing very gradually to 140°, and after that more rapidly. At the maximum the curve is moderately flat, only a very small variation being noticed between position angle 100° and 140°, a period of 36 days.

Dr. Müller remarks that the statements of epochs given in the astronomical ephemerides have no practical interest. As an example showing the deviations of the values therein stated from those computed by his formula he works out the next epoch of the greatest brilliancy of Venus, which will be in inferior conjunction on February 15, 1894. The values for the brightness and the corresponding times result as follows:—

Jan. 9	oh. G.M.T.	$h = -4·3776$
10	,, ,,	−4·3798
11	,, ,,	−4·3809
12	,, ,,	−4·3809
13	,, ,,	−4·3802
14	,, ,,	−4·3782

which give for the epoch of greatest brilliancy January 11, 15h. M.T.G. The times of epoch, as given by the ephemerides, are:—

Berliner Ast. Jahrbuch	Jan. 8	16h. M.T.G.
Nautical Almanac	11	2h. ,,
Connaissance des Temps	12	1h. ,,

FINLAY'S PERIODIC COMET.—This comet, which was discovered by Finlay in 1886, is one, if not the only one, of the periodic comets due this year. The following is a search ephemeris for the present month for intervals of four days:—

1893.	R.A. h. m. s.	Decl. ° ′
May 20	23 48 12	−4 24
24	0 5 24	−2 34
28	0 22 57	−0 40
June 1	0 40 53	+1 16

L'Astronomie FOR MAY.—This number commences with the discourses delivered by M. Tisserand and M. Flammarion before the Astronomical Society of France, the former "On the Progress of Astronomy during the Past Year," and the latter "On the Progress of the Society itself.—A brief but interesting article from the pen of Dr. Lorin, on "Celestial Photography," will be of special value to possessors of small instruments, since he shows how they can be adapted for the taking of such photographs. With reference to the late solar eclipse, several observatories have communicated their observations as made on the Continent, accompanying them with drawings, which are here inserted.

THE LUNAR ATMOSPHERE.—At the Observatory of Alger, M. Spée (*Comptes Rendus*, April 24, No. 17) made some interesting observations to find out whether any modifications due to a lunar atmosphere were produced in the lines of the solar spectrum (1) in the neighbourhood of the horns, and (2) at the point of contact of the lunar disc with a sun-spot. The observations, he says, were made under the best conditions, but gave a negative answer to the first of these two investigations. With regard to the second he says that no change was noted until at the moment of the greatest phase when the lines of magnesium b^1 b^2 b^4 "appeared sharp and seemed to be accompanied on both sides with very fine lines reminding one of what in spectroscopy is known under the name of *persiennes*. C was terminated, as M. Spée says, "*en fer de lance*" penetrating the chromosphere.

BULLETIN ASTRONOMIQUE FOR APRIL.—In this periodical for the past month M. Haerdtl contributes some notes relative to some small inequalities of long period in the movements of the Moon, Earth, and Mars. The determination of the orbit of the periodical comet Finlay (1886 vii.) is the subject of a long article by M. Schulhof, but in this (to be continued in the next) he only limits himself to the ephemeris and the mean positions of the comparison stars, with copious notes giving the authorities, proper movements, and remarks. *Apropos* of the question of the variation of latitudes M. Boquet gives an interesting historical notice on the latitude of the Observatory of Paris, in which he recapitulates all the attempts made to fix the value of this important element. Now that we know that variations occur, it is most interesting to read the remarks of the authors of these various determinations at different times with respect to the discrepancies between the values. M. Yvon Villarceau for instance, from his observations in 1866 and 1867 says: "Quant à la mesure exacte de la latitude, nous ne voyons pas qu'elle puisse résulter des mesures faites aux Cercles muraux de Gambey et de Fordin." . . . .

GEOGRAPHICAL NOTES.

THE death of Mr. W. Cotton Oswell on May 1st, at the age of 75, removed a famous African traveller and hunter whose name had almost ceased to be remembered by the general public. In his early life Mr. Oswell spent five years in South Africa hunting and exploring. His adventures were of the most thrilling kind, and the trophies he preserved in his house at Groombridge form a unique collection. He was associated with Livingstone in his earlier travels, and charged himself with the care of the waggons and the provision of food, while his companion planned the route and made scientific observations. In this way Mr. Oswell was with Livingstone at the discovery of Lake Ngami. Subsequently Mr. Oswell travelled and made collections in South America and elsewhere, but his extreme modesty prevented him from thrusting himself before the public, and he wrote nothing. His geniality in private life was as remarkable a feature of his character as his shrinking from all public appearances.

THE Canadian Government has decided to despatch an expedition, under the charge of Mr. J. B. Tyrrell, of the Geological Survey of Canada, to explore the barren ground northward from Lake Athabasca, a region which has not been visited by competent observers since 1772.

M. MARCEL DUBOIS has been appointed to the Chair of Colonial Geography, the foundation of which at the Sorbonne we intimated last year.

THE higher teaching of geography in England is not confined to the lectures delivered at the two ancient Universities. For some years Prof. C. Lapworth, F.R.S., has given courses on physical and political geography at the Mason College, Birmingham, which are this session attended by over eighty students. The complete course occupies two years, lectures being given twice a week; the syllabus is drawn out on thoroughly scientific lines, and while entirely original in treatment is comparable with the best instruction given in the same subject in German Universities.

ENGINEERING works of such magnitude as to be of geographical importance have been for some time carried out on the Alsatian slope of the Vosges in order to regulate the water supply for industrial purposes. A series of reservoirs, so large as to be described as artificial lakes, has thus been formed, and the rainfall of the district can now be utilised much more completely than was formerly possible.

THE FUNDAMENTAL AXIOMS OF DYNAMICS.

IN view of a discussion at the Physical Society of London on Friday, the 26th inst., it may be convenient if I anticipate future communications so far as to give in a brief or summary form the "Laws of Motion" somewhat as I propose to advocate their acceptance; not, however, entering into details, and not being specially careful about precise form of words, rather aiming at giving the general sense with the object of assisting discussion by abbreviating or summarising my paper in a few definite statements.

Notions derived more or less directly from sensations, and here accepted as understood without special definition.

Motion, Space (extent and direction), Velocity (including direction), Time, Stress, Force (including direction), Matter.

About all these there is much to say; some are more immediate sense-perceptions than others, but a detailed discussion of them verges on metaphysics, and is not an *essential* preliminary to a physical treatise. All that is *necessary* is explanation and illustration sufficient to render the terms intelligible. All that I shall say here is that by "matter" is meant primarily something tangible or resisting; that we experience "force" when we push a truck; that a thumbscrew gives us a notion of "stress": and that pushing a truck does also, if we attend to both hands and feet.

Remarks, Practical Assumptions, and Experiments.

There is no need to discriminate a force from a vector in a fundamental treatment, because all ideas about moment of force, angular momentum, and the like, belong to a consideration of the behaviour of a rigid body, which is an artificial agglomeration of connected particles: convenient, not fundamental.

But there are some assumptions and experiments needful to be made concerning the measurement of force more precisely than by our muscles.

(*Assumption* 1). That the weight of a given piece of matter at a given place is not liable to capricious change.

(*Assumption* 2). That two similar lumps of matter weigh twice as much as either.

(*Experimental result* 1). That strains of elastic bodies are proportional to the stresses within certain limits.

(*Experimental result* 2). That the frequency of a loaded elastic body, vibrating within the above limits is independent of amplitude.

(*Experimental result* 3). That in cases of impact there is one point whose motion is undisturbed by the blow.

Definitions, Simple Experiences, and Axioms.

(*Experience* 1). A stress consists of two forces.

(*Definition* 1). Acceleration (including direction) = dv/dt.

(*Experience* 2). Acceleration occurs in matter subject to an unbalanced force.

(*Axiom* 1). Without force there can be no acceleration of matter.

(*Experience* 3). The acceleration appears to agree with the force in direction, and is in some cases demonstrably proportional to the force. (A deduction from experimental result 2 above.)

(*Axiom* 2). The acceleration of a given piece of matter is proportional to the (effective or resultant or unbalanced) force acting on it, and is in the same direction.

(*Experience* 4). Stresses in a body do not accelerate it as a whole.

(*Axiom* 3). The two forces of a stress are always balanced.

[*Or otherwise* (after Experience 3).]

(*Definition* 2). The ratio of the force acting to the acceleration produced in a given piece of matter is called its "inertia."

(*Axiom a*). The inertia of a given piece of matter is unconditionally constant, and has no direction.

(*Remark*). Inertia is therefore taken as the most fundamental property of matter, and is used to measure its massiveness or "mass."

(*Definition* 3). The centre of mass of a system is a point such that $\Sigma(mr) = 0$; *or*, it is a point moving with speed v, such that $\Sigma(m)\mathrm{v} = \Sigma(m\mathrm{v})$.

(*Axiom b*). The centre of mass of a system is not accelerated by internal stresses, but only by one component of a stress whose other component acts on a body foreign to the system.

(*Deduction*). The two forces of a stress are always equal and opposite.

(*Remark*). A brief and convenient statement of Axiom 2, by help of Definitions 1 and 2, is $\mathrm{F}dt = m d\mathrm{v}$. Note that F and dv have necessarily the same sign; they are parallel vectors.

(*Experience* 5). Every force is one component of a stress; in other words, bodies can only mechanically act on one another (*i.e.* so as to affect each other's motion) by means of stress; or stress is essential to mechanical action.

(*Remark*). This might have been made part of Axiom 3, but it is really a distinct statement. Perhaps it should be stated as an axiom.

(*Axiom* 4). A stress cannot exist in or across empty space.

(*Deduction*). Therefore bodies (or any media) immediately acting on each other are necessarily in contact, and stress exists at the point of contact, where the normal components of their velocities (v) are identical.

(*Experience* 6). When stress and motion coexist, action occurs or activity is manifested.

(*Definition* 4). The scalar product of the two vectors Fv is called "activity."

(*Deduction*). The activities of two immediately acting bodies are equal and opposite.

(*Remark*). Elastic bodies under stress, and moving bodies with inertia, are found to be able to manifest activity, and are said to possess energy whereby they can do work on other bodies. Stress energy is called potential; motion energy is called kinetic.

(*Definition* 5). Work done $= \int(\text{activity})dt =$ energy gained or lost.

(*Remark*). There are two ways of regarding this quantity: $\int \mathrm{F}v dt$; namely either as $\mathrm{F}(vdt) = \mathrm{F}ds =$ change of potential energy, or as $v(\mathrm{F}dt) = v.m d\mathrm{v} =$ change of kinetic energy.

A body for which Fv is positive is losing energy; a body for which Fv is negative is gaining energy.

(*Deduction*). Since the activities of two immediately acting bodies are equal and opposite it follows by Definition 5 that energy lost by one is gained by the other; *i.e.*, that energy is simply transferred without loss or gain across the point of contact in the direction of the common velocity.

(*Axiom* 5). Energy which is not being actively transferred from one body to another remains unaltered in quantity and form.

(*Remark*). Energy which is being transferred from one body to another changes its form. The kind of transformation depends on the sign of dv with respect to the common velocity of the acting bodies at their point of contact.

If vdv is positive, energy is being transformed into kinetic; if vdv is negative, it is being transformed into potential; if vdv is zero, there is a mere flux or transmission of energy without transformation.

(*Deduction*). Since transference of energy is essential to activity it follows that only bodies which are able automatically to part with some of their energy, are able automatically to do work. In other words, automatically transferable energy is alone available or potential.

(*Experience* 7). The automatically transferable or potential energy of a body or system is liable to transfer and transform itself into kinetic. Hence

(*Axiom* 6). The potential energy of a system tends towards zero.

(*Experience*). Kinetic energy is only available when associated with appreciable or relative momentum.

The following statements may be made about the irregular and aggregate motion of particles called Heat.

(*Experience*). Heat will not flow from low to high temperature by mere conduction (as it could, for a time, if it possessed inertia, like water, air, or electricity). It can only flow from cold to hot by help of convection by matter or something else. Such flow is therefore not a cyclical or perennial process.

(*Deduction*). Energy of average temperature is useless for continuous work. In other words, the only available or potential portion of heat-energy, when dealt with in the aggregate, is that which a body is able freely to emit to colder bodies.

(*Definition*). The absolute temperature of a body is to its total heat-energy as the available fall of temperature is to its potential heat-energy.

OLIVER LODGE.

THE ROYAL SOCIETY SOIRÉE.

THE Royal Society Soirée on May 10 was in every way most successful. It was very numerously attended, and much interest was excited by many of the exhibits and by the demonstrations. In the following account of the exhibits we give a full account only of such objects as have not before been referred to in NATURE:—

Captain Abney, C.B., F.R.S., and General Festing, F.R.S., exhibited experiments on the extinction of light and colour.

Sir J. B. Lawes, Bart., F.R.S., and Dr. J. H. Gilbert, F.R.S., exhibited a series of photographs relating to the working of the Rothamsted Laboratory. In experiments on the growth of root-crops year after year on the same land, it was found that after a very few years of growth without manure, the root no longer developed the swollen character of the cultivated plant, but remain fusiform as in the uncultivated condition. The photographs strikingly show the same characters in roots grown in rotation without manure; also that mineral manures alone greatly favour the development of the swollen root, but that mineral and nitrogenous manures together do so in a much greater degree. The results further show how artificial a product is the cultivated root-crop, and how dependent it is on an abundant supply of food within the soil—nitrogenous as well as mineral. Indeed, details of the experiments afford conclusive evidence that it is quite fallacious to suppose that root-crops derive a large amount of their nitrogen from atmospheric sources by means of their extended leaf surface.

Three instruments for the study of Crystals were shown by Mr. H. A. Miers. (1) A goniometer by which crystals can be measured under liquids, or during their growth from solution. (2) A stage-goniometer by which small crystals or fragments can be adjusted and rotated under the microscope. It is here fitted to the stage of the petrological microscope designed by Mr. A. Dick. (3) An improved form of polariscope on the plan devised by Prof. W. G. Adams, F.R.S. The hemispheres which enclose the crystal section can in this instrument be accurately centred so that exact measurement of the optic axial angle is possible.

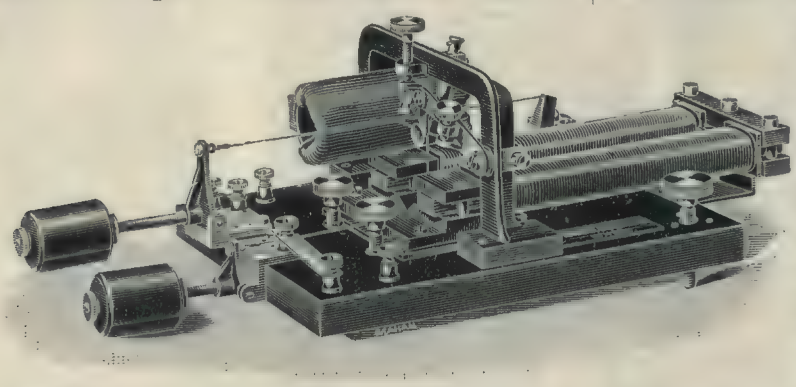
Prof. Rücker, F.R.S., and Prof. Thorpe, F.R.S., exhibited maps showing the forms of the true lines of equal declination, equal horizontal force, and equal dip in the United Kingdom for the epoch, Jan. 1, 1891.

Mr. A. A. C. Swinton exhibited high frequency electric experiments. (1) The filament of an ordinary 5 c.p. 100-volt lamp is caused to incandesce with current conveyed through the human body. (2) Sparks, evidencing a difference of potential of some thousands of volts, produced between the two hands of the same operator. (3) Luminous spiral produced in exhausted glass tube by molecular bombardment from wire spiral wound outside tube. (4) Some effects produced by high frequency discharges passing through semi-conducting substances, and striking liquids.

Sodium potassium high temperature thermometers, and specimens of the alloy, were exhibited by Mr. E. C. C. Baly and Mr. J. C. Chorley. These thermometers are filled with an alloy of sodium and potassium which is liquid at ordinary temperatures. Their range is from 0° to 620°C. (1,150°F.); the softening point of the glass, a specially hard kind, being about 650°C. The separate specimens of the alloy are exhibited to show its purity and its very remarkable surface tension.

Mr. Cecil Carus-Wilson exhibited the scotographoscope, for enabling lecturers to demonstrate with chalk in a darkened room. A compartment encloses a lamp so arranged as to cast a pure white light upon the interior surface of the sheet of specially prepared glass, which forms the front of the apparatus. In a darkened room, on removing the sliding screen, an intensely white surface is exposed, upon which chalks of any colour can be used in the ordinary way. Small chalk drawings easily seen at a distance of 100 feet or more, and they may be rapidly deleted by means of a damp sponge. The whole apparatus folds into a small compass for travelling.

Magnetic curve tracers, were exhibited by Prof. Ewing, F.R.S. The magnetic curve tracer exhibits the relation of magnetism to magnetising force in iron. A mirror, which is free to move both vertically and horizontally, receives two component motions: one (horizontal) proportional to the magnetising force H, and the other (vertical) proportional to the magnetisation B. The reflected light traces the characteristic cuve or B and H, exhibiting the influence of magnetic hysteresis. The instrument at work in the recess shows a cyclic process caused by periodic rapid reversals of magnetising force. A more recent form of the magnetic curve tracer is also shown (made by



Messrs. Nalder Brothers) which is arranged for the commercial testing of iron. The metal whose magnetic qualities are to be tested is made up in rods, which are readily inserted and removed. The rods which are shown are built up of narrow strips of sheet iron.

Prof. A. Smithells, B.Sc., exhibited experiments to demonstrate the structure of flames. (1) The separation of a non-luminous coal-gas flame into two combustion cones is effected by sliding a wider tube over the one on which the flame rests. The products of combustion can be aspirated from the intervening space. (2) Using benzene vapour instead of coal-gas, the transition from a simple luminous flame to a non-luminous flame is shown. The two cones of the latter are separated as before, and by a further addition of air the outer cone disappears, the complete combustion occurring in a single cone. (3) By introducing a spray of a solution of a copper salt, it is seen that the coloration of the flame occurs only in the outer cone where copper oxide is formed. (4) The cone flames are also separated by using a single tube. A platinum wire is pushed up axially till it touches the inner cone. On drawing it down, the inner cone is inverted and follows the wire.

Rev. F. J. Smith, M.A., exhibited an inductoscript. The inductoscript figures and pictures are made by placing the object to be reproduced in contact with an ordinary photographic plate, placed upon a conducting sheet of metal. The object and the plate are connected to the terminals of an induction coil or other source of electricity, for a fraction of a second, and then developed in the usual manner. Several of the pictures shown were produced on plates which had been exposed to full daylight. The pictures marked B were produced by the same method on bromide paper. Non-conductors such as wood blocks are coated with a surface of plumbago before being operated on. The best results are obtained by conducting the process in oxygen gas under a pressure of about two atmospheres.

Platinum thermometers and pyrometers, compensated resistance boxes and galvanometers, compensated barometer and air thermometer, exhibited by Mr. H. L. Callendar; a series of sections illustrating the seasonal distribution of temperature in sea-water lochs, exhibited by Dr. Hugh R. Mill; a portable hydrogen oil safety lamp, adapted for illumination and delicate testing in air containing any kind of inflammable gas or vapour, exhibited by Prof. Frank Clowes, D.Sc.; tuning forks worked electrically, a portable photometer, a table polariscope, exhibited by Sir David Salomons; high tension apparatus, exhibited by Sir David Salomons and Mr. L. Pyke; electrical apparatus, exhibited by Major Holden.

The Marine Biological Association exhibited marine invertebrata from the Plymouth area. Selected specimens of crustacea decapoda, and mollusca opisthobranchiata, including many rare species, and illustrating the richness of the Plymouth fauna.

Dr. G. H. Fowler exhibited specimens of oyster shells. The specimens illustrate:—(1) The rate of growth of the oyster. (2) Natural varieties of the shells. (3) Modifications of a variety bred under new conditions.

Prof. Weldon, F.R.S., exhibited diagrams showing the frequency of variations in the size of certain organs of crabs. The diagrams are based on measurements of portions of the carapace and other parts of *Carcinus mænas.* The organ to which each diagram refers is indicated in the central drawing of a crab. Each diagram is based upon measurements of 1,000 individuals, and the size of the organ measured is indicated (as a percentage of the body length) on the base-line of each. The vertical ordinates of the black curve show the number of individuals having the organ measured of the given magnitude, and the red curve is a probability curve.

Spectra of the flame from a Bessemer converter, exhibited by Prof. W. N. Hartley, F.R.S. The photographs comprise the solar spectrum intended for reference, together with spectra of the Bessemer flame taken at consecutive periods of the "blow" as indicated by the time during which the plate was exposed in each case. The flame spectra will be seen to be composed of (1) a continuous spectrum due to carbon monoxide; (2) a band spectrum belonging to metallic manganese; and (3) a line spectrum principally belonging to iron. Lines of potassium, sodium, and manganese are also present. Taken at the Crewe Works of the London and North-Western Railway Company, by permission of Mr. F. W. Webb, January, 1893. Enlarged ten diameters by the Autotype Company.

Prof. J. Norman Lockyer, F.R.S., exhibited the photographic spectra of some of the brighter stars.

Mr. Isaac Roberts, F.R.S., exhibited five original negatives and enlarged photographs of nebulæ and clusters of stars, taken with the 20-inch reflector by the exhibitor.

Some species of butterflies, illustrating protective mimicry were shown by Colonel Swinhoe. Mimetic forms of the nymphalid genus Hypolimnas in India, Malayana and Africa, showing the various phases of development of mimicry in two widespread species of the same genus; also mimetic resemblances to different protected species in the females of *Euripus halitherses*, &c.

The Zoological Society of London exhibited specimens of lepidopterous insects bred in the insect house of the Zoological Society in London. Four cases containing specimens of *imagines* or perfect insects, raised from *chrysalides* or pupæ in the Zoological Society's insect-house in the season of 1892. They belong chiefly to the silk-producing moths of the family Bombycidæ, and to the diurnal lepidoptera or butterflies.

Remains of extinct birds from New Zealand and the Chatham Islands (off the coast of New Zealand), exhibited by Mr. H. O. Forbes. The exhibit consisted of the chief portions of the skeleton of *Aphanapteryx Hawkinsi* (Forbes), a genus of rails known hitherto only from Mauritius, and of *Palæocorax Moriorum* (Forbes), a large raven, a form not otherwise known in the region; portions of the skeleton of a large *Fulica*, and of a species of swan, now extinct, from the Chatham Islands; a part of the skull of a large Auserine bird allied to *Cereopsis*, found associated with moa remains in a bog in New Zealand; the tibia of a new species of *Cnemiornis*, an extinct giant goose

(*C. gracilis*, Forbes), and the limb bones of three species, belonging to a new genus *Palæocasuarius* (Forbes), of the *Dinornithidæ*.

Dr. D. Sharp, F.R.S. exhibited some ants and their sound producing organs. The sound-producing organs of ants consist of very fine parallel lines engraved on a portion of the outer surface of the chitinous skeleton and of a scraper or very fine edge. Great delicacy of movement may be given to the latter instrument by means of a ball-and-socket joint.

Sections showing the microscopic structure of certain fossil cryptogamic plants from the coal-measures, exhibited by Prof. W. C. Williamson, F.R.S., and Dr. D. H. Scott; white corpuscles of the blood and lymph under the microscope, exhibited by Mr. W. B. Hardy and Dr. A. A. Kanthack; maps and photographs illustrating the Sandgate Landslip, exhibited by Mr. W. Topley, F.R.S., and Mr. R. Kerr, F.G.S.

Mr. Edward Matthey F.C.S. exhibited form in which antimony separates from bismuth at a temperature of 350°C. The specimens are those of the film as removed from the surface of the melted antimonial bismuth. They consist of antimony oxide, containing about ten per cent. of bismuth.

Two compact voltaic batteries of zinc and platinum, were shown by Dr. G. Gore, F.R.S.

Major P. A. MacMahon, F.R.S., exhibited peramutational tesselations. A new method of obtaining designs for tesselated pavements, based upon the property possessed by the twenty-four different isosceles right-angled triangles derived by permuting four designs in all possible ways upon the sides.

Mr. E. Wethered exhibited photo-micrographic lantern slides, illustrating the micro-organisms in limestone rocks. The slides especially illustrate the remarkable structure known as *Girvanella*.

Lord Armstrong, C.B., F.R.S., exhibited experiments to show the nature of the electric discharge in air and water. The experiments will all be exhibited in action on the screen of the electric lantern, and will include the transfer of a cotton string from one vessel to another by means of a current of water flowing within another under the influence of electricity. Various dust figures will also be formed and similarly shown, displaying the nature and effects of the electric discharge in air.

Preparations and photographs demonstrating the action of solar and electric light on the spores of bacteria and fungi, exhibited by Prof. H. Marshall Ward, F.R.S.

THE INTERDEPENDENCE OF ABSTRACT SCIENCE AND ENGINEERING.

ON Thursday evening, May 4, the first "James Forrest" Lecture was delivered at the Institution of Civil Engineers, by Dr. William Anderson, F.R.S. The subject was "the interdependence of abstract science and engineering." After briefly explaining the origin of the lecture, Dr. Anderson proceeded:—The theme which has been prescribed is "The Interdependence of Abstract Science and Engineering," and I imagine that the subject has been chosen because of an uneasy feeling, which possesses many thoughtful men, that this country is not keeping pace with its neighbours in engineering progress, and that we shall, in the future, have to pay more attention to abstract science and its application to practice, than we have been, so far, in the habit of doing.

With rare exceptions, in this country, has there been even a slender amount of theoretical knowledge imparted to various grades of employment; it is only during the last few years that Science Colleges and technical education in schools and People's Palaces, are beginning to bring our operatives up to the level of our foreign friends, but, unfortunately, too late to retain that pre-eminence which we at one time could claim, and, I fear, placed too much confidence in; and moreover, a new danger has arisen in the circumstance that popular scientific education has taken a one-sided direction, that of mechanical and technical knowledge alone, so that, though the operative approaches his work with increased intelligence, he remains unfit to reason out the great economic problems on which his own welfare and that of the nation depend.

It is a matter of extreme surprise to me that so little attention is paid to the science of Political Economy, that not only the mass of the people, in whose hands the voting power now lies, but even, in a great measure, the representatives whom they elect, have no systematic training in, and are grossly ignorant of, the principles which lie at the root of national prosperity. The further misfortune follows that politicians of the highest position do not scruple to trade on this ignorance, or pursue a course which, in its consequences, is as bad—being ignorant themselves they strive to lead the ignorant, and set the operative against his employer and against society in general. The cheapness of newspapers, their wide diffusion, and their blind, not to say reckless advocacy of popular fallacies acting on the ignorance, prejudices, and discomfort, if not suffering, of the operative classes, are giving enormous power to trade organisations, whose avowed object it is to improve the earnings and social standing of the operative at the expense of, or at any rate without regard to, the interests of every other class in the community, and this is to be accomplished not by encouraging education, not by advocating thrift and temperance, not by urging the workman to improve his mechanical dexterity, the thoroughnesss of his work and the amount which he produces, but by holding out visions of shortened hours of labour, by compelling a minimum of pay which will enable him to live in comfort, of systematically restricting the amount of work done by each individual, even in the shortened day, all under the fatal illusion that by such means a greater number of men will find more remunerative employment.

The employer is usually credited, by the trade leaders, with accumulating wealth without effort, risk, or anxiety, by the slavish labour of his operatives, while the proofs to the contrary, so easily to be obtained in the slender dividends declared by most industrial enterprises, and in the records of the Bankruptcy Courts, are steadily kept out of view.

There would be no fault to find with the new class of professional agitators, who live by the discontent which they foment, were they, and the Unions which they manipulate, to contribute in the smallest degree to the obtaining of that work and of those orders, in the execution of which the wage-earning portion of the community have their being. This, the most difficult part of every commercial enterprise, is left to the much-abused capitalist, so that the absurd and impossible system is fast asserting itself, that professional skill, mercantile ability, and capital, shall obtain the work, and run all the risk of design, execution, and financial security; but that work shall be carried out according to rules which self-constituted and perfectly irresponsible bodies choose to impose. The smallest acquaintance with the principles of political economy would demonstrate that such methods must end in ruin, that they are utterly incompatible with our policy of Free Trade—a system which is perfectly reasonable and proper if thoroughly carried out, and which certainly never contemplated the protection of one particular class, and that, not by edict of the State, but at the bidding of self-constituted tribunals whose claims amount to this:—that there shall be free trade in all products which the operatives require to buy, but the strictest protection as to all that they have to sell, namely their labour, and whose ultimate methods are violence, and the coercion of all who differ from views which many intelligent but timid workmen know to be at variance with the true interests of their class.

Under all this lies the socialistic idea of equality in the condition of every member of the community, an idea which political economy demonstrates to be utterly Utopian and impossible. Since the creation of mankind the differences in social position and in material comfort which follow naturally from the endless variations of mental and bodily powers in men, have existed, and, in spite of many abortive attempts, more or less violent, to establish equality, will exist for ever; for it seems to me that the doctrine of Carnot with respect to heat-engines applies by analogy to the question of national prosperity. To obtain mechanical power from a source of heat there must be a fall of temperature, and the greater that fall is the more efficient will the engine be—a dead level of temperature simply means extinction of energy and of life. To ensure active trade and prosperous manufactures there must be a fall of money or of its equivalent from the wealthy to the comparatively poor, the one class is absolutely essential to the other; the prosperity of the community is bound up in the existence of these differences, and a dead level of wealth would be a dead level of poverty, which would end, as a state of uniform temperature must end, in absolute stagnation and death.

However much we may regret the inequality which exists in the distribution of wealth and comfort, it is just as much a law of nature as the unequal distribution of warmth, of sunshine, or of rain, and seems to me to follow naturally and inevitably from the endless variations in the physical, moral, and mental powers of human beings, and therefore to be as unalterable at the bidding of man as these attributes are. It only remains for us to recognise the fact, to make the best of it, and to avoid the gross wickedness of attempting to delude the poorer and more ignorant members of the community by incessant representations that it is the greed and selfishness of the wealthy which keep them low.

If the so-called "working man" be the embodiment of all that is needed for the industrial prosperity of a country, and if the possession of capital and the far wider consequence, the existence of credit, be a crime, why does he not arise in his strength and exhibit the faculties of combination which are so well illustrated in the trades unions, and establish engineering works and manufactories, or undertake engineering enterprises from which he will be able himself to reap the golden harvest which the capitalist and the shareholder are supposed to gather, and who thereby excite his envy and arouse his hatred.

In deference, I presume, to the immense numerical importance of the operative classes, politicians are vieing with each other in supporting the impossible claims put forth—claims which, if conceded, will only precipitate the ruin of the class they profess to benefit, and which already is the form of what may be termed benevolent legislation in favour of the operative, is heaping up elements of cost which our productive energy is unable to bear. The absurd cry that manual labour is the sole source of wealth has been well combated by that acute reasoner, Mr. Macfarlane Gray, who, in a recent discussion on the labour question, happily compared the body politic to a tree. The popular belief is that plants are nourished through their roots, which for that reason are believed to be the all-important parts, while the leaves are mere ornaments, enjoying the upper air and sunshine and profiting by the work done underground. But a juster knowledge, one of the fruits of abstract investigation, tells us that the roots are mainly useful in holding the tree erect, and have comparatively little to do with providing the materials for building up its structure. It is the leaves which form the great laboratory in which the main components of the plant are extracted from the region where superficial observers would least expect to find them—namely, from the atmosphere. He compares the roots to the operatives' part of the community; the trunk and leaves to the monetary, the scientific and the commercial part which drew from far and wide that which is necessary to keep the growth advancing and maintain it in health. The roots may just as well claim to be the sole sources of life in the tree as the operatives may claim to be the only producers of wealth, and conversely the leaves could, with as much reason, consider themselves as the only essential portion of the plant as the merchant or the capitalist claim to be independent of the operatives. Each grade in the body politic is essential to the other; it is an axiom that there can be no degrees of comparison between essential parts; and those who, from ignorance or from interested motives, persistently preach the doctrine of the superior importance of the "masses" over the "classes" are inflicting a deep injury on the prosperity of the country, and especially on those whom they so grossly flatter.

Nothing, save bitter experience, will alter the course of events. It seems to be the fate of peoples to attack social problems from the wrong end, to solve them by the painful and dilatory process of trial and error, rather than by means of investigation based on first principles. And this method is commonly applied to engineering problems also. Random trials, as a rule, are the methods by which great results have been achieved, while the application of the scientific principles involved have been left to other heads long after the results sought have been attained at much needless cost, and by much unnecessary expenditure of labour and of time.

It is not often that a genius of the order of James Watt rises in the mechanical world. Up to his time the "fire-engine," as it was most properly called, was being slowly developed without any exact knowledge of the properties of the agent by means of which the heat generated by the combustion of fuel was converted into work, and this in spite of the circumstance that such a master mind as that of Smeaton had been directed to perfecting the new method of utilising the potential energy of fuel, and of applying it to engines of large power, and on an extensive industrial scale.

The lucky chance which presented itself of having to put in order a working model of a Newcomen engine illustrates in an interesting manner how, in pursuance of his business, he quickly executed the necessary repairs and alterations, and afterwards, at greater leisure, attacked the problem which the failure of the model presented, from the theoretical side, but soon found that the then state of knowledge did not afford the means of explaining the failure, and compelled him to set about the determination of such elementary data as the specific volume of steam, the latent heat of evaporation, and the law of tension of steam under varying temperatures. In the astonishingly short period of two years, and with the rudest and cheapest apparatus, he had furnished himself with the abstract knowledge required for explaining in a definite manner the action of the steam engine, and he had no difficulty, as soon as his theoretical ground was sure, in determining what mechanical arrangements were necessary to realise the conditions imposed by science. From investigations apparently of an abstract or non-practical character, sprung at once the separate condenser, the closed cylinder and the equilibrium working of a single-acting engine, the steam jacket, the air-pump, the theory of expansive working, the function of the momentum of the moving parts, and the exact calculations based on first principles by means of which the proportions of engines could be fixed, and the quantities of steam, water, and of fuel calculated. Watt, of course, was a born mechanic, as well as a seeker after physical knowledge. The workshop in his house near Birmingham, happily preserved to this day as he left it, shows that his mind was ever bent on mechanical contrivances which his own hands were skilful enough to carry out; his valve-gear, the stuffing box, the parallel motion, the governor, are all instances of that happy blending of mechanical skill and of scientific research which must ever mark the qualifications of a great mechanical engineer.

A contrast to Watt's achievements is the singular history of the development of iron and steel bridge building, which necessarily followed the introduction of railways. Watt felt the want of first principles by which to shape his actions, and set about discovering them; but the principles which underlie the determination of stresses in braced structures, such as roofs and frameworks of various kinds, as well as those in solid bars subjected to the action of transverse forces, have long been known; and early in this century Navier made them the subjects of lectures at the École des Ponts et Chaussées, yet engineers in this country seem to have been but dimly aware of them, or, at any rate, to have made little use of the knowledge which was at their disposal. It is difficult, from the published histories of such enterprises as the Conway and Britannia bridges, to arrive at any conclusion as to the extent of knowledge, or rather ignorance, which existed among engineers before these works were commenced. It is sufficiently evident, however, from the long series of purely tentative experiments by which the proportions of the Conway and Britannia bridges were determined, as well as from the singular vagaries to be noticed in the smaller bridges of that day, that only the haziest ideas of the disposition of stresses, and of the functions of the component members of girders existed.

In the experimental investigations of the time, the function of the web or vertical member of a girder was completely ignored, for it was looked upon merely as the means of keeping the top and bottom flanges in their relative positions, while the essential difference in effect of a uniformly distributed load, or of a rolling load, as compared with a load concentrated at the centre, on the vertical member of a girder, and even on the flanges, appears to have been overlooked till made evident by the results of experiment. Yet the principle that a force cannot change its direction unless combined with another force acting in a direction inclined to it, was perfectly well known, and should have led to the discovery that it is only by diagonal stresses in the vertical members that the load resting on a beam can be transmitted to the abutments; that the stresses due to loads concentrated at the centre were very different to those arising, both in the vertical web and in the flanges, from the action due to a load distributed in a given manner along the top or the bottom flanges, and that a rolling load would produce effects peculiar to itself.

The girder with diagonally braced webs, or the lattice girder, as it is commonly called, appears to have had its origin in Ireland; at any rate it was in that country that it received its earliest and chief development; and in the hands of Wild, Barton, Bow, and Stoney, the true principles began to assert themselves, and Mr. Barton's Cusher River bridge, of 70 feet span, on the Great Northern of Ireland Railway, was probably the first example of a lattice girder in which the cross-sections of the members of the webs as well as those of the flanges were correctly proportioned to the stresses imposed by a rolling load. This comparatively small bridge was followed by the Boyne viaduct at Drogheda, which must ever rank as a signal illustration of the successful application of abstract principles to a great work by men who were capable, not only of appreciating them, but of following their guidance in a practical manner.

The wrought-iron portion of the viaduct consists of three spans, the main girders of which are continuous; and the points of contrary flexure in the middle, and larger span, were determined by direct calculation, the correctness of which was demonstrated in the actual structure by setting free the plates of the flanges at the points indicated, and by observing the opening and closing of the plates so disunited when the land ends of the girders formimg the side spans were raised or lowered.

Mr. Wild appears to have been the first to demonstrate correctly the distribution of stresses under any disposition of load in the Warren girder, a form of beam in which the web is composed of a single system of diagonal bracing inclined at an angle of about 60°. In the museum of Trinity College, Dublin, there has existed since, I believe 1854, a model of a Warren girder, 12 feet 6 inches long and 12 inches deep, in which the tension members both of the flanges and diagonal bracing are so arranged and articulated that any one section can be taken out and a spring balance inserted, by means of which it can be demonstrated that the stresses calculated for any disposition of load do actually arise.

The history of scientific research teems with instances of discoveries which at first seem to have had no practical value, but which nevertheless have ultimately proved to be of the utmost importance to the engineer. For example, the changes of temperature which occur in many chemical reactions were merely noted at first as interesting accompaniments to such reactions; but, by degrees, it was perceived that the amount of heat evolved or absorbed in each change was a constant and definite quantity, capable of exact measurement, and in process of time the thermal values which characterised a vast number of chemical changes were determined, and are now considered of cardinal importance in many industrial operations, and constitute the science of thermo-chemistry, and render it possible to judge of the efficiency of a boiler, for instance, when the rate of fuel combustion and that at which the water was heated or evaporated were known, by calculating the proportion which the heat imparted to the water bore to that produced by the combustion of any fuel of which the chemical composition had been ascertained, and from which the heat capable of being developed could be calculated by general rules.

One practical effect of the exact knowledge which every competent engineer now possesses on this subject, or can easily obtain, is that inventors have ceased to squander their time and their means in seeking for impossible high boiler duty, and the public is no more entreated to try contrivances which are to save at least 50 per cent. of the fuel they use, because inventors know that the testing of boilers is now usually carried out by experienced and educated men, who, by very simple and inexpensive trials, obtain the data by means of which they can calculate with certainty how much scope for improvement actually exists.

Still more remarkable perhaps is the application of thermochemistry to the complicated reactions in the blast and regenerative furnace, and the valuable conclusions arrived at in consequence by such thorough and patient investigators as Sir Isaac Lowthian Bell, Sir William Siemens, Charles Cochrane, and others who have succeeded in equating the heat-units resulting from the oxidation of fuel to the ultimate thermal results of the decomposition of the ore and fluxes, showing thereby the limits of economy which the ironmaster may hope to reach, and the proportions of the furnaces in which his expectations may be realised.

No less valuable have been the fruits yielded by the discovery of the great law of the Conservation of Energy, and by the recognition of the fact that, though energy cannot be destroyed, it may be made to assume various forms, and may be rendered either dormant or active. The sun's rays, aeons of ages ago, during the dense vegetation which characterised the period of the coal measures, expended their energy in tearing asunder the carbon and oxygen of the carbonic acid distributed through the atmosphere, and in storing the carbon, thus endowed with potential energy, in the deposits whence we now derive our coal supplies. By suitable arrangements this dormant energy is quickened into that quality of motion which we recognise as heat, and which, setting into sympathetic vibrations the material of the furnace-plates and smoke-flues of boilers, operates on the surrounding water, the molecules of which, under this influence, assume the more extended movements of the highly elastic substance which we know as steam. The products of combustion, on the one hand, are restored to the atmosphere, their remaining store of heat is slowly dissipated, while the carbonic acid gas produced in combustion is again ready to present itself, in the green leaves of plants, to the decomposing action of the sun, and by that means the carbon and the oxygen become once more sources of heat. The steam produced, on the other hand, communicates its molecular motion to external bodies in various heating operations, in the visible motion and force of the steam-engine or into the slower dissipation through space or over the earth, whereby it is again condensed to water and returned to its normal condition, while the energy, for the exhibition of which, Carnot has taught us, steam was the mere agent, becomes transformed into masses of water lifted, into air compressed, into electrical currents generated, into mechanical work done, or into the heat developed by friction; but the general tendency is towards dissipation under the form of heat into space, the waste being made good by the stores of heat poured on to our planetary system by the huge and mysterious body which is its centre.

But modern investigators, and, most of all, engineers, are not content with vague statements such as I have just made; they hold with the motto of the ancient Society of Civil Engineers, "Omnia in numero pondere et mensura," and they are therefore greatly indebted to Rumford, Carnot, Davy, Mayer, and Joule, who not only showed that heat was a "mode of motion," but determined by tedious and delicate experiments its mechanical equivalent.

And what is now the result?

When examining heat-engines or other applications of heat in the arts, the engineer collects the apparently aimless work of half a century, and of many minds, and finds himself able to construct a balance sheet by which he can show on the Dr. side, to a fraction, the quantity of heat he has received, and on the Cr. page, with astonishing precision, the manner in which that heat has been expended. This method of treatment is not only lucid, but it is self-checking, and it points out exactly how much heat has been uselessly dissipated, and consequently in what direction improvements may be made, and it indicated further, the limits within which it is alone possible to make advances in economy.

These general principles apply even to the conversion of heat into the work done in the bore of a gun. The enormous pressures which require to be developed in order to impress high velocity on the projectile in the necessarily limited length of the barrel, the shortness of the time of action, and its violence, render it extremely difficult to obtain accurate and trustworthy records of pressures along the chase of a gun by direct methods; but by invoking the aid of the chemist and of the physicist in first ascertaining the properties of the explosive, that is to say, the specific volume of the gases, the quantity of heat evolved during combustion, and the specific heat of its products at high temperatures, it becomes possible to calculate curves of mean pressure which will account for the energy imparted to the projectile and to the expelled gases, although the question of abnormal local pressures, due apparently to the mode of ignition of the charge and the rate at which explosion is propagated through it, will not be revealed. This process is made the easier, in the case of smokeless explosives, because the products of combustion are wholly gaseous and retain that condition till expelled from the bore.

One of the loftiest of abstract conceptions relating to the structure of the universe, the product of many acute minds of this century, is the imagining of a substance of infinite tenuity but of immense elasticity, which permeates all space and every substance. It cannot be seen, or felt, or weighed, its composition is unknown, it cannot be pumped out of a closed vessel, it does not appear to offer any resistance to the motion of planetary bodies, and its existence is only made manifest by its property of transmitting chemical rays, light, radiant heat, electricity, and probably some more recondite forms of energy, at enormous velocity from the remotest regions of the universe and by means of vibrations the nature of which, the astounding frequency and minute pitch, have been determined by mathematicians. It is pardonable in human beings to disbelieve in the existence of the luminiferous ether, even though the profoundest thinkers and most successful workers of the present day may have all the conviction of Lord Kelvin, who has declared that "it is the only substance that we are confident of in dynamics, the one thing we are sure of is the reality and substantiality of the luminiferous ether!"

But what has the Engineer to do with such speculations, and what does it matter to him how light and heat are transmitted from the sun or from the stars, or by what mechanism heat, magnetism, and electricity are diffused over the earth? This question is being answered already in our daily practice, and is destined, no doubt, to receive fuller and more convincing response as time rolls on. I will give one or two instances. The study of the spectrum produced by the passage of light through triangular prisms has revealed the fact that the ordinary rays of white light are of a complex nature, that only a portion of them are discernible directly by the sense of sight or by that of feeling, while the ultra-violet rays can only be seen in their action on Uranium glass, or in the chemical decomposition they produce in certain substances. But, further, the spectrum viewed by modern instruments is found not to be continuous; it is crossed by dark, by light, and by coloured bands, which the patient researches of Fraunhofer, Kirchhoff, Huggins, Norman Lockyer, and others, have shown by their position, thickness, or colour to characterise certain glowing substances, and by comparison with the spectra produced by heated terrestrial solids and gases, it has been proved that many of the elements in the sun and in the stars are identical with those with which we are familiar on this earth, and this knowledge has served in a striking manner to confirm the correctness of the nebular theory as to the origin of our planetary system.

Not only have a large number of terrestrial elements been discovered in the sun, but the spectroscope has revealed, to a large extent, the order in which they are arranged on the sun's surface, and this leads to the conclusion that at one time a similar order prevailed on the earth, and therefore throws some light on the deep geology of our planet.

One of the practical outcomes of these discoveries has been the theory of Mendeleeff on the origin of petroleum, a theory of the utmost importance to the human race, and to our country in particular, in view of the inevitable exhaustion of our coal supplies, for it asserts that petroleum is the product of the action of water on the carbides of metals at high temperatures at no very great relative depths in the crust of the earth, that this production is continually in progress, and that deposits thus actually forming may be reached in many places by sufficiently deep borings; and in view of recent progress in mechanical skill, it certainly would be rash to say that borings of immensely greater depth than any that we are as yet acquainted with will never be made, for if accumulated evidence as to the correctness of Mendeleeff's views together with the ever-increasing cost of fuel, shall hold out hopes of success, enterprising men will be found ready to embark their means in undertakings, the risks of which would not seem to be more formidable than those which surrounded the laying of the first Atlantic telegraph cable, and the rewards of success in which would be incomparably greater.

The researches of Roberts-Austen, of Osmond, Le Chatelier, and others, are slowly, but it is hoped surely, establishing laws by which the relative atomic volumes of ingredients will become a guide to the nature of their mutual interaction, and it seems probable that spectrum observations which are of such value in gauging the purity of the materials dealt with, will come in aid and in support of the indications given by automatically traced curves of rates of cooling, which have given such a deep meaning to the phenomenon of recalescence, a property of iron and steel which for many years remained a mere laboratory curiosity.

Many bodies, including metals and their alloys, may exist in more than one form; sulphur, for example, assumes two allotropic states, but at ordinary temperatures and in a comparatively short time the one condition passes into the other Mr. Addenbrook has recently prepared an alloy of aluminium, and nickel, which when freshly made possesses considerable tenacity, but which, after a few hours, crumbles into powder. The researches of Osmond seem to show that pure iron also can exist in two states—one very hard, the other soft, and it is more than probable that these states merge into each other under certain conditions of heating or cooling, or under the influence of foreign substances. There can be no doubt that steel also, in course of time, undergoes molecular change at ordinary temperatures, and possibly under the influence of strains produced by internal stresses due to unequal rates of cooling. It is a common opinion, based on experience, that tool steel should not be used as freshly made, but should be kept some months, and the same precaution applies to dies used in coining and similar operations, and to armour-piercing shot, both of which, having been hardened by necessarily unequal and rapid cooling, either accommodate themselves to the stresses engendered by slow changes in the motion of the molecules, or fail spontaneously even after months of repose. Glass undergoes similar changes, and generally materials which have been severely strained either by the external application of force, or by heating, will only gradually recover their normal condition. This has been beautifully demonstrated by Prof. Hughes, with the aid of his induction balance, on specimens of the narrow steel ribbon used in the manufacture of Longridge wire guns. A number of specimens recently submitted to him showed a remarkable uniformity of structure, but when heated to only 100° and examined immediately on cooling to the normal temperature, a distinct change was observable, yet after a few hours' rest the material returned to its normal state. If such changes are measurable in ribbon $\frac{1}{4}$ in. × $\frac{1}{16}$ in. in cross section, what may not be the molecular conflict in large masses? These may be produced by alternations of stresses as well as by changes of temperature, and point to the necessity of assisting the molecules and atoms to adjust themselves, or to return to a normal condition by raising the temperature of the substance to about the point indicated by *b* on Chernoff's scale, below which no change in the nature of crystallisation takes place, no matter how slowly the mass is allowed to cool. This principle is recognised in many ways in the arts. In drawing wire or in solid drawn metal-work, such as tubes and cartridge-cases periodical annealing must be resorted to; moreover, experience has shown that crane-chains, for example, should be annealed from time to time if they are to be used with safety; and Mr. Webb has adopted, with the best results, the plan of treating in a similar manner the moving parts of his locomotives after they have run a certain number of miles.

I feel convinced that the frequent disasters with screw propeller shafts, especially after they have been some time in use, arise from the failure to recognise the practical bearing of the tendency to molecular change under the influence of strain and temperature. A propeller shaft is subject to constant variations of stress due to the action of the cranks of the engine, to similar variations caused by the inertia of the screw, and again to a totally different set of stresses which may often be alternately tensile and compressive, due to the wear of the journals and to the working of the hull. The remedy, I feel convinced, lies in the periodical annealing of the material which must of necessity be so hardly used.

I think that it is now generally acknowledged that the luminiferous ether is also the medium by which electrical energy is transmitted by some kind of vibratory motion; hence the ease with which heat or mechanical work is transformed directly into electric currents in the thermopile, or in the frictional electrical machine, and the reasonableness of the great generalisation that we are living on a huge magnet—the poles of which are not far from coinciding with the poles of the earth.

Any one who doubts the value of abstract science should study the construction of the mariners' compass, and especially in the improved form introduced by Lord Kelvin; let him compare the blind groping after correction for the local attraction of the ship with the beautiful and simple theory which has rendered that correction not only easy but readily adapted to changes in the ship's position in the world; he will find that there is not a more striking instance of the profoundest abstract knowledge blended with the power to turn it to practical use, than in this and in so many other labours of the distinguished man whom I have named more than once, and whom this institution is proud to number among its honorary members.

I would now draw your attention to a startling consequence of the undulatory theory in the power which exists of exercising influence, by what is termed induction, at great distances. Animated by the conviction that electric energy was transmitted in the same manner and by means of the same all-pervading medium as radiant energy, and that the distance to which its effects would reach should be unlimited, though the appreciation might be a question of the delicacy of instruments, Mr. Preece has succeeded in sending messages by Morse signals across the Bristol Channel between Lavernock and Flatholme, a distance of over three miles. The electro-magnetic disturbances were excited by primary alternating currents, having a frequency sufficient to generate a low musical note in a telephone, in a copper-wire 1237 yards long, erected on poles along the top of the cliff on the mainland. The radiant electro-magnetic energy was transformed into currrents again in a secondary circuit of 610 yards long, laid along the island parallel to the first and at a distance of 3·1 miles; the messages were read off on the island through the instrumentality of the induced currents.

Any one who has meditated deeply on the nature of the luminiferous ether and on its universal presence has probably felt that it must also be concerned in the action of the human brain. The mechanisms of the "five gateways of sense" have been worked out by anatomists and physicists, but their researches are incompetent to declare how the impressions sent along the nerves at last reveal themselves as images or perceptions in the mind. Lord Kelvin has discoursed on this matter; he has suggested the existence of a magnetic sense, and has shown that the mind may be influenced independently of the recognised organs of perception. There are undoubtedly occult phenomena which can only be accounted for by the supposition that one mind can interact upon another, even as Mr. Preece's parallel wires acted on each other.

Setting aside the immense amount of calculated delusion and imperfect observations which has characterised animal magnetism, clairvoyance, &c., though probably not more than astrology, necromancy, transmutation of metals, and other delusions, hampered the early advance of physical and chemical science, there still remains a substantial amount of authentic fact on which argument may be founded. Prof. Oliver Lodge drew attention to the matter in his Presidential Address to section A at the meeting of the British Association in Cardiff in 1891, and in the opinion of that acute investigator the subject seems to deserve the attention of scientific societies.

It is less than fifty years since the nature of epidemics and the mode of their propagation seemed to be beyond the reach of human comprehension, and when Pasteur commenced his classic investigations into the causes of fermentation and of contagious disease, no one, I presume, thought that such an abstruse study as bacteriology could ever be of the least interest to engineers, nor would they have thought that the controversy relating to spontaneous generation, which raged so fiercely only a few years ago, could have influenced the science to which they were devoted.

But the triumphant demonstrations of Pasteur, of Lister, of Burdon Saunderson, of Tyndall, and of many other workers at home and abroad have shown that there is no such thing as spontaneous generation; that zymotic diseases, those scourges of animal and vegetable life, are caused by living organisms whose modes of propagation and of travel are being eagerly studied, and are day by day being better understood; they have shown that we are no longer fighting at random against an unknown and covert enemy, but are face to face with a subtle foe, whose tactics we are rapidly learning to understand. We have discovered that his best allies are to be found in the carelessness of his victims as to cleanliness, to drainage, and water supply, and that his most formidable enemy is the engineer, who, being guided by the abstract investigations of the biologist and the chemist, can select with certainty the most fitting source of potable water, and can get rid of the sewage of centres of population, not only without inflicting injury on the surrounding community, but very often actually benefiting them by removing existing sources of pollution and by increasing the productiveness of the soil.

But not alone in sanitary matters has bacteriology produced profitable results; it may truly be said that the great industries of brewing, of wine and vinegar-making, and many other manufactures, have been placed on a sound footing by the knowledge we now possess of the occult action of ferments and of bacteria; and even in agriculture the true nature of the operations which take place in soil, by which the nitrogenous food of plants is rendered capable of assimilation, is one of the triumphs of the research of these our days. Schloesing, Müntz, Pasteur, Munro, Percy Frankland, and others, have shown that one of the most important of plant-foods in the soil is nitric acid, and that this substance is elaborated from ammonia by the action of minute living organisms. The singular fact has been demonstrated that the work is performed by a system of division of labour, one kind of bacterium converting the ammonia into nitrous acid and declining to do any more, when another species takes up the work and produces nitric acid, which presents the nitrogen in a form which can be assimilated by the plant. "Not only," to use the words of Dr. P. Frankland, "is this process of nitrification going on in the fertile soils, but enormous accumulations of the products of the activity of these minute organisms in the shape of nitrate of soda are found in the rainless districts of Chili and Perú, from whence the Chili saltpetre, as it is called, is exported in vast quantities, more especially to fertilise the overtaxed soils of Europe!" But more than that, long and patient research has established the fact that, in certain of the legumenous plants, the same microscopic agency acting in the roots endows them with the power of assimilating the nitrogen of the atmosphere, and by that means makes them the instruments for actually enriching the soil instead of exhausting it.

I have already alluded to the circumstance that the engineer cannot be satisfied with vague statements or with mere abstract opinions. The very nature of his calling implies action; he has to construct, his works must be stable, his machinery must act, his estimates of cost and of the consequences of his operations must come true, and hence he has to make a close alliance with that most fascinating and fruitful of the sciences—mathematics. It is not given to many to possess the peculiar aptitude which leads up to the highest investigation, but neither has the engineer often need of anything deeper than almost elementary knowledge, especially if he gets into the habit of working out the problems that come before him by the graphic methods which are now so assiduously cultivated, and if he will realise that slovenliness in the matter of calculations commonly leads to disastrous results. Though his attainments may not be high, and though disuse may have made it difficult to wield the power which knowledge, early acquired, once gave him, yet he can always appreciate and put his faith in the great minds which delight in subjecting the theories of physicists to the rigid test of mathematical analysis, and thereby stamping them with the seal of irrefragable fact.

One great quality he must possess, especially in these days when numerous science colleges have rendered high mathematical training of easy access—and that is common sense. There is a tendency among the young and inexperienced to put blind faith in formulæ, forgetting that most of them are based upon premises which are not accurately reproduced in practice, and which, in any case, are frequently unable to take into account collateral disturbances, which only observation and experience can foresee, and common sense provide against.

I have endeavoured to show how the history of abstract science, by which I intend to designate the history of researches entered into for the sole purpose of acquiring knowledge of the operations of Nature and of her laws, without any thought of reward, or expectation of pecuniary advantage, has had its reflex in the records of the engineering profession, and how the most recondite investigations, apparently unlikely to have any direct influence on our practice, have, in course of time, become of cardinal importance. I have also ventured to point out how, in these days, the engineer must banish from his mind the idea that anything can be too small or too trifling to deserve his attention. "Nothing is too small for the great man," is, I am told, written over the cottage once occupied by Peter the Great at Saardam. The truth embodied in that legend should ever dwell in our minds; for success, I am persuaded, lies largely in close attention to details.

The discourse concluded by a warm tribute to the merits of the old servant of the Institute who had established the lectureship.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—It is proposed to appoint a Syndicate for the purpose of considering the desirability of establishing an examination in agricultural science, open to all trained students, whether members of the University or not. The successful candidates in such an examination would receive a University diploma similar to the existing diploma in Public Health. It is understood that this plan has received the approval of the Royal Agricultural Society and the Board of Agriculture. These bodies, and certain of the County Councils, have further agreed to subsidise a scheme for the regular instruction within the University of candidates for the examination if it be established.

SCIENTIFIC SERIALS.

American Journal of Science, May.—Deportment of charcoal with the halogens, nitrogen, sulphur, and oxygen, by W. G. Mixter. The tenacity with which charcoal retains hydrogen even after ignition in chlorine makes it difficult to decide whether certain gases absorbed by charcoal are occluded or chemically combined with it. Experiments performed on sugar-charcoal, gas carbon, and "Diamond Black," a variety of lampblack derived from natural gas, indicate that chlorine does combine with charcoal, but that the combination is brought about by a replacement of the hydrogen. Pure native diamond and graphite do not take up chlorine, while iodine and bromine are not absorbed even by impure charcoal. Nearly pure amorphous carbon takes up but little sulphur, while a soft charcoal containing much hydrogen and oxygen combines with a considerable amount, taking it up even from carbon bisulphide.—Note on some volcanic rocks from Gough's Island, South Atlantic, by L. V. Pirsson. An examination of beach pebbles from the shores of this craggy island, 240 miles S.E. of Tristan da Cunha, establishes its recent volcanic nature, and thus adds one more to the line of mid-Atlantic volcanoes which, sweeping southward through the Azores, Cape Verde Islands, Ascension, St. Helena, and Gough's Island, terminates on Bouvet Island on the confines of the Antarctic Ocean.—The influence of free nitric acid and aqua regia on the precipitation of barium as sulphate, by Philipp E. Browning. In the presence of nitric acid to the extent of 5 per cent. very little solvent action is shown, and the sulphate may be safely filtered after an hour's time. Even with 20 to 25 per cent. the solubility does not exceed 0·001 grm. on the average. Aqua regia has even less solvent effect, and the presence of ten per cent. of either is a positive advantage since it gives the precipitated sulphate a coarsely crystalline form.—On a rose-coloured lime-and-alumina bearing variety of talc, by Wm. H. Hobbs. A talcose mineral was found developed in some specimens of white crystalline dolomite from Canaan, Conn., on lines evidently corresponding to fracture planes in the rock. One of the specimens had a deep rose colour, the other was nearly white, having lost its colour by exposure to light. The mineral was shown to belong to the talc family by its chemical composition and its physical properties, but it differed from known varieties by its colour, its high percentages of lime and alumina, its low fusibility, and by its being easily decomposed by acids.—Also papers by Messrs. A. M. Edwards, A. W. Whitney, S. T. Moreland, S. L. Penfield, N. H. Darton, and M. I. Pupin.

Bulletin of the New York Mathematical Society, vol. ii. No. 7 (New York, April 1893).—The contents are a review, by J. Harkness, of Prof. Greenhill's "The Applications of Elliptic Functions" (pp. 151–57), in which, though there is much appreciative commendation, there is also the *amari aliquid* to add pungency to the criticism.—Next comes a further contribution, the third, on the non-Euclidian Geometry (pp. 158–61), this time by Prof. W. Woolsey Johnson.—The remaining articles are a notice of the Lehrbuch der Ausgleichsrechnung nach der Methode der Kleinsten Quadrate of Dr. Bobek, and the theory of errors and method of least squares of W. Woolsey Johnson, by Mansfield Merriman (pp. 162–63); and two notes (1) on the definition of logarithms (*i.e.* the definition given by Prof. Stringham in the *Amer. Journ. of Math.*, vol. xiv.), by Prof. Haskell; (2) a note on the preceding note, by Prof. Stringham (pp. 164–70).—The number closes with general notes and list of new publications.

SOCIETIES AND ACADEMIES.

London.

Royal Society, March 9.—"The Electrolysis of Steam." By J. J. Thomson, M.A., F.R.S., Cavendish Professor of Experimental Physics in the University of Cambridge.

The following explanation of the results of the experiments seems to the author to be that which agrees best with preceding investigations.

When an electric discharge passes through a gas the properties of the gas in the neighbourhood of the line of discharge are modified. Thus, as Hittorf and Schuster have shown, the gas in the neighbourhood of the discharge is no longer an insulator, but can transmit a current under a very small potential difference. Faraday's remark, that when once a spark has passed through a gas the passage of another following it immediately afterwards is very much facilitated, is another example of the same thing. We have thus good reasons for believing that when a spark passes through a gas it produces a supply of a modification of the gas, whose conductivity is enormously greater than that of the original gas. I have shown ('Phil. Mag.,' November 1891) that the conductivity of this modified gas is comparable with that of strong solutions of electrolytes. When the discharge stops, this modified gas goes back to its original condition. If now the discharges through the gas follow each other so rapidly that the modified gas produced by one discharge has not time to turn to its original condition before the next discharge passes, the successive discharges will pass through this modified gas. If, on the other hand, the gas has time to revert to its original condition before the next discharge passes, then the discharges pass through the unmodified gas; we regard this as being accomplished by means of successive decompositions and recombinations of its molecules, analogous to those which, on Grotthus' theory of electrolysis, occur when a current passes through an electrolyte.

We regard the arc discharge as corresponding to the first of the preceding cases where the discharge passes through the modified gas, the spark discharge corresponding to the second when the discharge goes through the gas in its unmodified condition.

From this point of view, the explanation of the results of the experiments on the electrolysis of steam are very simple. The modified gas produced by the passage of the discharge through the steam consists of a mixture of hydrogen and oxygen, these gases being in the same condition as when the arc discharge passes through hydrogen and oxygen respectively, when, as we have seen, the hydrogen behaves as if it had a negative charge, the ovygen as if it had a positive one. Thus, in the case of the arc in steam, the oxygen, since it behaves as if it had a positive charge, will go to the negative, while the hydrogen, behaving as if it had a negative charge, will go to the positive electrode. We saw that this separation of the hydrogen and oxygen took place.

The correspondence between the quantities of hydrogen and oxygen from the electrolysis of the steam and those liberated by the electrolysis of water shows that the charges on the atoms of the modified oxygen and hydrogen are the same in amount, but the opposite in sign to those we ascribe to them in ordinary electrolytes.

In the case of the long sparks where the discharge goes through the steam, since the molecule of steam consists of two positively charged hydrogen atoms and one negatively charged oxygen one, when the molecule splits up in the electric field the hydrogen will go towards the negative, the oxygen towards the positive, electrode, as in ordinary electrolysis.

April 27.—"On the Coloration of the Skins of Fishes, especially of Pleuronectidæ." By J. T. Cunningham, M.A. Oxon., Naturalist on the Staff of the Marine Biological Association, and Charles A. MacMunn, M.A., M.D. Communicated by Prof. E. Ray Lankester, F.R.S.

The anatomical analysis of the structural coloration elements having not previously been adequately carried out, we have described these elements as they are found in the Pleuronectidæ and various other fishes. In the former family there are two kinds of chromatophores, the black and the coloured, the latter usually of some shade of yellow or orange. The coloured elements in the skin on the upper side are chiefly developed in the more superficial layer immediately beneath the epidermis and for the most part outside the scales, and on the inner side of the skin in the subcutaneous tissue, the rest of the skin being almost destitute of these elements. In the superficial layer the iridocytes are somewhat polygonal plates of irregular shape, distributed uniformly, and separated by small interspaces. The chromatophores are much larger, and farther apart, and are superficial to the iridocytes, although sections show that their processes often pass down between adjacent iridocytes. The coloured chromatophores have less definite outlines than the black, and as a rule radiating processes are but indistinctly indicated in them. The external part of the coloured chromatophore consists of diffused yellow pigment, while in the centre the concentration of the pigment produces a deeper colour, varying from orange to red, as in the plaice and flounder. On the upper side of the fish the subcutaneous coloration elements are quite similar, but not so uniformly distributed; the iridocytes are larger, and the chromatophores not so symmetrical in shape.

The lower side of the normal flounder is uniformly opaque white, like chalk. Here in the more superficial part of the skin there is a uniform layer of iridocytes like those of the upper side, opaque and reflecting, but not very silvery or iridescent. Chromatophores are entirely absent. In the subcutaneous layer there is a continuous deposit of reflecting tissue, to which the whiteness of the skin is due, the superficial iridocytes not being sufficiently thick to make the skin so opaque.

We have shown by descriptions of the coloration elements in a number of species of symmetrical fishes such as mackerel, whiting, gurnard, *Cottus*, pipe-fishes, &c., that the general distribution of the elements is constant in all, the differences being in minute details.

In chemical and physical properties the substances contained in the coloration elements are as distinct as the elements are in appearance and form. The black chromatophores owe their colour to a melanin which is granular in its natural condition, is a nitrogenous body, and is very refractory towards reagents. The pigment of the coloured chromatophores is always a lipochrome, and the absorption bands of the various lipochromes obtained from the fishes examined do not differ to any great degree. The reflecting tissue was found always to consist of guanin in the pure state, not, as has often been stated, to a combination of guanin and calcium.

These investigations of the elements and substances of coloration were undertaken in order to find out what exactly took place when coloration was developed on the lower side of flounders in certain experiments carried on at the Plymouth Laboratory since the spring of 1890. The first experiment was not quite conclusive, although some pigment was found on the lower sides of the fish after an exposure to light of four months. The second experiment was quite conclusive. Four flounders were taken on September 17, 1890, from a number reared in the aquarium since the preceding May: they were five to six months old, and 5 to 8 cm. in length. They had been living under ordinary conditions, and were in all respects normal, having no colour on the lower sides. They were placed in the vessel above the mirror. On one of these, two faint specks of pigment were observed on April 26, 1891, one died on the following July 1, which showed no pigment, and one on September 26, 1891. The latter was 16·7 cm. long and showed only a little pigment on the posterior part of the operculum. At this time one of the two survivors had developed pigment all over the external regions of the lower side, and the other had a few small spots. The first of these two is still alive (March, 1893), being now three years old, and it is now pigmented over the whole of the lower side except small areas on the head and the base of the tail. A drawing showing its condition in November, 1891, was exhibited at the *soirée* of the Royal Society in 1892, and is laid before the Society with this paper. The other specimen died on July 4, 1892. It was then 25 cm. long and had a good deal of pigment in scattered spots on the lower side. This specimen had been exposed about one year and ten months. Several other experiments gave similar results.

The occurrence of abnormal coloration in pleuronectids is fully considered in the memoir; a large number of specimens are described, and it is shown that there is no evidence whatever that these specimens have been exposed to abnormal conditions. We conclude that these abnormalities are congenital and not acquired.

We conclude that exposure to light does actually cause the development of pigment in the form of normal chromatophores on the lower side of the flounder, and also causes the absorption of the argenteum to a great extent. We infer, in spite of the occurence of congenital abnormalities, that the exclusion of the light from the lower sides of flat fishes is the cause of the absence of pigment from that side in normal specimens. We think that the fact that the metamorphosis of the flounder takes place at first normally, in spite of the light coming from below and being shut off from above, is, in respect of the pigmentation, in favour of the inheritance of acquired characters. When the exposure is continued long enough, the change that has taken place in consequence of heredity is reversed, and pigment appears.

We consider that these investigations afford support to the view that the incidence of light is the reason why the upper and dorsal surface of animals is more strongly pigmented than the lower or ventral throughout the animal kingdom, and that the absence of light is the cause of the disappearance of pigment in many cave-inhabiting and subterranean animals.

Zoological Society, May 2.—Sir W. H. Flower, F.R.S., President, in the Chair.—The Secretary read a report on the additions that had been made to the Society's Menagerie during the month of April; and called special attention to a young male Orang (*Simia satyrus*) brought home from Singapore, and presented by Thomas Workman, Esq.; a White-bellied Hedgehog (*Erinaceus albiventer*) from Somaliland, presented by H. W. Seton-Kerr; and a female Gibbon (*Hylobates muelleri*) brought home from North Borneo, and presented by Leicester P. Beaufort.—The Secretary laid on the table a list of the exact dates of the issue of the sheets of the Society's "Proceedings" from 1831 to 1859, concerning which information had lately been applied for.—Mr. P. L. Sclater, F.R.S., made some remarks on the occasional protrusion of the cloaca in the Vasa Parrot at certain seasons.—Mr. Sclater also read some further notes on the Monkeys of the genus *Cercopithecus*, and called special attention to *C. boutourlinii*, Giglioli, from Kaffa, Abyssinia, of which he had lately examined specimens in the Zoological Museum of Florence, and which he considered to be a perfectly valid species.—Mr. M. F. Woodward read a paper (the first of a series) entitled "Contributions to the Study of Mammalian Dentition." In the present communication the author treated of the dentition of the Macropodidæ, and described the presence of a number of vestigial incisors. He also showed that the tooth generally regarded as the successor to the fourth premolar was, in reality, a distinct tooth, and that the molars in this family of Marsupials belonged to the second dentition.—Mr. W. T. Blanford, F.R.S., read a description of two specimens of a Stag from Central Tibet, belonging to the Elaphine group, on which he proposed to found a new species, *Cervus thoroldi*. These specimens had been obtained by Dr. W. G. Thorold about 200 miles north-east of Lhasa, at an elevation of 13,500 feet above the sea-level, during his late adventurous journey through Tibet in company with Capt. Bauer.

Royal Microscopical Society, April 19.—A. D. Michael, President, in the Chair.—Mr. E. M. Nelson exhibited and described a mirror to be used instead of the camera lucida for the purpose of reflecting the real image from the microscope for drawing.—Mr. C. Rousselet exhibited a compressorium, the great advantage of which was that it enabled the object to be seen in every part of the field.—Mr. R. Macer exhibited and described a reversible compressorium which he thought might be useful.—Dr. G. P. Bate read a note on the illumination of diatoms by light reflected from the cover-glass in such a way as to produce a white ground illumination.—A letter from Captain Montgomery, describing the abundance of ticks in the coast lands of Natal, was read by Prof. Bell.—Mr. H. M. Bernard gave a *résumé* of his paper on the digestive processes in Arachnids.—Prof. Bell said that Mr. Bernard had made it appear probable that digestion was not confined to the digestive tract as usually understood, and in that case it might be that they were at the beginning of a series of observations which might throw a new light upon the processes of digestion.—The President said he had never worked much on these groups except amongst the Acarina. It was a curious thing that the distribution of the crystals referred to by Mr. Bernard was by no means the same in different families of the Acarina; in the majority of cases they lie outside the canal altogether, and are not found inside until they reach the hind gut. In the Gamasidæ they are poured into the cloaca. On the other hand there are families, such as the Tyroglyphidæ, where the crystals apparently never enter the hind gut at all, but are spread through the general body cavity. In the Oribatidæ a medium course seems to hold good, it being very difficult to ascertain where they enter the hind gut. Whilst in the Trombididæ they seem to enter in a definite channel down the centre of the back.—Mr. F. Chapman read a fourth paper on the Foraminifera of the Gault of Folkestone.—Prof. D'Arcy Thompson's paper on a Tænia from an Echidna was read by Prof. Bell.—Mr. C. H. Gill called attention to some pure cultivations of Diatoms which he exhibited.

EDINBURGH.

Royal Society, May 1.—Sir Douglas Maclagan, President, in the Chair.—A paper by Mr. John Aitken, on breath figures, was read. These figures are generally produced by breathing upon a piece of glass, on opposite sides of which two coins, or a coin and a piece of metal, have been placed, and have been oppositely electrified to high potentials. An image of the coin is thus developed. It appeared to the author that these figures depended on the presence of dust, or other impurities on the surface of the glass, and that similar effects might be produced by means of heat. The results of his experiments verified his conjecture and showed that dust has an effect on the formation of some kinds of breath figures.—A paper, communicated by Mr. H. B. Stocks, on some concretions from coal measures, and the fossil plants which they contain, was read. The concretions are found at Halifax, Yorkshire, and at Oldham, Lancashire. They are called "coal-balls" by the miners, and are found in a bed, belonging to the lower coal measures, above a stratum containing marine shells. The chief constituents are carbonate of lime and iron pyrites. The remains of plants which the balls contain are wonderfully preserved, every cell being well defined. Often the nodule is a mass of fosil wood, with a thin mineral coating. The author thinks that the bed has been formed in shallow water near the sea coast, the process of formation being similar to that now going on in the mangrove swamps of South America.—Lord Maclaren communicated a paper on the general eliminant of three equations of different degrees.

PARIS.

Academy of Sciences, May 8.—M. Lœwy in the chair.—On the equation $\Delta u = ke^u$, by M. Émile Picard.—On an objection to the Kinetic theory of gases, by M. H. Poincaré. If, in equation 75 of the theory of adiabatic expansion, Maxwell had made $Q = \phi$ instead of $= \theta$, as he ought to have done, since Q is a function of $u+\xi$, $v+\eta$, $w+\zeta$, he would have obtained the formula

$$\frac{dp}{p} = \frac{5}{3}\frac{d\rho}{\rho}$$

where p is the pressure and ρ the density. This formula is not in accordance with experiment, but is a legitimate conclusion from the kinetic theory. Another error is pointed out in the theory of the conductivity of gases, where Maxwell's formula $K = \frac{5}{3\gamma}\nu$ ought to have been $K = \frac{5}{2\gamma}\nu$. For air, the experimental value is 56×10^{-6}, the calculated value from Maxwell's formula 54×10^{-6}, and the value calculated from the corrected formula 81×10^{-6}.—Shooting stars and fluctuations of latitude, by M. d'Abbadie.—On a new type of phosphorites, by M. Armand Gautier.—On a general case in which the problem of the rotation of a solid body admits of integrals expressible by means of uniform functions, by M. Hugo Gyldén.—The surmulot in the ancient western world, by M. A. Pomel. From evidence furnished by archæological excavations carried out by Prof. Waille at Cherchell, on the coast of Algiers, it appears that the surmulot or Norway rat, *Mus decumanus*, lived there at the time of the Roman occupation, instead of invading Europe from India in the middle of the eighteenth century. There appears to be no doubt that the remains found were contemporary with the Roman settlement of Julia Cæsarea.—Mr. Rowland was elected correspondent for the section of physics in the place of the late M. Soret.—Researches on the formation of the planets and satellites, by M. E. Rodger.—Solar observations of the first quarter of 1893, by M. Tacchini.—On isothermal surfaces with plane lines of curvature in one or both systems, by M. P. Adam.—On the transcendentality of the number e, by M. Gordan.—On an application of the theory of Lie's groups, by M. Drach.—On the limitation of degree for algebraic integrals of the differential equation of the first order, by M. Autonne.—On a theorem relating to the transformation of algebraic curves, by M. Simart.—On a class of dynamical problems, by M. Goursat.—Remarks on the specific heat of carbon, by M. H. Le Chatelier. Recent experiments conducted by MM. Euchène and Biju-Duval, engineers to the Parisian Gas Company, place beyond doubt the conclusion arrived at by M. Monckman, that the specific heat of carbon does not asymptotically approach a certain value as the temperature rises. A large number of experiments show that the specific heat of graphite increases between 250° and 1000° in a manner rigorously proportional to the temperature. For temperatures between 0° and 250° the atomic heat $c = 1.92 + 0.0077t$, and between 250° and 1000° $c = 3.54 + 0.00246t$.—Electric interferences produced in a liquid lamina, by M. R. Colson.—On the flame-spectra of some metals, by M. Denys Cochin.—An attempt at a general method of chemical synthesis, by M. Raoul Pictet.—On the basicity and the functions of manganous acid, by M. G. Rousseau.—On the constitution of licareol, by M. Ph. Barbier.—On aluminium chloride syntheses, by M. P. Genvresse.—On a liquid isomer of hydrocamphene, by M. L. Bouveault.—On the chemical composition of essence of Niaouli, by M. G. Bertrand.—Methodical moulding of glass, by M. Léon Appert.—On basic nepheline rocks of the Central Plateau of France, by M. A. Lacroix.—On the quantities of water contained in the arable lands after a prolonged drought, by MM. Demoussy and Dumont. The percentages of water contained in garden earth at depths of 0, 25, 50, 75, and 100cm. respectively were 4.5, 27.1, 24.0, 24.2, and 22.8. One hectare of such soil, 1m. deep, and weighing 12000 tons, would therefore contain 2460 tons of water, while a specimen of open land containing double the amount of fine sand contained only 1400 tons of water.—Comparative toxicity of the blood and the venom of the common toad (*Bufo vulgaris*), considered from the point of view of the internal secretion of the cutaneous glands of this animal, by MM. Phisalix and G. Bertrand.—The pyocyanic bacillus among vegetables, by M. A. Charrin.—Microbian synthesis of tartar and salivary calculus, by M. V. Galippe.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Essays on Rural Hygiene: Dr. G. V. Poore (Longmans).—Notes on Recent Researches in Electricity and Magnetism: Prof. J. J. Thomson (Oxford, Clarendon Press).—The Health Resorts of Europe: Dr. T. Linn (Kimpton).—Catalogue of the Snakes in the British Museum (Natural History), vol. I: G. A. Boulenger (London).—Lehrbuch der Botanik, Zweiter Band: Dr. A. B. Frank (Leipzig, Engelmann).—Sitzungsberichte der K. b. Gesellschaft der Wissenschaften. Math.-Naturw. Classe 1892 (Prag).—The Story of the Atlantic Telegraph: H. M. Field (Gay and Bird).—The Mammals of Minnesota: C. L. Herrick (Minneapolis, Harrison).—U.S. Commission of Fish and Fisheries; Commissioner's Report, 1888 (Washington).—Geology of the Eureka District, Nevada, and Atlas to ditto; A. Hague (Washington).

PAMPHLETS.—The Moon's Face: G. K. Gilbert (Washington).—Observations on Karyokinesis in Spirogyra; Dr. J. W. Moll (Amsterdam, Müller).—The Colours of Cloudy Condensation: Prof. C. Barus.—Beiträge zur Anatomie holziger und succulenter Compositen: J. Müller (Berlin, Friedländer).—Report on the Climatology of the Cotton Plant: Dr. P. H. Mell (Washington).

SERIALS.—Journal of the Institution of Electrical Engineers, No. 105, vol. xxii. (Spon).—The Physical Society of London Proceedings, vol. xii. Part 1 (London).—Proceedings of the Academy of Natural Sciences of Philadelphia, 1892, Part 3 (Philadelphia).—Zeitschrift für Wissenschaftliche Zoologie, 56 Band, 1 Heft (Williams and Norgate).—Morphologisches Jahrbuch, 20 Band, 1 Heft (Williams and Norgate).—Mémoires de la Section Caucasienne de la Société Impériale Russe de Géographie, livre xv.

CONTENTS.

THURSDAY, MAY 25, 1893.

REASON versus INSTINCT.

The Intelligence of Animals. By Charles William Purnell, Barrister-at-Law. (Christchurch and Dunedin, N.Z.: Whitcombe and Tombs, Limited, 1893.)

THIS little work has been written, the author states, in order to awaken public interest in the daily lives of the numerous animals which surround us, and to enforce the view that they are not mere lumps of animated clay, but creatures quickened by the fire of intelligence, and mentally as well as physically our brethren. The facts and arguments of modern writers on the subject have been condensed, and the results presented in a way calculated to interest the average reader, but always from the somewhat peculiar standpoint of the author. In his own words:—"The object of this work is, first, to prove that, among animals instinct, as distinguished from intelligence, is non-existent, that, in fact, it is a mere name; and, secondly, that the intelligence of the higher animals is essentially the same as our own."

After giving the definition of instinct from several writers, he proceeds to discuss the "Origin of Instincts," and he attributes it to hereditary habit, apparently unaware that the hereditary transmission of habits is either doubted or actually denied by a large number of naturalists. And he does not seem quite clear himself as to the meaning attached to the term, and to the necessity of excluding in any particular case in which it is alleged to exist, the possible influence of imitation, of physical or mental idiosyncrasies which are admittedly hereditary, and of natural or artificial selection. He considers handwriting to be sometimes hereditary, but does not apparently see that both imitation and inherited muscular or nervous peculiarities are almost sure to be present; while in the case of trained dogs and horses whose acquired habits are supposed to be hereditary, he clearly perceives that selection comes in, since he says:—"We know precisely how these habits have been acquired. The dogs and horses have been taught them by slow degrees; the animals displaying most aptitude for their acquisition have been carefully selected as breeders, until, finally, the habit has grown into the animal's mental constitution, and is perpetuated from parent to offspring." Further on, he tells us that when the beaver builds a lodge or constructs a dam, it does so by virtue of the inherited experiences of its forefathers. Of this there is no evidence whatever, while we are told that there is evidence of increased skill with age; so that instruction by, and imitation of, the older animals, with progressive improvement through experience, will account for all the facts.

A considerable portion of the work is occupied by facts and arguments directed against the doctrine that the actions of animals emanate from blind instinct, a doctrine which Mr. Purnell seems to think is almost universally held. When speaking of animals exhibiting joy, grief, love, hatred, pride, shame, revenge, or jealousy, he adds that we cannot conceive of an automaton being thus moved. And, after describing the dances of gnats and other insects, and the amusements of ants, he again declares that he cannot believe that these are "mindless beings no more responsible for their actions than the piston of a steam engine." Similar remarks are repeated again and again, as if the doctrine of the automatism of animals, instead of a philosopher's paradox, was the common belief of the educated world.

The author fully adopts the view that animals possess an æsthetic sense, admiring beauty of form and colour for its own sake; and he appears to be quite unaware that all the facts he adduces are explicable on the theory that the varied ornaments which we admire as being beautiful in themselves, may be to animals mere signs of the presence of desirable objects. Throughout his chapter on this subject he repeatedly states as facts, that animals *do* love beauty; that what delights our eyes delights their eyes also; that they admire the beauty of their fellow's brilliant colours; and as an indication that this is so, he urges that the colours of all animals form "harmonious combinations." The colours may be gaudy or odd, but they "harmonise well together," and "a true and perfect harmony does actually prevail in the colours of animals." This is often asserted, but how can it be proved? Do the glaring colours of the blue and yellow macaw form a harmonious combination? Or those of many of the barbets or chatterers? The colours, contemplated individually, are beautiful, owing to their purity and the delicacy of the glossy surface on which they are exhibited, often presenting the lustre of silk or satin, or the soft texture of velvet, while the rounded contours and delicate gradations of tint are also pleasing. Bu to assert that the combinations of colours are always, or even usually harmonious, in the sense in which we use the term as applied to combinations in a lady's dress or in the decorations of a room, seems to me to be completely opposed to the facts.

Notwithstanding these slight drawbacks, the work is full of interest. Almost every aspect of the subject is touched upon, and the writer often displays much originality in his discussions. We find very interesting chapters on the amusements of animals, on their individuality of character, on the education of their young, and on their language; and if he had confined his statement as to reason *versus* instinct, to the case of the higher animals, we might have been inclined to acknowledge that his view is the correct one. He does not, however, attempt to show how the theory of reason will apply to the acts of the larvæ of many insects, which seek special stations and construct special habitations for the pupæ, or of the perfect insects which lay up food for their young with the most admirable foresight and precautions. For these cases he falls back on hereditary habit; but it is difficult to see how this differs from the instinct which at the outset he denies the existence of.

Among the most original portions of the book is the chapter "On the Aspect which Man presents to the Lower Animals," and that on "The Animal View of the World." These are not so purely speculative as would appear at first sight, and some very good reasons are advanced for the conclusions arrived at. Mr. Purnell holds very strong views as to the rights of animals. He maintains that we are not justified in destroying them without adequate reasons. "The struggle for existence may force us to kill them for food or for our own self preservation; but the mere sportsman, and still less, he who destroys animals simply in order to display his skill in shooting, can show no moral sanction for his acts." And after a strong protest against cruelty to animals, he adds:—"Fortunately for us, the memory of the unutterable wrongs which dumb animals have sustained at man's hands cannot have been transmitted by them from generation to generation, or assuredly the entire Animal Kingdom would rise up in fierce rebellion against the common oppressor!"

On the whole, the book is very pleasingly and clearly written; it is divided into a number of short chapters each treating some well-defined aspect of the question; it contains examples of the best and most instructive facts illustrative of animal intelligence, and it is pervaded by a feeling of sympathy for the whole of animated nature. It is a pity that it is not issued in a more attractive form, the paper covers being hardly suited for such a book; but it is nevertheless well adapted as an introduction to the study of the subject, and will be especially interesting to those who think highly of the intelligence as opposed to the mere instincts of animals, and who are not afraid to recognise that even in their mental faculties and emotions the lower animals have much in common with ourselves.

ALFRED R. WALLACE.

OUR BOOK SHELF.

The Principles of Agriculture. By G. Fletcher. (Derby: The Central Educational Company, Ld.)

THIS little book is essentially a note-book of lectures given by the author, at the instance of the Technical Education Committee of the Derbyshire County Council, to schoolmasters and others intending to become teachers of agriculture. The syllabus covers the ground usually gone over in such a course, the arrangement of subjects being somewhat similar to that adopted by Fream in his well-known "Elements." The book contains, in a small space, a good deal of information, and, at the same time, indicates points with which the student should make himself acquainted, but which could not be given in detail in a work of this kind. It seems to be carefully written, and, on the whole, very free from errors; it will, no doubt, be a useful guide both to teachers and students of agriculture.

Au Bord de la Mer: Géologie, Faune, et Flore des Côtes de France. Par le Dr. E. L. Trouessart. (Paris: J. B. Baillière et Fils, 1893.)

IT often happens that people who go to the seaside for a holiday would be glad, if they could, to learn something about the scientific meaning of the objects by which they are surrounded. They have neither time nor inclination for the study of elaborate works, and as a rule there is not much to be gained by the perusal of local guide-books. Persons of this class in France will find exactly what they want in the present volume. The author gives first a sketch of the geology of the French coasts from Dunkirk to Biarritz, then deals with such marine plants as are likely to interest the reader, and finally presents an account of marine animals. The style is clear and unpretending, and the text is illustrated with no fewer than 149 figures.

LETTERS TO THE EDITOR.

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

Mr. H. O. Forbes's Discoveries in the Chatham Islands.

IN a recent letter in NATURE (vol. xlviii. p. 27), under the above heading, Mr. Wallace has done me the honour to make some observations on the conclusions I have arrived at on other discoveries I have made in the Chatham Islands, and on the evidence adduced in my paper read before the Royal Geographical Society on March 12 last, *i.e.*, that an Antarctic continent—which I may name Antipodea—is necessary to explain the distribution of life in the southern hemisphere. Mr. Wallace says, "It is this tremendous hypothesis which appears to me to be not only quite unnecessary to explain the facts, but also to be inadequate to explain them. If one thing more than another is clear, it is that these comparatively small flightless birds were developed, as such, in or near to the islands where they are now found, since they could not possibly have arisen on any extensive land inhabited by carnivorous mammals and reptiles, and, if introduced into such a country could not long survive." If by this Mr. Wallace means that only the flightlessness of these birds, apart from their general structure as members of the genus *Aphanapteryx*, arose in or near the islands where they now are, he still leaves the, to me, greater difficulty unexplained how two so closely related species of the same genus should have arisen in regions separated by nearly one half of the circumference of the globe. For it has to be remembered that *Aphanapteryx* belongs to the *Ocydromine* group of the Rails, which is quite unknown in the northern hemisphere, and, therefore, to have reached "Lemuria" (the ancient land of which Madagascar, Mauritius, Bourbon, Rodriguez, and the Seychelles, are the fragments) the genus must have arisen independently in both regions where its species are now found, or it spread from one or the other centre, or from some common land *by flight*. Mr. Wallace has himself pointed out that to explain the presence of the flightless *Notornis* and *Ocydromus* in two groups of islands in the New Zealand region requires a land connection, for it has been hitherto considered an axiom of geographical distribution that the regions inhabited by the same genus or species have been continuous, or have been, at all events, such as to afford possibilities of migration from one to another. If *Aphanapteryx* could have spread from the Chatham Islands to Mauritius by flight, surely *Notornis* and *Ocydromus* did not require a land connection to reach from New Zealand to the nearer outlying islands, for they may equally have lost the use of their wings only after they reached their present homes.

When Mr. Wallace asserts that these birds "could not possibly have arisen on any extensive land inhabited by carnivorous mammals and reptiles," he affirms what does not really appear to me to carry with it conviction without more proof. Rails belong to a family of birds that have become of world-wide distribution, not improbably because of the habits of its members enabling them to escape destruction. They are better runners than flyers; they are water and marsh-loving birds, many of them living in reed and rush brakes, and the dense vegetation surrounding marshes, amid which pursuit is difficult or impossible. I was much struck when in the Chatham Islands by observing how the habits of the small *Ortygometra tabuensis* protected it. The upland districts of Wharekauri are covered by a very dense rush-like vegetation—the *terahina* of the natives—in which this little Rail lives. We hunted over acres and acres of country with the aid of a dog well trained to pursue and catch this species, but only after two days did we succeed in securing a specimen. We could see that the dog disturbed plenty of birds, but so rapidly could they make their way through the *terahina* that they all escaped, for they never took to flight. The *Cabalus modestus* is a nocturnal bird hiding securely in hollow trees and grass thickets all day. *Notornis* inhabited, and perhaps still inhabits, the dense scrub of the south-western portion of New Zealand, and could have there escaped the severest persecution of carnivorous animals and reptiles. But even if *Aphanapteryx* had been subjected to the incessant and successful attacks of such enemies, its extinction, whether early or late, would depend on the numbers in which it was reproduced. Many species of animals, it is needless to point out, such as rats and mice, are ceaselessly persecuted by enemies, and yet survive, and from time to time spread over vast areas. The lemming, notwithstanding that thousands yearly perish by their own act, and from the attacks of enemies during their migration, has not become extinct. Nor can I see that 2000 miles is such an "enormous extent of land" for a migration to extend over, even in face of carnivorous mammals and reptiles. It is at least not so great as the distance covered during the migration of the South American tapirs from Central Europe *via* Behring's Straits to Brazil, the route supposed by Mr. Wallace to have been taken by the ancestors of these interesting animals.

Mr. Wallace asks, "What difficulty is there in the same or closely allied species of this widespread group finding their way at some remote epoch to Mauritius and the Chatham Islands, and from similar causes in both islands, losing their power of flight while retaining their general similarity of structure?" I must reply, none; and then ask in turn, from where did they find their way? which is the point under discussion. I am constrained to believe that they came from an extensive land, capable of supporting large numbers of them, which must have been continuous with (as indicated by other evidence) or approaching close to both regions, otherwise we have to believe that this strictly Notogæan group has "found its way" across half the globe, or has arisen independently in both regions from different sections of the family—an occurrence which we have no evidence to warrant our believing has ever taken place.

I am unable to speak for the present opinions of Prof. Newton or his brother; but I know of no additional evidence that has come to light that is likely to have modified their well-considered opinion of a few years ago. On the contrary, it seems to me confirmatory of their views.

I beg, however, to protest against the implication that I have invoked this "tremendous hypothesis" to account for the distribution of the *Aphanapteryx* and *Fulica* I discovered. I have given prominence no doubt to the valuable evidence their presence contributes, additional only, however, to the numerous other facts I have adduced in my paper before the Royal Geographical Society, in support of the theory that a land of extensive dimensions—not isolated islands only as Mr. Wallace agrees to—existed in the southern seas, in order to explain the distribution of plants and animals, *unknown in the northern side of the equator*, in regions so distant as South America, Australia, New Zealand, and "Lemuria." I have, in my own opinion, adduced no more cogent facts pointing in this direction than those published by the late Prof. W. K. Parker, showing plainly the common ancestry existing between the Notogæan (Gymnorhine) crows of Australia, and the Deudrocolaptine birds of South America. Their common progenitor must have occupied some *southern* land connected with both Australia and South America.

I might adduce still other weighty examples from the domain of ornithology, tending to support my opinion, which have been kindly communicated to me by Dr. Bowdler Sharpe, but I forbear now, as I understand that this will form the subject of the second lecture of the course he is now delivering on Thursday afternoons at the Royal Institution.

104, Philbeach Gardens, May 20. HENRY O. FORBES.

Phagocytes of Green Oysters.

IN your issue of May 4 you refer in a note to a suggestion made by my friend and former pupil, Dr. Paul Pelseneer that the green amœboid cells described by me as occurring on the surface of the gills of green oysters are to be interpreted as out-wandered phagocytes. It is, I think, only right to point out that Dr. Pelseneer (as he is careful to explain in the note published by him) has made no new observations on the matter, and merely professes to give an interpretation of the facts which I described in 1886 in the *Quart. Journ. Micr. Sci.* in my article on green oysters. I there described and figured large granular cells occurring in and upon the epithelium of the gill-filaments and regarding them as epithelial secretion-cells attributed to them the active part in the elimination of the blue pigment "marennin" taken in by the oyster in its food—the diatom *Navicula ostrearia*. At that time the general doctrine of "phagocytosis" had not been so fully developed as it is now seven years later. But I may say that already in 1887 one of my pupils (Mr. Blundstone) had established to my satisfaction the existence of extensive out-wandering of phagocytes through the surface epithelium of *Anodon* in various regions of the body, and that I was very soon led by the accumulating evidence of a similar kind (*e.g.* Durham's observations on star-fishes) to adopt the view that the large "secretion-cells" discovered by me both in the epithelium of the oyster's gill and freely moving on its surface, were out-wandered phagocytes. I have taught this view in my lectures, and have made some further observations (two years ago) on similar out-wandering phagocytes in other Lamellibranchs. The subject is one well worthy of minute study, phagocytosis in Mollusca being as yet an unexplored ground likely to yield results of great physiological importance. E. RAY LANKESTER.

Oxford, May 7.

The Conjoint Board's Medical Biology.

THE pertinent remarks of L. C. M. (NATURE, vol. xlviii., p. 29), and G. B. H. (vol. xlvii., p. 530), respecting the course of elementary biology prescribed by the Conjoint Board, expresses, I think, the feelings of most biologists.

Either it is desirable, or not, that previous to entering upon a course of purely medical studies the student should have a training in elementary biology. The Board have decided in the affirmative, and have prescribed a course as amusing as it is absurd. It demands a practical acquaintance with the structure of certain protozoa, *Hydra*, the leech, two or three parasitic worms, a scrappy knowledge of botany, and a few generalities. The insecta, crustacea, mollusca, and the whole of the vertebrata, are entirely omitted in the practical work. Under such circumstances it is almost ridiculous to attempt to impart any true knowledge of biology, in fact it is quite impossible to do so, for in the absence of such types as the crayfish, dogfish or cod, very many important morphological facts cannot be illustrated.

It would be interesting to learn the constitution of the committee who have drawn up this inexplicable syllabus. One really cannot for a moment suppose that they are acquainted with the scope and aim of present-day biological teaching, but from hazy memories of their student days, and an acquaintance with *Tænia*, *Ascaris*, and the leech, have drawn up the present course. The examination, I should remark, is in *perfect keeping* with the syllabus.

The important morphological facts to be gained by a dissection of the leech are probably best known to the Board.

It is sincerely to be hoped that the matter may not be allowed to rest here, but that some steps will be taken to impress upon the Board the utter absurdity of their present syllabus and mode and standard of examination, and the need for a recognized course in both zoology and botany.

WALTER E. COLLINGE.

Mason College, Birmingham, May 15.

Vectors *versus* Quaternions.

AS in recent numbers of NATURE my views on analysis have been quoted, and not very correctly, I ask for space to state them more explicitly. I see truth in the quaternion analysis and in the vector analysis; but I believe that neither the one nor the other, nor the two combined, contain the whole truth. The vector is an important idea, and the quaternion is an important idea, but there are in physical science many other important ideas which call for a more direct notation. To avoid any narrow hypothesis I denominated my first paper "Principles of the Algebra of Physics"; but in the notice which NATURE honoured it with it was printed as "Principles of the Algebra of Vectors." The title I gave it indicates briefly my position. I have been looking at analysis from the point of view of the physicist, and one of my guiding ideas has been that the fundamental rules of analysis, instead of being assumed as so many arbitrary rules of operation, should be grounded on the fundamental laws of physics.

What is the greatest want of the physicist of the present day? It is a generalised analysis which shall not contradict the Cartesian analysis, but be a logical generalisation of it, which shall include and harmonise such methods as the Double Algebra of Argand, Cauchy, and De Morgan (an excellent presentation of which has recently been published by Mr. Hayward), the method of Determinants, the Matrices of Cayley, the

Quaternions of Hamilton and Tait, the *Ausdehnungslehre* of Grassmann, the vector analysis of Gibbs and Heaviside. It is this problem of how to harmonise, unify, generalise, and extend that I have been studying. Analysts and physicists dislike Mr. McAulay's idea of an independent plant; they prefer to cultivate the old tree venerable with the growth of ages.

After studying impartially all the writers at my command I came to the conclusion that the analysis of vectors is complementary to the analysis of versors, and that the fundamentel rules for the former are :—

$$i^2 = + \qquad j^2 = + \qquad k^2 = + \qquad (1)$$
$$ij = -ji \qquad jk = -kj \qquad ik = -ki \qquad (2)$$
$$ij = k \qquad jk = i \qquad ki = j \qquad (3);$$

whereas for the latter they are :—

$$i^{\frac{\pi}{2}} i^{\frac{\pi}{2}} = - \qquad j^{\frac{\pi}{2}} j^{\frac{\pi}{2}} = - \qquad k^{\frac{\pi}{2}} k^{\frac{\pi}{2}} = - \qquad (4)$$
$$i^{\frac{\pi}{2}} j^{\frac{\pi}{2}} = - j^{\frac{\pi}{2}} i^{\frac{\pi}{2}} \quad k^{\frac{\pi}{2}} j^{\frac{\pi}{2}} = - j^{\frac{\pi}{2}} k^{\frac{\pi}{2}} \quad i^{\frac{\pi}{2}} k^{\frac{\pi}{2}} = - k^{\frac{\pi}{2}} i^{\frac{\pi}{2}} \quad (5)$$
$$i^{\frac{\pi}{2}} j^{\frac{\pi}{2}} = - k^{\frac{\pi}{2}} \qquad j^{\frac{\pi}{2}} k^{\frac{\pi}{2}} = - i^{\frac{\pi}{2}} \qquad k^{\frac{\pi}{2}} i^{\frac{\pi}{2}} = - j^{\frac{\pi}{2}} \qquad (6)$$

It follows that in the manipulation of the products of vectors, the distributive rule applies but not the associative; while in the products of versors both apply. These fundamental rules for vectors are based on physical considerations, the principal one of which is that the square of a vector is essentially positive, whereas, according to quaternionists, it is essentially negative. My view agrees with that principle of analysis which considers the cosine in the first and fourth quadrants to be positive; to make it negative produces confusion and error. These principles harmonise with those of Gibbs and Heaviside; and in the memoir quoted I have carried them out to their logical development. It is this development which Prof. Knott characterises as "a pseudo-quaternionic system of vector algebra, which is non-associative in its products." I see no worthy aim in being canny about the matter; my sole aim was to develop the system so that its truth or falsity might the more readily appear. At the end of his article Prof. Knott admits that the *assumption* that the square of a unit vector is positive unity leads to an algebra which is essentially different from the algebra of quaternions. As regards the fundamental principle being an assumption, I refer him to that same chapter of "Kelland and Tait" which he quotes, where he will find, italics and all:—"We retain what Sir Wm. Hamilton terms the *associative laws of multiplication*: the law which assumes that it is indifferent in what way operations are grouped, provided the order be not changed; the law which makes it indifferent whether we consider abc to be $a \times bc$ or $ab \times c$. This law is *assumed* to be applicable to multiplication in its new aspect (for example that $ijk = ij.k$) and being assumed it limits the science to certain boundaries, and, along with other assumed laws, furnishes the key to the interpretation of results. The law is by no means a necessary law. Some new forms of the science may possibly modify it hereafter. In the meantime the assumption of the law fixes the limits of the science." Here an authoritative expounder places the quaternion algebra on precisely the same footing that Dr. Knott places the "pseudo-quaternionic;" and he even predicts that in the course of time such a complementary algebra will be developed. It is incumbent on a critic, having admitted the logical development, to show that the assumptions are absurd, or correspond to nothing in physical science; instead of which he informs us that he is appalled by the complexity, but nevertheless he feels sure that it contains nothing new. As regards newness I invite his attention to pr. 93 of the "Principles," where I have investigated the rules for the several partial products of any number of vectors in space of not more than four dimensions (and they may be easily extended to space of higher dimensions). These consist of certain rules of reduction which are to be taken along with the rule of signs of determinants, thus embracing determinants and Grassmann's combinatory products in the general theory of products of vectors. He will also find there some reasons for believing that the triad of rules No. 3 are very different in nature from the other two triads, Nos. 1 and 2. It is possible to get along without No. 3.

That vectors should be treated vectorially, and versors versorially, and rotors rotorially, is neither nonsense nor a truism. It is an important maxim, and of growing importance in these days. Violation of it has produced the fundamental weakness of Hamilton's analysis. In a more recent paper I have published the generalisations for space of the exponential, binomial, multinomial, and other fundamental theorems of analysis, and I show that it was from treating versors vectorially that Hamilton failed to discover them.

Prof. Knott defines a quaternion as the quotient of two vectors. Why choose the quotient; is not the product always the simpler idea? But further on vectors are identified with quadrantal quaternions, from which it follows that a quaternion is the quotient of two quadrantal quaternions. I have devoted some attention to logic; but I fail to extract any meaning out of this implicit definition.

Prof. Knott informs the reader that whereas Heaviside and myself find that $\nabla^2 u = d^2u/dx^2 + d^2u/dy^2 + d^2u/dz^2$ the real $\nabla^2 u$ is minus that quantity; but he does not explain why Prof. Tait prefers the unreal $\nabla^2 u$ in his "Treatise on Natural Philosophy." A scientific critic would, instead of using exclamation points, proceed to show that in every case $\nabla(\nabla\omega) = (\nabla\nabla)\omega$. If that can be proved, not from any fancied properties of italic letters, but from physical considerations, then I shall readily admit that ∇ behaves as a versor rather than a vector. The *onus probandi* lies on the minus men.

Austin, Texas, May 6. Alexander Macfarlane.

An Atmospheric Phenomenon in the North China Sea.

During a recent wintry cruise in H.M.S. *Caroline* in the North China Sea, a curious phenomenon was seen which may be of interest to your readers. The ship was on passage between Shanghai and the western entrance of the famous inland sea of Japan. On 24th February, at 10 p.m., when in latitude 32° 58′ N., longitude 126° 33′ E., which, on reference to the map, will be seen to be sixteen to seventeen miles south of Quelpart island (south of the Korean peninsula) some unusual lights were reported by the officer of the watch between the ship and Mount Auckland, a mountain 6,000 feet high. It was a windy, cold, moonlight night. My first impression was that they were either some fires on shore, apparently higher from the horizon than a ship's masthead, or some junk's "flare up" lights raised by mirage. To the naked eye they appeared sometimes as a mass; at others, spread out in an irregular line, and, being globular in form, they resembled Chinese lanterns festooned between the masts of a lofty vessel. They bore north (magnetic), and remained on that bearing until lost sight of about midnight. As the ship was passing the land to the eastward at the rate of seven knots an hour, it soon became obvious that the lights were not on the land, though observed with the mountain behind them.

On the following night, February 25th, about the same time, 10 p.m., the ship having cleared Port Hamilton, was steering east, on the parallel of 34°, when these curious lights were again observed on the same bearing, at an altitude of 3° or 4° above the horizon. It was a clear, still, moonlight night, and cold. On this occasion there was no land in sight on a north bearing when the lights were first observed, but soon afterwards a small islet was passed, which for the time eclipsed the lights. As the ship steamed on at a rate of seven knots an hour, the lights maintained a constant bearing (magnetic) of N. 2° W., as if carried by some vessel travelling in the same direction and at the same speed. The globes of fire altered in their formation as on the previous night, now in a massed group, with an outlying light away to the right, then the isolated one would disappear, and the others would take the form of a crescent or diamond, or hang festoon-fashion in a curved line. A clear reflection or glare could be seen on the horizon beneath the lights. Through a telescope the globes appeared to be of a reddish colour, and to emit a thin smoke.

I watched them for several hours, and could distinguish no perceptible alteration in their bearing or altitude, the changes occurring only in their relative formation, but each light maintained its oval, globular form.

They remained in sight from 10 p.m. until daylight (about 5.30 a.m.). When lost sight of the bearing was one or two points to the westward of north. At daylight land 1300 feet high was seen to the north and north-north-west, distant fifty miles, the mirage being extraordinary.

Thus, these lights were seen first in longitude 126° 33′ E., and last in longitude 128° 29′ E. At first the land was behind them, but during the greater part of the distance run it was forty-five or fifty miles away to the north; and the bearing of the lights for at least three-fourths of the distance did not change.

On arrival at Kobé I read in a daily paper that the "Unknown light of Japan" had, as was customary at this season of the year when the weather is very cold, stormy, and clear, been observed by fishermen in the Shimbara Gulf and Japanese waters. The article went on to say that these lights were referred to in native school-books, and attributed to electrical phenomena. On mentioning the matter, however, to the leading Europeans in Yokohama and Tokio, they appeared to have no knowledge of the matter.

Captain Castle, of H.M.S. *Leander*, informed me that, not long ago, the officers of his ship saw lights in the same locality which they thought at first were caused by a ship on fire. The course of the vessel was altered at once with a view of rendering assistance, but finding that the lights increased their altitude as he approached, he attributed them to some volcanic disturbance, and being pressed for time, resumed his course.

The background of high land seen on the first night dispels all idea of these extraordinary lights being due to a distant volcano. The uniformity of the bearing renders the theory of their being fires on the shore most improbable. I am inclined to the belief that they were something in the nature of St. Elmo's fires. It is probable that there are travellers among the readers of your interesting journal who have seen or heard of this phenomenon, and will be able to describe its origin and the atmospheric conditions necessary for its appearance.

CHAS. J. NORCOCK.

H.M.S. *Caroline*, Hongkong, April 10.

The Greatest Rainfall in Twenty-four Hours.

IN NATURE, May 4, Mr. Clement Wragge, of Brisbane, confidently asserts that Queensland has beaten the world's record in the extraordinary amount recorded on February 3, viz., 35·7 inches. I am sorry to have to take away such an unenviable palm from Queensland, by recalling a fact well known to every Indian meteorologist that the highest record extant belongs to Chirapunji, in the Khasia hills, where on June 14, 1876, 40·8 inches were recorded in the twenty-four hours. Not only so, but on the 12th 30 inches fell, and in the four days, from the 12th to the 15th inclusive, as much as 102 inches. Of course the effects were not so disastrous in this case, as indeed such a state of things is little removed from the normal at Chira in the early part of June, but I have a very clear recollection of it as I was at Chirapunji on the 12th and 13th, and not far from it on the memorable 14th.

The conditions which have occurred in Queensland and the North Island of New Zealand during the last six months have been a remarkable example of persistent abnormals, and though the total number of rational causes may still be wanting to explain everything, one or two were evidently in operation when I was there from October to January, and I am confident that from the empirical law of persistency, coupled with a few rational inferences, a forecast of impending floods could have been made and can be made for the future, much in the same way as the general character of the monsoon can be foretold in India.

May 13. E. DOUGLAS ARCHIBALD.

A Dust-whirl or (?) Tornado.

IN NATURE (vol. xl. p. 174) you kindly allowed me to describe a dust-whirl seen to originate on a heated dust-covered highway. The phenomenon has just been repeated under much similar circumstances, only in this instance the column of dust after oscillating to and fro on the highway for about half a minute, moved rapidly away in a curvilinear path in a northerly direction, the lower end of the whirl catching up loose material in its track where it touched the ground, which it did at intervals of from ten to fifteen yards, carrying the strawy litter from a strawberry bed upwards of 50 yards in the air. It appeared to dissipate into the upper air when crossing a meadow some 300 yards from its place of origin. The characteristic "swish" of the rushing air was very marked, and the four motions common to all tornadoes (see Lieut. Finley's "Character of Six Hundred Tornadoes"), viz. whirling from right to left, progressive motion to the north, a curvilinear track, and the dipping up and down, were all distinctly traced. The question therefore, naturally arises—Can these dust-whirls be tornadoes in miniature?

Conditions at the time of the occurrence:—Date, Thursday, May 11, 1893; time, 11 a.m. Corrected barometer, 30.327 (falling slightly). Dry bulb, 66°.5; wet, 51°.8 = rel. hum. 38 per cent. Wind, south; force, 1. Some upper cirrus radiating from north-east, and drifting slowly from north-west, showing top and bottom arcs of halo at 10 a.m. Black bulb *in vacuo* 128°.2; weather very warm and dry.

Driffield, May 11. J. LOVEL.

What becomes of the Aphis in the Winter?

I HAVE spent many weeks this spring closely observing the budding trees, with the object of discovering in what condition of life the aphis spends the winter; as the result of my observations, which were made under the microscope, I believe that the aphidæ during the autumn (or as many of them as have reached the state of reproduction) attach themselves to the stem of the tree, with their young inside them, in much the same way as the female members of the closely-allied family coccidæ do. In course of time the mother-aphis becomes simply a dried skin serving as a protection to the young. When the warm days of spring come these are developed and easily make their way through the skin and crawl on to the young leaves, there to begin their work of sucking and reproduction.

T. A. SHARPE.

Soot-figures on Ceilings.

MAY I suggest a distinct, if not an alternative cause for Prof. E. B. Poulton's soot figures in NATURE, April 27th? The ceiling plaster is very porous, except where it is in contact with the joists, etc. At such points very little deposit occurs compared with the spaces where the hot air is vigorously diffusing through into the cold space above. I suggest this because I am very familiar with a large ceiling where the rafters are thus picked out in light shades. Even the laths are picked out, but less distinctly. The main bolts likewise show dark, as in Prof. Poulton's sketch, as if there were an air-space by them. There is no perceptible difference in the figures near the central chandelier from those in the corners remotest from heating causes. The bombarding pattern is often very well shown where super-heated water pipes run along a white-washed wall. The effect of every little break, even a nail in the wall, is most striking.

J. EDMUND CLARK.

A Difficulty in Weismannism Resolved.

IN my letter of the 1st inst. an omission of parentheses and quotation marks, which I omitted to note on the proof, alters the sense of the paragraph with quotations from the "Germ Plasm," pp. 434–5. It should be as follows:—"The note runs thus: 'Compare Marcus Hartog, NATURE, vol. xliv. p. 102,' (the reference omits my letter of Oct. 31, 1891). 'The deductions made by this author are logically correct but are no longer justifiable, since I myself have gained further insight into the problems concerned.'" The absence of the inverted commas disguises this recognition by Weismann of the validity of my objections, and of the consequent change in his own views.

Cork, May 15. MARCUS HARTOG.

NOTES.

THE Hon. Ralph Abercromby has given to the Royal Society of New South Wales the sum of £100, which is to be offered as prizes with the object of bringing about exhaustive studies of certain features of Australian weather. So far only one feature has been selected, and a prize of £25 is now offered for an exhaustive study of the well-known "Southerly Burster." It is understood that no essay which does not deal fully with the following points will be considered:—(1) The motions of the various strata of clouds for some hours preceding, at the time of, and following the "burster;" (2) the weather conditions which lead up to and follow the "burster," with weather charts of Australia for the day of occurrence and the following day; (3) the general conditions which modify the character of the "burster;" (4) The area of the "burster" and its track; (5) barograph traces showing the changes of pressure during the "burster;" (6) the direction and character of wind preceding it; (7) the relation of "bursters" to rainfall. The essay must not exceed 50 pages of foolscap, and must be sent in not later than March 31, 1894. It must embody studies of several "bursters," and must be chiefly the result of original research of the author, but authors are not debarred from making use of any available information, published or otherwise, on the subject. A photograph of each "burster" described, giving a characteristic view of the cloud roll should, if possible, be sent with the essay.

DR. N. WILLS has been appointed ordinary professor of botany at the University and Director of the Botanic Gardens at Christiania.

A MOST disastrous landslip occurred on the night of May 18, at Vaerdalen, in the district of North Trondhjem. Vaerdalen is a straggling country town with about 6000 inhabitants, and is an agricultural centre. The landslip occurred in the outskirts of the town, where there are a number of houses occupied by peasants, each farming his own land. The subsidence was so sudden and severe that between thirty and forty of these farmhouses fell instantaneously in ruins, leaving scarcely a wall standing. Twenty-two of the demolished houses were of considerable size, and many people were asleep in them when the catastrophe happened. The number of victims is estimated at close upon one hundred. The loss of property is very great. According to a Reuter's telegram, from which we learn these details, the most fruitful part of the Vaerdals-Elv Valley lies under a mass of mud and slime, and it is feared that further landslips will occur.

DURING the past week the day temperatures over the British Islands have been mostly below 70° in the south and west, while in the north of Scotland several of the maximum readings have not exceeded 55°. On the 18th inst. rainy weather had become general, with thunderstorms in many places; on that morning some heavy falls were measured, Ardrossan reporting 0·75 inch, York 0·74 inch, Loughborough 1·60 inch, and Jersey 0·91 inch, while on the following days large amounts were measured in various parts of Ireland. A small depression lying off the south-east coast of England on Sunday, the 21st inst., also brought over half an inch of rain to that part of the country, while in the early part of the present week the distribution of atmospheric pressure was favourable for further falls over the country generally. The *Weekly Weather Report* of the 20th inst. showed that the excess of temperature for that week ranged from 4° in the northern districts to 6° in most parts of England, that the rainfall was rather less than the mean in the north of Scotland, and equalled, or exceeded it, in all other districts. From the beginning of the year there is a deficit in all districts, amounting to 5·3 inches in the west of Scotland. Bright sunshine was below the average amount in all districts.

A PAPER on "Wreck-raising in the River Thames" was read by Mr. C. J. More, engineer to the Thames Conservators, at the meeting of the Institution of Civil Engineers on May 16. Mr. More mentioned that during the past eleven years seventy-four steamers of 55,758 tons register, fifty-four sailing vessels of 9,128 tons, and three hundred and one barges of 11,956 tons, being a total of 76,842 tons register of shipping, had been raised by the Conservancy lighters.

THE death of the well-known engineer, Mr. E. A. Cowper, is announced. He was in his seventy-fourth year. Mr. Cowper displayed much ingenuity as an inventor, and was connected with many technical institutions, including the Institution of Civil Engineers, of the council of which he was a member, the Institution of Mechanical Engineers, of which he was president in 1880–81, and the Iron and Steel Institute.

A MAP of the smokes of Paris has been recently prepared by M. Foubert, of the Tour Saint Jacques. The idea is to note the position of the principal factory chimneys, to observe during the day the emission of smoke, then to indicate on the map, for each chimney, by means of circles of various sizes and tints, the extent of the nuisance. There are obvious defects (as M. Delahaye points out in the *Revue Industrielle*) in such a mode of representation. Thus no account is taken of smoke from the environs, which materially affects Parisian air. The black particles emitted from factory chimneys in some cases sink rapidly, but in others are long maintained in suspension. Then there is the large emission of smoke from private dwellings. M. Delahaye manifests some partiality for city smoke; he remarks on its antiseptic properties in time of epidemic, and on the screening action, whereby it prevents losses of heat by radiation.

AT the meeting of the Linnean Society of New South Wales on March 29 Prof. David contributed a note on the discovery by him of the mineral sphene *in situ* in granite at the Bathurst waterworks. In the latest edition of his work on the minerals of New South Wales, Prof. Liversidge has described a single well-formed crystal of sphene from New South Wales, but the exact locality from which it came is uncertain. In the Bathurst granite crystals of sphene are abundant, and vary in size from $\frac{1}{30}$th up to $\frac{1}{4}$ inch in longest diameter. The crystals are of a very deep brown colour, and feebly translucent. In chemical composition the mineral is a compound of silica, lime, and titanic acid.

M. VERNER has a note in the *Journal de Physique* on an explanation of the rotation of the plane of polarisation in a magnetic field based on de Reusch's experiments. From the experimental fact that a pile of birefringent plates in which the principal sections are arranged helically rotates the plane of polarisation, it follows that a birefringent body turning about a direction perpendicular to its optical axis will rotate the plane of polarisation of a ray which traverses it parallel to the axis about which it is turning. For if the body is supposed divided into a series of plates by planes perpendicular to the axis of rotation, while the light is traversing the first plate the body will have turned through an angle, and therefore the principal plane of the second plate will be inclined to the direction which the principal plane of the first plate occupied when the light passed through it. Thus if the speed of rotation is comparable with the velocity of light the plane of polarisation will be rotated. This being so, the author makes the hypothesis that, in a magnetic field, at any given moment, the magnetic stress at a point on a line of force is only exerted in a certain azimuth normal to the direction of the line, and that the plane containing the portion of the line of force, and the direction of this stress, turns about the direction of the line of force with a velocity proportional to the intensity of the magnetic field at the point. Hence, when a substance such as carbon bisulphide is placed in a magnetic field, this magnetic stress, transversal to the lines of force, causes the body to become birefringent, with its principal plane coinciding with the direction of this stress, and if, as is supposed, this direction rotates, the principal plane will rotate, and the substance will exhibit magnetic rotatory power. The above explanation accounts for the fact that the direction of the rotation is independent of the direction in which the ray of light traverses the magnetic field.

THE extensive researches of Pellat have shown the considerable change produced in the value of the difference of potential between the layers of air covering two metals in contact by the least chemical or mechanical alteration of the surfaces. In the *Journal de Physique* for May M. Gouré de Villemontée describes his attempts to prepare metallic surfaces which shall give a constant difference. For this purpose he deposits the metal by electrolysis on plates of copper, or on small lead shot, and has studied deposits of iron, nickel, zinc, and copper made from solutions of different salts, at temperatures ranging from 10° to 40° C., and with varying current densities. The method adopted to determine the difference of potential consists in forming, with the two plates which are being experimented on, a condenser having its plates joined by a wire in which an opposing electromotive force could be produced. The conclusions the author arrives at are, that the difference of potential at the point of contact of two electrolytically deposited layers of the same metal is independent of the density of the current, and of the temperature and composition of the solution used in forming the deposit. He also finds that two deposits prepared at different times are identical, and give no contact difference of potential even when as much as a month elapses between their preparation.

AN improved apparatus for exhibiting the phenomena of gaseous diffusion is described by Prof. V. Dvorák in the *Zeitschrift für Physikalischen Unterricht*. A porous pot such as is used for galvanic batteries, but in a fresh and clean condition, is well closed by a greased cork through which pass a bent glass rod and a glass tube. The tube is attached to a narrow india-rubber tube leading to a horizontal capillary glass tube ending in a small cup. The capillary tube contains a drop of alcohol which serves as an indicator. The earthenware pot is placed in an inverted position, the glass rod serving as a handle. A tray of sulphuric acid containing pieces of zinc is placed under an inverted beaker, which collects the hydrogen evolved and is then slipped over the porous pot. The gas, entering the pot by diffusion more rapidly than the air leaves it, drives the drop of alcohol quickly outward. A similar effect is produced by coal-gas, and the opposite effect by carbonic acid or ether. This may also be strikingly shown by lightly breathing into the beaker and applying it to the porous pot, when the displacement of the drop will indicates the presence of the heavier gas in the breath.

IT is a common belief in India that, if a cobra is killed, and the remains are left in a bungalow, others of the species will be attracted to the spot. A correspondent of the *Pioneer Mail* records an incident which appears to indicate, as he says, that there is some truth in this theory. About nine months ago Col. Ilderton killed a very large cobra in the compound of his bungalow at Dinapore, and had its skin stuffed and set up by a native mochee. Since then the compound has been infested with these snakes, and no less than eight full-grown cobras, measuring from 4 ft. 8 in. to 5 ft. 4 in., have been killed there; one of which was sitting up, with its hood extended, contemplating the house where the remains of its preserved friend were. It is a curious fact that every snake when found was making in the direction of the bungalow, and most of them showed fight when tackled. The last two were within a few feet of each other, when Col. Ilderton killed them with a stick, and were advancing up the carriage drive together. No cobras have been seen in other parts of the station.

MR. HOPE HUNTER, writing in the *Journal of the Royal Agricultural and Commercial Society of British Guiana* on gold in that colony, says that the explorer has no reason to penetrate further than two hundred miles inland for the discovery of new and extensive gold fields, but that, if he desired to extend research further, the debatable land between the colony and the Brazilian possessions in the south would offer a favourable field for exploration. Mr. Hunter has been made acquainted with some particulars of an expedition composed of a party of Americans to that part some years ago. They discovered abundant evidence of the country being rich in precious metals, but the hostility of the Indians, culminating in the massacre of nearly the entire party, prematurely terminated their investigations, the few survivors making their escape with much difficulty. Mr. Hunter says that this portion of the South American continent is inhabited by various Indian tribes who are believed to practise cannibalism, and that one tribe, the Pianoghottos, on the confines of British Guiana, are well known for their inveterate hostility to strangers, many instances having been recorded of their having repulsed and murdered boats' crews penetrating to their country from the Brazilian side.

SEVERAL parcels of land and fresh-water mollusks collected by Prof. José N. Rovirosa, mainly in the State of Tabasco, Mexico, were sent last summer to the Academy of Natural Sciences, Philadelphia. As some of them are of considerable interest, a list has been prepared by Mr. H. A. Pilsbry, and is printed in the latest instalment (Part III.) of the Academy's "Proceedings" for 1892. The list is illustrated with several figures brought together on a single plate.

THE bulk of fine gloves produced in Russia are made, it seems, from foal skins. So says the U.S. Consul-general at St. Petersburg in a recent report on the subject. Very little is done in Russia, he says, in the manufacture of gloves from sheep, goat, or kid skins. Much hand-labour is needed to prepare foal skins for gloves, and it is doubtful whether they could be profitably used in countries where hand labour is dear. When well dressed they are very durable, and at the same time delicate, and have a great advantage in taking well all sorts of dyes.

THE report of the United States Commissioner of Fish and Fisheries for the fiscal year ending June 30, 1889, has just been issued. Among the appendices is an elaborate and valuable report on the fisheries of the Pacific coast of the United States, by J. W. Collins. The scope of this report is limited to a consideration of such fisheries as are prosecuted in or from the region embraced between the southern extremity of California and the north-western limit of Washington. Incidentally, a somewhat extended reference has been made to certain phases of fishery in Alaska, in explanation of industries which are controlled by capitalists of San Francisco, or elsewhere, and constitute a part of the fishing interests of the region specially treated of in the report.

THE *Journal of Geology*, which is being issued from the University Press of Chicago, promises to be a periodical of much interest to geologists. Two numbers have been published, and among the contents are papers on the pre-Cambrian rocks of the British Islands, by Sir Archibald Geikie; geology as a part of a college curriculum, by H. S. Williams; an historical sketch of the Lake Superior region to Cambrian time, by C. R. van Hise; the Glacial succession in Ohio, by F. Leverett; traces of Glacial man in Ohio, by W. H. Holmes; and the volcanic rocks of the Andes, by J. P. Iddings.

MESSRS. GAUTHIER-VILLARS ET FILS have added to their "Encyclopédie Scientifique des Aide-Mémoire" a volume entitled, "Traité Pratique de Calorimétrie Chimique," by M. Berthelot, secretary of the Academy of Sciences. In the same series have been published "L'Art de Chiffrer et Déchiffrer les Dépêches Secrètes," by the Marquis de Viaris; "Unités et Étalons," by C. E. Guillaume; and "Principes de la Machine à Vapeur," by E. Widmann.

A VOLUME containing an excellent account of "The Story of the Atlantic Telegraph," by Henry M. Field, has been issued by Messrs. Gay and Bird. The "story" is one of profound interest, and the author tells it vigorously and clearly. He is a brother of the late Cyrus W. Field, and has therefore had access to many new and important sources of information. He does full justice to the part played by his brother in the great enterprise, but does not underrate the services rendered by "the science and seamanship, the capital and the undaunted courage, of England."

A SECOND edition of Mr. W. W. Rouse Ball's "Short Account of the History of Mathematics" (reviewed in NATURE, vol. xxxix. p. 265) has been issued by Messrs. Macmillan and Co. The author has revised the book and made some changes in detail, but he explains in the preface that the general character of the work—as a popular account of the leading facts in the history of mathematics—remains unaltered.

MESSRS. CASSELL AND CO. have published a fifth edition of "The Field Naturalist's Handbook," by the late Rev. J. G. Wood and the Rev. Theodore Wood.

MESSRS. ASHER AND CO., Berlin, have begun the publication of a series of reprints of remarkable writings and maps relating to meteorology and earth-magnetism. The series is handsomely printed, and edited by Prof. G. Hellmann. The first two numbers are L. Reynmann's "Wetterbüchlein von wahrer Erkenntniss des Wetters" (1510), and Pascal's "Récit de la Grande Expérience de l'Équilibre des Liqueurs" (1648).

MESSRS. C. GRIFFIN AND CO. have published the tenth annual issue of the "Year-Book of the Scientific and Learned Societies of Great Britain and Ireland." The work comprises lists of the papers read during 1892 before societies engaged in fourteen departments of research, with the names of the authors.

MESSRS. FRIEDLÄNDER & SON, Berlin, have published an inaugural dissertation, prepared with a view to the attainment of a doctor s degree at Göttingen, by Johannes Müller, embodying the results of researches on the anatomy of Compositæ. The essay is illustrated with four plates.

A CATALOGUE of the types and figured specimens in the geological department of the Manchester Museum, Owens College, by Herbert Bolton, has been issued as one of the "Museum Handbooks." In the same series appear an "Outline Classification of the Vegetable Kingdom," by F. E. Weiss, and a second edition of Prof. Milnes Marshall's "Outline Classification of the Animal Kingdom."

THE Geological and Natural History Survey of Minnesota has published as one of its Bulletins (No. 7) a volume on "The Mammals of Minnesota." It is described on the title-page as "a scientific and popular account of their features and habits." The work is illustrated with twenty-three figures and eight plates.

A WORK on the "Geology of the Eureka District, Nevada," with an atlas, by Arnold Hague, has been published by the United States Geological Survey. It forms the twentieth volume of the Survey's "monographs." The author explains in the preface that the work is purely geological in its scope and is mainly a careful study and survey of a comparatively small block of mountains, which may be designated the Eureka Mountains, but which should not be confounded with the Eureka mining district, as several other well-known but less important mining districts lie wholly within the same mountain area.

THE first part of M. E. Burnat's important *Flore des Alpes Maritimes* has just been published.

A REPORT of the results so far obtained from Bornmüller's botanical travels in southern Persia is published in the *Mittheilungen* of the Thuringian Botanical Association.

DR. P. H. MELL has prepared for the U.S. Department of Agriculture a valuable report on the climatology of the cotton plant.

AN important series of well-crystallising double halogen salts of tellurium with potassium, rubidium, and cæsium, have been prepared by Mr. H. L. Wheeler, and are described in the current number of the "Zeitschrift für Anorganische Chemie." They correspond to the general formula M_2TeR_6, where M represents potassium, rubidium, or cæsium and R chlorine, bromine, or iodine. They all crystallise in octahedrons belonging to the cubic system, in this respect resembling the platinochlorides and other kindred double halogen salts of that type. The crystals of the chlorides possess a bright-yellow colour, those of the bromides various shades of deep red, while those of the iodides are quite black and opaque. In order to prepare the chlorides, tellurium is converted into tellurious acid by means of nitro-hydrochloric acid; the solution is evaporated to dryness, and the residue dissolved in hot hydrochloric acid. Upon adding to the solution of tellurium tetrachloride so obtained an aqueous solution of the chloride of the alkali metal, a crystalline precipitate of the double chloride is obtained. In the case of the cæsium salt, Cs_2TeCl_6, a precipitate is obtained even in very dilute solutions, owing to the difficult solubility of the salt. Upon boiling the precipitate dissolves, and on cooling brilliant little yellow octahedrons are deposited. The presence of excess of either cæsium chloride or tellurium tetrachloride is quite immaterial; indeed, the salt may be recrystallised from a solution of either. Water at once decomposes it, with production of a voluminous white precipitate of tellurious acid H_2TeO_3. It is only stable in solution in presence of a little free hydrochloric acid. Concentrated hydrochloric acid precipitates it from solution in the form of microscopic octahedra. The rubidium salt, Rb_2TeCl_6, is more soluble so that precipitation only occurs in concentrated solutions. The crystals, moreover, are usually much larger than those of the cæsium salt. The potassium salt, K_2TeCl_6, is much more soluble, and is even deliquescent. An excess of tellurium tetrachloride is necessary in its preparation, and it is best obtained in good crystals by spontaneous evaporation of a dilute hydrochloric acid solution.

THE bromides are obtained by dissolving finely divided elementary tellurium and caesium bromide in dilute hydrobromic acid containing excess of bromine. In the preparation of the cæsium salt, Cs_2TeBr_6, the solution is effected at a moderately elevated temperature, and the concentrated solution deposits large brilliant red octahedrons of the salt upon cooling. The rubidium salt, Rb_2TeBr_6, is readily obtained in magnificent deep red octahedrons by spontaneous evaporation of the solution prepared at the ordinary temperature. In preparing the potassium salt, if a hot solution is made, octahedral crystals of the anhydrous salt, K_2TeBr_6 are obtained, but if the concentration is effected by spontaneous evaporation light red coloured rhombic crystals of a hydrated salt, $K_2TeBr_6 \cdot 2H_2O$, are deposited. The iodides are prepared by addition of the alkaline iodide to a solution of tellurious acid in hydriodic acid. The cæsium salt, Cs_2TeI_6, is so difficultly soluble that it was only obtained as a finely divided black powder. The rubidium salt, however, Rb_2TeI_6, is more soluble and is precipitated in microscopic black octahedrons. The potassium salt is deposited in the hydrated form, $K_2TeI_6 \cdot 2H_2O$, in long monoclinic prisms which lose their water of crystallisation at 100 – 115° and become converted into a dull black powder consisting of the anhydrous salt.

SIMULTANEOUSLY with the above work of Mr. Wheeler, Drs. Muthmann and Schäfer, of Münich, have been engaged in investigating the formation of double halogen salts of the alkali metals with tellurium and selenium, and in the current number of the "Berichte," an account of some corresponding selenium compounds is given. Analogous chlorides were found to be incapable of preparation in presence of water, but the corresponding potassium and ammonium selenium bromides have been obtained in good crystals. When selenious acid is dissolved in hydrobromic acid and to the solution of selenium tetrabromide thus formed a solution of potassium bromide is added, and the mixture evaporated and allowed to cool, a deep orange-coloured precipitate is produced, consisting of small regular octahedrons of potassium selenium bromide, K_2SeBr_6. These crystals are decomposed by water like those of the tellurium salts previously described, a colourless solution being obtained which contains selenious and hydrobromic acids and potassium bromide. They dissolve without decomposition, however, in dilute hydrobromic acid and separate from the solution again upon evaporation. The ammonium salt $(NH_4)_2SeBr_6$, is likewise readily obtained by employing ammonium bromide instead of potassium bromide. A precipitate of minute dark-coloured regular octahedrons is usually at once obtained upon adding the ammonium bromide, and the mother liquor after filtration yields by spontaneous evaporation beautiful garnet red octahedrons, modified by faces of the cube, which frequently exceed half a centimetre in diameter and exhibit a brilliant semi-metallic lustre.

NOTES from the Marine Biological Station, Plymouth.—Last week's captures include a number of the Lucernarian *Depastrum cyathiforme* (one individual exhibiting a lateral bud), several varieties of the Actinian *Thoë* (*Sagartia*) *sphyrodeta*, the Mollusca *Sepiola atlantica*, *Philine aperta* and *Æolidiella Alderi*, and species of the Cumacean genera *Diastylis*, *Iphinoë* and *Pseudocuma*. There has been no noteworthy change in the floating fauna. The following animals, in addition to the larger number of those already recorded, are now breeding:—the Actinian *Urticina felina* (= *Tealia crassicornis*), the Cumacean *Pseudocuma cercaria*, the Brachyura *Xantho floridus* and *rivulosus* and the Echinid *Echinus miliaris*.

THE additions to the Zoological Society's Gardens during the past week include a Chacma Baboon (*Cynocephalus porcarius*, ♂), a Lion (*Felis leo*, ♀) from South Africa, presented by Mr. Frederick Vaughan Kirby; a Mozambique Monkey (*Cercopithecus pygerythrus*, ♂) from East Africa, presented by Mr. Lewis Atkinson; a Sykes's Monkey (*Cercopithecus albigularis*, ♂) a Garnett's Galago (*Galago garnetti*) from East Africa, presented by Mr. Thomas E. C. Remington; a Diana Monkey (*Cercopithecus diana*, ♀) from West Africa, presented by Surg.-Major S. J. Flood; a Japanese Deer (*Cervus sika*, ♂) from Japan, presented by Mr. C. J. Lucas; two Emus (*Dromæus novæ-hollandiæ*) from Australia, presented by Mr. Charles E. Milburn; four Sociable Marsh Hawks (*Rostrhamus sociabilis*) from South America, presented by Mr. G. R. Gibson; two Madagascar Weaver Birds (*Fondia madagascariensis*) from Madagascar) presented by Mr. Ginn; a Laughing Kingfisher (*Dacelo gigantea*) from Australia, presented by Mr. W. B. Brett; a Radiated Tortoise (*Testudo radiata*) from Madagascar, presented by Mr. B. Smith; a Bonnet Monkey (*Macacus sinicus*, ♂) from India, (two Mexican Guans (*Penelope purpurascens*) from Central America, a Wattled Guan (*Uburria carunculata*) from United States of Columbia, deposited; a White-lipped Peccary (*Dicotyles labiatus*, ♂) from South America, an Orange-winged Amazon (*Chrysotis amazonica*) from South America, twelve Spotted Salamanders (*Salamandra maculosa*) European, purchased; a Reindeer (*Rangifer tarandus*, ♂) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE TOTAL SOLAR ECLIPSE (APRIL, 1893).—In *Comptes Rendus* for March 15 (No. 20) M. Deslandres gives a brief preliminary account of some of the main results that he has been able to gather from the photographs taken by him during the recent total solar eclipse. The instrumental equipment that he had, enabled him to obtain photographs of the corona, to study its spectrum, to examine the coronal light in the most refrangible part of the ultra-violet region, and to measure the rotation of the corona by the method of the displacement of lines in the spectrum. The coronal photographs showed luminous jets of a length equal to twice the diameter of the sun, while the general outline had a form somewhat usual at times of maxima spot frequency. With regard to the spectroscopic results, the large dispersion that was employed in one case was found to have been too great; but from the photographs taken with the small dispersive instrument at least fifteen new coronal and chromospherical lines have been discovered. Perhaps the most interesting results obtained relate to the rotation of the corona. The negatives showed the spectra of two points exactly on opposite sides of the corona, situated in the equatorial plane of the sun, at a distance equal to two-thirds of his diameter. The lines in the spectra indicated large displacements, which on measurement were found to correspond to velocities of 5 and 7 kilometres. The conclusion to be gathered from such a result as this is that the corona must travel nearly with the disc in its motion and thus be subject to its periodical rotational movement.

THE ECLIPSE OF APRIL, 1893.—It is very satisfactory to hear that the photographs taken by the English party situated at Fundium, on the west coast of Africa, have, on closer examination, turned out very excellent. There seems great reason also to believe that many old points may be cleared up, while hope is also entertained of raising some new ones.

FINLAY'S PERIODIC COMET.—A telegram from Kiel informs us that Finlay's comet has been found. It runs as follows:—

18 May, 16h. 15m. 6s., Capetown
R.A. 355° 30′ 18″ N.P.D. 95° 1′ 50″
Dim.

VARIABLE STAR NOMENCLATURE.—Now that a systematic means has been adopted for numbering the minor planets until their orbits are fully recognised, much unnecessary confusion has been avoided. Just as it was with asteroids so it is with variable stars, many stars being termed such although their variability has not been confirmed. To correct such errors and to eliminate various other sources of mis-notation, such as that of putting a catalogue letter in front of the constellation in which the star is situated, when another star in the constellation is so known in the star maps, Prof. Chandler adds a few notes with reference to the catalogue which will now soon be forthcoming (*Astronomische Nachrichten* 3161). He also gives a partial list of some of the letters that will be adopted to avoid further complexity.

JUPITER'S SATELLITES.—In this column, vol. xlvii., p. 518, we referred to the important work that was being carried on at Arequipa by Prof. Pickering with reference both to the telescopic appearances of Jupiter and his system of satellites. Since that time further observations, more especially of the satellites, have occupied his attention, and an account of them is given in the current number of *Astronomy and Astrophysics* (No. 115). The first investigation he undertook was to find out whether the rotations of the satellites on their axes were retrograde or direct. To do this the alternate lengthening and shortening of the discs were minutely observed, use being made of the revolution of the earth, since it is on this account that after opposition with *direct* motion of rotation a given phase will be presented earlier, and with retrograde motion a given phase will be presented later than if the observations had been made from the centre of the sun. Working with the first satellite it was found that a series of observations occupied about two hours, and upon the hypothesis of a *direct* rotation the synodic period was 13h. 3m. 25·8s., and upon a *retrograde* motion hypothesis, 13h. 3m. 10·8s. The conclusion of the discussion of the observations here given is that the rotation is probably retrograde. In the clear air of Arequipa, and with excellent instrumental equipment, Prof. Pickering has been able to make many quite unique observations. We have mentioned before the flattening of the disc of the second satellite when about to undergo an occultation. This observation has later been confirmed, and thus shown to be a genuine observed fact. The reappearance of the third satellite on January 27 has given perhaps a better series of observations of this atmospheric effect. When the satellite was half uncovered "it was noted that the cusps were distinctly rounded as in the case with the sun when near the horizon, as seen from a high mountain peak." That Jupiter is not self-luminous, and that outside its cloud surface is situated a rare atmosphere capable of producing a measurable refraction, are two of the results of these observations, and taking the refraction at the cloud surface, the value $0''\cdot50 \times 0''\cdot05$ probably is not far from the truth.

THE MOON'S SURFACE.—Under the title of "The Moon's Face," a study of the origin of its features, we have before us a small book of fifty pages, containing the address, as retiring President, of Mr. G. K. Gilbert, before the Philosophical Society of Washington (*Bulletin*, vol. xii., pp. 241–292). After giving a short survey of the various theories that have from time to time been suggested as explaining the origin of the features on our satellite's surface, Mr. Gilbert has been led to put forward what he terms a "moonlet theory," which "not only harmonises with the varied details of crater character, but aids in the explanation, and even in the history, of the other features of the moon's surface." The hypothesis may be stated as follows:—Previous to the existence of the moon the earth was circled by a ring analogous to that which surrounds Saturn. The small bodies or satellites constituting this ring in time gradually coalesced, first into a large number of nuclei, and finally into one, this nucleus being our moon. The lunar craters are, to use Mr. Gilbert's own words, "the scars produced by the collision of those minor aggregations, or moonlets, which last surrendered their individuality." In discussing this hypothesis the inquiry is carried on three lines: an investigation of the ellipticity of the lunar craters, experimental investigation of the relation between the angle of incidence and ellipticity of impact craters, and of the orbital relations affecting the incidence angles of moonlets. With regard to some of the peculiar features of the lunar surface, let us briefly refer to some of the explanations given here. In the production of small craters small moonlets were employed, the cups being moulded as the result of collision. For large craters, greater moonlets are supposed to have been in action, the rims round the cups being raised partly by the overflow at the edges of the cup, or resulting in the upheaval of the surrounding plain in all directions. The central cone is accounted for by supposing that the top parts of the walls of the cup are so "weakened by the efforts of heating," that they consequently fall into the centre of the cup from all sides. In the region of the Mare Imbrium he supposes that a collision of great violence occurred, dispersing in all directions a deluge of material "solid, pasty, and liquid." The outrush from the Mare Imbrium thus introduces the elements necessary to a broad classification of the lunar surface. Smooth planes were produced by the liquid matter, parts were ground or sculptured by the solid matter, while some features were left entirely untouched. Such are one or two of the origin of surface features as put forward by Mr. Gilbert in his moonlet theory. That they are ingenious and lack not interest is true, but that the hypothesis itself is likely to be received with anything like favour seems very doubtful, since our present knowledge of the way nature works shows us that the last minor aggregations or moonlets could not very probably act in the way indicated above, because the state of the nucleus about that time would be one of intense heat in consequence of the collisions, and therefore would not be capable of receiving lasting impressions as required by the hypothesis.

AMÉDÉE GUILLEMIN.—It is with great regret that we have to record the death of M. Amédée Guillemin, which occurred recently in France. Many of our readers will have read the most interesting and valuable books which he wrote, setting forth scientific facts in a popular light. Of his many writings perhaps that which is most familiar to us are the volumes entitled "The Heavens" and "The Forces of Nature," as translated into English, and it is only quite lately that we had occasion to notice a small volume, evidently his last work, dealing with astronomical subjects, and entitled "L'Autres Mondes."

GEOGRAPHICAL NOTES.

LIEUTENANT R. PEARY, the explorer of North Greenland, has been reluctantly compelled to relinquish his projected lecturing tour in Europe, as all his time must be devoted to preparations for his new expedition toward the North Pole, which he hopes to commence this summer.

THE Governments of Sweden and Denmark have entrusted Prof. Otto Pettersson with the planning and direction of a series of simultaneous observations on the physical condition of the Skagerrack, Kattegat, and Baltic Sea. These observations are to be made on four days, three months apart, and commenced on May 1, 1893. Simultaneous observations between the Moray Firth and the north of Shetland would greatly enhance the value of the Scandinavian results, and it is possible that the Fishery Board for Scotland may undertake this work, at least on some of the observing days.

CAPTAIN RICHARD PIKE, well known as an Arctic navigator in recent American expeditions, died at St. John's, Newfoundland, in the beginning of May. In 1881 he conveyed the Greeley expedition to Lady Franklin Bay, and would have brought relief to the party, and saved the gallant explorers from their terrible experiences of starvation in 1883, had he not on that occasion been put under the orders of a United States cavalry officer, whose mismanagement ruined the expedition. Captain Pike's last Arctic work was the transport of Peary's expedition to McCormack's Bay, and his return for them in the sealer *Kite*. He had the reputation of being the best practical navigator of the Newfoundland Sealing Fleet, and his experience will be missed in connection with Lieutenant Peary's new expedition, which Captain Pike was to have taken north this summer.

THE anniversary meeting of the Royal Geographical Society will be held on Monday, the 29th, at 2.30 p.m. From the circular calling the meeting we observe that a very considerable change in the composition of the Council is contemplated. The President, Sir M. E. Grant Duff, does not seek re-election, in the hope, as he hinted at the anniversary dinner, that his "leap into the gulf in the cause of women" will heal the recent dissensions in the Society, and enable the scientific work in which it is engaged to be carried on without interruption. Mr. Clements Markham, F.R.S., has accepted the nomination of the Council as President. Captain Wharton, R.N., F.R.S., is proposed as a new Vice-President, and the following, amongst other names, are proposed as new members of Council:—Admiral Lindesay Brine, General T. E. Gordon, author of "The Roof of the World;" Mr. G. S. Mackenzie, of the British East Africa Company: Colonel C. M. Watson, and Mr. W. H. Hudlestone, F.R.S., President of the Geological Society. These nominations are subject to the approval of the annual meeting, which is expected to be unusually large and representative.

BACTERIA, THEIR NATURE AND FUNCTION.[1]

A WELL-KNOWN English writer a short time ago informed the public that Prof. von Pettenkofer, the distinguished veteran in sanitary science in Munich, expressed the opinion that "the atmospheric envelope of this globe is at present in a bacillophil humour." Expressions such as these have been repeatedly used in one form or another, some more, some less witty; the intention being, of course, to convey an exaggerated impression of the frame of mind of over-zealous enthusiasts. By such expressions more or less distinguished speakers and writers have been enabled to exhibit the smartness of their phraseology. Thus one distinguished professor relieved the anxiety of his students by the jocular observation that idleness and laziness will probably be found to be due to a specific bacillus, while another no less profound writer enunciated that crime and inebriety are probably due to bacilli. With regard to the distribution of bacteria, as well as with regard to their action, we meet with statements which are almost made humorous by smartness of exaggeration. Under the cover of the title "Science Notes," one of the London papers offered to its readers for breakfast the following palatable dish:—"In a grain of butter you have 47,250,000 microbes; when you eat a slice of bread and butter, you therefore must swallow as many microbes as there are people in Europe." Here it ought to be stated that a grain of solid matter of *London sewage* contains only a small fraction of this number of microbes. But leaving these silly exaggerations and those grotesque sayings to their authors for

[1] Lecture delivered at the London Institution, on February 27, 1893, by E. Klein, M.D., F.R.S., Lecturer on General Anatomy and Physiology at the Medical School of St. Bartholomew's Hospital, London

further improvement, it is nevertheless well established that a considerable number of phenomena in nature are intimately associated with bacterial life. The world of bacteria is comparable to an unseen flora which, in variety of character, of activity and importance in the economy of nature, compares with the visible flora, and in its extension and area of distribution is as great as, in some respects greater than, that of the visible vegetable and animal kingdom. Though unpreceived by the unaided eye, this bacterial world forces itself, by its multifarious activity, continually on our attention; it comes into prominence by the vast effects, the slow but far-reaching results which it produces on man, animal, and plant, for good and for evil, in life and in death. Some of these actions I shall have the honour to bring before you this evening, and you will see that while there are bacteria whose actions are undesired and not conducive to the well-being of man or animals, there are others which are of the greatest service both to them and to plants, and are an essential and integral part in the economy of nature.

I spoke just now of the bacterial world as of an unseen flora; I meant by this a part of the vegetable kingdom not perceived by the unaided eye, though, as you will see, it is easily brought to perception by a variety of means. The individuals that constitute the bacterial world are, as is no doubt known to you, of such extremely minute size that only by the aid of the microscope can they be seen, their size being often less than $\frac{1}{25000}$ or $\frac{1}{50000}$ part of an inch, rarely more than $\frac{1}{3000}$ part of an inch. They are spoken of as having the character of plants, because the elements, like those of a plant, are invested in a sheath of cellulose, within which is contained the essential part, the living protoplasm, the bacterial individuals being in fact comparable to unicellular plants, in which, however, no definite cell nucleus has been hitherto demonstrated. It ought, however, to be mentioned that various observers have attempted to show, and, by complex methods of staining, have succeeded in showing in some bacterial species the existence of parts which resemble, and which are considered as comparable to, the nucleus forming an integral part of the typical vegetable cell.

In speaking of bacteria as of plants there are other than morphological characters which guide us in this designation; bacteria resemble plants in this essential, that they possess the power to build up, out of simple organic compounds, the most complex substances such as the protoplasm of their own bodies. There are known not a few bacterial species which grow and multiply, *i.e.* which build up their highly complex nitrogenous albuminous substances at the expense of relatively simple nitrogenous bodies, such as ammonium tartrate, urea and allied substances, or which can do this even by the absorption of free nitrogen of the air. Other species require for their growth and multiplication as complex nitrogenous substances as the animal body itself, and like this latter are capable of breaking them up into simpler combinations. Pathogenic bacteria—many of the species concerned in the decomposition and putrefaction of albuminous substances—belong to this group.

All bacteria multiply by division; hence their name, schizomycetes, or fission fungi, the typical process of multiplication consisting in the enlargement of an individual, and in subsequent splitting into two by fission, at the conclusion of which process two new individuals are the result, each of them capable of enlarging and again dividing in the same way into two, and so on. But it can be easily shown by comparative observations and examination of suitably prepared specimens of artificial cultures of the different species that not seldom the process of multiplication does not follow this line.

I show you here a lantern slide of a microscopic specimen of one of those species which, owing to the spherical or nearly spherical form of the elements, is called a coccus, or micrococcus; and owing to the manner of growth in clusters and continuous masses, is called a staphylococcus; this microscopic specimen has been obtained by the method of making "impression preparations," that is to say, by means of a thin glass pressed on to a recent, *i.e.* a young colony or colonies growing on the surface of a solid medium, an exact impression is obtained of the growth, and a good and correct insight is obtained of the manner in which the colony enlarges, and the way in which the individuals constituting the colony grow and multiply. You see in this photographic representation that there are a good many individuals many times (4–10 times) as large as others, that some of these large elements are uniform, while others show just the indication of a transverse fissure by which the large element is dividing; still others show two fissures at right angles, by which the big element becomes divided into four smaller ones. But you see also the majority of cocci are only minute dots, some in pairs, others in clusters, the former looking like two demilunes separated by a straight clear line; in fact, this latter appearance denotes the typical manner in which one coccus, having first enlarged a little, divides into two small elements. But the presence of the huge elements mentioned above tells us also that one coccus may go on growing to a very large size without dividing, and having reached this huge diameter, then commences to divide, first into two, then into four, eight, and sixteen individuals of the typical size.

I show you here an impression preparation of a recent colony of another species (*Bacillus coli*), the individuals of which are rod-shaped or cylindrical, and are what are called typical bacilli. Here the great majority of the individuals are of cylindrical shape, and of a fairly uniform size; a few only are shorter, and arranged in the form of a dumb-bell, indicating that one of the longer individuals has by fission split up into two smaller individuals. But if you look at a third impression preparation, of which I here show you a photograph (Proteus), you will see that while there are a few chains of cylindrical bacilli, indicating successive division of the individuals and the new offsprings remaining joined end to end—thus constituting what is spoken of as a leptothrix—there are other threads in the colony which either show a division into cylindrical elements only imperfectly or not at all, appearing uniform and unsegmented threads; where the segmentation is imperfect the individuals are of very various lengths, some not longer than those typical bacilli in the first-mentioned chains, others three and more times as long. These appearances indicate that the multiplication of the bacilli does not always take place in that typical manner in which it is generally represented, viz. one individual elongates a little, then splits up into two short individuals; but a bacillus may go on elongating till it reaches the manifold length of the typical rods, and having reached this great length then segments into a great number of cylindrical rods. This mode of multiplication can be made out not only in these impression preparations, but can be actually observed in the fresh condition under suitable conditions, *e.g.* on the warm stage.

That this mode of growth appertains not only to cocci and bacilli, but also to the third morphological group of bacteria, viz. the vibrios, or spirilla, is ascertained by the fact that often one vibrio, *i.e.* a more or less curved rod-shaped individual or a comma-shaped bacillus, grows into a uniform homogeneous spiral or wavy thread, which is capable of splitting up into a number, *i.e.* a chain of comma-shaped vibrios.

We have then the typical mode of division, by which one individual, a coccus, or bacillus, or vibrio, as the case may be, slightly enlarges, and then by fission divides into two; or an individual continues to grow to abnormal size or length, and then splits up into a series of individuals of the typical size; this latter mode of multiplication implies a deficiency of fission for the time being, and is not, as far as can be made out, due to any abnormal conditions affecting the growth, for in many species this occurs in recent and active colonies under conditions which in all other respects must be pronounced as favourable for growth and multiplication.

Another interesting appearance, shown by some species of bacteria, is generally ascribed to degeneration or involution, *i.e.* the bacteria assume peculiar abnormal shapes stated to be due to abnormal influences, insufficient or unfavourable soil, unfavourable temperature, &c., &c.; but while it is true that such influences do produce abnormal shapes, disintegration, &c., there are certain changes in shape that are observed in some species of bacteria while growing under perfectly favourable conditions and with the normal rapidity, and which are anything but degenerating.

A recent colony of the bacillus anthracis, like the photograph I show you here, growing on nutritive gelatine, is made up of twisted and convoluted threads of cylindrical rods, which threads are seen to shoot out and to extend like filaments from the margin of the colony. Now, you notice in the next photograph that instead of these filaments being made up of the typical cylindrical rods the former consist of relatively huge spindle-shaped or spherical masses many times the diameter of the typical rods. The threads of this colony are perfectly active, and are growing with vigour and in perfectly normal circumstances as regards soil, temperature, and all other known conditions. As a matter of fact, a few days later, as comparative specimens show, all threads may be, and as a rule are, again of the typical aspect, *i.e.* uniform threads and chains of rod-shaped elements.

Another photograph which I show you here is from a colony of the bacillus of diphtheria. Here also you notice the appearances already mentioned of the anthrax bacilli, viz. shorter or longer filaments, in which some of the elements show a conspicuous enlargement: pear-shaped, spherical, or club-shaped. Such forms are not involution forms: they occur in vigorous and actively growing young colonies.

A still further illustration, and one of great importance, is shown by this photograph, illustrating a similar change of the tubercle bacilli. This change has now been confirmed by several independent observers. The typical tubercle bacilli of human or bovine tubercle and of early cultivations are cylindrical rods. In cultivations of long duration but still actively growing you notice forms which are more filamentous, and, as in the present illustrations, are branched filaments with club-shaped enlargements.

From all this the conclusion is justified that in all these cases of bacilli the typical cylindrical bacilli show occasionally an indication that reminds one of forms belonging to the higher or mycelial fungi, in which the growing filaments remain unsegmented and become thickened and even branched. These thickened, branched, and club-shaped forms of the bacilli would correspond to an atavism, and would recall a probable former fungoid phase in the evolutional history of these bacilli.

The next point to which I wish to call your attention is the rapidity with which multiplication of the bacteria takes place. This differs according to the amount and nature of the nutriment or soil on which they grow, and to the temperature. While some bacteria multiply even at lower temperatures at a great rate, others do so only at higher temperatures. But in order to give you an idea of the power and the rate of multiplication I may mention the following:—Direct observations show that the rate at which bacteria divide at a temperature of 20°C. varies from eighteen minutes to thirty minutes or a little longer, and at higher temperatures correspondingly faster. A tube of nutrient broth was inoculated with a trace of the growth of a staphylococcus (*Staphylococcus pyogenes aureus*), the number of cocci introduced into the tube having been previously determined to be 8 per cubic centimetre. The tube was then kept at 37°C.; in the first twenty-four hours the cocci had multiplied to 640,000 per cubic centimetre; in the second twenty-four hours to 248 millions per cubic centimetre, and in the third twenty-four hours to 1184 millions per cubic centimetre.

A point of interest is the motility exhibited by some bacteria. In some species most, in others comparatively few, individuals show active locomotion, spinning round and darting to and fro; in many other species no motility is observed. In the motile species it is known that this motility is due to the presence and active motion of cilia or flagella, and these have been seen and photographed in former years in some of the larger forms, but only within recent years has it been possible, by means of new methods (Löffler), to actually demonstrate in the smallest forms these flagella, and here the remarkable facts have been shown that while some possess only one flagellum at one end, in other species the bacillus possesses a bundle of them, or is covered with the flagella on its whole surface. I show here some photos of the flagella, one possessing two flagella at one end (spirillum volutans), the other (cholera bacillus) one at one end, and the third (typhoid bacillus) is covered with quite a number of flagella.

A not less interesting point is the formation of spores: the only trustworthily ascertained mode of spore formation is that which is called endospores, as is shown in the following photograms; a bacillus at a certain phase develops in its protoplasm a minute glistening granule, this increases in size and becomes oval, while the rest of the substance of the bacillus becomes pale, swells up and gradually degenerates and disappears, leaving the fully formed oval bright spore free. These spores are of great resistance to temperature, chemical obnoxious substances, drying, &c., so that even after long periods and various adventures, when again brought under proper and suitable conditions, they are capable of germinating into the bacilli. These then grow and divide and continue to do so, producing new crops. Non-sporing bacteria are for this reason more liable to succumb in the struggle for existence, although many species of non-sporing bacilli have such a vast power of multiplication and are so little selective in their requirements that they manage to keep their crops perpetually going; some notorious putrefactive cocci and bacilli belong to this class. Having now mentioned the essential features in the morphology of bacteria, as far as is possible in the limited space of time at my disposal, I proceed to give you a short summary of some of the most important activities which bacteria exhibit.

Bacteria causing Decomposition of Albumen.

Foremost in importance and vastness of result is the action which certain species of bacteria have on albuminous matter, an action which is termed *putrefactive decomposition of albumen*, animal or vegetable. All organic matter when deprived of life is resolved into simpler compounds, is broken up into lower nitrogenous principles, like leucin, tyrosin, indol, phenol, &c., of which the ultimate products are ammonia, nitrites, and nitrates. The plant, it may be said in a general way, builds up albuminous matter from nitrates, this albuminous matter it is which forms the protoplasm of its cells, this albuminous matter it is which serves as nitrogenous food for animals; these again supplying the food for other animals and man. In the living body of these the albuminous matter becomes broken up, yielding nitrogenous principles like urea and allied substances, which again, after further oxidation in the soil and in water, serve to supply nitrates to the plant; but also the bodies of animals and plants after death form a large stock from which by a long chain of processes, induced and sustained by micro-organisms, lower nitrogenous compounds, and ultimately ammonia and nitrates are produced, from which the living plants principally draw their nitrogen.

From this it is evident that the vegetable kingdom is dependent for its nitrogen chiefly on processes by which from the albumen of dead organic matter, by the activity of micro-organisms, in the first place lower nitrogenous principles and ultimately ammonia, and in the second place, also by micro-organisms nitrites and nitrates are formed. Now, the micro-organisms which are capable of producing the first series of decompositions of dead albuminous matter form, so to speak, the first army of attack; it is this army which, while multiplying at the expense of albumen, decomposes it, and thereby is instrumental in changing it into lower nitrogenous principles such as leucin, tyrosin, indol, and ammonia. Amongst the large number of species of putrefactive bacteria I will describe two only, which by their great distribution may be considered as playing a very important part in this decomposition of albumen. The first is the species known as *Proteus vulgaris*, the second is the *Bacillus coli*.

(*a*) *Proteus vulgaris*.—This species is the common putrefactive organism; it is almost invariably present in dead and decaying albuminous matter; it is the organism which in dead animals and man plays the principal part in the destruction and resolution of the body; it is present in the cavity of the normal intestine; it is found in connection with effete and dead matter occurring in the body in health and disease; it has a wide distribution in nature, and is present wherever organic matter happens to be in a state of putrescence; it is liable to pass from this and to be transmitted to other putrescible matter by air currents, by dust, by water, by human contact or otherwise, and then to set up in this new organic matter the same state of putrescence. The same applies to the bacillus coli, which has also a very wide distribution, and which is in most instances associated with putrefaction and decomposition of albuminous matter; it is a normal inhabitant of the human and animal intestine, and from here often passes into the soil, water, and air.

These two species of organisms may be considered then as being of great importance in the destruction and resolution of putrescible matter, in short of dead albuminous matter.

I show you here photographs of these two species as they appear in artificial cultures, under various forms of cultivation, and under the microscope under a magnification of 1000. Both these species are motile bacilli.

The *Proteus vulgaris*, as its name implies, presents itself in forms so varied, that it is at first sight difficult to recognise them as belonging to one and the same species: coccus forms, short ovals, short and long cylinders, homogeneous long threads, and even spiral forms. But by artificial cultivation by exact methods they can be shown to belong to one and the same species; and it can also be shown that under particular conditions of cultivation the bacillus almost invariably shows itself as cylindrical and thread-like forms; whereas under other conditions it assumes the character of cocci and ovals. The photographs which I show you here give an exact representation of these cylindrical and thread like forms observed in early gelatine plate cultures; later on, when the growth has proceeded for some days, and the gelatine has almost entirely become liquefied, the majority of the individuals are very short—either coccus-like or short ovals.

It is on account of this unstable or protean character of its form that Hauser gave it the name of Proteus, and being the common microbe of putrid decomposition, he called it *Proteus vulgaris*.

This organism, as a first and important action, peptonises albumen and liquefies and peptonises gelatine; then this peptone is decomposed, yielding, amongst other substances, leucin, tyrosin, indol, skatol, phenol, and further, ammonia.

(*b*) *The Bacillus coli.*—The normal inhabitant of the intestine of man and animals is another powerful albumen decomposing microbe, but, unlike the proteus, it decomposes albumen without first converting it into peptone; it therefore does not liquefy gelatine like the proteus; it rapidly decomposes albumen, forming indol and allied bodies, and even ammonia.

Bacteria causing Ammoniacal Fermentation of Urea.

In connection with these true putrefactive bacteria I have to mention a group of bacteria which, though not strictly connected with decomposition of albuminous matter, play an important part, inasmuch as their action supplements that of the former, the group in question consisting of species which can change urea and allied substances into ammonium carbonate. This action is generally and justly considered of the nature of a ferment or hydrating action, like that of other organised ferments to be presently described. But we mention this group here because by changing urea into ammonium carbonate it prepares, in one sense, the way for the action of certain other bacteria which, by oxidising ammonia into nitrites and nitrates, are the direct food-providers for the vegetable kingdom. Urea and allied substances, as stated above, are the last products of albuminous metabolism in man and animals, and therefore form an integral part of the material destined for the soil in which the plants of our gardens and fields live and thrive. I show you here one of the species of this group—for there are several—the *micrococcus ureæ;* this is a coccus growing as a white staphylococcus, and forming connected masses in the natural or artificial culture media; it does not liquefy gelatine, grows extremely rapidly at higher temperatures.

The photographs give you an idea of the character of this organism in plate, in streak- and stab-culture, and in microscopic specimens; in these latter you notice that neither in size, nor arrangement, nor mode of division does this microbe show anything that would distinguish it from other species of staphylococcus; its action on urea being its chief distinguishing character, being capable of converting it into ammonium carbonate.

At present it is well established that nitrogenous principles like indol, phenol, and ammonia are produced during the decomposition of albumen by proteus, bacillus coli, and other putrefactive bacteria; and, further, that substances, as indol, phenol, and the like, are, by the activity of certain other bacteria not yet sufficiently investigated, converted into ammonia. We have now traced the decomposition of albumen down to ammonia, and in this condition it is subjected in the soil to the action of the *nitrifying bacteria*—that is, bacteria which oxidise ammonia and convert it into nitrites and ultimately into nitrates; these bacteria complete then the series of processes by which the nitrogen ultimately returns from where it started. It started as nitrates in the soil surrounding the roots of plants, and as nitrates it ultimately again finds itself in the soil; first it had been used by the plant in order to build up its albumen, then as vegetable albumen it represents the food of animals; in these it serves to build up the protoplasm of the animal body, from which it passes as food for carnivorous animals. The albumen of animals or plants becomes decomposed by putrefactive bacteria, the ultimate products of this, ammonia, becoming converted by the nitrifying bacteria of the soil into nitrites and finally into nitrates. "From earth to earth" expresses the beginning and end of this wonderful migration and change!

Nitrifying Bacteria.

Schlœsing and Muntz were the first to show that the conversion of ammonia into nitrates in the soil is most probably caused by micro-organisms, but not till the researches of Warington, Winogradski, and P. Frankland, were these micro-organisms isolated and more carefully experimented with. Warington, and particularly Winogradski, have shown that there are two species of bacteria which play an important part in these processes, one species converting ammonia into nitrites, the other these finally into nitrates. I show you here some lantern slides of Winogradski, in which these two species are well shown; the slides are of preparations of artificial cultivations, in which Winogradski has been extremely successful. These two species (the nitrous and the nitric organism) are minute rod-shaped or oval bacteria; when in the act of dividing, they form short dumb-bells; the nitrous organism is larger than the nitric, but both show forms which possess celia, and which therefore are possessed of motility. Winogradski has by artificial cultivations obtained both these species in large quantities, and, on testing them on liquids of suitable composition, found that the one is capable of converting ammonia into nitrites, the other these latter into nitrates. There can then be no doubt that the problem of the manufacture on a large scale of these nitrifying microbes, so important for agriculture, must be considered as solved.

Bacteria of Leguminosæ.

I have now to introduce to your notice a group of organisms which, like the former, are of interest and importance to the vegetable kingdom, at any rate to one portion of it, viz. the plants belonging to the leguminosæ.

Hellriegel and Wilfarth had shown that the excess of nitrogen in leguminosæ is obtained from the atmosphere by the instrumentality of bacteria in the soil around the roots of the leguminous plants; that these bacteria "fix" the free nitrogen contained in the soil, derived, of course, from the atmosphere; and that if the soil be sterilised, by which the bacteria are killed, no fixation of nitrogen can take place, and the growth of the leguminous plant remains appreciably attenuated. The roots of leguminous plants growing in the ordinary soil are known to possess numbers of nodular growths. These nodules have been thoroughly investigated by a large number of observers, and their importance in the process of fixing the nitrogen, and in the proper development of the plant, has been satisfactorily worked out; foremost amongst these stand the investigations of Prof. Marshall Ward, of Sir John Lawes and Dr. Gilbert, of Beyerinck, Prazmowski, Nobbe, and Frank. Beyerinck, then Prazmowski, and particularly Nobbe, have shown that the nodules on the roots owe their origin to the growth in the tissues of the root of certain bacteria, and it is these bacteria which are instrumental in fixing the free nitrogen. These bacteria represent well-defined species, and, as Nobbe has shown, differ for the different leguminosæ.

My friend Prof. Marshall Ward has been kind enough to supply me for examination with roots of lupines containing the nodules, and I show you here some photos as the result of this examination, illustrating the distribution in the tissue of the nodules of particular species of bacteria, then the character of these bacteria under cultivations, and their aspect and size in microscopic specimens. This species of bacilli is composed of motile cylindrical rods, which, cultivated in gelatine, liquefy this, and produce in the liquefied gelatine a peculiar greenish fluorescent colouring; on agar they also produce this colouring; the nature of the young colonies in plate cultivation, their manner of spreading and swarming, are well shown in these photographs.

Chromogenic and Phosphorescent Bacteria.

Time does not permit of more than a passing allusion to those remarkable species of chromogenic bacteria which have the power to produce pigments, either pigments which become dissolved in the medium in which these bacteria grow, or remain limited to the substance of the bacteria themselves. Species of bacteria there are which produce pigments of scarlet red, orange, yellow, yellow-green, green, greenish-blue, blue, violet, or pink colour. The nature of these pigments and the meaning and object of their formation are still shrouded in a good deal of mystery, though Erdmann and Schrötter showed long ago that many points of similarity exist between some of these pigments and certain anilin colours. I show you here cultivations of some of those chromogenic bacteria, and in a diagram the spectrum of one species, viz. of the *Bacillus prodigiosus;* this is the more common of the chromogenic bacteria, being occasionally present in water and in air. The pigment is soluble in alcohol, though only to a limited degree, and when the spectrum of such a solution is examined it is seen to present a characteristic absorption-band in green; the spectrum of a watery distribution of these bacteria shows two bands: one narrow one in green, the other broader in greenish-blue; both are less deep than the single band of the alcoholic solution.

Nor have I sufficient time to do more than allude to another remarkable group of bacteria, which comprises several species, all having the power to produce luminosity of themselves and the medium in which they grow. These phosphorescent bacteria have been long known (Pflüger) to be concerned in the production of the phosphorescent condition of decomposing sea fish, but within recent times Ludwig, Fischer, Katz, and particularly Beyerinck have studied more in detail the conditions under which these bacteria grow, and have identified and cultivated several species. Dr. Beyerinck has kindly sent me one species of these phosphorescent bacteria. The elements of this species are short oval rods, often dumb-bells; they grow in fish broth, and when the growth becomes conspicuous to the unaided eye it is luminous when viewed in the dark. I show you here some cultures which, as you see, when I place them in the dark, show a beautiful phosphorescent appearance. The phosphorescence is more or less limited to the surface layer, that is the one in contact with the oxygen of the air; in the depth it is absent, but when shaking the flask the phosphorescence appears also in the depth.

Fermentation.

I have mentioned, in connection with a previous group, bacterial species which have the power to change by hydration urea into ammonium carbonate, a change which is called a fermentative action. Changes similar to these are caused by micro-organisms in many processes playing an important part in industries. Amongst these changes I may mention one in particular, the souring of milk. There are a good many others, the viscous or mannit fermentation, the butyric fermentation, the indigo fermentation, the dextran fermentation, the acetic acid fermentation, and others, but time does not permit me to describe more than one, viz. the common bacterium lactis. I show you here a number of photographs of the bacterium lactis under cultivation, and as seen under the microscope. It is a minute oval bacterium, which multiplies with great rapidity, and which, introduced into milk, turns this sour in 12 to 24 hours at the ordinary temperature; when sterile milk is inoculated with this bacterium and kept in a warm place at a temperature of 60° to 65° F., the milk is found solid and curdled before 20 or 24 hours are over, and in this curdled milk large numbers of the bacterium lactis are present either as dumb-bell ovals or as short chains. When a needle is dipped first into such curdled milk and then into normal milk, the same coagulation with the same appearances takes place in the latter. When a plate cultivation of such milk is made it is seen that a large number of colonies all of the same character are developed, which colonies are made up of the bacterium lactis; through however numerous generations this organism is cultivated in artificial cultivations,—it grows well on nutritive gelatine to which whey or only lactic sugar has been added—and if then transferred to fresh milk, it always produces this souring and curdling; that is to say, it changes lactic sugar into lactic acid, and as this is being formed it coagulates and precipitates the casein of the milk. With a trace of milk that has gone naturally sour—that is to say, to which the bacterium lactis has found entrance, and in which by its multiplication it has produced curdling, any amount of normal milk can be successively turned sour and curdled. The bacterium lactis is not by any means a rare organism; it is widely distributed, and can at any moment, in dairies and other places, through impurities of the utensils, by dust, &c., find access to milk which would soon succumb to its attacks; when, for instance, in dairies or in one or another locality the milk has a frequent tendency to turn sour, this means that the bacterium lactis has taken firm footing in such a locality. It is well known that only extreme measures of cleanliness, thorough boiling of all utensils and vessels, cleaning of walls and floors can banish or reduce it. In this the analogy with an epidemic of an infectious disease is obvious. Just as in an epidemic, every susceptible individual to which the contagion has had access becomes smitten by infection, and just as in an epidemic the contagium of the disease, being of wide distribution, and, having taken a firm hold of the locality, attacks an increasing number of individuals, and thus causes the epidemic—so also in the case of the bacterium lactis: when this has taken a firm hold of, and has acquired a great distribution in, any locality, any sample of milk (*i.e.* susceptible individual) may take the infection, either by coming in contact, directly or indirectly, with a trace of the milk already infected, *e.g.* by being placed in vessels in which infected milk has been kept previously, or becoming infected through dust charged with the bacterium lactis, or coming in contact with water poured from a vessel in which traces of the microbes were still left. All this finds its complete analogy in the case of an epidemic infectious disease. The fermentative processes due to microbic activity, and playing an important part in industries (alcoholic and other fermentations), illustrate in a very striking manner some of the essential features observed in the nature, in the production, and in the spread of infectious diseases in man and animals. The fermentative processes, thoroughly established as being due to microbic activity by the researches of Pasteur, were by Pasteur, and others after him, used as illustrations of the way in which infectious disorders in man and animals arise, and it was exactly these considerations which led Pasteur to his brilliant studies of these diseases, the results of which studies have been of such signal service in sanitary science in general, and in the prevention of infectious diseases in particular.

In the fermentative processes studied by Pasteur and others it was shown that each specific fermentative process is due to the growth and multiplication of a specific microbe. Just the same is the case with the infectious diseases—when from a substance which is in the process of fermentation, a trace containing the particular microbe is introduced into fresh fermentible substance, this latter undergoes the same fermentation; further, it is shown that, however great the number of accidental non-specific bacteria which may be introduced at the same time, unless that particular bacterium be present amongst them, the specific fermentative change does not ensue. The same is the case with infectious diseases: the number of non-specific bacteria in water, dust, air, various common articles of food, &c., is sometimes great, but no amount of these would set up any of the infectious diseases, like cholera or typhoid fever, tetanus or diphtheria; in order to do so there must be amongst them the particular microbe of cholera or typhoid fever, &c. Again, in each fermentative process the substance which is to undergo the fermentation must be susceptible of the particular fermentation: a substance that contains sugar can undergo the alcoholic fermentation, a substance that contains alcohol can undergo the acetic acid fermentation, &c. The same is the case in the infectious diseases: an individual must be susceptible to the disease, though it is not quite clearly established what the meaning of this is. Further: just as in the fermentative process the susceptibility of the substance alone is not sufficient, is only a preliminary condition, the actual infection with the specific microbe being the essential, so also in the infectious disease: in order that a susceptible individual should become the subject of the disease it is essential that the specific microbe should be present and should find entrance into this susceptible individual. Just as little as a particular condition of the atmosphere, of temperature, &c., is capable of producing the souring of milk, so also a particular atmospheric or telluric condition, season, or other external circumstances alone cannot produce an infectious disease. What is wanted in the first place is the presence of the bacterium lactis in the one, the specific pathogenic microbe in the other; atmospheric or telluric conditions may and do favour the more rapid multiplication and dissemination of the bacterium lactis or other specific microbes, but without the presence of the specific microbes these processes could not take place. "Thunder in the air" could not turn the milk sour, could not make meat tainted, could not turn beer or wine sour, without the presence of the specific microbes, which by their presence and multiplication produce those undesired changes in these substances; the particular condition of the air could and would increase their rate of multiplication and distribution, and therefore increase the chances of infection of these substances and therefore a more conspicuous manifestation of the effects of the activity of those microbes, but it could not produce the microbes themselves.

Pathogenic Bacteria.

The different pathogenic bacteria connected with and causing the different infectious diseases have then the power of growing and multiplying within the infected individual and through the different poisonous substances—toxins—which they therein produce, of causing the changes which characterise the particular disease.

I show you here photographs of a variety of such pathogenic bacteria, and you will see from them that both as regards the manner of distribution of these bacteria in the tissues of the infected individuals as also in their morphological and biological characters in artificial cultures, most of them are sufficiently distinguished from one another and from other non-pathogenie bacteria. In considering the general action of pathogenic bacteria we find that they may be grouped into (*a*) such as are entirely, so far as our knowledge at present goes, dependent on the living body of man or animals; these are endogenic bacteria or true parasites, for they do not appear to lead an existence independent of the living body: when, therefore, infection by them takes place, it takes place by direct transference from an infected individual to a new one; this is so in small-pox, in vaccinia, and in hydrophobia; (*b*) a second group comprises those which are capable besides a parasitic life, *i.e.* growing and multiplying within the animal body, to lead also an existence independent of the animal body; that is to say, they, like many other non-pathogenic bacteria, are capable of thriving in suitable materials in the outside world; such are anthrax and fowl cholera, asiatic cholera and typhoid fever, tetanus and diphtheria, and others. But also amongst these some can lead such an "ectogenic" life comparatively easily, while others do so only in a restricted sense; while, for instance, anthrax, tetanus, typhoid fever can lead such ectogenic life easily, *i.e.* growing and multiplying outside the animal body; others, like tubercle and glanders, do so only to a very small extent. The former are obviously the more dangerous to man and animals on account of their more ready distribution than the latter, of which the ectogenic existence is considerably restricted by various conditions, *e.g.* they require higher temperatures to grow at, they require a much more specialised nutritive medium than is generally attainable by them.

Time does not permit me to show you in detail the many and wonderful results obtained within a comparatively short recent period by a large number of workers, as regards the identification of many of the pathogenic bacteria, their habits of life, their mode of spread and infection; the way in which their action can be attenuated, their effects weakened, and such weakened cultures used for protective inoculations; the brilliant results achieved by Pasteur and many others in these protective and curative inoculations against anthrax, against fowl cholera, against tubercle, against hydrophobia, against tetanus and other diseases. But I will ask you to bear in mind that almost the entire study of bacteria, the exact methods first introduced by Koch and now universally used not only in regard to pathogenic bacteria, but in all other branches of bacteriology; the exact knowledge that we possess of some of the most important branches of hygiene: as the knowledge of the exact nature of contagium, its mode of spread, the means of disinfection, the methods of protective inoculation, and a hundred and one other important points have been the result of, and gained by, experiment on animals. Amongst the wilderness of misery, cruelty, and death inflicted by mankind on animals for gain, for sport, pleasure, and other similar objects, to decry, as some do, the use of a comparatively few animals for the sake of gaining knowledge of the most important and complex phenomena of life and of disease, and of securing power to apply this knowledge in the interest not only of mankind, but of the animals themselves, is apt to make one remember the words: "Ye blind guides! which strain at a gnat and swallow a camel," or the words, "Thou hypocrite! cast out first the beam out of thine own eye, and then shalt thou see clearly to pull out the mote that is in thy brother's eye."

SURGERY AND SUPERSTITION.

TO those unversed in the history of surgery it may come as a surprise that many of the appliances commonly regarded as the inventions of yesterday, are but the perfected forms of implements long in use. It is astonishing to find amongst the small bronzes of the National Museum at Naples, bistouries, forceps, cupping-vessels, trochars for tapping, bi-valvular and tri-valvular specula, an elevator for raising depressed portions of the skull, and other instruments of advanced construction which differ but little from their modern congeners. The invention of such instruments, and the skill displayed in their construction, presupposes a long period of surgical practice. We find, accordingly, that four hundred years before our era, Hippocrates was performing numerous operations bold to the verge of recklessness. Thus he was accustomed to employ the trepan not only in depression of the skull or for similar accidents, but also in cases of headache and other affections to which, according to our ideas, the process was singularly inapplicable. Strangely enough, the Montenegrins are, or recently were, accustomed to get themselves trepanned for similar trifling ailments, and it is probable that in both instances the procedure was but the surviving custom of primeval ages. That such operations were then performed Dr. Robert Munro, in his admirable article upon prehistoric trepanning in the February number of the *Fortnightly Review*, conclusively shows. His paper records a strange blending of the sciences of medicine and theology in their initial stages; for, whilst he makes it clear that during the neolithic period a surgical operation was practised (chiefly on children) which consisted in making an opening through the skull for the treatment of certain internal maladies, he renders it equally evident that the skulls of those individuals who survived the ordeal were considered as possessed of particular mystic properties. And he shows that when such individuals died fragments were often cut from their skulls, which were used as amulets, a preference being given to such as were cut from the margin of the cicatrised opening. The discovery arose as follows. In the year 1873 Dr. Prunières exhibited to the French Association for the Advancement of Science an oval cut from a human parietal bone, which he had discovered in a dolmen near Marvejols, embedded in a skull to which it had not originally belonged. His suggestion that it was an amulet was confirmed on the discovery of similar fragments of bone grooved or perforated to facilitate suspension. When Dr. Prunières's collection was examined by Dr. Paul Broca he pointed out that that portion of the margin of the bone which had been described as "polished" owed its texture to cicatricial deposits in the living body, and that, where these were wanting, death had ensued before the pathological action was set up, or the operation had been *post mortem*.

These discoveries led to widespread investigation, and to the production of trepanned skulls from Peru, from North America, and from nearly every country of Europe. These were not restricted to any particular race or period, but ranged from the earliest neolithic age to historic times, and included skulls of dolichocephalic and brachycephalic types.

The method of conducting the operation appears to have been to gradually scrape the skull with a sharp flint, though there is occasional evidence of its use in a sawing manner such as obtained when the ruder implement was superseded by one of metal. The process was almost exclusively practised upon children, probably on account of the facility with which it could then be accomplished, and possibly also as an early precaution against those evils for which it was esteemed a prophylactic. What the dreaded evils were was suggested by Dr. Broca, who, whilst he believed that the operation was primarily conducted for therapeutic purposes, saw behind these the apprehension of a supernatural or demoniacal influence. Readers of Lenormant's "Chaldean Magic" will remember "the wicked demon which seizes the body, which disturbs the body," and that "the disease of the forehead proceeds from the infernal regions, it is come from the dwelling of the lord of the abyss." With such an antiquated record before us it is, therefore, by no means an extravagant theory to broach, as Dr. Broca has done, that many of the convulsions of childhood, which disappear in adult life, were regarded as the result of demoniacal possession. This being granted, what more natural than to assist the escape of the imprisoned spirit by boring a hole in the skull which formed his prison. When a patient survived the operation he became a living witness to the conquest of a fiend, and it is comprehensible that a fragment of his skull taken after death from the very aperture which had furnished the exit would constitute a powerful talisman. Chaldean demons, as we know, fled from representatives of their own hideous forms, and, if they were so sensitive on the score of personal appearance, others may have dreaded with equal keenness the tangible record of a previous defeat. It is certain that to cranial bones medicinal properties were ascribed, a belief in the efficacy of which persisted to the dawn of the eighteenth century; whilst, in recent years, such osseous relics were worn by aged Italians as charms against epilepsy and other nervous diseases. When once the dogma was promulgated that sanctity and a perforated skull were correlated, fond relatives might bore the heads of the departed to facilitate the exodus of any malignant influence still lingering within, and to ensure them, by the venerated aperture, a satisfactory position in their new existence. For similar reasons the bone amulet was buried with the deceased, and sometimes it was even placed within his skull. Dr. Munro considers it hard to say for what purpose such an insertion should have been made, but, arguing from his data, the practice does not appear to me difficult of explanation. He has shown that disease was the work of a demon imprisoned in the skull; that this demon was expelled through the trepanned hole; and that its margins were thus sanctified for talismanic purposes. The unclean spirit was gone out of the man, and observation showed that, during the man's earthly existence, he did not return; but what guarantee was there that in the dim unknown region to which the deceased was passing the assaults of the evil one might not be renewed, that he might not return to his house whence he came out, and, with or without other spirits more wicked than himself, enter in and dwell in the swept and garnished abode? Surely, with such a possibility before them, it was the duty of pious mourners to offer all the protection that religion could suggest, and to defend the citadel with that potent amulet which recorded the previous discomforture of the besieger. The *post mortem* trepanning may have been such a pious endeavour to carry sacramental benefits beyond the grave, as induced the early Christians to be baptised for the dead, and, if there be truth in the deductions which have been made from the evidence, they point not only to a belief in the supernatural and in the existence of a future state, but also to that pathetic struggle of human love to penetrate the kingdom of death, which has persisted from the death of "Cain, the first male child, to him that did but yesterday suspire."

The possibility of reasonably making such deductions from a few decayed bones is a remarkable proof of the progress of anthropological science. Should any readers regard these deductions as unwarranted, they must remember that their value is dependent upon a series of facts which can here only be but very imperfectly reproduced. For these evidences in full sequence reference should be made to the paper by Dr. Munro, which forms the subject of this notice, and which will amply repay perusal. FRANK REDE FOWKE.

ANIMAL HEAT AND PHYSIOLOGICAL CALORIMETRY.[1]

THE problem of animal heat is one of the oldest problems of scientific speculation. Nevertheless it is only within recent years that we have been able to speak of it in terms of modern knowledge.

Among the earliest contributors to such knowledge we may cite John Mayow and Joseph Black. Mayow was the first to suggest that atmospheric air is not a simple element and that its "nitro-aeric particles," in combining with the blood in the lungs, produce the animal heat, while Black demonstrated that the air expired by the lungs contains "fixed air" or, as we now call it, carbonic acid.

Priestley discovered oxygen gas in 1771, but Lavoisier was the first to show that this constituent of the air is taken in by the blood in the lungs, and that its combination with the carbon, which is a regular constituent of all organic matter, produces animal heat in the same way as in all combustions. Lavoisier was the first, too, who measured the heat produced by an animal, making use of the ice calorimeter, constructed by himself and Laplace, while Crawford nearly at the same time made investigations with an apparatus similar to our water calorimeter.

Neither form of apparatus is very suitable for this purpose. Scharling, Vogel, and Hirn made use of an air calorimeter. Within the last few years Prof. d'Arsonval of Paris adopted the same principle, and I myself have worked out the theory of it, and constructed apparatus, with which I have made a great number of experiments.

The animal to be experimented upon in my apparatus is placed in a chamber surrounded by double metallic walls. The heat given out by the animal raises the temperature of the air contained between the walls, until the radiation from the outer surface causes a loss of heat equal to the amount gained by it from the animal. This state of things having been established, the temperature of the air becomes constant, the gain and loss of heat being equal. In this way the heat given out can be calculated.[1]

The chamber containing the animal is well ventilated by aspiration. If we measure the volume of the air aspired and conduct a part of it through liquids absorbing carbonic acid, the amount of this gas given out by the animal can be measured. In another series of experiments the amount of oxygen absorbed by the animal was also measured. The combination of apparatus I made use of for this purpose is a variation of the method invented by Regnault and Reiset.

I shall not weary you with a long enumeration of all my experiments. All I wish is to give a brief account of some of the results, which I think are of interest from a general biological point of view.

In the first place, I may mention my experiments on fever. The high temperature in cases of febrile disease—is it the result of greater heat production? Are we to assume that certain poisons taken into the body, or produced in it by microbes, stimulate the nervous system, or directly influence the tissues in such a way as to cause greater oxidation, and thus to produce more heat?

That is the opinion of many medical men, but it is met with the great difficulty that neither the expiration of carbonic acid nor the excretion of oxidized nitrogenous matter is increased to such a degree as to account fully for the rise of temperature. Therefore Traube, the late clinician of Berlin, proposed the theory that the rise of temperature in fever is caused, not by greater heat production, but by greater retention of heat.

On producing fever in animals by injection of various putrid substances, I found that at the beginning of the fever, heat production is not increased, that the loss of heat is diminished, and that the difference between the normal loss and that observed in the period of rising temperature is sufficient to cause the febrile rise. When the temperature reaches its highest point the amount of heat given out rises and comes to its *normal* rate. Finally, when the fever begins to subside, during the period of falling temperature, the loss of heat is greatly increased.

All this is in perfect accordance with Traube's theory. Nevertheless, I cannot say that heat production is *never* augmented in fever. I have not yet been able to make many experiments on man. There are two great difficulties in the way, and the greatest is the impossibility of making a strict comparison between the heat production in fever and that in the normal state, except in cases of the regular intermittent type. Malaria, once so frequent in several parts of Germany, nowadays, thanks to hygienic improvements, is very seldom met with. So I have been able to make only two experiments on an individual afflicted with intermittent fever, some on invalids with abdominal typhus (typhoid fever), some on cases of pneumonia, and others on cases of fever caused by the injection of Koch's tuberculine during the short time when such injections were practised in the hospitals of Erlangen. In these cases I found a small but real augmentation of heat production, and therefore I am inclined to suppose that the question is not yet solved. Perhaps there are two causes able to raise the temperature in fever, one of them prevailing in some cases or types of fever.

Most of my studies were conducted with a view to explain the connection between heat production and other physiological functions, and the influence of external circumstances on it. Higher animals, mammals and birds, maintain their own temperature nearly at the same degree, even when the temperature of the surrounding air changes within large limits. Is this *regulation*, as we call it, caused by adaptation of heat production to the greater or smaller loss, or are there means to keep the loss constant in spite of the changing difference between the animal and surrounding objects?

On measuring the heat production of the same animal in cold and warm air, I found that it is smallest in air of medium temperature, *i.e.* about 15° C., becoming greater in lower and in higher temperatures. Thus an animal produces and loses nearly the same amount of heat in air at 5° as in air at 25°. In this case regulation of the animal temperature can be effected only by changes of the co-efficient of emission of heat from the skin, caused by changes of circulation. But for longer periods

[1] Paper by Prof. Rosenthal of Erlangen, read before the Biological Section at the Edinburgh meeting of the British Association for the Advancement of Science.

[1] For a fuller account see my papers in: *Archiv für Physiologie*, 1889, and in *Sitzungsber. d. K. preuss.* Akad. d. Wissensch. 1888-1892.

that regulation is insufficient. In winter time we use thicker clothing, we need more food, and if the cold is very great, we produce more heat by muscular action. In accordance with that experience, I found that animals produce more heat in winter than in summer. If nourished with the same food, sufficient to maintain their weight constant in winter, they do not oxidize the whole in summer, and therefore they gain in weight. It is remarkable that similar changes were observed by Dr. Karl Theodor, Duke of Bavaria, in the amount of carbonic acid expired by a cat, in the case of which he measured the expiration of this gas during five months.

Many experiments have been made to find the combustion heat of our food-stuffs. For want of direct animal calorimetry, physiologists used these data for calculating the heat produced by living beings; but as my experiments show, there is frequently no exact accordance between the two.

Richly nourished animals produce less, sparely nourished ones more, heat than the calculation gives. Between the two cases there is a third one in animals *sufficiently* nourished, viz. such as take in so much nutriment as serves to maintain their weight unchanged for a long time. In this case only the amount of heat produced is really equal to that calculated upon the combustion of the constituents of food. But also in this case variations are observed, caused by change of temperature, muscular motion or other circumstances, so that only the middle figures correspond exactly to the theoretical value.

Thus, if a well-nourished animal is starved the heat production remains unchanged from three to four days, the animal burning its stored-up materials and losing much of its weight; only then is it suddenly reduced to a lower amount. If now food is given again, heat production remains small, the weight increases, and then, three or four days later, the heat production increases and reaches its former amount.

If a sufficiently nourished animal takes in all its food once a day, the heat production varies very regularly in the twenty-four hours. Two hours after the meal it begins to rise, comes to its maximum point between the fifth and seventh hour, falls suddenly between the eleventh and twelfth hour. In the second half of the period the changes are small, the minimum point being usually in the twenty-third hour.

Similar changes go on in the expiration of carbonic acid. But after the meal it rises much more rapidly, and therefore comes earlier to its maximum point. Thus the ratio between heat production and expiration of carbonic acid is not a constant. This is true not only in the daily period. The variations are seen to be still greater when we compare different animals, or the same animal at different times and in different states of nutrition.

By such researches we are enabled to examine more exactly what chemical changes are going on in the animal system. The materials afforded by food are all oxidized at last, and leave the body in the form of carbonic acid and nitrogenous matter like urea. What in a longer period is burnt in such a way, we can, with a certain degree of exactness, make out by chemical examination of the constituents of food on the one hand, and of the excretions on the other. We can make up, in such a way, a balance account for gain and loss of the animal, like the balance account of a merchant. But such an account gives no exact knowledge, because we have no means of completing it by taking an inventory. We are, as regards the living body, in the same position as a political economist, who knows the amount of goods imported into and exported out of a country, but does not know what has become of the goods stored up or used up in the country itself. Therefore political economists do not now regard the mere balance of trade as being so important as they formerly thought.

Physiology, like all branches of science, begins with a mere description of processes observed. With the progress of our knowledge, reason tries to connect these processes one with another, and with those going on in lifeless nature. What we call *understanding* is nothing else than knowing such connections. Now in the case of bodily income and expenditure, it is easy to observe that all materials going out of the system are more oxidized than those taken in as food, and reason tells us that the combination of these food materials with the oxygen inspired must be the source of animal heat. Hence, we have no doubt that the amount of heat produced must correspond to the amount of chemical processes going on during the same time. But these processes we cannot observe directly; we can only observe the final products carbonic acids and others, when they leave the body. But by some of the processes heat may be produced or absorbed without any visible change of the body as a whole, viz. by solution of solid matter, by splitting highly complex substances into more simple ones, by forming sugar out of starch or glycogen out of sugar. Considering this, we need not wonder that for a long time it was impossible to answer the question whether there is any other source of heat production in animals besides oxidation. Only long continued calorimetric measurements have enabled me to fill up this gap.[1] This done, I thought it possible to discover also something about these inner processes, by comparing, hour for hour, the heat production with the excretion of carbonic acid, and with the absorption of oxygen.

If the ratio between the heat produced and the carbonic acid expired changes, this cannot be explained otherwise than by the fact that different chemical substances are burned. Each substance, according to its chemical constitution, gives out, when oxidized, a certain amount of carbonic acid, and produces a certain amount of heat. But in the system it is a mixture of different substances which come to be oxidized. This mixture changes, not only in animals differently nourished, but also in the same animal in different periods of digestion. After a rich meal, what comes into the circulation first must be that part of the food that is easily and rapidly digested and easily and rapidly absorbed. Such substances are the proteid matters. Later, the other constituents of the food, especially fat, come to the tissues, where they are burned. Now *fats*, for the same amount of carbonic acid, produce far more heat than proteids; so, during the first hours of digestion the afflux of oxidizable matter to the tissues being very great, both heat production and expiration of carbonic acid increase, but the latter in a far higher degree than the former.

The animal body may be compared, as Prof. Huxley so well says, to an eddy in a river, which may retain its shape for an indefinite length of time, though no one particle of the water remains in it for more than a brief period. But there is not only the difference between the animal eddy and the eddy of the river, viz. that the matter which flows into it has a different chemical composition from the matter which flows out of it, but in addition, matters which make up the eddy in a given time, change, if I may so say, their chemical value, combine with or separate from each other, without any visible change of the whole system.

The study of heat production is of the greatest value. No doubt, the study of the vital processes becomes more complicated when we take into account the invisible internal changes occurring in the body. But simplicity is not the highest aim in scientific inquiries; the highest possible exactness is that to which we must aspire. Happily, the history of science shows that after trying several ways to solve complex problems, we find that one of them leads to a higher point of view, whence things appear in all their completeness, simplicity and distinctness. Towards such a point of view my researches are but the first step. Let us hope that the united forces of many physiologists will shorten the time necessary for the completion of the work.

MAGNETIC PROPERTIES OF LIQUID OXYGEN.[2]

AFTER alluding to the generous aid which he had received both from the Royal Institution and from others in connection with his researches on the properties of liquid oxygen, and to the untiring assistance rendered him by his co-workers in the laboratory, Prof. Dewar said that on the occasion of the commemoration of the centenary of the birth of Michael Faraday he had demonstrated some of the properties of liquid oxygen. He hoped that evening to go several steps further, and to show liquid air, and to render visible some of its more extraordinary properties.

The apparatus employed consisted of the gas-engine down stairs, which was driving two compressors. The chamber containing the oxygen to be liquefied was surrounded by two circuits, one traversed by ethylene, the other by nitrous oxide. Some liquid ethylene was admitted to the chamber belonging to its circuit, and there evaporated. It was then returned to the

[1] See also my address delivered to the general meeting of the German Association of Naturalists at Bremen, 1890.

[2] Abstract of Friday evening discourse delivered at the Royal Institution by Prof. Dewar, F.R.S.

compressor as gas and liquefied, and thence, again, into the chamber as required. A similar cycle of operations was carried out with the nitrous oxide. There was a hundredweight of liquid ethylene prepared for the experiment. Ethylene was obtained from alcohol by the action of strong sulphuric acid. Its manufacture was exceedingly difficult, because dangerous, and as the efficiency of the process only amounted to 15 or 20 per cent. the preparation of a hundredweight of liquid was no light task. The cycle of operations, which, for want of time, was not fully explained, was the same as that commonly employed in refrigerating machinery working with ether or ammonia.

The lecturer then exhibited to the audience a pint of liquid oxygen, which by its cloudy appearance showed that it contained traces of impurity. The oxygen was filtered, and then appeared as a clear transparent liquid with a slightly blue tinge. The density of oxygen gas at − 182° C. is normal, and the latent heat of volatilisation of the liquid is about 80 units. The capillarity of liquid oxygen at its boiling-point was about one-sixth that of water. The temperature of liquid oxygen at atmospheric pressure, determined by the specific heat method, using platinum and silver, was − 180° C.

Reference was then made to a remarkable experimental corroboration of the correctness for exceedingly low temperatures of Lord Kelvin and Prof. Tait's thermo-electric diagram. If the lines of copper and platinum were prolonged in the direction of negative temperature, they would intersect at − 95° C. Similarly, the copper and palladium lines would cut one another at − 170° C. Now, if this diagram were correct, the E.M.F. of the thermo-electric junctions of these two pairs of metals should reverse at these points. A Cu − Pt junction connected to a reflecting galvanometer was then placed in oxygen vapour and cooled down. At − 100° C. the spot of light stopped and reversed. A Cu − Pd junction was afterwards placed in a tube containing liquid oxygen, and a similar reversal took place at about − 170° C.

Liquid oxygen is a non-conductor of electricity: a spark taken from an induction coil, one millimetre long in the liquid requires a potential equal to a striking distance in air of 25 millimetres. It gave a flash now and then, when a bubble of the oxygen vapour in the boiling liquid came between the terminals. Thus liquid oxygen is a high insulator. When the spark is taken from a Wimshurst machine the oxygen appears to allow the passage of a discharge to take place with much greater ease. The spectrum of the spark taken in the liquid is a continuous one, showing all the absorption bands.

As to its absorption spectrum, the lines A and B of the solar spectrum are due to oxygen, and they came out strongly when the liquid was interposed in the path of the rays from the electric lamp. Both the liquid and the highly compressed gas show a series of five absorption bands, situated respectively in the orange, yellow, green, and blue of the spectrum.

Experiments prove that gaseous and liquid oxygen have substantially the same absorption spectra. This is a very noteworthy conclusion considering that no compound of oxygen, so far as is known, gives the absorptions of oxygen. The persistency of the absorption through the stages of gaseous condensation towards complete liquidity implies a persistency of molecular constitution which we should hardly have expected. The absorptions of the class to which A and B belong must be those most easily assumed by the diatomic molecules (O_2) of ordinary oxygen; whereas the diffuse bands above referred to, seeing they have intensities proportional to the square of the density of the gas, must depend on a change produced by compression. This may be brought about in two ways, either by the formation of more complex molecules, or by the constraint to which the molecules are subjected during their encounters with one another.

When the evaporation of liquid oxygen is accelerated by the action of a high expansion pump and an open test-tube is inserted into it, the tube begins to fill up with liquid atmospheric air, produced at the ordinary barometric pressure.

Dr. Janssen had recently been making prolonged and careful experiments on Mont Blanc, and he found that these oxygen lines disappeared more and more from the solar spectrum as he reached higher altitudes. The lines at all elevations come out more strongly when the sun is low, because the rays then have to traverse greater thicknesses of the earth's atmosphere.

Michael Faraday's experiments made in 1849 on the action of magnetism on gases opened up a new field of investigation. The following table, in which + means "magnetic" and − means "negative," summarises the results of Faraday's experiments.

Magnetic Relations of Gases (Faraday).

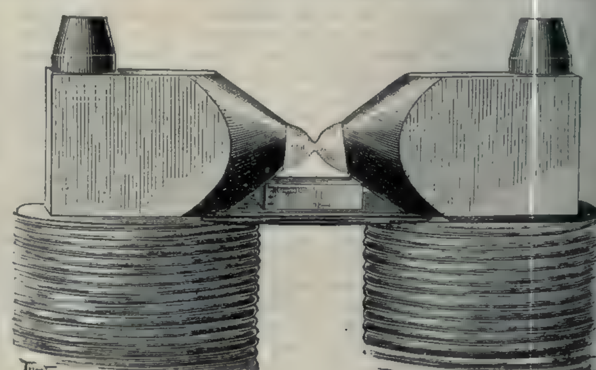
	In Air.	In Carbonic Acid.	In Hydrogen.	In Coal Gas.
Air	o	+	+ weak	+
Nitrogen	−	−	− strong	−
Oxygen	+	+	+ strong	+ strong
Carbonic acid ...		o	−	− weak
Carbonic oxide...	−	−	−	− weak
Nitric oxide ...	− weak	+	+	...
Ethylene ...	−	−	−	− weak
Ammonia ...	−	−	−	...
Hydrochloric acid	−	−	− weak	...

Becquerel was before Faraday in experimenting upon this subject. Becquerel allowed charcoal to absorb gases, and then examined the properties of such charcoal in the magnetic field. He thus discovered the magnetic properties of oxygen to be strong, even in relation to a solution of ferrous chloride, as set forth in the following table:—

Specific Magnetism, Equal Weights (Becquerel).

Iron	+	1,000,000
Oxygen...	+	377
Ferrous chloride solution, sp. gr. 1·4334	+	140
Air	+	88
Water	−	3

The lecturer took a cup made of rock salt, and put in it some liquid oxygen. The liquid did not wet rock salt, but remained in a spheroidal state. The cup and its contents were placed between and a little below the poles of an electro-magnet. Whenever the circuit was completed, the liquid oxygen rose from the cup and connected the two poles, as represented in the cut, which is copied from a photograph of the phenomenon. Then it boiled away, sometimes more on one pole than the other, and when the circuit was broken it fell off the pole in drops back into the cup. He also showed that the magnet would draw up liquid oxygen out of a tube. A test-tube containing



Magnetic ttraction of Liquid Oxygen.

liquid oxygen, when placed in the Hughes balance, produced no disturbing effect. The magnetic moment of liquid oxygen is about 1000 when the magnetic moment of iron is taken as 1,000,000. On cooling some bodies increased in magnetic power. Cotton wool, moistened with liquid oxygen, was strongly attracted by the magnet, and the liquid oxygen was actually sucked out of it on to the poles. A crystal of ferrous sulphate, similarly cooled, stuck to one of the poles.

The lecturer remarked that fluorine is so much like oxygen in its properties, that he ventured to predict that it will turn out to be a magnetic gas.

Nitrogen liquefies at a lower temperature than oxygen, and one would expect the oxygen to come down before the nitrogen when air is liquefied, as stated in some text-books, but unfortunately it is not true. They liquefy together. In evaporating, however, the nitrogen boils off before the oxygen. He poured two or three ounces of liquid air into a large test-tube, and a smouldering splinter of wood dipped into the mouth of the tube was not re-ignited; the bulk of the nitrogen was nearly five minutes in boiling off, after which a smouldering splinter dipped into the mouth of the test-tube burst into flame.

Between the poles of the magnet all the liquefied air went to the poles; there was no separation of the oxygen and nitrogen. Liquid air has the same high insulating power as liquid oxygen. The phenomena presented by liquefied gases present an unlimited field for investigation. At − 200° C. the molecules of oxygen had only one-half of their ordinary velocity, and had lost three-fourths of their energy. At such low temperatures they seemed to be drawing near what might be called "the death of matter," so far as chemical action was concerned; liquid oxygen, for instance, had no action upon a piece of phosphorus and potassium or sodium dropped into it; and once he thought, and publicly stated, that at such temperatures all chemical action ceased. That statement required some qualification, because a photographic plate placed in liquid oxygen could be acted upon by radiant energy, and at a temperature of − 200° C. was still sensitive to light.

Prof. M'Kendrick had tried the effect of these low temperatures upon the spores of microbic organisms, by submitting in sealed glass tubes blood, milk, flesh, and such-like substances, for one hour to a temperature of −182° C., and subsequently keeping them at blood heat for some days. The tubes on being opened were all putrid. Seeds also withstood the action of a similar amount of cold. He thought, therefore, that this experiment had proved the possibility of Lord Kelvin's suggestion, that life might have been brought to the newly-cooled earth upon a seed-bearing meteorite.

In concluding, the lecturer heartily thanked his two assistants, Mr. R. N. Lennox and Mr. J. W. Heath, for the arduous work they had had in preparing such elaborate demonstrations.

SCIENTIFIC SERIALS.

IN the *Journal of the Royal Agricultural Society of England* (third series, vol. iv. pt. 1) there is an interesting paper on the home produce, imports, consumption, and price of wheat over forty harvest years, 1852–3 to 1891–2, by Sir J. B. Lawes and Dr. J. H. Gilbert. This paper, extending to fifty-five pages, contains a general review of the produce of the experimental plots at Rothamsted, from which they have annually calculated the wheat crop of this country.—The first of the official reports is that of the Royal Veterinary College on investigations conducted for the Royal Agricultural Society during the year 1892. An interesting case of actinomycosis is related; a heifer with tongue badly diseased was put under Thomassen's treatment. Potassium iodide administered at first in doses of one drachm, twice daily, and the doses gradually increased to three drachms, effected a complete cure in about ten weeks.—Experiments have lately been made at the Veterinary College with Koch's tuberculin. The results in the case of seventy-two animals inoculated and afterwards killed show that "the tuberculin pointed out correctly the existence of tuberculosis in twenty-seven animals and wrongly in five, and it failed to indicate the existence of the disease in nineteen. In only three of the twenty-seven animals in which the tuberculin correctly pointed out the existence of tuberculosis could a positive diagnosis have been made by any other means." Experiments have also been made with Kalning's mallein, and "the results warrant the statement that mallein is an agent of greater precision than tuberculin, and that it is likely to render most important service in any attempt to stamp out glanders."

Wiedemann's Annalen der Physik und Chemie, No 4.—On electric discharges; the production of electric oscillations, and their relations to discharge tubes, by H. Ebert and E. Wiedemann. The influence of electric oscillations of given frequency in producing glow in vacuum tubes without electrodes was investigated by means of Lecher's wire system. The oscillations in the primary circuit were produced by means of an influence machine throughout. The terminals of the machine were connected to the primary condenser, consisting of four plates, to the further two of which the two Lecher wires, copper wires or thick metal tubes, were attached, running parallel for distances varying from 2 to 14 m., and ending in another condenser of variable capacity. The sensitive tubes were placed in various positions between or near the plates of the secondary condenser. It was found that wide tubes, not too short, glowed most readily. Nodes along the wires were discovered by means of wire bridges, which were moved along the wires until the tube glowed, or, if it was glowing already, until it reached a point where the glow became more intense and uniform. It was found that the position of the nodes was independent of the pressure in the tube, but that as evacuation proceeded the limits within which the tube would glow grew wider. Hence the most accurate method for finding the nodes, was by finding them for the highest possible pressure of gas in the tube.—On the comparison of intensities of light, by the photoelectric method, by J. Elster and H. Geitel. Apart from the dissipation of an electric charge from a negative zinc pole by ultra-violet radiation, it is also possible to measure the intensity of optically active light by an electric method. If a clean surface of potassium is joined to the negative pole of a battery, and a platinum or aluminium electrode to the positive pole, and the two electrodes are placed in a vacuum cell, the illumination of the potassium surface will allow a current to flow whose strength will be proportional to the intensity of the light source, and can be measured by means of a galvanometer. That this is really the case was proved by measuring independently in this way the intensities of two luminous sources, and then combining them, when the resultant reading was found to be equal to the sum of the other two, within the limits of constancy of the sources themselves. The greatest effect is produced by the blue rays.—Also papers by Messrs. Bjerknes, Zahn, Voigt, Richarz, Ambronn, Christiansen, Goldhammer, and Oberbeck.

Meteorologische Zeitschrift, March.—Iridescent clouds, by H. Mohn.—The paper contains observations made at Christiania during the years 1871-1892, together with a detailed investigation of the formulæ recently employed. During this period iridescent clouds were only visible on forty-two days; in some years the phenomenon failed entirely, and was not observed during the whole lustrum 1876-80. The great majority of cases occurred in December and January, but a few occurred in summer; the phenomenon was also seen somewhat more frequently at sunset than at sunrise or mid-day, but the difference is so small as to make it appear that its occurrence is independent of the time of day. The height of the clouds varied from about fourteen to more than eighty miles, the lower level being about twice the height at which ordinary cirrus clouds are usually seen at Christiania. The phenomenon appears to have some connection with the state of the weather, as an examination of the synoptic charts showed that it mostly occurred during the prevalence of stormy weather in the North Atlantic and over Northern Europe, and when the air was dry and warm at Christiania.—On the determination of wind force during gusts of a Bora storm, by E. Mazelle. From an investigation of the anemometer observations at Trieste for the ten years 1882-1891, the greatest hourly velocity recorded was seventy miles. But as hourly values give little idea of the violence of individual gusts, the author adapted an ingenious electrical arrangement to the anemometer, by which he could record the number of revolutions of the cups in each second. During a storm on January 16 last, the gusts during the space of a few seconds reached the velocity equivalent to 100 to 140 miles an hour. Presuming the instrument to have been a large-sized anemometer, this high velocity is not unlikely, as in a paper read before the Royal Meteorological Society on May 18, 1881, by R. H. Curtis, a velocity at the rate of 120 miles an hour at Aberdeen is quoted as recorded in gusts lasting two minutes, while shorter intervals, if they could be measured, would no doubt show higher velocities; and at Sydney a velocity of 153 miles an hour was recorded during one or two minutes. In all these cases the factor 3 has been used for the ratio of the movement of the cups to that of the wind, but this factor has been shown to give a velocity which is nearly 30 per cent. too high.

Bulletin de la Société des Naturalistes de Moscou, 1892.—(No. 1.) The chief papers are:—The development of the gemmulæ in *Ephydatia fluviatilis*, by W. Zykoff.—Catalogue of Kazan Lepidoptera, continued, by L. Kroulikovsky.—Analogy between the solution of a gas and of a salt in indifferent solutions of salts, by I. M. Syetchenoff. The author's law, which was found or carbon dioxide $\left(y = ae - \frac{k}{x}\right)$, holds good within certain limits, for the solution of salts in the same solutions; but the latter must only be taken either weak or of medium strength.—New plants and insects from Sarepta, by Alex. Becker.—On a mesozoic fish from the Altai, by J. V. Rohon (*Lepidotus altaicus*, n. sp.).—On the cells of some conjugata devoid of nucleus, by J. Gerasimoff.—(No. 2.) The Rhinoceridæ of Russia, and the development of Rhinoceridæ, by Marie Pawloff. —Researches relating to some Protococcoidæ, by Al. Artari (in German). The work has been done chiefly in order to study the doubtful species. They were cultivated in different conditions, and proved to be independent species. At the same time the author experimented upon the influence of various media upon variations; the latter proved to occur within certain well-defined limits only, not exceeding the specific differences. The Algæ, when returned to their previous conditions, may return to their previous forms, thus proving a certain resistance of the organism against the medium. The following new species are described:—*Glœocystia nægeliana*, *Pleurococcus simplex*, *P. conglomeratus*, *P. regularis*, *P. Beyerinckii*, and *Chlamydomonas apiocystiformis* (three plates).—The birds of the Government of Moscow, by Th. Lorenz, with preface by Prof. Menzbier (first paper). Eighty-eight species are mentioned, with remarks upon their manners of life, based upon many years' observations.

Zapiski (*Memoirs*) *of the Novoros Sian* (*Odessa*) *Society of Naturalists*, vol. xvii. 2.—N. Andrussoff contributes, under the name of bio-geographical notes, a paper on pelagic diatoms, which contains a list of all named species of diatoms which have hitherto been found, either free, or in the stomachs of pelagic animals, both near to the coasts and in the open sea. The list is based on the researches of Hooker, Ehrenberg, Baddeley, Grunow, Castracane, and so on, down to the *Challenger* expedition, and the works of Murray, Hensen, and Brun, and it is followed by short remarks upon the geological importance of diatoms. The paper is summed up in German. —Prof. Sintsoff gives a list of Neogene fossils in Bessarabia, the following species being new:—*Acmæa* (*Scurria*) *Reussi*, *tennissima*, *subrostata*, and *striato-costata*, *Acmæa pseudolævigata*, and *Buccinum subspinosum*.—D. Zabolotny discusses animal phosphorescence, and gives some facts on the same phenomenon observed in *limans*, near Odessa. The phosphorescent water was of a brown red colour, and contained masses of Daphniæ, Rotifers, and Infusoriæ. It appeared that luminosity was due to one Cilioflagellate, *Glenodinium*, from the *Peridinidæ* tribe, and it seems that light was emitted by the protoplasm itself of the little animal.—A. Lebedintseff describes the bathometer used in 1891 and 1892 during the explorations of the Black Sea; and G. Muskatblüth gives a note on mitotic division of leucocytes in circulating blood.

Annalen des K. K. Naturhistorischen Hofmuseums, viii. No. 1. (Wien, 1893.)—Dr. O. Finsch continues his "Ethnological experiences and authenticated objects from the South Sea." The present is the first paper on Micronesia, and deals with the Gilbert Islands. As is usual with Dr. Finsch's papers, it is well illustrated by eight plates, two of which are in colours, containing 110 figures, besides 16 wood-cuts. Although this paper, like the others of the series, is a catalogue of the objects collected by Dr. Finsch, and now in the National Museum in Vienna, it is at the same time an important contribution to the ethnography of Micronesia, a region of the great ocean about which comparatively little is known. The Gilbert Archipelago—often called the Kingsmill Islands—are best known to the frequenters of museums as the country of formidable weapons armed with serried rows of sharks' teeth, and of the coir armour which was worn as a defence against these deadly weapons. Dr. Finsch is of opinion that the Gilbert Archipelago, with Banaba and Nawodo, constitute a well-marked sub-province, as there is a distinct language, peculiar pantomimic dances (in which both sexes participate), characteristic tattooing, a special style of house, which latter are grouped into large villages, colossal assembly houses, well-built canoes, even for the South Sea, shark-tooth weapons, armour, a noose for catching eels, &c. He concludes by saying, "In every respect the Gilberts exhibit more affinity with Melanesia than with Polynesia, and least of all with Micronesia." The other articles are: "Characterless birds' eggs: an oological study" [on *Corvus corone*, *C. cornix* and *C. frugilegus*], by Emil C. F. Rzehak; "On the crystalline structure of meteoric iron," by G. Linck, and the usual official reports for 1892.

THE last three numbers received (2-4) of the *Bullettino della Società Botanica Italiana* contain a very large number of papers on the flora, phanerogamic and cryptogamic, of various districts of Italy and the adjacent countries, including an interesting note on the very rich flora of Monte Nerone. In addition to these Prof. R. F. Solla describes a case of polyembryony in the carob, *Ceratonia siliqua*, and also the structure of the tanniferous cells in the same plant. Sig. E. Baroni has a note on the relationship of calcicolous lichens to their substratum. Dr. C. Massalongo describes a gall on the bay, *Laurus nobilis*, due to the attacks of an insect which he regards as a new species, and names *Phytoptus Malpighianus*. Prof. G. Arcangeli gives the result of observations on the growth of the leaf-stalk of various species of Nymphæaceæ, which he finds to be greater in the case of immersed than of floating leaves. This he attributes to the vertical pressure of the water on the upper surface of the leaves in the former case. A paper by the late Prof. F. Pasquale was read, describing a fall of rain from lime-trees, quite unconnected with the manna produced by aphides, and due to the inability of transpiration to eliminate the whole of the water absorbed through the roots.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 23.—"Preliminary Notice on the Arrow-Poison of the WaNyika and other Tribes of East Equatorial Africa, with special reference to the Chemical Properties and Pharmacological Action of the Wood from which it is prepared." By Thomas R. Fraser, M.D., F.R.S., Professor of Materia Medica in the University of Edinburgh, and Joseph Tillie, M.D. (Edin.)

Burton,[1] Cameron,[2] and other travellers have given accounts of much interest of an arrow-poison used in warfare and in the chase by the WaNyika, WaKamba, WaGyriama, and other tribes of Eastern Equatorial Africa.

Several years ago, an opportunity was given to one of the authors to examine poisoned arrows, and the poison used in smearing them, of the WaNyika tribe. While the pharmacological action of this poison was found to have a close resemblance to that of *Strophanthus* seeds, its physical and chemical properties enabled the conclusions to be drawn that the poison was not made from these seeds, but was chiefly composed of an extract prepared from a wood.[3]

These conclusions have been confirmed by the examination of further specimens of the WaNyika arrow-poison, and of the wood from which it is prepared; and some of the results of this examination are stated in this paper.

The authors have separated from the arrow-poison and from the wood a crystalline glucoside, whose elementary composition, reactions and other characters they describe.

They have elaborately investigated the pharmacological action of this glucoside. The minimum-lethal dose for frogs was found to be about 0·00005 grain per 100 grains of weight of frog, and for rabbits about 0·000035 grain per pound of weight of animal.

The glucoside has a very pronounced action upon the heart. A large dose causes, in the frog, arrest of the contractions in a state of ventricular systole, and the heart soon afterwards acquires an acid reaction. After the heart is paralysed, respiration may continue for so long as an hour, and for a considerable time the frog can jump about actively. Smaller doses, on the other hand, slow the heart by prolonging diastole, and arrest its pulsations in a state of ventricular diastole. This diastolic arrest is not prevented by the administration of atropine, and is probably due to a direct action on the motor ganglia and muscle of the heart. The action on blood vessels is very slight. Transfusion experiments in the frog with a solution of 1 in 10,000 of saline produced only about the same effect as the pure saline solution alone.

A marked paralysing action is exerted upon the skeletal muscles, which also quickly pass into a condition of *rigor mortis*. The spinal cord and sensory and motor nerves are but little affected, and the former only doubtfully, except indirectly through the enfeebled circulation when large doses are administered. In warm-blooded animals, artificial respiration does not prevent death from cardiac failure.

In blood-pressure experiments, non-lethal doses were found to produce a remarkable slowing of the pulse, the vertical height of each pulse-curve indicating, at the same time, a great increase in the force of the ventricular contractions.

1 "The Lake Regions of Central Africa," 1860, vol. 2, p. 305.
2 "Across Africa", 1885, p. 59.
3 Fraser, "On *Strophanthus hispidus*: its Natural History, Chemistry, and Pharmacology," "Edinburgh Roy. Soc. Trans.," vol. 35, Part IV, 1890, pp. 966-67.

The action upon the circulatory, muscular and nervous systems, therefore, closely resembles of that strophanthin.

April 27.—"The Electric Organ of the Skate. Note on an Electric Centre in the Spinal Cord." By J. C. Ewart, M.D., Regius Professor of Natural History, University of Edinburgh. Communicated by Prof. Sir W. Turner, F.R.S.

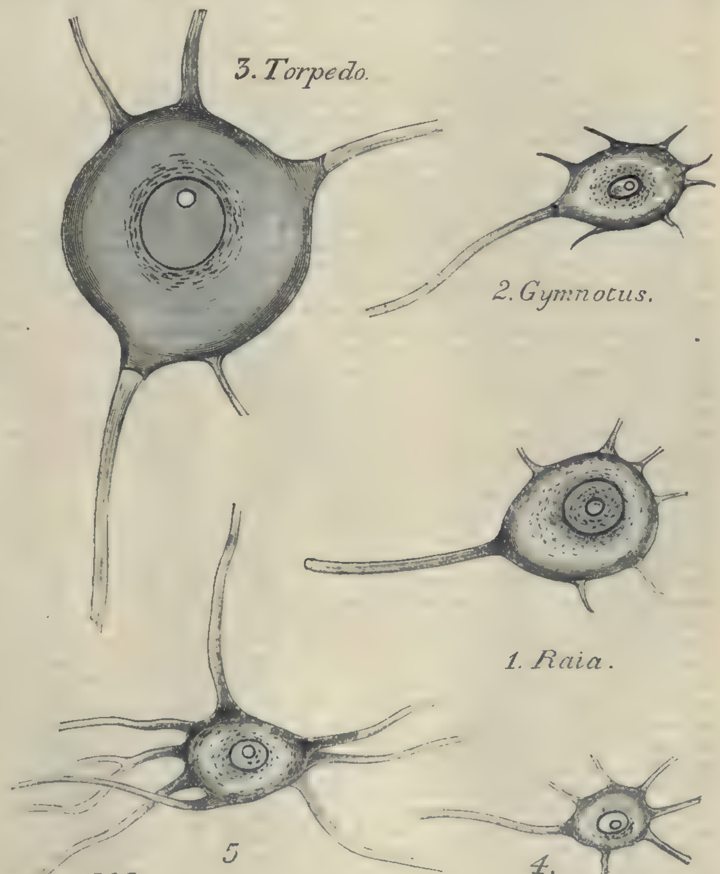
Having considered the development and structure of the electric organ of the Skate, it appeared to me desirable, by way of making my work more complete, to reinvestigate the nervous apparatus of the organ, and more especially to ascertain whether, as in *Torpedo* and *Gymnotus*, there is an electric centre. In *Torpedo* the electric organs are developed from a limited number of myotomes, and innervated by afferent fibres, belonging to a limited number of cranial nerves, which proceed from two large collections of cells—the electric lobes—situated in the region of the medulla. In *Gymnotus* the nerves for the electric organs proceed from two well-marked cellular tracts which extend along the greater length of the spinal cord, one at each side of the central canal. In the case of the Skate the question at the outset is, granting the existence of an electric centre, is it, as in *Torpedo*, situated in the brain or, as in *Gymnotus*, in the spinal cord? Sanderson and Gotch (*Journal of Physiology*, vol. x. No. 4), made out that in the Skate "a reflex centre is situated in the optic lobes," but, notwithstanding this, these lobes in the Skate in no way differ histologically from the corresponding structures in *Acanthias* and other Selachians unprovided with electrical organs.

The development of the Skate's organ from portions of the caudal myotomes, and its innervation by afferent fibres from certain caudal nerves, point to the electric centre being situated in the spinal cord rather than in the brain, and to its being, as in *Gymnotus*, on a level, and all but coextensive, with the electric organ.

Having observed, when working at the development of the electric organ, a number of large nerve-cells in the caudal portion of the spinal cord, the sections of Skate embryos made some years ago were first examined. It soon became evident that in sections from the middle of the tail on a level with the electric organ certain cells of the anterior horn of the cord were very much larger than in sections through the root of the tail, and further that in late embryos and very young Skate there was an electric centre, resembling in many respects the electric centre in *Gymnotus*.

It did not, of course, follow that the electric nerve-cells persisted into adult life. They might degenerate, and thus the supposed feebleness of the Skate's organ might be accounted for. The fact that the Skate's organ increases in size as the fish grows larger led me, however, to expect that large nerve-cells would be found in the caudal region of the spinal cord in well-grown fish. In this I was not disappointed, for, though there was at first some difficulty in demonstrating the presence of electric nerve-cells in large fish, on obtaining perfectly fresh material their position, size, and relations were easily made out, and the remarkable difference in the appearance of sections of the cord at, and in front of, the root of the tail, from sections on a level with the electric organ, was at once evident. From the observations already made, it appears that the electric centre in the Skate closely resembles, from a morphological point of view at least, the electric centre in *Gymnotus*. The electric tract is, however, much shorter in the Skate than in the Electric Eel, and the cells are relatively fewer in number. On the other hand, the cells in the Skate are larger than in *Gymnotus*, and this is true not only of *Raia batis* but also of *R. radiata*, in which the organ is extremely small and poorly developed. Nerve-cells from the electric centres of *Torpedo*, *Gymnotus*, and *Raia* are represented in the accompanying figures. Fig. 1 represents a cell from the electric centre of the Skate (a *R. batis* two feet in length); Fig. 2 a cell from the electric centre of a well-grown *Gymnotus*; and Fig. 3 a cell from the electric lobe of a large *Torpedo*. All three figures are camera drawings, and the same lenses were used in each case—objective D and ocular 2, Zeiss. It will be noted that, though the cell from the Skate is much smaller than the *Torpedo* cell, it is decidedly larger than the one from *Gymnotus*.

In sections of the Skate's cord on a level with the electric organ, small, as well as large, cells are usually visible in the anterior horn. The small cells are in connection with the fibres which supply the untransformed caudal muscles. They agree exactly with the cells in the anterior horn throughout the entire length of the spinal cord lying in front of the electric organ region. One of these unenlarged motor cells is represented in Fig. 4. It was drawn from a section of the cord (of the same fish from which Fig. 1 was taken), about six inches in front of the electric organ. It closely resembles, except in size, the electric cell (Fig. 1), and it also resembles the large motor cells of the Mammalian cord. A motor cell from the spinal cord of a Mammal, drawn to the same scale as the other cells given, is represented in Fig. 5.[1] This cell, smaller than the electric cell of the Skate (1), and still smaller than the cell from *Torpedo* (3), is about the same size as the electric cell of *Gymnotus* (2).



With the help of sections through a series of embryo Skate, for most of which I was indebted to Dr. Beard, I have been able to study the development of the cells in the Skate's electric centre. This part of the subject, together with the condition of the electric cells in large fish, will be dealt with in a subsequent communication. It may, however, be stated now: (1) That in *R. batis* embryos under 5 cm. in length none of the motor cells in the caudal region had undergone enlargement. (2) That in an embryo 5·8 cm. in length, although the muscular fibres seemed still unchanged, certain cells in the anterior horn of the caudal portion of the cord were distinctly larger than similarly-shaped cells in their vicinity. (3) That in an embryo 15·5 cm.

[1] For the use of the section from which Fig. 5 was drawn I am indebted to Sir William Turner, F.R.S.

in length, in which the electrical elements were already well developed, the electric nerve-cells were large and conspicuous, so that sections through the cord in the region of the electric organ presented quite a different appearance from sections through the root of the tail, where no change had taken place in the cells of the anterior horn.

May 4.—"On the Differential Covariants of Plane Curves, and the Operators employed in their Development." By R. F. Gwyther, M.A., Fielden Lecturer in Mathematics, Owens College, Manchester. Communicated by Prof. Horace Lamb, F.R.S.

"On the alleged Increase of Cancer." By George King, F.I.A., F.F.A., and Arthur Newsholme, M.D., M.R.C.P. Communicated by Dr. J. S. Bristowe, F.R.S.

The general result is that the supposed increase in cancer is only apparent, and is due to improvement in diagnosis and more careful certification of the causes of death.

Chemical Society, April 20th.—Dr. Armstrong, president, in the chair. The following papers were read:—A contribution to the chemistry and physiology of foliage leaves, by H. T. Brown and G. H. Morris. This paper deals with the occurrence, relations and physiological significance of the starch, diastase and sugars contained in foliage leaves. The first part relates to the starch and diastase of leaves, and the second treats of the sugars of the leaf. A bibliography of the subject is appended. The work originated in an attempt to discover the explanation of the conditioning effect of "dry-hopping;" viz., the addition of a small amount of dry hops to finished beer. This was ultimately traced to the presence in the hop strobiles of a small, but appreciable, quantity of diastase, sufficient to cause slow hydrolysis of the non-crystallisable products of starch-transformation left in the beer, and to reduce them to a condition in which they can be fermented by the yeast. The authors were then led to enquire into the first formation of starch in the chloroplasts of the foliage leaf, the mode of its dissolution and translocation in the plant and the nature of the metabolised products; the results obtained are antagonistic to the assumption made by Sachs, that all the products of assimilation at some time take the form of starch. Only a small portion of the assimilated material exists at any one time as starch. The fluctuations in the amount of starch in leaves under various conditions were also determined. Wortmann's recent denial that diastase plays any part in the dissolution and translocation of starch in leaves is incorrect; the authors prove that, instead of leaves containing little or no diastase every leaf examined by them contained sufficient diastase to transform far more starch than the leaf can have contained at any one time. The difference between the author's and Wortmann's results is chiefly due to the faulty method of examination employed by the latter. The products of the hydrolysis of starch by leaf-diastase are identical with those formed by malt-diastase, maltose having been directly separated from the leaves; leaf-diastase is not able to convert maltose into dextrose, but the leaf contains an enzyme capable of inverting cane-sugar. The amount of diastase present varies greatly in different plants, and within narrower limits even varies in the same plant at different times; it is very high in the case of the Leguminosæ. Any conditions which favour a decrease in the leaf-starch result in an increase of the leaf-diastase; thus a marked increase in diastatic activity is observed with leaves kept in darkness. Contrary to Wortmann's statement, leaf-diastase can attack the starch-granule under certain conditions; no evidence could however be obtained of the disappearance of starch in killed leaves under the influence of the contained diastase, and the authors are led to the conclusion that the *first stage* of dissolution of the starch-granule in the leaf is in some way or other bound up with the *life* of the cell. From experiments on the leaves of *Tropæolum* the authors draw the following conclusions:—Cane-sugar is the first sugar to be synthesised by the assimilatory processes. This sugar accumulates in the cell-sap of the leaf-parenchyma whilst assimilation is proceeding vigorously, and when the concentration exceeds a certain point starch commences to be elaborated by the chloroplasts at the expense of the cane-sugar. This starch forms a more stable reserve material than the cane-sugar, and is only drawn on when the latter more readily metabolised substance has been partially used up. Cane-sugar is translocated as dextrose and levulose and the starch as maltose. From the invert-sugar derived from the cane-sugar, the dextrose is more readily used up for the respiratory processes, and possibly also for the new tissue-building, than is the levulose; hence in a given time more levulose than dextrose must pass out of the leaf into the stem. The reading of this paper was followed by an interesting discussion in which the President, Mr. Thiselton Dyer, Dr. D. H. Scott, Prof. Green and Dr. Lauder Brunton took part.—The interaction of alkali cellulose and carbon disulphide: cellulose thiocarbonates, by C. F. Cross, E. J. Bevan and C. Beadle. The maximum number of hydroxyl groups in alkali cellulose appears to be four, expressing cellulose as $C_{12}H_{20}O_{10}$. By the interaction of alkali cellulose and carbon disulphide, cellulose thiocarbonates result; these products, when treated with water, swell enormously and regenerate cellulose. From a study of a large number of these thiocarbonates the authors are led to assign to them the formula $CS\begin{cases}OX\\SNa\end{cases}$, where X is the cellulose residue, a radicle of variable dimensions. The thiocarbonates yield solutions of extraordinary viscosity.—Sulphocamphylic acid, by W. H. Perkin, jun. On heating Walters' sulphocamphylic acid, a monobasic acid, $C_9H_{14}O_2$ distils; on dissolving this in sulphuric acid sulphocamphylic acid seems to be regenerated. By oxidation with permanganate the latter yields a dibasic acid, $C_{18}H_{22}O_7$, which on reduction gives another dibasic acid, $C_{18}H_{24}O_6$. The substance of the composition $C_{18}H_{22}O_7$ yields, on hydrolysis, hydroxymetaxylenecarboxylic acid (CO_2H : Me : Me : OH = 1 : 2 : 4 : 5). A number of salts and derivatives of the above substances are described.—Magnesium diphenyl, by Lothar Meyer. In reference to a recent note by Hodgkinson (NATURE, this vol., p. 22) the author states that magnesium diphenyl has been recently prepared in his laboratory; it is a voluminous powder and is spontaneously inflammable. The formation of pyridine derivatives from unsaturated acids, by S. Ruhemann. Ethyl methyldicarboxyglutaconate yields methylmalonamide and ethyl amidoethylenedicarboxylate with aqueous ammonia; with phenylhydrazine it gives ethyl methylmalonate and the ammonium compound of the pyrazolon $PhN\begin{cases}CO.C.COOEt\\ \quad\ \ \| \\NH.CH\end{cases}$. Ethyl methylglutaconate gives β-methyl-αα'-dihydroxypyridine with aqueous ammonia and β-picoline on reduction with zinc dust. Similar reactions hold in the cases of the higher homologues of these two substances. Chlorinated phenylhydrazines, Part II., by J. T. Hewitt. Orthochlorophenylhydrazine does not yield a urazole when heated with biuret; both the meta- and para-isomerides give urazoles and their hydrochlorides yield semicarbazides with potassium cyanate. A number of other compounds are described.—The oxidation of tartaric acid in presence of iron, by H. J. H. Fenton. On adding a small quantity of hydrogen peroxide to a solution of tartaric acid containing a trace of ferrous salt, a yellow colour is produced which changes to violet on adding alkali. The substance which gives the colour with ferric salts seems to be represented by the formula $C_2H_2O_3$; it is crystalline and behaves as a powerful reducing agent. The author is still engaged in its examination.—The inertness of quicklime, by V. H. Veley. The author is still making experiments on the velocity of reaction between lime in various states of hydration and sulphurous and carbonic anhydrides at different temperatures.—The products of the interaction of tin and nitric acid, by C. H. H. Walker. This investigation is a continuation of the work of Veley on the conditions of the interactions of metals and nitric acid. The whitish substance formed by the action of fairly concentrated nitric acid on tin seems to have the composition $Sn(NO_3)(OH)_3$.—Interactions of thiourea and some haloid derivatives of fatty acids, by A. E. Dixon. Thiourea reacts with dichloracetic acid, yielding thiohydantoic acid and ultimately thiohydantoïn in accordance with the following equation:—

$$2CSN_2H_4 + CHCl_2.COOH = NH : C\begin{cases}S\text{---}CH_2\\ \qquad\ \ | \\NH.CO,\ HCl\end{cases}$$
$$+ HCl + S + H_2O + CN.NH_2.$$

α-monochlor (or brom) propionic acid interacts similarly with thiourea, giving methylthiohydantoïn; on boiling this substance with hydrochloric acid it yields β-methyldioxythiazole

$$CO\begin{cases}NH.CO\\ \qquad\ | \\S\ \text{—}CHMe\end{cases}$$

Mathematical Society, May 11.—Mr. A. B. Kempe, F.R.S., president, in the chair.—The following communications were made:—On the collapse of boiler flues, by A. E. H. Love. The problem consists in discovering the conditions of a collapse of a thin cylindrical shell under external pressure, when the ends are constrained to occupy fixed positions. Since all problems of collapse depend on the geometrical possibility of finite displacements accompanied by only infinitesimal strains, it appears at the outset that unless the shell can receive a displacement of pure bending without stretching of the middle surface collapse is impossible. The assumed condition of no terminal displacement is equivalent to closing the ends of the shell, and, since a closed surface cannot be bent without stretching, this condition apparently precludes the possibility of collapse. On the other hand it is well known that, if the external pressure exceeds a certain value, an infinitely long cylindrical shell of given small thickness and given diameter will collapse under the pressure. The critical pressure has been determined by Bryan and Basset, who find the same result. It is therefore to be expected that, if the cylinder is of sufficient length, the extensional displacement which must be superposed upon the displacement of pure bending in order to satisfy the end conditions will be practically unimportant, except in the neighbourhood of the ends. The problem is thus reduced to discovering the order of magnitude of the length of the shell in order that it may be treated as infinite when the thickness is small. For this purpose consider the case where the pressure is just equal to the critical pressure, and the displacement of pure bending in the infinite cylinder is consequently of the form

$$u = 0, \quad v = \tfrac{1}{2}A \cos 2\phi, \quad w = A \sin 2\phi,$$

where A is a small arbitrary constant. The displacement u is parallel to the generator, v is along the circular section, and w along the radius outwards. By means of displacements of this form the equations of equilibrium can be satisfied, but the boundary conditions at the ends cannot. Now take the case of an infinite cylinder with an end $x = 0$, at which v and w must vanish, and seek a displacement involving both flexure and extension of the middle surface to be superposed on the displacement given by the above form, such displacement to satisfy the equations of equilibrium and the boundary conditions:—(1) that the new v and w are equal and opposite to those above given at $x = 0$; (2) that the new u, v, w vanish at $x = \infty$. The required solution can be determined and is of the form

$$u = \epsilon^{-mx} (A_1 \cos mx + B_1 \sin mx) \sin 2\phi,$$
$$v = \epsilon^{-mx} (A_2 \cos mx + B_2 \sin mx) \cos 2\phi,$$
$$w = \epsilon^{-mx} \frac{m^2 d^2}{4(2 + \sigma)} (B_2 \cos mx - A_2 \sin mx) \sin 2\phi,$$

in which B_2 and A_2 can be determined so as to satisfy the conditions at $x = 0$, σ is the Poisson's ratio of the material of the shell, and

$$m = [12(1 - \sigma^2)]^{\frac{1}{4}} / \sqrt{(dt)},$$

t is the thickness and d the diameter of the shell. If σ be taken equal to $\frac{1}{4}$ the reciprocal of m is about ·546 of the mean proportional between the thickness and the diameter, and it follows that whenever x is great compared with this quantity the influence of the end is unimportant, and the displacement approximates to one of pure bending. To make the tendency to collapse occur in practice, it would be necessary that the half length of the flue be great compared with m^{-1}, and the practical conclusion would be that for a flue of length l stability would be secured if

$$\tfrac{1}{2}l < n/m, \text{ or } l < N \sqrt{(dt)},$$

where N is a considerable number. It is customary in stationary boilers to make the flues in detached pieces connected by massive flanged joints, so that the effective length of the flue is the distance between consecutive joints. If the number N be taken equal to 12 we have the rule that the distance between the joints must be not greater than twelve times the mean proportional between the thickness and the diameter. The value $N = 12$ accords well with what has been found safe in practice, but the rule as to spacing the joints is new.—On some formulæ of Codazzi and Weingarten in relation to the application of surfaces to each other, by Prof. Cayley, F.R.S.—On the expansion of some infinite products, by Prof. L. J. Rogers.—On a theorem for bicircular quartics and for cyclides corresponding to Ivory's theorem for conics and conicoids, by Mr. A. L. Dixon. Using a form of the equation to these curves and surfaces (in quadricircular and pentaspherical co-ordinates) already studied by Darboux and Casey, the writer deduced that the ratio of the distance of any two points to the product of the lengths of the tangents from them to a fixed focal circle or sphere is the same as for the pair of corresponding points. He also showed how the theorem for the Cartesian oval could be derived from its equation in terms of elliptic functions.—A supplementary note on complex primes formed with the fifth roots of unity, by Prof. Lloyd Tanner. The author investigates a method of determining whether a complex number is prime or composite. The process takes two distinct forms, one of which was established, on different grounds, by Tchébicheff. The other appears to be new, and is convenient in testing the sets of complex integers described in the author's previous communication on the subject. The discussion is based upon a certain classification of complex integers according to the "orders" of their complexity, and this conception facilitates the direct factorization of complex numbers. The theory is restricted to the case of 5, but seems to be quite general.—On the linear transformations between two quadrics, by Mr. H. Faber. In *Crelle's Journal*, vol. v. (also Phil. Trans., 1858), Cayley gave a representation of the automorphic linear transformation of the unipartite quadric function in the notation of the theory of matrices. In the present paper the author extends Cayley's method to the determination of the general linear transformation of a given quadric into another given quadric, and applies the results to the determination of the general real linear transformation between two equivalent quadrics and to the reduction of a quadric to a sum of squares. The determination by this method of the general linear transformation between two quadrics depends upon the solution of an algebraic equation of the n^{th} degree, to which the problem as it originally presents itself—viz., the solution of a system of n^2 quadratic equations in n^2 variables, is thus reducible.—On maps and the problem of four colours, by Prince C. de Polignac.—On Fermat's proof of the problem that primes of the form $4n + 1$ can be expressed as the sum of two squares, by Mr. S. Roberts, F.R.S.

Entomological Society, May 10, Mr. Henry John Elwes, President in the chair.—Mr. R. McLachlan, F.R.S., exhibited for Dr. Fritz-Müller, of Blumenau, Santa Catarina, Brazil, specimens of larvæ and pupæ of a dipterous insect, and read a letter from Dr. Fritz-Müller on the subject. The writer stated that the larvæ were similar to those exhibited by Mr. Gahan, at a meeting of the society in October, 1890, and which were then thought by Lord Walsingham, F.R.S., and Mr. McLachlan, to be allied to the Myriapoda.—Mr. S. G. C. Russell exhibited specimens of *Hesperia alveolus*, including one of the variety *Taras*, taken by him at Woking in April last.—Mr. J. M. Adye exhibited a long series of *Moma orion*, *Eurymene dolobraria*, *Amphidasis betularia*, *Cloephora prasinana*, and a few specimens of *Notodonta dodonea*, *N. chaonia*, and *N. trepida*, *Acronycta alni*, and *Selenia illustraria*, all bred by him in March and April last, from larvæ obtained in the autumn of 1892 in the New Forest.—Mr. H. Goss read a copy of a letter received by the Marquis of Ripon, at the Colonial Office, from the Governor of the Gold Coast, reporting the occurrence of vast swarms of locusts at Aburi and Accra, West Africa, about the middle of February last. The writer stated that at Accra the swarm extended from east to west as far as the eye could see, and appeared to occupy a space about two miles wide and from a quarter of a mile to a mile in height.—Colonel Swinhoe stated that some years ago he had been requested by the Indian Government to report on plagues of locusts. He said he had witnessed swarms of these insects far larger than the one just reported from the Gold Coast, and mentioned that many years ago, when going up the Red Sea in one of the old P. and O. paddle boats, the boat had frequently to stop to clear her paddle-wheels from locusts, which had settled in such swarms as to choke the wheels and stop their action.—Mr. E. C. Reed, of Valparaiso, Chili, communicated a paper entitled "Notes on *Acridium paranense*, the migratory locust of the Argentine Republic." Colonel Swinhoe, Mr. Champion, Mr. Elwes, Mr. McLachlan, and Mr. Merrifield took part in the discussion which ensued.—Prof. L. C. Miall, F.R.S., communicated a paper entitled "Dicranota; a Carnivorous Tipulid Larva."—Dr. T. A. Chapman communicated a paper entitled "On a Lepidopterous pupa (*Micropteryx purpurella*) with functionally active mandibles." Mr. McLachlan said he thought Dr. Chapman's observations were of great value, and tended to show that the position of *Micropteryx* was nearer the Trichoptera than had been supposed.—The President announced that the new Library Catalogue, which had been edited by Mr. Champion, with the assistance of Mr. McLachlan and Dr. Sharp, F.R.S., was now ready.

PARIS.

Academy of Sciences, May 15.—M. Lœwy in the chair.—On the quantitative determination of boron, by M. Henri Moissan. The determination is based upon Gooch's methyl alcohol method, in which several improvements were introduced. The boron is first obtained in the state of boracic acid by treating with nitric acid in a sealed tube. The boracic acid is separated by means of pure methyl alcohol. The reaction takes place in a bulb tube provided with a funnel which reaches down into the bulb and can be closed by a cock. Four distillations with alcohol are carried out, the vapours passing through a coil of glass tubing into a Bohemian glass flask. Any uncondensed vapour is absorbed by ammonia solution. The liquid collected is poured upon a known weight of pure slaked lime, forming calcium borate. The latter is calcined and weighed, and the increase of weight gives the amount of boric anhydride absorbed. To test whether the boron has all distilled over, a drop of the distilling liquid is caught on a strip of paper and placed in a flame, when a green colour will indicate any trace of boron. The slaked lime is kept, when not in use, in the form of a stable basic nitrate, which is made ready for use by a strong calcination. The quantity of lime should be 16 to 20 times the probable quantity of boracic acid. The process, though still somewhat laborious, has given very consistent results.—The working of the soil and nitrification, by M. P. P. Déhérain.—Re-appearance of certain latent affections (etiology and pathogeny), by M. P. Verneuil.—Results obtained with mixtures of butters and diverse fatty materials by means of the new method for the recognition of adulteration of butter, by M. Auguste Houzeau.—On the terms of the second order resulting from the combination of aberration and refraction, by M. Folie.—On the observation of the total eclipse of the sun of 16th April, made at Fundium (Senegal), by M. H. Deslandres.—The solar eclipse of 16th April, 1893, at the Vatican observatory, by P. F. Denza.—On a class of systems of ordinary differential equations, by M. Vessiot.—On the generalisation of the analytical functions, by M. G. Scheffers.—On the cases of integrability of the motion of a point in a plane, by M. Elliott.—On the general law and the formulæ of the flow of saturated water vapour, by M. H. Parenty.—On the dimensions of absolute temperature, by M. H. Abraham.—On a new kind of manometer, by M. Villard.—On the inversion of Peltier's phenomenon between two electrolytes beyond the neutral point, by M. Henri Bagard.—Study of the cadmium and sal-ammoniæ cell, by M. A. Ditte.—Influence of the temperature of tempering upon the mechanical properties and the structure of brass, by M. G. Charpy.—On malic acid substitutions, by M. Ph. A. Guye.—Action of chloride of zinc upon chlorocamphor, by M. A. Etard.—On a certain number of organo-metallic combinations belonging to the aromatic series, by M. G. Perrier.—Inulasis and indirect alcoholic fermentation of inuline, by M. Em. Bourquelot.—Chemical phenomena of assimilation of carbonic acid by chlorophyll-bearing plants, by M. A. Bach.—On the meteoric iron of Augustinowka (Russia), by M. Stanislas Meunier.—Influence of the medium on respiration in the frog, by M. A. Dissard.—Action of oxygen and compressed air upon warm-blooded animals, by M. G. Phillippon.—On the ophthalmic nerves of *Spondylus Gœderopus*, by M. Joannes Chatin.—On the parthogenetic fragmentation of the ovules of mammifers during atresia of the Graafian follicles, by M. L. F. Henneguy.

AMSTERDAM.

Royal Academy of Sciences, April 28.—Prof. van de Sande Bakhuyzen in the chair.—Mr. Kamerlingh Onnes exhibited isogonic charts for 1540, 1580, 1610, 1640, 1665, and 1680, drawn by Dr. van Bemmelen according to observations discovered by him in old, especially Dutch books, in the manuscripts of van Swinden and in old Dutch ship-journals.—Mr. Franchimont treated of hydrocyanic acid in plants. A short time ago Mr. van Romburgh found hydrocyanic acid, probably as an unstable compound with acetone (and perhaps with glycose), in the caoutchouc-yielding plants *Manihot glaziovii*, Müll. Arg., *Hevea brasiliensis*, Müll. Arg., and *Hevea spruceana*. Now Mr. van Romburgh has examined Indigofera's, and found that the leaves of the *Indigofera galegoides* D.C. (*Tarvem octan*), which do not produce indigo, and have no particular smell, yield a considerable quantity of hydrocyanic acid and of benzaldehyde by being weakened in water for two hours. By new researches Mr. van Romburgh will try to find out if this Indigofera contains amygdaline or laurocerasine, and whether the enzyme, to which the decomposition is due, is identical or not with emulsine. This seems to be the first time that hydrocyanic acid has been found in a plant belonging to the family of the Papilionaceæ.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Catalogue of the Library of the Entomological Society of London, edited by G. C. Champion (London).—Evolution and Religion: A. J. Dadson (Sonnenschein).—Zoology of the Invertebrata: A. E. Shipley (Black).—Archæological Survey of Egypt; Beni Hasan. Part 1: P. E. Newberry (K. Paul).—Some Further Recollections of a Happy Life (Macmillan).—Helps to the Study of the Bible (Oxford University Press).—A History of Crustacea: Rev. T. R. R. Stebbing (K. Paul).

PAMPHLETS.—Manchester Museum, Owens College Museum Handbooks, Outline Classification of the Animal Kingdom, 2nd edition (Manchester, Cornish).—Outline Classification of the Vegetable Kingdom (Manchester, Cornish).—Catalogue of the Type Fossils: H. Bolton (Manchester, Cornish).—The Romanes Lecture. 1893—Evolution and Ethics: T. H. Huxley (Macmillan).—Syllabus of Elementary Course of Botany: J. B. Philip (Aberdeen, Bisset).

SERIALS.—Dictionary of Political Economy, Part 5 (Macmillan).—Astronomy and Astro-Physics, May (Northfield).—Journal of the College of Science, Imperial University, Japan, vol. 6, Part 1 (Tōkyō).—American Journal of Mathematics, vol. xv. No. 2 (Baltimore).—Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie, Siebzehnter Band. 1.u. 2 Heft (Williams and Norgate).

CONTENTS.

THURSDAY, JUNE 1, 1893.

MODERN METEOROLOGY

Modern Meteorology: an Outline of the Growth and Present Condition of Some of its Phases. By Frank Waldo, Ph.D., Member of the German and Austrian Meteorological Societies, late Junior Professor, Signal Service, U.S.A. (London: Walter Scott, 1893.)

IF it be true that the condition of the weather forms a general and engrossing topic for conversation among Englishmen, books which treat of meteorology should attract the attention of many readers in this country, and Dr. Waldo be assured of many students. But in this particular work the author has not dwelt upon the more popular side of the subject, he has not exhibited the capacity for making weather forecasts, or discussed the success which has attended such predictions, or the future that lies before work of that description. He has had in view rather that smaller class of readers, with whom meteorology means something real and hopeful, and who by accurate and patient work are earnestly striving to make it rank among the exact sciences. Considering the very substantial progress that meteorology has made, the opinion is shared by many, possibly by the author of this work, that the day has already come when this science is entitled to rank among the older and more systematised branches of scientific inquiry. This is entirely to misconceive the situation. Just as incorrect and unfair would it be, to see in the widely scattered and ardent meteorological observers, a class, whose power and knowledge are limited to the acquisition of the readings of barometers and thermometers, Meteorology may not yet have produced its Kepler. certainly not its Newton, but working hypotheses, founded on rigorous dynamical principles are everywhere being tested, amended, harmonised with observed facts, showing that the days of simple accumulation of observations are giving place to a new and more hopeful era. It is with the earnest hope of encouraging and instructing this army of observers, that Dr. Waldo in this little book endeavours to place before them the most recent results, which the pioneers of meteorology are seeking to establish with a fair prospect of success.

Dr. Waldo explains that he is mainly a student of what may be termed the German school of meteorology, a fact which may be expected to colour his work very materially. Practically it has its advantages and disadvantages. The views supported by that school are set forth at very considerable length, and since the ordinary English reader may not have had the same opportunities for making himself acquainted with the original memoirs that Dr. Waldo has enjoyed, it is a great advantage to be introduced to the special teaching of von Bezold, or of Oberbeck, or von Helmholtz, by one who has graduated in that school with no mean honours. On the other hand it is curious to the English reader, to find names which are as familiar to him as household words, authorities which he is accustomed to hold in the highest respect, passed over with the briefest mention and apparently as undeserving of consideration. This is a disadvantage both to the author and reader. The author admits the drawback and apologises for omissions to French and English authorities, while in the student it is liable to produce a sense of disproportion and exaggeration, and even of unfairness to his own countrymen. But with this exception, understood and allowed for, this book is a valuable contribution to the literature of the subject.

In an introductory chapter, which might have been extended with advantage, the author gives a rapid but admirable sketch of the various sources whence the recent history of meteorology may be gathered. These sources include not only distinct treatises and the periodical literature, but the work accomplished and recorded at the various congresses that have been held from time to time. This latter portion is treated in a very sketchy manner, and might have been much enlarged, lest the importance of such gatherings and the international benefits to be derived therefrom should be overlooked.

The second chapter, which is practically a book of nearly two hundred pages, will certainly not be considered the least satisfactory part of the volume. Here is given the history and description of the more important of the meteorological instruments, with their methods of use, and given too, at great length, because the author asserts that there is no work in English which gives an adequate description of such instruments. Without endorsing this somewhat sweeping assertion, there can be no doubt but that this chapter is eminently worthy the attention of those for whom in a great measure the book is intended—the teachers of physical geography and elementary physics. The author is as a rule fortunate both in what he inserts and in what he omits in his descriptions. His remarks on normal barometers are especially valuable and will be much appreciated. Dr. Waldo is particularly qualified to speak on questions touching the construction of these instruments, for we believe he was engaged in comparing the accuracy of the various standard barometers in use in the principal observatories in Europe.

In the section on wind-measuring apparatus, is well illustrated that feature to which attention has been called, the small regard paid to English experiments in meteorological inquiries. We place very considerable confidence, in this country at least, in the researches of Mr. Dines, and are disposed to consider him as an authority on the proper constant to be employed in the reduction of the indications of Robinson's anemometer. It is true these researches are not altogether ignored, but they are dismissed in a couple of lines, which though they may give fairly accurately one of the principal results of his work do not in any adequate degree express the value of his inquiry, and this omission, if such it can be called, contrasts very remarkably with the enormous space which is given a little further on to the description of the instruments and the record of the hourly and momentary occupation of the staff at the Pawlowsk observatory. We have no wish to disparage this, possibly, first of meteorological observatories. We believe all that experience can suggest and devotion effect to secure accuracy and well directed observation is done here. It may well be that Pawlowsk presents us with an ideal meteorological observatory, supported with magnificence and directed with equal energy and ability. But the scale of magnificence depicted is more likely to breed a spirit of discontent in those who do excellent work with smaller means, than furnish a scheme on which they can conduct their more modest establishments. We are the more disposed to quarrel with the author for the space devoted to this long and tedious description because we feel that useful matter which Dr. Waldo could so ably have contributed has been crowded out. Under the title "Apparatus and Methods" we could have hoped space would have been found for "Methods of Reduction." Dr. Waldo admits not only that the ordinary observer is at times at a loss for reliable guidance in the reduction and discussion of a particular series of observation, but that the specialist in other inquiries into which meteorology enters or may enter cannot find the observations put into a form ready for use. Possibly the author feels that the subject of reduction is sufficiently large to demand a treatise to itself, but nevertheless many a meteorologist who has carefully tabulated his readings, for years it may be, would turn to a book expressly addressed to himself in the hope of finding some hints, which would enable him to extract something useful from his observations or at least to reduce them on systematic and uniform lines.

Having dismissed the subject of instruments and observatories, the author proceeds to discuss the Thermodynamics and general motions of the atmosphere, and these two chapters, upon which has evidently been lavished an immense amount of care, sustain the interest of the book and carry us a long way into a very difficult subject. It cannot be said that these chapters are light reading. The author has attempted a difficult, it may be an impossible task, for he virtually proposes to give the results of mathematical analysis without the use of mathematical symbols. Such forms of descriptive writing are seldom a success for any class of readers and it is scarcely too much to say that any one who can follow the successive steps of the argument, put forward by the various authorities here quoted, would find his work easier if the author had not dispensed with the assistance of ordinary symbols. But any one who struggles successfully with the difficulties of these chapters will find himself put in possession of the latest views of the exponents, of what the author has called the German School of Meteorology, though at the head of it we should place Prof. Ferrel with his high American reputation.

Of the views of the various authorities here set out, we think Prof. Ferrel fares the best, as being most clearly expressed and in the completest detail, but in this instance Dr. Waldo was assisted by the fact that Prof. Ferrel has himself translated his book on "Recent Advances in Meteorology," published under the auspices of the United States Government in 1885, into a popular treatise on "The Winds." We are thus enabled to have in this section and particularly in the following one on the "Secondary Motions of the Atmosphere," copious extracts from Prof. Ferrel's book in his own words, and this is extremely fortunate, for Ferrel's views have altered not a little since he first submitted them to public consideration, and it is a little difficult to be certain that we have the last words of this distinguished meteorologist. For the remainder, it would be a great advantage to the reader if the various views quoted from the original authorities were not left so disconnected, but the points of harmony and divergence brought into stronger relief. The author is too content to stand in the background and allow the various authorities to put forward their views without sufficiently accentuating their strong points. Indeed, it would seem at times as though the several points of divergence were not fully appreciated. We may illustrate this peculiarity by an instance which also shows the indifference of the author to English authorities on the theoretical side, a peculiarity to which we have already called attention in practical work. In the historical account of Ferrel's work is mentioned (p. 275) the fact that Prof. James Thomson published a paper in the Proceedings of the British Association, 1857, "expressing somewhat of the same dissatisfaction with current theories that Ferrel had printed in 1856, and the line of reasoning as regards a new theory was much of the same nature, but not so complete as Ferrel's. This paper is now chiefly valuable historically." Then follows a defence of the late Prof. Thomson against a possible charge of plagiarism. We doubt whether this defence will be appreciated, for in 1857 the views of the Glasgow Professor differed widely from those held by Prof. Ferrel. That they have gradually approached since, is due rather to the fact that Ferrel has modified his views as originally held. The distinguishing feature, or at least one distinguishing feature, in the theory of the latter, a theory which Prof Thomson had characterised as pervaded by impossibilities and incongruities, is the assertion that there must be a heaping up of the top layers of the atmosphere to a maximum height at about the parallel of 28°, and a depression of them not only over the Equator but around the Poles and in high latitudes generally. He would thus produce six zonal vortex rings of circulation, three in the Northern and three in the Southern Hemisphere. Prof. Thomson's theory was a modification of the older theory of Hadley, recognising and emphasising the conditions to which a thin stratum of air would be submitted under the effects of friction and impingement at the earth's surface. As the final outcome of his theory, Prof. Thomson concluded that in temperate latitudes, there are three currents at different heights :—"That the uppermost moves towards the Pole and is part of a grand primary circulation between equatorial and polar regions; that the lowermost moves towards the Pole, but is only a thin stratum forming part of a secondary circulation; that the middle current moves from the Pole and constitutes the return current for both the preceding, and that all these three currents have a prevailing motion from west to east in advance of the earth."[1] Those who have followed the development of Prof. Ferrel's ideas will find and will admit, that his later theory, published in 1860 bears a far greater likeness to that published by Prof. Thomson in 1857, than it does to his own earlier efforts in 1856. If there be any plagiarism, and it is not at all necessary that there should be, since the change of view could be amply explained by the gradual growth and improvement of Ferrel's views in the interval, it can scarcely affect the reputation of the English meteorologist.

But the value of the book is not to be measured by

[1] Phil. Trans. vol. 1893 A. p. 675.

the appreciation the author may have of English work. That it would have been better written if his reading had been wider or his acquaintance with the English literature of the subject more thorough, Dr. Waldo would himself admit. The object of the book is distinctly to make known in English reading circles what has been effected on the Continent by the studies of Von Bezold, Siemens and others, and this object is well executed. The exhibition of the views of these masters in lucid terms, and with a few exceptions the author makes his meaning very clear, is more than a sufficient reason for the appearance of the book, which will be welcomed by many students, who are thus put in easy possession of much abstruse work, which possibly embodies the more or less crudely shaped views that they themselves have held, but have been unable adequately to express.

WILLIAM E. PLUMMER.

THE TRANSMISSION OF TELEPHONE CURRENTS.

Telephone Lines and their Properties. By William J. Hopkins. (London: Longmans, Green and Co.)

IN this book the author has attempted the difficult task of instructing both the student and the practical man, and the result is, on the whole, more successful than is usually the case. The first half of the book is a text-book of the modern practice of telephone lines in America, and contains a large amount of good and interesting information on overhead and underground lines, poles, insulators, wires, conduits, cables, exchanges, and switchboards. This covers too wide a field to be useful to a telephone engineer, as each subject is necessarily treated in a cursory manner, but to an English reader it is very interesting, if he knows enough of his own practice to note and appreciate the points of difference. Some of these indeed will make the general public thankful for the restrictions under which telephone men labour over here, and one of the illustrations—a street telephone pole, about 100 feet high, with eighteen heavy wooden cross-arms—is a testimonial to the patience of American people. One or two of the explanations of facts outside strictly electrical information require revision; for instance, the coating formed on copper wire exposed to damp air is the hydrated carbonate of copper, and not the chloride, as stated by the author. Also the dictum on cables for underground circuits is somewhat curious, indiarubber insulation being condemned as not impervious to moisture, and liable to soften by heating, thereby allowing the wire to sink through the insulation. Considering that in another part of the book a current of ten milliamperes is given as a maximum for telephone work, it is difficult to see how any appreciable heating is to take place, as the current density is such as would rejoice the heart of Mr. Heaphy. Again, the accusation that indiarubber will not exclude moisture for a longer time than anything else, makes one wonder what they make it of in America. But after all these may be differences of opinion, and in general the information is unusually accurate. and is very clearly expressed. The only exception to this is in the chapter on switchboards, where the frequent use of technical terms is likely to give some difficulty to a student who is ignorant of practice. The addition of inverted commas to a technical expression is small assistance, where no explanation of its meaning is volunteered.

The second half of the book rises above the text-book standard, and gives a very good account of recent work on the bearing of the capacity and inductance of a circuit on its transmitting power, and the effect of the configuration of itself and neighbouring wires, on its freedom from cross-talk and external influences. The paper of Mr. J. J. Carty, of New York, on the effects of electrostatic induction from neighbouring wires is largely quoted from and discussed, and his theory of the phenomena energetically advocated. A large number of experiments are described in a very clear manner, and the deductions seem mostly incontestable. But the law connecting length of wires that run parallel with each other with the amount of cross-talk produced seems incorrect. It is founded on only one series of experiments, and is given as $C=k\sqrt{l}$ where C is the induced current and l is the length of parallel line. It should surely be of the form $C=kl/(R+r)$ where R and r are the impedance of the receiving instruments, and of the whole length of line respectively.

The experiments very ingeniously show that by electrostatic induction the charged wire will induce a charge in the neighbouring wires, and a series of such induced charges in opposite directions make an alternating current similar to the primary current. The comparatively high potential of a telephone wire and the extremely small current render this explanation the only possible one, and the absence of electro-magnetic induction even from a much larger current is shown by simple experiments. After this the method of shielding the line by symmetrical arrangement, or by stranding or transposition of the wires is clearly explained, as the induced current causing cross-talk is reversed in direction at every turn, so that only the last section will affect the receiving instruments. After considering air lines, the author gives a careful investigation of the construction of cables, with the effects of large capacity and the methods of reducing it. Cross-talk is also considered, and designs for non-inductive cables suggested. The unequal efficiency of composite lines from the two ends is mentioned with unnecessary hesitation as to the reality of the fact, and no definite explanation is offered. It is found best to have the larger capacity at the sending end, probably because there is a considerable loss of electricity in transmission, and hence a smaller current over the larger half of the line, whereas in the reverse direction a large current has to be transmitted over a great distance, only to be, to a great extent, absorbed in the capacious cable.

The chapter on external influences is written with impartiality and completeness, and contains an account of some curious observations on the effect of tramways and electric lighting wires. Some good advice is given on the methods of avoiding disturbance, the double metallic circuit being recognized as the only completely satisfactory way out of the difficulty. An account of one instance of disturbance is sufficiently alarming, that a small arc lamp was maintained in a telephone circuit during a magnetic storm! If this source were only more regular, it might be another solution of what to do when the coal gives out. An elaborate investigation of the action of electric light circuits ends in a set of rules and restrictions for the electric light engineer so stringent and complicated that it would effectually check all disturbances by frightening off a contractor altogether, and a three-wire system would be rendered impossible. However the author recognises that the best remedy lies in the telephone engineer's own hands.

The book concludes with a reprint of a paper by Mr. J. J. Carthy on Inductive Disturbances in Telephone Circuits.

The general style of the book is good and intelligible, and the diagrams clear and new, the old familiar text-book pictures being rigidly excluded. The arrangement into chapters and headings is carefully done, though in the endeavour to make each one complete some repetition is unavoidable. The reason of the omission of an index at the end is hard to understand, as its use in a book intended to be kept is undoubted, and the insertion of the title of the book on every page instead of that of the chapter does not mend matters. As the author states, the mathematical processes have been mostly omitted, or inserted as footnotes. But the few that are found in the latter place might just as well have been left out. For instance, to quote Lord Kelvin's somewhat complicated formula for the current density at any point in a conductor is not so useful as a reference to his original paper would have been, and the formula is not used to obtain any result. Immediately after this follows a remarkable *proof* that $dN/dt = E$. The use of the term "volume" for "current" is needlessly unscientific, but in general the terminology is accurate and consistent. That comprehensive but dangerous word, "retardation" is used with careful explanation of the component parts of its cause, though in one or two places it is loosely employed for "inductance," or "capacity," with consequent inaccuracy.

To sum up, it will be found a useful and very readable book, giving information not otherwise easily obtainable, and both practical men and students will find it repay careful reading.

FRANCIS G. BAILY.

MODERN PURE GEOMETRY.

An Elementary Treatise on Modern Pure Geometry. By R. Lachlan, M.A. (Macmillan, 1893.)

BY a recent regulation for the Cambridge Mathematical Tripos provision is made for the introduction of a paper on "Pure Geometry": this to include, in addition to Euclid, the simple properties of lines and circles, the elementary properties of conic sections treated geometrically, for which a place has already been found, such questions as may be treated by inversion, reciprocation, and by harmonics. It has been for some time a reproach that pure geometry has not occupied a more prominent position in the University curriculum. The University has never lacked able geometers, and amongst the present generation our author has won for himself a good name. He has put together an excellent manual complete enough to meet present wants, and doubtless in subsequent editions he will bring the present work even more up to date than it is. Some of our best text-books are overloaded with corollaries and much other matter which it is difficult for the student to retain clearly in his mind. Mr. Lachlan appears to us to have steered a most judicious course, and avoided overloading his book in this way. Mr. Pinto (in "Lothair") speaking of the limited range of the English language (which, however, he admitted to be expressive), said it consists of four words. If this be so, the word we should select to characterise Mr. Lachlan's essay is that it is "charming." It treats of the subject in sixteen chapters, in which, after devoting the first three to an introduction, measurement of geometrical magnitudes and fundamental metrical propositions, he starts from harmonic ranges and pencils, and carries the student at once to the theory of involution. He then discusses properties of the triangle (giving an account here of the recent additions to this branch of the subject, from which we infer that it has at length got a footing in the University) and of rectilinear figures. The reader then has laid before him a clear account of the theories of perspective, of similar figures (previously introduced to English readers in Casey's "Sequel"), and of reciprocation. The properties of the circle are discussed under the heads of the circle as a figure by itself, and then in relation to one or more circles. In this division of the subject our author gives account of his own discoveries and of the many interesting additions contributed by Mr A. Larmor. In two remaining chapters the theories of inversion and of cross ratio are unfolded. The treatment in the text is strictly confined to the line and circle. We believe that a further volume extending the methods herein employed to the conic sections is in course of preparation. A few slips have caught our eye, viz. p. 53, ex. 4; § 97 ex.; p. 55, ex. 7; § 116; § 262; § 268, and one or two other easily corrected mistakes. In such a mass of mathematical work there may well be others. References are given to the sources whence many of the questions are taken. We note that an oversight, which we have had occasion to point out twice before in NATURE in reviewing the late Dr. Casey's "Sequel," is perpetuated here. On pp. 68, 71, a question is cited from a "Trin. Coll., 1889" paper, whereas it was given many years previously in the *Educational Times* (Feb., 1865, and April), and was then by a correspondent carried back to Steiner (Crelle, vol. liii.). Th e figures illustrate the text very clearly, and there is a full index at the end.

OUR BOOK SHELF.

An Analytical Index to the Works of the late John Gould, F.R.S. By R. Bowdler Sharpe, LL.D. With a Biographical Memoir and Portrait. (London: Henry Sotheran and Co., 1893).

THE compiler of the present work mentions in the preface that the need for it was originally suggested in the course of a discussion between Lord Wharncliffe and Lord Walsingham as to some ornithological question. They decided to refer to one of Gould's plates, but could not readily find the volume in which the figure was given. It occurred to both of them that "such a difficulty would not arise if there existed a complete 'Index' to all the folio works issued by Gould," and Lord Wharncliffe asked Mr. Bowdler Sharpe whether he would undertake the preparation of the kind of volume that was wanted. As Messrs. Sotheran were willing to publish an "Index," Mr. Sharpe set about the task, hoping to be able to accomplish it within a reasonably short period. As a matter of fact, he says, the enterprise "has taken me as many years to finish as I expected it would have taken months." The "Index" does not relate to all the papers published by Gould in various journals, but it does include every work which he issued separately, whether in folio, or octavo, or quarto form; and Mr. Sharpe, with the aid of his assistant at the Natural History Museum, has been careful to check the various references, the number of which is nearly seventeen thousand. He has also put in some "extra synonyms from popular works, such, for instance, as Oates's 'Birds of British India,' which in a few years will have familiarised Indian naturalists and sportsmen with a certain set of names which do not occur in Gould's works, though the species may be duly figured therein." The work, which is very handsomely "got up," will be of great value to all who are fortunate enough to possess Gould's writings, and it will frequently be of good service to every serious student of ornithology. In the biographical memoir Mr. Sharpe not only presents the leading facts of Gould's career, but has much that is fresh and interesting to say about the results of his scientific labours and about the essential qualities of his character.

An Elementary Treatise on Pure Geometry, with numerous examples. By J. W. Russell. (Oxford: Clarendon Press, 1893.)

THE opening sentence of the Preface—"The author has attempted to bring together all the well-known theorems and examples connected with Harmonics, Anharmonics, Involution, Projection (including Homology), and Reciprocation"—indicates that the writer has given himself a "tall order." Within the limits of 323 pages we have here collected every possible property that a student can desire to have. Our only objection to the book is that it is too full for ordinary purposes, but as the matter is put together with considerable skill and ability—thus evidencing the writer's familiarity with, and mastery over, his subject—and illustrated with a choice collection of worked-out exercises, we cordially commend it. We could wish that a handbook for school use were founded upon it. There used to be a rumour abroad that the late Prof. Henry Smith intended to publish his Geometrical Lectures. That hope is now, we presume, frustrated, but as Mr. Russell's first lessons in Pure Geometry were learnt from Mr. Smith's lectures, and as many of the proofs of the present work are derived from the same source, we must possibly take it as the substitute for the "Geometrical Lectures." The get-up of the text is on the usual lines of the Clarendon Press and is all that one could desire.

Sun, Moon, and Stars: Astronomy for Beginners. By A. Gilberne. (Seeley and Co., Limited).

THIS small book comprises 300 pages of matter, and contains a most interesting account of the various members of the solar system and other celestial objects more remote. The narrative is particularly adapted to a large class of people who desire to know somewhat of the wonders and awe-inspiring phenomena connected with the science of astronomy without making a special study of them; yet sufficient interest is aroused to induce a beginner to search for more information. The work, however, does not claim to be a text book, although to a beginner it will serve as a capital starting-point. It is printed in open and pleasing type, and contains instructive illustrations. A few passages might be somewhat improved upon, as for example, p. 143—

"It is said that a cannon-ball, reposing on the sun, if lifted one inch and allowed to fall, would dash against the ground with a speed three times greater than that of our fastest express-trains."

LETTERS TO THE EDITOR.

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

Mr. H. O. Forbes's Discoveries in the Chatham Islands.

UNWILLING as I am to interpose in the discussion between Mr. Wallace and Mr. Forbes (*supra* pp. 27, 74), yet each of those gentlemen having referred to opinions formerly expressed by my brother and myself, it seems fitting that I should offer a few words on the present occasion, if it were only to avoid misapprehension; but I would premise that I have not seen Mr. Forbes's paper read before the Geographical Society or his article in the *Fortnightly Review*. To this I would add that I am no more ashamed of opinions in the utterance of which before the Royal Society in 1868 I took a share, than I am of having then been a quarter of a century younger than I am now. Whether they are to be considered modified by what I published some halfdozen years later, when I next touched upon the subject, I do not greatly care, and leave to the judgment of those (if any there be) who may take the trouble of comparing the passage in the *Philosophical Transactions* (1869, pp. 357, 358) with that in the "Encyclopædia Britannica" (ed. 9, iii. p. 760); and what I now think, or at least thought some eighteen months ago, when the last thing I wrote on the question was passed for press, will I hope be before the public in October.

However I would point out that one thing seems needed to make this discussion real, and that is proof of the assertion, made in NATURE—at first tentatively (xlv. p. 416), then positively (*tom. sit.*, p. 580), and again with fuller details (xlvi. p. 252), that *Aphanapteryx* ever inhabited the Chatham Islands. Mr. Forbes has been so kind as to show me on two occasions the bones which he ascribed to a species of that genus, and I was fortunately able to let him compare them with those of the real *Aphanapteryx* in the Museum of this University, being all that have as yet been recovered from Mauritius. I pointed out to him differences between the remains of the two forms which appeared to me of generic value, and I thought I had satisfied him on this score, since he did me the honour of asking me to suggest a new name for the form which he had discovered. In that view I was confirmed by finding that, shortly after his last visit to Cambridge, he described the Chatham-Islands bird as *Diaphorapteryx* at a meeting of the British Ornithologists' Club on 21 December, 1892, as I learn from its printed *Bulletin* (No. IV. p. xxi.). All this would matter little to any but specialists did it not seem that what Mr. Wallace rightly terms a "tremendous hypothesis" is based on the asserted existence of *Aphanapteryx* in the Chatham Islands, and I understand that, on the strength of the assertion, further daring speculations have been indulged in, to support which Purple Waterhens, extinct or expiring Starlings, and what beside I know not, have been dragged in. Whether the additional evidence is worth anything remains to be seen; but though I fully recognise the importance of Mr. Forbes's discoveries, rightly interpreted, we are as yet without proof that *Aphanapteryx* inhabited any part of the New Zealand Region; and if it did not, then as regards the speculations based upon it *cadit quæstio*.

ALFRED NEWTON.

Magdalene College, Cambridge, 27 May.

The Fundamental Axioms of Dynamics.

REFERRING to my previous article in NATURE on the above subject (May 18, vol. xlviii. p. 62), there are a few explanatory remarks which may be usefully made,—most of them suggested by the recent discussion at the Physical Society, especially as summarised by the President (Prof. Rücker).

There seems to be some feeling against the advisability of ascending successive steps in a ladder of reasoning unless there be already some perception as to what is to be met with on the top. If the ladder shows signs of ending in a medium of unknown and in some respects paradoxical properties, that fact appears to be felt as an inducement to mistrust the steps which lead thither.

But it must surely be admitted that if each rung is in itself firm and strong, and if successive rungs follow one another with a reasonable amount of sequence, then we ought fearlessly to mount and abandon ourselves whithersoever they lead, quite irrespective of dim suspicions about unacceptable consequences.

Some doubt seems also felt concerning the wisdom of attempting to pack important laws into small compass; but to this I plead that the axioms already stated by me are most of them purely Newtonian, and that for the attempt thus to summarise science in as few and simple statements as possible we have the high encouragement of his example. It is true that Newton issued his axioms in a form as perfect as it was reasonable or possible then to make them, and did not bring them out as matter for discussion. But to this two pleadings may be put in:—

(1) That their perfect form did not by any means *prevent* discussion, nor would it have been desirable if it had; it only made the inevitable discussion painful to him instead of pleasant.

(2) That in his day he was minting fresh coins, complete in design and workmanship, for the use of a race which possessed nothing of the kind; whereas now one is partly trying to rub off a little tarnish and furbish up old currency in more modern style, and partly trying to put into circulation a few fresh coins at a time when everybody feels that they have quite as much money as they want.

The step in advance which I believe has now to be made is the explicit introduction of the Ether into the scheme of physics. Newton knew well enough that a connecting medium was a philosophic necessity, but he did not see his way to asserting its physical existence and discovering its properties. Consequently his philosophy was all stated in terms of action at a distance.

But science has progressed since then, and the ether has become accessible in many then undreamed-of ways. It appears to me, therefore, that the time has come for enlarging the Newtonian axioms, on the basis of the labours of Faraday and Maxwell and of other men now living, and for fearlessly following up any consequences to which the new axioms may lead us.

My philosophic creed runs somewhat thus:—First that by our senses we become aware of *motion;* I don't much care by what sense it is, it seems to me by the muscular sense—partly eye muscles perhaps, mainly arm or leg muscles—but it may be by a succession of tactile sense-perceptions as some modern physiologists and psychologists believe. But none of these questions belong to pure physics: somehow or other we *are* aware of Motion and Time and Space. We had already erected the structure of Geometry without invoking motion and time, we now erect Kinematics. And by motion, which is a usefully vague term, I mean nothing less than the whole of kinematics.

Next in order of complexity we become aware of *force* plainly through our muscular or our tactile sense, and thus, indirectly, we gain the tremendously important idea of "matter." The *ratio* of force to motion is *inertia*; one of the most constant and fundamental qualities in the apparent universe. The *product* of force and motion is *activity*, whence arise the complex but brilliantly useful ideas associated with the term *energy*. In elaborating these we erect the whole science of Dynamics.

Thus far the scheme is essentially Newtonian, and the Newtonian axioms may be held to summarise its essentials in the briefest and clearest way. If I presume to restate them it is because the modern terms "acceleration" and "stress," which were not available for Newton's use, assist the expression, so that by their aid some minor difficulties, such as those caused by the phrase "uniform velocity and direction" disappear; this phrase need not have been introduced had a vector acceleration been a thing of easy apprehension or of common knowledge in Newton's time.

Prof. Minchin urges the explicit retention of the first law, not as a measure of time only, but as a qualitative statement introductory to the quantitative assertion of the second; and I fully agree. I should like to take the opportunity of thanking both Prof. Minchin and Prof. Henrici for their careful criticism of my Physical Society paper.

Premising that the necessary definition of terms must be understood or supplied, I now repeat from my former article the essence of the Newtonian laws.

Axiom 1. Without force there can be no acceleration of matter.

Axiom 2. The inertia of matter is unconditionally constant. [*Or*, Acceleration of matter is proportional to unbalanced or resultant force.]

Axiom 3. Every force is one component of a stress, and a stress in a body or system does not accelerate it.

Before proceeding, let me here intercalate a remark about the kind of *scholium* with which, on page 62 (NATURE, vol. xlviii., May 18) I prelude the definitions and axioms. I do not intend the "experimental results" there quoted to be used for teaching purposes; in fact, my present aim is in no respects pedagogic, but more ambitious; I quote them as affording some sort of experimental basis for the Newtonian axioms. An experimental basis is a necessity—in other words, an axiom must be based on some sort of experience; and the experience on which the Newtonian laws are based can hardly be considered as of a very commonplace type.

It is easy to *illustrate* the second law with bits of elastic and trucks on wheels, but it is not so easy to prove it with accuracy—the sort of accuracy attempted, for instance, in the case of the law of Ohm. It is customary to say that Astronomy proves it, but as a logical procedure that would be a terribly circular one; and besides, the nature of gravitation is so singularly unknown that it can hardly with satisfaction be used as a foundation stone.

Anyhow, the proof which by those experiments I *suggest* is, first to establish Hooke's law for a spring, statically, by weights, *i.e.*, to prove that force is proportional to displacement; next to show that vibrations of the spring are isochronous, *i.e.*, that acceleration is proportional to displacement; and thus to deduce that force and acceleration are proportional (in this case at any rate) to a high degree of accuracy. The difficulties, such as they are, of this proof are of a merely mathematical order, and are hence entirely unimportant.

The third "experimental result" quoted is only to suggest the impact experiments which Newton himself considered desirable as a basis for his third law.

One other point before proceeding. With regard to the claim for obviousness, or *prima-facie* certainty, sometimes set up in connexion with a long-known law of nature, on any such ground as that it is a mere assertion that Cause equals Effect:—may I say once for all, and quite impersonally, that such a claim appears to me to be metaphysical nonsense of the worst kind—the kind which has tended to bring real Metaphysics into unmerited disrepute. Is it not plain that everything depends on what is cause and what is effect, and that the interpretation of nature essentially consists in the discovery and accurate specification of what in any given case the true cause and the true effect are?

Now comes the new departure, or extension of the Newtonian axioms, so as definitely to include the medium which it has been one of the chief works of the present century to discover.

The chief axioms I intend to propose and trace the consequences of are:—

Axiom 4. A stress cannot exist in or across empty space.

Axiom 5. Material particles (atoms of matter) never come into contact.

Axiom 6. A stress must extend from one material particle to another: it cannot end in ether.

This last is hardly axiomatic, but it is based on special experimental evidence (Phil. Trans., 1893).

From these laws and from the law that stress is essential to activity (which last does not need a separate statement, being deducible from the Newtonian axioms), a series of what appear to me fundamentally important deductions may be made.

Some of these deductions relate to already known and admitted facts, while others introduce some as yet unknown or unadmitted: the former set are mostly referred to in my paper to the Physical Society, the others must be dealt with hereafter.

OLIVER LODGE.

MAY I make through your columns some criticisms on Prof. Lodge's views of dynamics, which I am afraid I failed to render intelligible to him during the discussion on his paper before the Physical Society?

It would be useless to say anything about his theory of "Contact Action," for he has rendered the whole discussion upon that point nugatory by saying in his reply to the criticisms that he does not admit that any two bodies can ever come into contact at all, *i.e.*, that the contact action he contemplates is something that takes place only between "the bodies" and an "ether" which exists between them. It follows that his own arguments and illustrations, as well as the criticism upon them, are all beside the point, for they all dealt with contacts between "bodies," not between a body and an "ether" in which it was moving. We must therefore begin *de novo*, and we must start this time with some definition or explanation of what he means respectively by "the bodies" and "the ether" which surrounds them.

But the point I particularly wished to discuss was his view of the "identity" of energy. I do not think any such identity can be recognised, at any rate if we grant Prof. Lodge's own hypothesis that energy on being transferred from one body to another is always transformed from Kinetic to Potential energy, or *vice versâ*, for I maintain that potential energy, as such, belongs to a system of bodies not to any particular one of them, and so has no local habitation even though it has a name.

The law of the conservation of energy is usually expressed by the formula—

$$\text{Kinetic} + \text{Potential Energy} = \text{Constant.}$$

But if this is to be a physical law, and not a mere truism, its terms must be defined in such a way that it is not a mere formal consequence of their definitions. As to Kinetic energy, everybody is practically agreed in defining it as $\Sigma\frac{1}{2}mv^2$, or, which is the same thing, as $\Sigma\int mvdv$. But if we define potential energy, as Prof. Lodge would apparently have us do, as $\Sigma\int -Fds$, the formula does not assert a physical fact—at least no new one—but is merely an identity. The equation of energy in this form would, indeed, be quite useless, for we should have to know the previous path of each particle in order to evaluate $\int Fds$. And so we find that in the equation of energy, as used by mathematicians, the "Potential Energy" has nothing to do with any paths the particles may have described, but is a mere function of their present co-ordinates.

The truth is that the physical fact implied in the law of conservation is not that the *energy in general* is conserved throughout all changes in the system, but merely that the *kinetic* energy is always the same whenever the system returns to the same configuration; that term being held, if necessary, to include, not only geometical form, but such conditions as temperature, chemical or electrical state, &c.

The law of energy is then better stated thus: "In any independent system of bodies—

Kinetic energy + A function of the configuration of the system = Constant."

And we may, if we like, call this function "Potential energy," since it diminishes as the kinetic energy increases; but we have no right to assume *à priori* that it is the same sort of thing as kinetic energy. It is true that in some cases what used to be called potential energy is now regarded as in great part kinetic, but this can only be done if at the same time we change our conception of the "configuration" of the system. If we regard the energy stored in a reservoir of compressed air as kinetic instead of potential, we must include the average positions of its particles in our statement of the configuration of the system.

But the important conclusion to be drawn from this is that potential energy (*quâ* potential) does not belong to a single particle but to the system as a whole, or at least it can only be allocated to such portions of the system as may by themselves be regarded as independent systems. If ever all energy were explained to be kinetic energy, and if we could then explain how it comes to be transferred from one body to another, we might be able to trace the biography of a piece of energy as we might that of an atom of matter. But even if "potential energy" may thus be regarded as only a name used to veil our present ignorance of what has happened to the kinetic energy, it is still illogical to talk of the "identity" of energy till this veil has been removed. And I cannot see that anything Prof. Lodge has said helps us in the smallest degree to remove it.

EDWARD T. DIXON.

Trinity College, Cambridge, May 27.

On the Velocity of Propagation of Gravitation Effects.

IF, according to the accepted kinetic theory of gases, the velocities of molecules "vary between zero and infinity" (Maxwell): it must certainly result that frequently enormous velocities are accidentally attained by even gross molecules, and this produces no perceptible disturbance measured by us. It would be admittedly almost puerile to ask how high a velocity might normally be possessed by a large number of particles of matter (as an *à priori* question, that is), provided the particles be perfectly elastic, so that there is no jar at their encounters, but the movement goes on with perfect smoothness, so that its existence may escape detection by the senses. Moreover there is no resistance in space to free motion of material particles.

In regard to the effects of gravity then, the practical question for us (in regard to their elucidation) becomes, What is the velocity demanded for the transmission of gravity? This velocity, whatever it be (if very great, but finite), may then reasonably be considered to exist in matter in some form, or to be possessed by it. To assert *à priori* that the existence (say among particles of matter) of a velocity even many times that of light, is unlikely, or to view this with incredulity as an abstract fact apart from its possible utility—would seem to partake somewhat of the nature of a prejudice, due possibly to absence of adequate reflection.

A high normal velocity has the undoubted mechanical advantage of being able to produce a given dynamical effect by means of very small particles, *i.e.*, without demanding for such effect any large collective mass or the employment of a great quantity of material. Smallness in size moreover allows the particles to possess a very long mean path: and they have the advantage of occupying, *in toto*, very little room (although they may be relatively numerous).

Without going into the question of the *modus operandi* of such effects as explosions of gases, dynamite, &c., it at least appears manifest that by the rejection of "action at a distance," a store of motion of a very high intensity in the matter of space would be consistent with, or would be demanded in order to give some rational account of sudden developments or transferences of motion. It may appear questionable whether a normal velocity of matter in space only equal to that of light, would be sufficient to account for the explosive violence of somt transferences of motion. The rate of travel of light when viewed in relation to the intervening distances of the chief bodies of the universe—may appear even slow. More than three years, for instance, are occupied in the transmission of a wave from the *nearest* star to our system.

It may be reasonable then to assume that the possibilities for the existence of a higher rate of intercommunication than this (that of luminous effects) may exist in nature, and that the bodily mass movements of the units of the universe may influence each other more quickly than their molecular movements; since gravitational disturbances or their measures appear to demand this. It is so far certain that in addition to the luminiferous ether there may be plenty of room for finer and therefore more mobile material: or no one, as far as I am aware, has urged a difficulty on this head, provided its presence were subservient to some great mechanical purpose.

Hamburg, May 16. S. TOLVER PRESTON.

Singular Swarms of Flies.

IT may interest some of your readers if I describe a sight which I saw this forenoon, which was quite new to me and apparently to all who witnessed it. After a brisk N.N.E. breeze in the morning, at about 11 a.m. it fell flat calm, the sky becoming inky black, with every sign of a heavy thunderstorm impending. Soon after, looking out of my office window at a belt of trees some hundred yards away, my eye was caught by a most singular and to me (at first) uncanny sight.

Above the trees, apparently one on each principal prominence of their outline, there appeared a number of slim clouds, like straight wreaths of thin smoke, slanting upwards into the sky. Though they maintained their positions, they seemed alive and moving, in a manner partly suggestive of the twisting motion of a waterspout. A field-glass showed the clouds to be swarms of small flies; and looking around, similar swarms were seen above all the trees everywhere. They were perfectly visible to the naked eye a quarter of a mile off, and the glass showed them on the furthest trees in sight, these being nearly a mile away. All seemed to have much the same peculiar slant, pointing more or less towards the (then invisible) sun. Some of the swarms looked to be fifteen or twenty feet long.

Over a few of the low bushes on a bank of rough ground close by, similar swarms were to be seen. Even these, however, were inaccessible; but I caught some of an apparently similar swarm drifting over the ground between the bushes, and inclose some of the specimens herewith. To me they look just like the insects which ordinarily strew one's table under the lamp at night (I notice, by the way, that to-night there are none, though the window is open as usual), and therefore I am led to suppose that the special character of the swarms noticed to-day appertains to some condition of the atmosphere, and not to the species of insect; but perhaps some of your contributors can throw light on this point. It would also be very interesting to know whether similar swarms were noticed elsewhere to-day, and whether they showed the same slant as was noticed here.

R. E. FROUDE.

Admiralty Expt. Works, Haslar, Gosport, May 27.

P.S.—The swarms of flies disappeared about 1 p.m., as the thunder clouds cleared away.

Popular Botany.

WE do not expect accurate scientific information from journalists; but so much confusion and error are seldom compressed into a small space as are to be found in a paragraph of which I send you extracts, cut from a London daily:—"A sad case of accidental poisoning by wild hemlock is reported from Tyne Dock. A little band of school children playing on some waste ground had gathered a quantity of a common variety of this dangerous plant, known to country folk as 'fool's parsley.' According to the evidence of one of the party, a little girl aged eight named Pringle, her sister 'said it was cabbage, and she should eat some.' Another boy and girl, named Shafter, who were still younger, followed her example. All three were soon afterwards taken ill. One 'complained of her legs as if they were tired'—a common symptom of hemlock poisoning—and 'her head afterwards got bad.' Pringle ultimately recovered under treatment, but the two Shafters on reaching home gradually became unconscious, and died the same afternoon within twenty minutes of each other. This species of hemlock, known to science as the *Conium maculatum*, is said to be much more poisonous in May than in any other month." It would be interesting to know what the plant really was. It can hardly have been the true hemlock, *Conium maculatum*, and instances of fatal poisoning by fool's parsley, *Aethusa cynapium*, are so rare that an authentic record would be valuable. It is difficult to imagine either of these plants being mistaken for cabbage. Can it have been *Cicuta virosa* or *Oenanthe crocata?* It would be interesting if any reader of NATURE could throw light on the subject.

The following delightful paragraph is cut from the same paper a few days later:—

"Can plants see? Darwin gave it as his opinion that some of them can [one would like to know where], and an Indian botanist relates some curious incidents which tend to verify the belief. Observing one morning that the tendrils of a convolvulus on his verandah had decidedly leaned over towards his leg as he lay in an attitude of repose, he tried a series of experiments with a long pole, placing it in such a position that the leaves would have to turn away from the light in order to reach it. In every case he found that the tendrils set themselves visibly towards the pole, and in a few hours had twined themselves closely round it."

ALFRED W. BENNETT.

Gaseous Diffusion.

IN your Notes of last week there is a description of an experiment for showing gaseous diffusion, devised by Prof. v. Dvorák, which, however, does not seem so striking as one that was shown at the Royal Institution more than twenty years ago by, I think, Dr. Odling.

A cylindrical porous battery cell was closed by a cork through which passed a vertical glass tube of about half an inch in diameter. The lower end of the tube was bent upwards into the form of a delivery tube, and was placed in a pneumatic trough, with a cylinder filled with water inverted over the end of the tube. On placing an inverted bell-jar of hydrogen over the porous cell, gas was rapidly collected in the cylinder, and this contained sufficient hydrogen to explode on the application of a flame. On removing the bell-jar, the hydrogen diffused outwards, and water was drawn up the wide tube.

Cooper's Hill, May 29. HERBERT MCLEOD.

NOTES UPON THE HABITS OF SOME LIVING SCORPIONS.

THE literature which treats of the habits of living scorpions is not voluminous, but it labours under the disadvantages of being based largely upon undetermined species, and of being often of questionable trustworthiness with regard to the statements that are made. Even accounts that have been given of late years of the same species of scorpion differ widely as to facts of no small importance. Mons. L. Becker, for instance, asserts that the senses of hearing and seeing are highly developed in *Prionurus australis*, the thick-tailed yellow scorpion of Algeria and Egypt; Prof. Lankester, on the contrary, declares exactly the opposite to be the case. Discrepancies such as these and the deficiencies above mentioned show the need for fresh observations upon the subject, and no further excuse need be offered for publishing the following notes upon the habits of some specimens of two species of scorpions, *Parabuthus capensis* and *Euscorpius carpathicus*, which I was fortunate enough to keep for some months in captivity.

For the specimens of Parabuthus I gladly take this opportunity of expressing my thanks to my friend Mr. H. A. Spencer, of Cape Town, who kindly collected them for me at Port Elizabeth, while acting as medical officer on board the Union Steam Ship Company's s.s. *Mexican;* while for the Euscorpius I am indebted to the kindness of Dr. Gestro, of the Natural History Museum at Genoa. This last genus of scorpion Prof. Lankester has also written about; many of my observations, therefore, merely confirm those of this author. No description, however, has to my knowledge ever been published upon the habits of any species of Parabuthus. This genus, however, belongs to the same family as Prionurus, and the behaviour of the two in captivity seems to be very similar.

There is an abundance of evidence that scorpions are nocturnal, and mine were no exception to the rule. They would spend the daytime huddled together in corners of their box or under pieces of wood; at night they would wander about, presumably in search of food. It was easy, however, at any time during the day to rouse them from their sluggishness by applying a little artificial warmth to the box. One end of the box containing the Parabuthus was closed with a plate of perforated zinc. If this box was placed in the fender at a distance of about a couple of feet from a moderate fire, with the zinc end turned towards the grate, the scorpions would climb upon the metal plate and bask in the warmth. But immediately the box was brought near the bars of the grate they would all clamber or tumble from their position with ludicrous haste. It must not be supposed, however, that the amount of heat required to make them retreat was at all great. As a matter of fact warmth that I could without inconvenience bear for several minutes upon my hand would throw these animals at once into a state of the greatest consternation.

When walking both Parabuthus and Euscorpius carry the large pincers or chelæ well in advance of the head; these appendages thus fulfil the office of antennæ or feelers. In Parabuthus the body, however distended and heavy with food, is raised high upon the legs exactly as Prof. Lankester has described in Prionurus, and the tail is usually carried, curled in a vertical plane, over the hinder part of the back. In Euscorpius, on the contrary, as has also been pointed out by Prof. Lankester, the ventral surface of the body is scarcely raised from the ground during progression, and the tail, which is very slender and relatively much lighter than in Prionurus or Parabuthus, is dragged along, extended, and with a slight curl only at its hinder end. This difference in the carriage of the tail depends possibly upon the difference in its size and weight. For it seems reasonable to suppose that the heavy, robust tail of a Parabuthus or Prionurus is carried with less muscular effort when curled over the back than when stretched out behind as in Euscorpius.

When attempting to climb up the smooth sides of their box the Parabuthus would raise themselves upon the extremity of the fifth segment of the tail, and by keeping this organ perfectly rigid and in the same straight line as the body they could maintain themselves in a nearly vertical position, thus reaching considerably higher than if supported upon the hind legs alone.

The method of digging shallow pits or holes in sand, which Mons. Becker and Prof. Lankester have described in the case of Prionurus, is also practised by Parabuthus. Standing upon the first and fourth pairs of legs, and using the tips of the chelæ and the end of the tail as additional props, with the disengaged legs a scorpion rapidly kicks the sand backwards between the legs of the last pair, very much as a rabbit or rat does when burrowing. Then with the apparent intention of removing what would prove an obstacle to its vision when crouching in the hole, it sweeps aside with its tail the heap of sand that has been thrown up, until the area surrounding its lurking place is tolerably level.

I never saw a Euscorpius digging in the sand. They were usually to be found during the daytime under pieces of wood, to which they were nearly always clinging belly uppermost. It is difficult to explain why this attitude should be assumed. Many terricolous arthropods, however, have the same habit, and I see no reason for thinking that in the case of Euscorpius it has any connection with the copulation of these animals as Prof. Lankester suggests.

All scorpions appear to be carnivorous, and there seems to be little doubt that they live principally upon insects or other articulated animals. My specimens of Euscorpius would eat blue-bottles and small flies, small cockroaches (*E. germanicus*), wood-lice, small spiders, and centipedes (*Lithobius* and *Geophilus*). The Parabuthus were fed principally upon the common house-cockroach and upon blue-bottles. It is interesting to note in connection with this last fact that Prof. Lankester's examples of Prionurus would not eat this common cockroach, nor did they seem to care for blue-bottle flies. This difference of instinct in the choice of food is remarkable, seeing how similar these two scorpions are in other particulars, both of habit and structure.

No one acquainted with the agility of a cockroach and the usual sluggishness of a scorpion would think that the latter would often succeed in capturing the former. Yet in truth, when placed in the same box, the insect seldom has a long lease of life. Its ultimate fate is always due to its ignorance of the scorpion's nature, and to the latter's adroitness in seizing anything that comes within reach. Wandering round the box, and exploring every inch of its new quarters with its antennæ, the cockroach soon discovers the presence of the scorpion by touching it with the tips of these organs. The scorpion's sense of touch, however, is as delicate as the insect's, and the latter's antennæ, or any part of it that happens to be near, is quickly seized by the pincers of the scorpion. Should the latter be disinclined for food and take no notice of the cockroach's first approach, the insect, continuing its wanderings, will fearlessly creep over the scorpion, just as a rabbit will over a python. Obviously this fearlessness must prove its destruction in the end, if not immediately. By means of its agility and strength, a cockroach sometimes eludes the scorpion's first clutch, and sometimes, but not often, breaks away from the latter's hold. But it does not readily learn from its narrow escape the advisability of giving its enemy a wide berth the next time they meet.

Although usually trusting to their heels for escape, cockroaches occasionally resort to a method of self-defence which is sufficiently curious to be described. Advancing upon an adversary rear end foremost, and at the same time wagging from side to side this region of the body, they deliver vigorous backward kicks with their spiny hind-legs. This novel and humiliating mode of fighting, although not likely to prevail long against jaws and stings, is sufficient, nevertheless, to gain sometimes for the insects a temporary reprieve. I have indeed seen a fine female Madeira tarantula spider retreat in discomfiture before a big cockroach of the same sex, which assaulted her in the way described.

As soon as a cockroach is seized the use of the scorpion's tail is seen; for this organ is brought rapidly over the latter's back, and the point of the sting is thrust into the insect. The poison instilled into the wound thus made, although not causing immediate death, has a paralysing effect upon the muscles, and quickly deprives the insect of struggling powers, and consequently of all chance of escape. If the insect, however, is a small one, one in fact that can be easily held in the pincers and eaten without trouble while alive, a scorpion does not always waste poison upon it. Thus I have seen a Parabuthus seize a blue-bottle fly, transfer it straight to its mandibles, and pick it to pieces with them when still kicking. Prof. Lankester only rarely saw his scorpions feed. I was more fortunate and repeatedly watched the operation, which is always performed exactly as this author has described. An insect is literally picked to pieces by the small chelate mandibles, these two jaws being thrust out and retracted alternately, first one and then the other being used. The soft juices and tissues thus exposed are drawn into the minute mouth by the sucking action of the stomach. It would seem, however, that some hard chitinous pieces are also introduced into the alimentary canal, for the entire exoskeleton of a cockroach is rarely, if ever, left after the meal is finished.

Feeding is a slow process; a good-sized cockroach will last a Parabuthus for upwards of two hours or more. But although voracious eaters when the chance presents itself, they are able to endure with impunity starvation of several weeks' duration. Unlike spiders, which are notoriously thirsty creatures, scorpions never seem to need anything to drink. At least none of mine were ever seen to touch water, although a supply of it was at first always kept in their box.

With regard to the higher senses, the only one that seems to be highly developed is that of touch. Mons. L. Becker declares that sight and hearing are excessively developed; but I cannot substantiate this statement in either particular. With regard to hearing, my observations agree entirely with those of Prof. Lankester, who could not detect the existence of any sense of this nature. None of my scorpions ever gave the slightest response to any kind of sound, although they were tried with tuning forks of varying tone and with shouts of both high and low pitch. These animals, in fact, resemble the hunting spiders in being apparently devoid of auditory organs. They further resemble them in the development of their visual powers, being able to see a moving body, like a living cockroach, at a distance of only about three or four inches. Even at a distance less than this they do not seem able to distinguish form. Thus a specimen of Parabuthus excited by the presence of cockroaches in the box, was seen to rush at one of its fellows that crossed its line of vision about two inches off, evidently not recognising by sight a member of its own species, for directly the pincers came in contact with the latter the mistake was discovered, the pugnacious attitude dropped, and no further notice was taken. This last observation shows that more is learnt from the sense of touch than from that of sight, an inference which is further supported by the habit, above referred to, of carrying the pincers well in front of the head as if to feel the way. There is no doubt that the external organs of touch in scorpions are the hairs which thickly or sparingly cover various parts of the body. The tail is often very thickly studded with setæ, and the poison vesicle always has some upon it. Their use upon this latter organ is very plainly seen during the act of stinging. For this act is not by any means a random thrust delivered indiscriminately at any part of a captured insect. On the contrary, a scorpion generally feels carefully for a soft spot, and then with an air of great deliberation delicately inserts its sting into it. There can be little doubt that this care is taken that there may be no risk of damaging the point of the sting against a substance too hard for it. A reckless stab against the resisting chitinous exoskeleton of a beetle, for instance, might easily chip this point and thus deprive the scorpion of its most efficient weapon of attack and defence. The same care of the sting is shown in the carriage of the tail, this organ being curled in such a way that the point cannot come into contact with any foreign bodies. Even when teased with a piece of stick or irritated by being crawled upon by a cockroach, a scorpion is not often sufficiently provoked as to use the sting. The tail is certainly used to knock aside the instrument or sweep off the insect, but the sides or lower surface of the organ are employed, the vesicle being carefully tucked down. Upon one occasion a Parabuthus was seen to kill a cockroach and retire to a corner to eat it in peace, beginning at the tail end. Presently a smaller example of the same species coming along and finding the opposite extremity of the insect disengaged, started feeding on its own account. So quietly was the process carried on by the two, that not until nothing but a few shreds remained did the larger discover the presence of its messmate. Thereupon it quickly brought its tail into use and by beating off its unwelcome guest secured for itself the remains of the meal. But although the provocation was great the defrauded one never attempted to use its sting to punish the intruder.

In connection with the organs of touch, the pectine or ventral combs must not be forgotten. Of the function of these appendages something is known, though no doubt much remains to be learnt. Their situation near the generative aperture, their larger size in the males, and the modification of their basal portion in the females of some species, *e.g.* Parabuthus, suggest that they are tactile sexual organs of some importance, and Gaubert's discovery of the nervous terminations in the teeth is a satisfactory confirmation of this supposition. But apart from sexual functions it is highly probable that they are useful organs of touch in other relations of life, enabling their possessor to learn the nature of the surface over which it is walking. In favour of this view may be adduced the fact that these animals have been seen to touch the ground with their combs. Moreover, it is a very noticeable circumstance that scorpions which, like Euscorpius, creep along with their bellies close to the ground, have very short combs; while in others which, like Parabuthus, stand high upon their legs, the combs are exceedingly long. I once noticed a Parabuthus marching over a piece of a dead cockroach. When she had half crossed it, instead of going straight ahead as was expected, she halted abruptly, backed a little, and, stooping down, started to devour the fragment. From the height at which the body was being carried, I am persuaded that no portion of its lower surface, except the combs, could have come into contact with the piece of food; so there can be little doubt that its presence was detected by means of the organs in question.

Creatures which, like snakes, are both carnivorous and venomous, and present at the same time an appearance which is by no means reassuring, are always held in bad repute by mankind in general, and suffer in accordance with the principle laid down in the adage, "Give a dog a bad name and hang him." But amongst creatures of this description it is probable that scorpions qualify for first place with respect to the number and enormity of the vices with which they have been charged. Those that are most frequently alleged against them are general ferocity, murder, cannibalism, infanticide, and suicide. And yet in spite of this serious charge-sheet, there is no doubt that they are much-maligned animals. For in defence of the accusation of ferocity I can say that I never saw a scorpion use its destructive weapons except with the legitimate object of killing prey for purposes of nutrition, or as a reasonable means of defence when molested. Naturally enough they will not tolerate handling, but when allowed to crawl upon the hand they make no attempt to sting it, and merely evince a desire to escape to surroundings more natural and congenial than human skin. From the charges of cannibalism and murder, however, these animals cannot be so easily cleared. For there is an abundance of evidence that they do sometimes, when in captivity, both kill and eat each other. Nevertheless, so far as my experience goes, members of the same species do for the most part live together in perfect harmony. Once only did I see a large Euscorpius eating a small one. But since the latter showed no signs of violence, there are no reasons for supposing that it had died other than a natural death. Like many other animals, scorpions may be made to fight by artificial means, and when roused to a high pitch of excitement by too much heat, they will clutch and grab at each other with the appearance of the greatest ferocity. But I never saw any evil result from these tussles. The combatants always seemed to prefer to part company without bloodshed.

As for the accusation of infanticide, it appears to be quite groundless. For it is well known that a mother-scorpion protects her young by carrying them about on her back until they are able to shift for themselves.

The question as to whether scorpions do or do not commit suicide by stinging themselves to death, when placed in a circle of fire, or otherwise tortured by that element, is one which has excited a considerable amount of discussion. The belief that they do do so, with the object of escaping from the pains of burning, is of long standing, and probably has many adherents at the present time. But the experiments of Mr. Bourne upon some Madras species have shown (firstly) that the poison has no effect upon the scorpion that possesses it, nor yet upon a member of the same or of a closely allied species, and (secondly) that these animals are easily and quickly killed by a moderately warm temperature (50° C.). Moreover, when distressed by a too warm atmosphere, or, according to Lankester, by chloroform vapour, these animals have a habit of waving their tails in the air and of thrusting the sting forwards over the head, as if to punish some unseen enemy. And if the sun's rays be focussed with a lens upon the back of a scorpion, the animal immediately brings its tail over, and attempts to remove with it the cause of irritation. So that the true account of at least some of the so-called cases of suicide by scorpions seems to be this: the animals in reality have died from the heat to which they were exposed, and the observers have erroneously inferred that the thrusts of the tail were intended to put an end to the animal's sufferings. My own experiments are all in favour of this conclusion. I held a specimen of Euscorpius in a corked test-tube over a low fire. As soon as the air in the tube began to grow warm the animal, apparently in great distress, struggled about the confined space for a few seconds, brandishing its tail the while, then lapsed into insensibility. The glass of the tube at this period was only slightly warm to my hand. Taken out of the tube and placed near an open window, the animal quickly revived; but it died the third time the experiment was tried. On no occasion, however, did it attempt to sting itself. I also experimented upon Euscorpius and Parabuthus by focussing the sun's rays upon them, and by placing mustard upon the membrane between the plates of the back. Both the species attempted to remove the cause of irritation by scraping at the burning spot with the sting of the tail; but they seemed particularly careful not to sting themselves.

There seems, however, to be sufficient evidence to prove that some scorpions have been seen to sting themselves during the course of experiments of a nature similar to those described above. One observer indeed mentions, in the case of an Indian scorpion, that blood issued from the wound made by the sting—a piece of corroborative detail which enhances the probability of the accuracy of the observation. But it is *à priori* improbable that the scorpion has any intention of killing itself. It seems, however, not improbable that a random blow meant for an unseen enemy might accidentally strike and pierce the deliverer; or that when the irritation is localised, as in the cases of burning with a lens, acid, whisky,[1] or mustard, the scorpion, failing to remove the substance by the ordinary means of scraping with the tail, might thrust its sting into the spot affected, with the intention, not of killing itself, but of destroying the agent that is causing the pain. Or, indeed, it is conceivable that the mental faculties are so deranged by torture and the approach of death, that the scorpion does not recognise its own body by its sense of touch, and stings it as it would sting any other object within reach of its tail. If a blow inflicted in either of these ways were to pierce the brain, or were to seriously lacerate the great dorsal blood-vessel, it might, one can suppose, cause death of itself, independently of the burning.

So that if it be admitted that scorpions have sometimes killed themselves, our verdict, it would seem, must be—accidental suicide, or suicide while of unsound mind.

R. I. POCOCK.

[1] It is stated that in some parts of N. America scorpions sting themselves to death if a drop or two of whisky be placed upon their backs; and that from this manifestation of their dislike of alcohol, these animals are known to the natives as teetotallers.

NOTES.

WE greatly regret to have to record the death of Dr. Charles Pritchard, F.R.S., Savilian Professor of Astronomy at Oxford. He died at Oxford on Sunday morning last in his eighty-fourth year. We hope to give on a future occasion some account of his career as a man of science.

THE gold medal of the Linnean Society has this year been awarded to Prof. Daniel Oliver, of Kew, to whom it was presented at the anniversary meeting of the Society held at Burlington House on the 24th inst.

A TABLET erected in Truro Cathedral to the memory of the late Prof. John Couch Adams was unveiled by the Bishop of Truro on Saturday last. Canon Mason, a companion of Prof. Adams at Cambridge, delivered an address, in which he spoke of the illustrious astronomer as "one of the greatest of Cornishmen." The tablet—the cost of which has been defrayed by public subscription—was designed by Mr. Pearson, R.A., and executed by Mr. Juleff, sculptor, of Cornwall. The Latin inscription, a translation of which will be placed near the tablet, is by the Archbishop of Canterbury.

THE new engineering and electrical laboratories at University College, Gower Street, were opened on Monday last by the Duke of Connaught. Many invited guests were present at the ceremony. Mr. J. E. Erichsen, the president of the college, in beginning the proceedings, said it was confidently anticipated that when the two laboratories which were about to be opened were fully equipped with mechanical appliances and electrical apparatus the college would possess every requirement for advanced research and thorough teaching. The cost would not fall far short of £20,000, and the council hoped that a liberal response would be made to the appeal for funds which had been issued, and especially that the great City Companies, which had done so much for education and were so deeply interested in the success of such an enterprise, would give their assistance. Engineering was all-important, not only from a scientific, but from a national point of view, and it was needless to dwell on the importance of increasing the opportunities of the youth of this country for the study of the wonderful science of electricity, which half a century ago was little more than a toy for the learned, but now, through the telegraph and the telephones, entered into the daily life of us all, and before which gas was, it would seem, destined to "pale its ineffectual fires" as an illuminant. It was to be hoped that such laboratories as these would lead to fresh scientific triumphs and further practical developments. The Duke of Connaught, before formally declaring the laboratories open, delivered a short address, in the course of which he said it had been his good fortune to see some of the greatest engineering works in different parts of the Empire, and he was certain that those who, like himself, had seen them would recognize the vast importance of a thorough study of the sciences on which they reposed. Foreign nations were competing with us on all sides, and if we were to maintain the proud position which we had hitherto held we should have to use every endeavour to increase the opportunities of study and of practical work. He trusted that the ceremony of to-day would mark a new era in the history of the college, and would tend to the prosperity and the increased power of engineering in this country.

THE death of Prof. Ernst Eduard Kummer is announced. He died at Berlin on May 14. Dr. Kummer was a Foreign Member of the Royal Society, and at the time of his death was in his eighty-fourth year.

A MEMOIR of the late F. A. Genth was read at a recent meeting of the Chemical Section of the Franklin Institute, and will be published in the June number of the Institute's Journal. It was prepared by a committee specially appointed for the purpose. Mr. Genth is described in the paper as one of the ablest mineralogists, and certainly the foremost mineral analyst, hitherto known in the United States. The writers also speak in high terms of his personal character, and of his remarkable power as a teacher.

MISS AGNES CRANE writes to us from Brighton with regard to an intimation she has just received from the "chief commissioner (Geology) of the Women's Auxiliary Branch of the World's Congress." It is to the effect that the last week in August has been set apart, for a short session during the day, for the presentation of specially-prepared geological papers by women. Such papers are not to exceed half an hour in reading. The co-operation of English workers in this science is invited, and an address to "geological women" will shortly be issued. The chief commissioner in geology is Mrs. Louisa F. Lowery, of 11, Gainsborough-street, Boston, Mass.

A GEOLOGICAL excursion to Dorking will be made by members of the Geologists' Association on Saturday, June 3, under the direction of Prof. Boulger and Mr. T. Leighton, the object being to examine the district described by the directors in a paper read before the Association on December 2, 1892. Arrangements for excursions on the remaining Saturdays of June have also been made.

THE following prize subjects have been recently announced by the Belgian Academy for 1894:—A. Mathematics and Physics. (1) Exposition and discussion of the various theories of diffusion of one liquid into another, with new facts bearing on this; (2) Estimate of theories explaining the constitution of solutions; new experiments throwing light on the subject, and especially on the existence of hydrates in aqueous solutions; (3) The investigations of modern geometers on the theory of the triple orthogonal system to be summarised and extended in some important respect. B. Descriptive Sciences. (1) New researches on the intervention of phagocytosis in the development of invertebrates; (2) Description of the phosphate, sulphate, and carbonate minerals of the Belgian region, with indication of beds and localities; (3) New researches on the peripheral nerve-system of Amphioxus, and especially on the constitution and genesis of the sensitive roots; (4) New researches on the mechanism of cicatrisation in plants. The prize in each case is a gold medal worth 600 francs. Further, the Jean Servais Stas prize of 1,000 francs is offered for new researches determining the (at present uncertain) atomic weight of one or several elements. Memoirs may be written in French or Flemish, and must be sent in, with motto, &c., before August 1, 1894. Only manuscripts are allowed.

AT the time of our last issue an anticyclone from off the Atlantic was spreading over the south-west of this country, and caused a renewal of the drought in many places in the south and east of England, but in Scotland and the north of Ireland the conditions were less settled, and a moderate gale was experienced in the north of Scotland. The maximum day temperature ranged during the first part of the period from about 55° in some parts of the north to 74° in the extreme south, while the night minima were generally high for the season. During the early part of the present week the barometer continued high, but several small depressions formed over the south and east of England; cold northerly winds spread over the whole kingdom, accompanied by rain in many districts, and adecrease of several degrees in the temperature, the shade thermometer falling to the freezing point in the north of Scotland during the night of May 29. The *Weekly Weather Report* of May 27 showed that the temperature for that period was again above the mean, the average excess being from 3° to 5°. Rainfall was rather more than the mean in the north of Scotland, but less in all other districts. Bright sunshine was more prevalent over England and parts of Scotland than in the previous week; in most parts of England the percentage of possible duration was from 41 to 46, while in Ireland it was 19 to 20, and in the north of Scotland only 17 per cent.

DR. J. HANN has published in the *Sitzungsberichte* of the Vienna Academy of Sciences some of the results of the anemometrical observations made at the Meteorological Institute at that place from 1873 to 1892. The discussion, which occupies eighty octavo pages, is divided into three sections: (1) the daily period of absolute wind velocity (without regard to direction), (2) the yearlyperiod of the velocity, and (3) the yearly period of the direction. In the two first sections a comparison of similar results for other stations, partly specially calculated for this purpose, has been made. The following are a very few of the results of Dr. Hann's valuable and elaborate work. The wind velocity shows a principal single daily period, with a minimum at 6h. a.m., and a maximum at 1h. p.m. Another secondary minimum is exhibited at 7h. 30m. p.m., and is followed by a secondary maximum at 10h. p.m. The cause of these secondary extremes is found to lie in the daily range of stormy winds; on calm days the secondary extremes disappear. The absolute mean maximum velocity occurs in March, about 14 miles per hour, and the minimum in October, about 10 miles per hour. There also appears to be a secondary maximum in November, and a secondary minimum in January, while from spring to summer there is again a slight increase in the velocity. With regard to direction, the northerly component has its maximum in March and its minimum in October, the easterly component has its maximum in April and minimum in July, the southerly component has also its maximum in April and its minimum in June and, lastly, the westerly component reaches a maximum in July and a minimum in February.

THE Royal Observatory of Turin has recently published a work on the climate of that place, prepared by Dr. G. B. Rizzo, which is based on one of the longest series of observations extant. The monthly means and extremes of temperature and summaries of weather are given for 138 years (1753–1890), and the monthly means and extremes of atmospheric pressure for 104 years. The climate of Turin is of the Continental type, but is not very severe, as the mean difference between the hottest and coldest months is only 40°. The mean for January is 33°, and for July 73°; the mean of the annual minima is 13°, and the maxima 93°. The average number of days with rain and snow is 106, and the amount 33 inches. As this long series offers facilities for the investigation of secular variations, Dr. Rizzo has endeavoured to determine the periods of recurrence of hot and cold years. He finds that the observations do not support the period of thirty-five years quoted by Brückner, but that the hot and cold years succeed each other at intervals of about nineteen years. The causes which produce these variations are unknown, but they appear to depend upon local, rather than upon any extra-terrestrial conditions. The years of most rainfall are the coldest, but the series shows no sign of the climate changing, as some persons have imagined.

IT is well known that the population of France is made up of many different elements, including, among others, Aquitanians, Ligurians, Gallic and Belgic peoples, Franks, Burgundians, and Norsemen. The Paris Society of Anthropology is strongly of opinion that much might be done to distinguish these various elements from one another, and has accordingly issued a circular in which it indicates to local observers the points about which information is wanted. These relate both to living persons and to human skeletons, or parts of skeletons, found in ancient monuments and elsewhere. Such remains, if there are no local buildings in which they can be placed, will be received by the Society and preserved in its museum.

M. A. DE MORTILLET contributes to the *Bulletins de la Société d'Anthropologie de Paris* (No. 1, 1893) an interesting note on Manx cats. He points out that the Isle of Man is not the only part of the world in which tailless cats are found. They are very common on the coasts of Japan, and have been cleverly represented by Japanese artists. M. de Mortillet suggests that Manx cats may be descended from specimens brought to the Isle of Man from Japan by sailors.

DURING a recent stay at Buitenzorg, in Java, Herr Haberlandt made some experiments in the Botanical Gardens there, on the transpiration of tropical plants. In general this was found considerably less than that of plants in Central Europe. Thus of seventeen tropical species, some with coarse, leather-like, others with tender, leaves, nine species transpired per day and per square decimeter surface less than 1 gramme; in six the amount was between 1 and 2 gr.; and in two only it reached 2·6 and 3·25 gr. Now, with European vegetables and woody plants it varies commonly between 2 and 5 gr., and sometimes reaches 6 or 7 gr. or more. This result the author considers a strong argument against the view that the transpiration current is of first importance in nutrition of land plants. These tropical plants, with their small transpiration, show extremely luxuriant vegetation, and are able, through osmotic forces, doubtless, to convey nutritive salts to their highest parts. It is curious that, spite of the great humidity of the air and the large amount of water in the ground, these plants often possess guards against too great transpiration, such as thick, cuticularised epidermis, deeply sunk stomata, and especially tissues adapted for storage of water. And the reason cannot lie, as sometimes at the coast, in the presence of salt in the ground. Herr Haberlandt finds an explanation in the fact that while he total transpiration is comparatively small, the hot sunny forenoons may occasion large evaporation. The transpiration in a forenoon hour was, in general, four to twelve times that in an afternoon hour; sometimes as much as twenty or thirty times. The forenoon hours are by far the most favourable to assimilation, and it is most important to the plant that its turgescence be not then too much depressed, an end accomplished through those water reservoirs.

THE last issue of the memoirs of the Novorossian (Odessa) Society of Naturalists (vol. xvii. 3) consists of a very elaborate work in French, "Monographie des Turbellariés de la Mer Noire," by Dr. Sophie Pereyaslawzewa, ex-director of the Sebastapol Biological Station. The title of the work does not, however, exactly render its contents, as the author has not only given a monograph of forty-five species of Turbellariæ from the Black Sea, of which twenty-nine species and the genus, Darwinia, are new; she deals also with the anatomy and embryogeny of the Turbellariæ, and presents them in a new light. The striking likeness between a young Acœla and an Infusorian—she says—must probably be considered as the cause of the many errors committed as regards the Turbellariæ altogether. Various authors have differed immensely in their description of the Acœla; some have found in it no digestive cavity, others have denied the histological differentiation of the teguments; others, again, have denied the existence of a nervous system. It might have seemed that such instances would soon have been dissipated when carefully-prepared sections were resorted to; but the sections, made by different explorers, seemed to support the same views, as known from the works of Graeff and Goethe. Mrs. Pereyaslawzewa now maintains, and supports her affirmations by carefully-prepared sections, that the Acœla has a nervous system, almost simultaneously discovered by Metchnikoff, herself, and Delage, and demonstrates that it possesses also a pharynx and a digestive cavity; that its teguments are histologically differentiated, and that the name Acæla is not applicable to adult individuals, so that she has felt bound to change this name into *Pseudo-acoela*. This very elaborate monograph being published in French, it is accessible to all men of science. It is illustrated with sixteen well-printed plates, lithographed in Warsaw, from the author's own drawings.

IT is known that certain plant-stuffs (alkaloids, tannin, oxalic acid, &c.) protect plants from attack by animals. This function, in the case of oxalic acid, has been recently studied by Herr Giessler (*Jenaische Zeits.*), taking species of rumex, oxalis, and begonia. The acid mostly occurs in the epidermis and peripheral tissues of the vegetative organs; parts underground have little or none. The leaves show most, but the acid may be found in the stem, and the leaf and flower stalks. Curiously, it does not, like other protective matters, appear in young organs. The older and more sappy the tissues, the more oxalic acid do they contain. Snails, which avoided those plants in the natural state, ate them when the oxalic acid had been precipitated. The substitution of various means of protection for one another was elucidated by Stahl; plants not protected mechanically have chemical protection, and *vice versâ*. In the plants studied by Herr Giessler mechanical protection is deficient. Further, in organs that have little or no oxalic acid, is found tannin. These two "vicariate" with each other also in different species of a genus. In many tissues both occur together. The protective function of a secretion, lastly, does not exclude other functions. Thus, regarding the epidermis as a water-reservoir, the osmotically very active organic acids doubtless play an important part in the filling of the cells with water. The occurrence of begonia and oxalis species in very dry places, as also the deficiency in means of protection against transpiration, more pronounced the higher the quantity of acid, put this function of oxalic acid in a still clearer light.

PROF. SOLLAS, F.R.S., communicated a paper on the granophyre of the Carlingford and Morne mountains to a recent meeting of the Royal Irish Academy. The granophyre is everywhere intrusive into the gabbro, and owing to the contrasted character of the two rocks it is possible to trace out their relation in the fullest manner. The behaviour of the granophyre is of great interest; from wide dykes, comparatively few in number, it passes into innumerable thin lamellar injections, which seam the gabbro through and through. These can be further followed into cracks of microscopic minuteness, and these swell out at intervals into ganglia, which give a white spotted appearance to the otherwise almost black gabbro. The ganglia are granophyric infillings of what were once drusy cavities in the gabbro, and it is suggested that the quartz so frequently found in gabbro associated with granitic rocks, as *e.g.*, at Carrock Fell, is of a similar origin. Of equal interest is the abundance of gabbro fragments included in the granophyre, and since the mineral constituents of the gabbro present features peculiarly easy to recognise, there is no difficulty in following the changes which they have suffered in consequence of their immersion in the originally molten granophyre. Thus the Bytownite, which frequently occurs as phenocrysts in the granophyre, has frequently become surrounded by a marginal zone of orthoclase, and the diallage can be traced into amphibole and biotite and colourless granules of pyroxene, which either remain in clusters about their place of birth or are dispersed throughout the rock. It would, indeed, appear that the ferro-magnesian constituents of the granophyre which have led observers to designate it as syenite and augite granophyre are entirely derived from the grabbro, and it hence becomes an interesting question to consider whether in numerous other instances rocks intermediate in composition to the extremely acid and basic rocks with which they are associated may not also have arisen from the admixture of two already differentiated magmas, and not by the progressive modification of a single original magma.

AT a recent exhibition by the French Société de Physique, MM. Macé de Lépinay and Perot showed a lecture-experiment illustrating well the phenomenon of mirage. A long vessel with plane sides contains a saline solution, on which is poured some distilled water. By diffusion, the liquids gradually mix and form a layer in which the density varies in a continuous way. If now a ray be sent, by means of a reflector, slightly upwards in the axis of the vessel, it describes a curve, passing through a maximum and descending. Its trace on a vertical plate of ground glass traversing the tube throughout its length, shows exactly the path taken, and gives a very pretty effect. On the same occasion, M. Pellin exhibited photographs of the fine gratings produced by Prof. Rowland, of Baltimore, whereby fine lecture experiments in diffraction can be produced at but small cost.

AN elegant method of optically studying the process of diffusion in liquids is described by Herr O. Wiener in *Wiedemann's Annalen*. It is somewhat similar to MM. de Lépinay and Perot's beautiful imitation of the mirage, and consists in sending a beam of parallel rays through a vessel containing two liquids of different density and refractive power. A trace of fluorescein makes the path of the rays visible, and shows that they are bent away from the less highly refracting liquid in the region where diffusion is taking place. By carefully pouring a layer of carbon bisulphide on to one of chloroform, and a layer of alcohol on the top of both, it is possible to make the beam describe a wavy path, due to alternate refractions by the alcohol and the chloroform, both of which are less highly refractive than carbon bisulphide. For the purpose of minutely investigating the process another arrangement is adopted. Parallel rays of monochromatic light are sent through a slit at 45 degrees to the horizon, and pass through the diffusion vessel on to a screen. The dividing surface is indicated by a decided upward or downward bend of the line on the screen, which becomes gradually less pronounced and more evenly distributed as diffusion equalises the refractive indices. The amount of vertical displacement at each point of the curve measures the difference of concentration in the region traversed by the ray. The constant of diffusion can be calculated from the rate of change of the diffusion curve, and the displacement of the point of maximum bending indicates the lesser diffusivity of the liquid towards which it takes place. Herr Wiener has also successfully applied the method to the determination of the thermal conductivity of water by photographing the diffusion curve in various stages.

The question as to whether there is a true hysteresis in the case of dielectrics has received considerable attention lately, and Arno, Hess, and Janet have published the results of extensive researches on this subject. A note by M. Charles Borel in the current number of the *Comptes Rendus* has some bearing on this point. He suspends a disc of paraffined paper by its centre in front of a plate which is charged, by means of a rotating commutator, alternately positively and negatively. The duration of the charge was 0·006 second, and between charges of opposite sign it was put to earth for an equal intervals When a glass rod is placed on one side of the disc, so that the plane of the disc and the axis of the rod are parallel to the lines of force of the field, and the end of the rod nearest the charged plate is slightly inclined towards the disc, the latter is rotated. This rotation can be explained by the mutual action of the residual charges in the disc and glass rod when the charged plate is earthed. Different specimens of glass produced very different results on the suspended disc, some having no effect whatever. The replacement of the disc of paraffined paper by one of mica had little effect, while discs of pure paraffin or ebonite showed only a feeble effect. It was found that rods formed of conductors or of good insulators, such as ebonite and shellac, produced a feeble rotation in the opposite direction to that produced by most dielectrics. If the rotation is really due to the residual electrification of the disc or rod this rotation in the inverse direction may be expected whenever the rod has no residual electrification. The effects of crystals held in different directions was tried, and it was found that, in general, the deflection varied with the direction of the crystal, which was normal to the charging plate.

Wiedemann's Annalen for May contains a paper by Herr J. von Geitler on the reflexion of electrical waves in wires. The waves were generated by means of the arrangement used by Blondlot, the secondary circuit being connected to two parallel wires 280 metres long. The variation of potential along these wires was measured by means of a differential electrometer, consisting of a double aluminium needle suspended by a quartz fibre before four metallic plates. These plates were connected, two and two, to the parts of the wire whose difference of potential had to be measured, in such a way that the attraction between the pairs of plates tended to turn the needle in opposite directions. The experiments show that if a series of electrical waves travel along two equal and uniform parallel wires there is a regular loss of phase and partial refexion wherever the parallelism of the wires is destroyed, or wherever there is a change in the diameter of the wire. The same effect is produced by joining the plates of a condenser to the two wires at any point. The curves showing the connection between the electrometer throw and the length of a branch circuit attached to the main wires are of a very curious form, and owing to the loss of half a wave length at the reflexion at the end of the branch circuit in one case, the curve obtained when the ends were separate was the exact inverse of that obtained when the ends were joined together.

Mr. W. Roe contributes to the *Agricultural Journal*, of Cape Colony (April 6) an interesting paper on some of the disadvantages that may result from irrigation. Most water used for irrigation contains variable quantities of soluble salts, more especially soda salts, chlorides, and sulphates, not taken up largely by plants. Every application of water, therefore, adds to the saline ingredients of the soil—a very different effect from that of excess of rain water, which so far as there is open subsoil for it to drain away would be likely to take out rather than add to the soluble salines in the soil. This mischief, accumulation of salts in the soil, is aggravated in a dry-air land where evaporation is great. The air, acting like a sponge on a surface, takes up the water, leaving the accumulated salts in the surface soil. But this surface soil is as the sponge to the layer beneath. Constantly after each water-leading the water is drawn to the surface, and evaporated, and its measure of salts left behind. Obviously the harm done by this accumulated salt will depend on the nature and quantity of the salines in the water used, as also upon the quantity of water applied. A good quality of river water may vary in having five to twelve grains to the gallon of soluble salts ; more than this becomes risky, unless the sub-soil is very porous.

The Rugby School Natural History Society has issued its report for the year 1892. The report, as the editor explains, differs from those of previous years in that the papers included in it deal solely with the natural history of the neighbourhood. They are all, with one exception, reprinted from the Rev. W. O. Wait's "Rugby, Past and Present," and as in the main they are written by old members of the Society, they may be regarded as presenting a kind of summary of the Society's work from its foundation to the present day.

A paper on the Siyin Chins, by Major F. M. Rundall, is included in the third volume of the "Supplementary Papers" of the Royal Geographical Society, and has also been printed separately. The author knows the Chin Hills well, and gives a very interesting account both of them and of the tribes by which they are inhabited. The paper is accompanied by a map.

The new instalment of the proceedings of the Geologists' Association includes the presidential address of Prof. J. F. Blake, delivered on February 3. It deals with the basis of the classification of Ammonites.

An essay on the laws of heredity, read originally by S. S. Buckman before the Cotteswold Field Club, has been translated into German, and issued as one of the series of "Darwinistische Schriften," published by Ernst Günther, of Leipzig. The German title of Mr. Buckman's work is "Vererbungsgesetze und ihre Anwendung auf den Menschen."

Messrs. Crosby, Lockwood and Son will issue in a few days an English edition of the "Handbook of the Steam Engine," by Herm. Haeder. The editor and translator of the English edition is Mr. H. H. P. Powles.

"A Contribution to the Chemistry and Physiology of Foliage Leaves," by H. T. Brown, F.R.S., and Dr. G. H. Morris, has been reprinted, by Messrs. Harrison and Sons, from the "Journal of the Chemical Society," May, 1893.

The Entomological Society of London has issued a catalogue of its library. The work has been edited by G. C. Champion, hon. librarian, assisted by R. McLachlan, F.R.S., and D. Sharp, F.R.S. Great additions to the collection have been made since the last printed catalogue was published in 1861 ; but there are still certain deficiencies, and Mr. Champion expresses a hope that some of these may be speedily supplied by Fellows, and that the publication of a separate Appendix may thus at no distant date be rendered necessary.

A COMPREHENSIVE study of the nature of the dissociation of hydriodic acid gas by heat, the conditions of equilibrium of the dissociated constituents, and the circumstances under which recombination occurs, has been made by Prof. Victor Meyer and Herr Bodenstein, and their results are contributed to the current number of the *Berichte*. The investigation was conducted upon similar lines to Prof. Meyer's recent experiments upon gaseous mixtures of hydrogen and oxygen, a series of a large number of equal-sized bulbs connected by capillary tubes being simultaneously filled with the pure gas and subsequently sealed and separated by fusion of the capillaries. In commencing the experiments Prof. Meyer was surprised to observe the comparative readiness with which gaseous iodine and hydrogen unite without the aid of platinum sponge or other condensing agents. If a glass tube containing a little iodine is filled with hydrogen, sealed, heated in a bath of the vapour of boiling sulphur, and after cooling opened under water, a considerable escape of pent-up hydriodic acid gas occurs, and the water immediately afterwards ascends in the tube owing to the absorption of the remainder. The hydriodic acid for the purpose of the experiments was all prepared by the direct union of the pure elements, inasmuch as the gas prepared by the usual method from iodide of phosphorus was always found to contain admixed volatile phosphorus compounds. The preparation was conducted by leading the mixture of iodine vapour and hydrogen over heated platinised asbestos, when it was found that 86 per cent. of the iodine entered into combination. The product, after passing through a suitable vessel in which the uncombined iodine was condensed, was received in cooled water, the gas regenerated by warming the fuming aqueous solution, and finally freed from moisture by leading it over phosphoric anhydride and from the last traces of free iodine by passing it over red phosphorus free from yellow phosphorus and lower oxides of phosphorus. The hydriodic acid gas thus obtained proved to contain no perceptible trace of impurity. Before proceeding to fill the bulbs the air was expelled from them by means of a current of pure hydrogen, which was allowed to pass through them for 24 hours, with occasional heating to near the softening point of the glass in order to remove the film of condensed air adhering to the surface of the glass. The hydrogen was finally displaced by pure hydriodic acid and the bulbs sealed. These extreme precautions, which were adopted in order to secure a number of specimens of pure hydriodic acid, afford a striking example of the infinite pains which are required to effect the final settlement of many of the apparently simple problems of elementary chemistry.

PROF. MEYER has definitely decided the question of the action of light upon pure hydriodic acid gas. Bulbs exposed upon the roof of the Heidelberg laboratory during the summer months became filled in a few days with large brilliant crystals of iodine. After ten days' exposure 58 per cent. of the gas had been dissociated, and at the end of the summer 99 per cent., or practically all. The fact that the waves of light are so active in effecting dissociation rendered it imperative that the thermal experiments should be conducted in the dark. The whole of the above experiments in connection with the preparation of the gas and the filling of the bulbs were therefore conducted in a dark room. The thermal results may be very briefly summarised. The statement in text-books that hydriodic acid commences to dissociate at 180° is incorrect. It is only in presence of admixed air that this occurs. At 310° the decomposition of the pure gas is so slight that it would take 2,000 hours to attain the point of maximum dissociation at which equilibrium is established. This point was determined indirectly to be attained when 0·1669 of the original quantity of gas was dissociated. At the temperature of the vapour of boiling mercury (350°) equilibrium was found directly to be established when 0·1731 was decomposed. At 394° (boiling retene) 0·1957 was dissociated, and at the temperature (448°) of boiling sulphur 0·2150. It is of particular interest to learn that Prof. Meyer has further proved by direct experiment that the formation of hydriodic acid from gaseous hydrogen and iodine proceeds at any temperature until exactly the same condition of equilibrium is attained as in the corresponding dissociation experiment. Thus when the synthesis of hydriodic acid was conducted at the temperature of sulphur vapour the reaction proceeded until only 0·21 of the elementary gases remained uncombined, the same amount as was dissociated when starting with the compound gas. Perhaps the most interesting result of the investigation is that concerning the rapidity of the dissociation. It has been found that whenever two bulbs of equal size are heated for equal lengths of time precisely the same amount of decomposition or of formation occurs. The reaction is thus found to proceed with strict regularity, the amount of dissociation or of synthesis at any fixed temperature being a direct function of the time, and capable of expression by a simple mathematical formula which is given in the memoir and which is amply verified by a large number of experiments.

NOTES from the Marine Biological Station, Plymouth.—Last week's captures include the Mollusca *Eulima distorta* and *Rostanga coccinea*, the Isopoda *Anthura gracilis* and *Munna Kröyeri*, and the Brachyura *Eurynome aspera* and *Portunus marmoreus*. The gelatinous alga, which has been so abundant in the townettings since the beginning of April, has at length almost completely disappeared. Swarms of the Leptomedusæ *Irene pellucida* (half-grown) and *Obelia lucifera* (full-grown and mature) have repeatedly been taken; but for some weeks past an occasional specimen of *Corymorpha nutans* has been the only representative of the Anthomedusæ. A single large *Bipinnaria* larva has been observed. On the shore young individuals of this year's growth of the Nemertines *Amphiporus lactifloreus* and *Lineus obscurus* (= *gesserensis*), and of the Crustacean *Carcinus mænas* are now plentiful. The following animals are now breeding:—Several *Terebellidæ*, the Opisthobranch *Philine aperta*; the Crustacea *Virbius varians*, *Portunus marmoreus*, *Stenorhynchus phalangium* and *tenuirostris*.

THE additions to the Zoological Society's Gardens during the past week include a Common Hedgehog (*Erinaceus europæus*, white var.) from Berkshire, presented by Mr. R. T. Hermon-Hodge: a Ruddy Ichneumon (*Herpestes smithi*) from India, presented by Mr. Maurice Welsh; a Guillemot (*Lomvia troile*) British, presented by Mr. H. B. Hewetson, F.Z.S.; two Ringhals Snakes (*Sepedon hæmachetes*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; an Aurora Snake (*Lamprophis aurora*) from South Africa, presented by Mr. T. E. Goodall; a Levaillant's Amazon (*Chrysotis levaillanti*) from Mexico, a Grey Parrot (*Psittacus erithacus*) from West Africa, a Cardinal Grosbeak (*Cardinalis virginianus*), a Rose-breasted Grosbeak (*Hedymeles ludovicianus*) from North America, deposited; a Jaguar (*Felis onca*, ♀) from South America, two Striped Hyænas (*Hynna striata*, ♂ ♀) from North Africa, a Black-necked Swan (*Cygnus nigricollis*, ♂) from Antarctic America, twelve Green Lizards (*Lacerta viridis*) South European, purchased.

OUR ASTRONOMICAL COLUMN.

THE ECLIPSE OF APRIL, 1893.—M. Bigourdan communicates to *Comptes Rendus* for May 23 (No. 21) a brief preliminary account of his observations made during this total eclipse of the sun. The station he occupied was Joal (approximately Longitude 1h. 16m. 38s. E. of Paris, and Latitude 14° 9′ 25″ N.)

and the observations were made from the Observatory erected by the Expedition of the Bureau des Longitudes. With an eyepiece magnifying 190 times he observed several occultations of solar spots by the moon, and in about fifteen cases he noticed the phenomenon that is equivalent to that seen in observations of the Transit of Venus and known as the black drop. It was produced, he says, not only at the contact of large spots, but at the point of contact of small ones, and even of the simple filaments forming the penumbræ of spots. M. Bigourdan also made a special look for the phenomena known as Baily's beads, sometimes seen when the sun has been reduced to a very fine crescent by the advance of the lunar disc, but from all accounts he seems to have been unable to see any trace of them. A search round the sun for an intra-Mercurial planet, with a telescope giving a field of 25′, was also made, but with no satisfactory result, since he says that his instrument was not suited for that purpose: the negative result thus obtained affords no argument against the existence of such a body. The duration of totality lasted exactly 4m. 1s.

FINLAY'S COMET (1886, VII.).—The following is the current ephemeris of this periodic comet, as given in *Astronomische Nachrichten*, No. 3164:—

12h. M.T. Paris.

1893.	R.A. (app.) h. m. s.	Decl. (app.) ° ′
June 1	0 40 53	+1 15·6
2	45 24	1 44·6
3	49 55	2 13·9
4	54 29	2 43·2
5	0 59 4	3 12·5
6	1 3 41	3 41·9
7	8 18	4 11·3
8	1 12 56	4 40·6

AURORA OBSERVATIONS.—In the event of Lieut. Peary's expedition to a high station in North Greenland (about Lat. 77° 30′ N. and Long. 70° 15′ W.), where regular observations of the aurora will be undertaken, it is hoped that everyone, wherever he may be, will help to supplement these observations by noting himself the times of absence and presence of this phenomenon. With so many workers in so many lands, it is needless to say that a systematic method of recording what is seen should be followed. With the intention of supplying this demand, Mr. M. A. Veeder has issued a set of blanks similar to those that will be used in the expedition, so that when properly filled up comparisons can be made in detail. In addition to the investigation of the local distribution of the aurora, it is hoped that the electro-magnetic conditions of solar origin may be more inquired into, and it is on this account that these circulars have been sent to both solar and magnetical observatories as well as to individual observers. As for the Arctic records, they will be continuous whenever observation is possible, relays of observers connected with the expedition relieving each other. In making such observations it is emphasised here that minute descriptions of the formation of arches, streamers, prismatic colours, and the like, accompanying such variations in the extent of displays, are of interest, but are far less important than that the times should be noted as accurately as possible. Any one desiring these blanks can be supplied directly by applying to M. A. Veeder, New York.

THE CONSTANT OF ABERRATION.—Prof. Chandler, in the *Astronomical Journal* (No. 296), gives the third of his most important papers relating to the constant of aberration, treating in this article specially of Struve's Prime-Vertical Observations, 1840–55, from the new point of view with respect to the variation of latitude. In this discussion, in addition to a direct solution for all the unknowns, he has made an indeterminate one, employing the constants pertaining to the 427-day term, and expressing the unknowns in terms of y and z. As regards the former solution, employing the observations of the seven stars from the years 1840–42, the value of the observations obtained is 20″·533, Struve's value from the same material being 20″·445, and for the whole data from 1840–55 the aberration is 20″·514. This last-mentioned value would be the "definite value from Struve's Prime-Vertical Observations, if we accept the direct solution as the best," but he says the *indeterminate* solution throws doubt upon this point. The definite value, as given by this solution, gives $20''\cdot481 + 0\cdot111y + 0\cdot230z$; and, since as yet the most probable values of these constants are not known, those of the 427-day period applied to the special case of Polaris, which were independent of the aberration, give, on this assumption, 20″·474, a value, as will be noticed, smaller than that by the direct solution. The value 20″·500 for the aberration constant is, according to Prof. Chandler, too great, as inferred from the discussion here given. As a "matter of interest" he gives the values of the aberrations deduced from the observations of the several stars made in 1840–42.

THE ASTRONOMICAL DAY.—"Is it desirable, all interests considered, that on and after January 1, 1901, the astronomical day should everywhere begin at mean midnight?" This is the question that has been put forward by a joint committee of the Canadian Institute and the Astronomical and Physical Society of Toronto, and printed in a circular-letter addressed to astronomers of all nations. Many of our readers may remember that as far back as 1884 the Washington International Conference carried unanimously the following resolution, there being representatives of twenty-five nations, "counting among them several astronomers of world-wide fame," that "the conference expresses the hope that as soon as may be practicable, the astronomical and nautical days will be arranged everywhere to begin at mean midnight." That the astronomical and civil day should start together at the same moment seems without doubt the right method of procedure, for what is gained really by reckoning the astronomical time from noon and the civil from the preceding midnight? It is true that changes will have to be made in the *Nautical Almanac*, and all such-like year-books, both astronomical and nautical; but on the assumption that the change is made simultaneously by all nations, and taking into account that such a change cannot come into vogue for five or six years on account of the fact that these books are printed a few years in advance, there seems really no difficulty ahead. The suggestion that the change, if made, should take place with the change of the century seems to be an excellent epoch for such a transition, for besides giving time for a thorough discussion of so important a question, it will, as Otto Struve says, "stamp itself on the memory of all who hereafter would be busied in the investigations in which exact chronology plays a part."

ROYAL OBSERVATORY, GREENWICH.—The Annual Visitation of the Royal Observatory at Greenwich by the Board of Visitors takes place on Saturday, June 3 next. The Observatory will be open for inspection at 3 p.m.

GEOGRAPHICAL NOTES.

DR. NANSEN writes confirming the statement made in this column as to the baselessness of the assertions regarding the failure of his expedition. He is making rapid progress with his preparations, and expects to sail in the *Fram* on his great venture on June 20.

THE most recent change of name in Africa is the adoption of the official title Niger Coast Protectorate for what was previously known as the Oil Rivers Protectorate, comprising the coastward part of the Niger delta.

NATAL, which has been a British colony for fifty years, has entered upon the final stage of colonial independence by the adoption of responsible government. It is expected that this step will lead to a rapid development of the resources of the country, and a considerable extension of its railways.

THE Antarctic whaler *Balæna* put into Portland Roads for coal on May 25, and reached Dundee on May 30, being the first to return. Mr. W. S. Bruce, who was on board as surgeon and in charge of scientific observations, reports that the homeward trip was favoured by very fine weather. He confirms our fear that opportunities for scientific work had often to be lost on account of the purely commercial character of the trip, and the rigid interpretation of his instructions by the captain. An account of the voyage and its results will probably be given to the meeting of the British Association at Nottingham. On the return journey a series of floats was thrown overboard from the Antarctic ice-margin to the equator, in order to endeavour to get light on the direction and speed of the currents. The lowest air temperature experienced amongst the ice was 21° F.

THE new number of the *Geographical Journal* publishes an old minute of a committee of the Royal Geographical Society held in 1845 to consider the nomenclature of the oceans. At this meeting Sir John Franklin took part, and as he sailed on his last voyage shortly afterwards it is possible that his absence prevented the matter from being further discussed. The provisional resolution come to by the committee was to give the following names and limits to the oceans:—Arctic Ocean and Antarctic Ocean, to the waters lying within the Arctic and Antarctic Circles respectively. The Atlantic and Pacific Oceans stretched from the Arctic to the Antarctic Circles, and were separated from each other by the meridian of Cape Horn. The Indian Ocean extended from India to the Antarctic Circle, divided from the Atlantic by the meridian of Cape Agulhas and from the Pacific by that of the south point of Tasmania. Mr. Arrowsmith, the eminent cartographer, was present at the meeting, and it is customary in Continental works to refer this systematic definition of the oceans to him. As a matter of fact his maps had a great deal to do with the nomenclature acquiring popularity. The committee proposed a triple sub-division of the Atlantic and Pacific into a northern, southern, and inter-tropical part. This has not come into general use. It is time that the question of oceanic nomenclature should be seriously considered again, and that the morphology and physiology of these great features be taken into account as well as their superficial outlines in determining a scientific classification.

THE IRON AND STEEL INSTITUTE.

A MEETING of the Iron and Steel Institute was held on Wednesday and Thursday of last week, May 24 and 25. There was a somewhat short programme, only five papers being on the agenda, and one of these was not read. There were, however, two additional papers afterwards brought in, but they were only read by title, and as they were not discussed, had very little influence on the proceedings. The papers read were as follows:—On the elimination of sulphur from iron and steel, by J. E. Stead, of Middlesbrough; on the Saniter process of desulphurisation, by E. H. Saniter, Wigan; notes on puddling iron, by John Head; on the recording pyrometer, by Prof. W. H. Roberts Austen. On the members assembling on Wednesday morning, the president, Sir Frederick Abel, occupied the chair, and the usual formal business of reading the minutes was first undertaken, after which the report of the council was read by the secretary, from which it appears that the advance of the institute in respect to membership has not been altogether satisfactory of late. The resignation of the secretary, Mr. Jeans, was also mentioned. The opportunity has been taken by the council, of Mr. Jeans's retirement, to introduce some modifications in the secretarial and editorial arrangements. Mr. Bennett H. Brough, an Associate of the Royal School of Mines, who has for some time past been an assistant professor at the Royal College of Science, has been appointed to the office of secretary and editor to the institute.

Sir Frederick Abel next evacuated the presidential chair, which was then occupied by Mr. E. Windsor Richards, the new president. Mr. Richards is an excellent representative of the practical steel manufacturer, having been engaged in the iron and steel trades all his life. He was for some time manager at the important steel works at Eston in Middlesborough. Some time ago he vacated his position there to take the management of the Lowmoor Iron Works, an establishment almost classical in its antiquity, in an industry which has been so entirely reformed within the last few years. Lowmoor, however, keeps to its old traditions and still produces best Yorkshire iron in the manner practised from a period extending back into the early days of iron manufacture, and this in spite of the improvements and advances made in the manufacture of mild steel. Mr. Richards having been conducted to the chair, at once proceeded to deliver his inaugural address. One of the most important parts was his reference to the remarkable extent to which English steel is made from foreign ore. It is, of course, unnecessary to state at any length the reason for this, as the fact must be well known to nearly all our readers. The iron ores of Britain, upon which our engineering supremacy was so long supposed to rest, is, with some not very important exceptions, unfitted for the production of ingot iron, more generally known as Bessemer, or mild steel. The chief reason for this is the considerable percentage of phosphorus it contains. We have, however, in Lancashire and Cumberland, hæmatite ores which are of a suitable description, but these are not so largely worked as at first might be thought they would be, and the bulk of hæmatite ore required for steel making in England is brought from Bilbao, in North Spain. It has been generally thought of late that these deposits are being rapidly exhausted, and though the use of calcium will perhaps somewhat extend the life of the supply, the end may be sufficiently near to the present time to make it worthy of the serious consideration of steel makers. In the basic process, there is, however, a means by which our native phosphoric ores can be rendered suitable, to a large extent, for steel making purposes, and the successful working of the basic system is therefore a matter of national concern. In England, the process has received serious opposition. Perhaps we have been over-conservative in this matter; or perhaps, on the other hand, we have displayed no more than salutary caution. However this may be, the Germans have gone far ahead of us in the production of basic steel. Germany, like England, has large deposits of phosphoric ore and, unlike England, has not that free sea communication with Spain, which has rendered the importation of hæmatite ores a matter of little difficulty and small expense. It was natural, therefore, that Germany should take hold of the new system with less caution and more vigour than the English steel makers, but the result has been somewhat antagonistic to English interests. Mr. Windsor Richards, in his presidential address, told us that the west coast of England has raised 2¾ million tons of ore, free from phosphorus, and could probably increase that quantity to produce 1½ million tons of pig iron, should the demand arise. During the twelve months ending December 1892, the quantity of basic steel made in England was 406,839 tons. In Germany and Luxemburg 2,013,484 tons of steel were made from phosphoric ores.

Mr. Windsor Richards is now, as we have said, an "ironman," which seems a curious thing in the present day, after he has held, perhaps the most important position of his time in the steel trade; however, there is yet a large demand for Lowmoor iron, and the old-fashioned methods of production are still in vogue. Of this he gave some very interesting particulars. The address dealt at some length with the question of over-production, and it seems pretty evident that our facilities for making steel are far ahead of the demand for the material. In spite of this money is still being expended in steel-making plant, although so large a part of that already existing is at present lying idle, and appears likely to do so. The year 1892 was in many respects one of the very worst the iron and steel industry has ever known.

The two papers by Mr. Stead and Mr. Saniter on the elimination of sulphur from iron, were contributions of great value. The subject is one of very considerable importance, and fortunately has been occupying the attention of metallurgists for some time past. It would be impossible for us, in a brief notice of this kind, to give an abstract of these two papers; indeed they are only complementary to papers already read by the authors at former meetings. Calcium chloride is the purifying material in admixture with lime, and the process is adapted, either for purifying fluid iron or pig iron direct from the blast furnace. The process is effected by running the fluid metal into a ladle having a layer of the purifying materials on the bottom, and afterwards running the metal into pigs or plate metal for subsequent use in the puddling process; or the crude sulphury pig may be treated in the basic Siemens furnace or Bessemer converter, with the desulphurising mixture. About ½ cwt. of crude calcium chloride is used per ton of steel, in conjunction with an excess of lime above that which is usually employed; the cost of the calcium chloride is about 35*s.* per ton. About 70 per cent of sulphur can be removed from the charge of metal in an open hearth furnace by this process. It may be added that the process is in practical working at Wigan. What we have already said with regard to dephosphorisation of ore in its bearing on the use of our native ores also applies, to a great extent, to desulphurisation, and although Mr. Saniter does not stand alone in the introduction of a desulphurising process, there is no doubt that he has rendered this country considerable service by his efforts in this direction. The reading of these two papers, together with the introductory business and the presidential address, occupied the whole of the Wednesday sitting, and the discussion on both papers was taken jointly on Thursday morning. The chief point raised was whether the process was one requiring such delicacy in manipulation that ordinary workmen could not be trusted to carry it out so as to produce uniform results. Whether this objection will be fatal time will show, but the general opinion appeared to be that by employing fairly skilled workmen the difficulties of manipulation were not such as could not be got over, and that fairly uniform results would follow reasonable care in working.

The next business was the reading of Prof. Roberts-Austen's paper on the recording pyrometer. It will be remembered that at the annual meeting of two years ago, Prof. Roberts Austen gave a description of the Le Chatelier pyrometer, and the application of it, which he had introduced, by which it was adapted for recording work in blast furnace practice. The object of the present paper was to give some particulars of the most recent form of this recording pyrometer, which Prof. Roberts-Austen has devised. At the request of Mr. E. P. Martin, Managing Director of the Dowlais Iron Works, Cardiff, an instrument was made and put into operation as a means of recording temperature of the blast in an iron smelting furnace. The spot of light from the mirror of a galvonometer is thrown on sensitised paper, the paper itself being traversed at a uniform speed. In this way the record of temperature at all times is obtained. The author gave an instance of the value of the instrument. The blast to the furnace in question was supplied by a number of hot blast stoves on the ordinary regenerative principle. When the chequer work in a stove has been heated up sufficiently and the blast is first turned on for supply of the furnace, the temperature of the blast is naturally at its maximum. As the blast cools the chequer work, by abstracting heat from it, the temperature gradually falls, and it continues to decrease until it is considered desirable to re-heat the stove, and then a new stove is switched on. It will be seen therefore, that the temperature of the blast in the main, common to two or more stoves, will vary regularly, so that a curve on the diagram indicating temperature, will consist of a number of more or less steep inclinations; in fact, very much representing the teeth of a saw. That would be the normal inclination; occasionally, however, the gas valves leak, and then the stove may be receiving hot gases when it ought only to be passing air. The average temperature when this leaky stove is in use will naturally be higher than that due to another stove; in fact, it will be heated at the expense of the remaining number of the group. The result is antagonistic to regular working which is so much desired in blast furnace practice, and though the evil effect may be neutralised by the heat absorbing property of the large mass of material in the blast furnace—acting, as it were, as a fly-wheel for heat—the state of irregularity, if carried to excess, might be very harmful. It is also, of course, desirable that the blast furnace operator should know at the earliest time when his valves are going wrong; in fact, the whole system upon which the Cowper stove is based bears on the proper reversal of the blast. Prof. Robert Austen's apparatus fulfils the required conditions in supplying the knowledge required, and the invention cannot fail to be one of the greatest service to the metallurgist.

A paper by Mr. John Head on puddling iron was next read and was followed by a short discussion, after which the meeting concluded with the usual votes of thanks.

ROYAL GEOGRAPHICAL SOCIETY ANNIVERSARY MEETING.

THE anniversary meeting of the Royal Geographical Society held on Monday afternoon was, as we anticipated, exceptionally large and representative. The report of the council stated that the membership of the Society on the 1st of May was 3691 (including 22 ladies), a net increase of 166 fellows since May 1st, 1892, being the largest net addition to the membership of the Society since 1875. The total net income for the year was £93,000, and the expenditure £9012. In addition to the services performed to the fellows and the public by means of evening meetings, the use of the Map Room and Library and the publication of the *Geographical Journal*, twenty four intending travellers have received instruction in practical astronomy and route-surveying from Mr. Coles, and instruments have been lent to eleven travellers for use in all parts of the world.

In order to express disapproval of the words we italicise in the first paragraph of the report, which ran as follows:—

Membership.—The question of electing Ladies as Ordinary Fellows was considered by a Special General Meeting on April 24th, when it was decided in the negative by a considerable majority. The Council regard this vote (unless hereafter rescinded by a General Meeting) as conclusive against any further election of Ladies as Ordinary Fellows, *without prejudice to the* status *of those already elected.* They consider that, under the circumstances, all the legal expenses incurred in connection with this important question may equitably be defrayed by the Society, and they have accordingly provided for their being so defrayed.

Mr. Dibden, seconded by Colonel Montague, moved the rejection of the report, but on a division being taken the report was accepted by a large majority. The medals and other awards for the year were then presented as follows:—

The Founder's Medal, to Frederick Courtney Selous, in recognition of his extensive explorations and surveys in British South Africa. The Patron's Medal, to W. Woodville Rockhill, for his travels and explorations in Western China, Kokonor, Tsaidam and N.E. Tibet. The Murchison Grant for 1893, to Mr. R. W. Senior, who, for several years in succession, has carried out a most laborious duty in the higher ranges of Kulu and Lahaul, Punjab Himalayas, and the results achieved in point of accuracy, expedition, and amount of work done, have been exceptional in the face of great hardships and great physical difficulties. The Gill Memorial, to Mr. Henry O. Forbes, for his explorations and natural history observations in New Guinea, the Malay Archipelago, and the Chatham Islands. The Cuthbert Peek Grant, to Mr. Charles Hose, for explorations and natural history observations and collections in Sarâwak, North Borneo. Six prizes of £5 each, and eight of books, given by the Royal Geographical Society to Students in Training Colleges for 1893, were presented to the successful candidates who were introduced by Mr. Mackinder.

A ballot was then taken for the election of officers and council for the ensuing year, and the list proposed by the council was, as usual, adopted. The new president is Mr. Clements R. Markham, F.R.S., and the vice-presidents are the Hon. G. C. Brodrick, Sir Joseph Hooker, F.R.S., Sir John Kirk, F.R.S., Dr. W. T. Blanford, F.R.S., General R. Strachey, F.R.S., and Captain W. J. L. Wharton, F.R.S.

Sir M. E. Grant Duff, the retiring president, then read the anniversary address on the progress of geography, in which he summarised the various activities of the Society. In the course of this he said that during the four years in which he had the honour to be president, he had seen the number of Fellows increase by three hundred and fifty-eight, and they were now close upon three thousand seven hundred. Before long the Society would have to take into the most serious consideration the acquisition of a new domicile. "Our constantly increasing collections would of themselves, as I have pointed out before, ere long drive us from our present quarters, and we have, in addition, reason to believe that even if we could extend our borders where we now are, on anything like reasonable terms, which we cannot, certain changes in the streets in this part of the town would ere long improve us off the face of creation. Then, although the University of London has been most kind to us in lending us their theatre, and although the character of our papers and of our publications, as well as our position as the leading geographical society of the world make us, I think, not unworthy recipients of the kindness of a university, whose operations extend over the whole of the British Empire, we cannot look forward to the present state of things continuing for an indefinite period. A vote of the Senate might at any time put an end to it."

An epitome of the year's exploration—which has been sufficiently recorded in our "Geographical Notes" from week to week—concluded the address, which was received with great applause. On the motion of Lord Northbrook, seconded by Sir John Lubbock, an enthusiastic vote of thanks was passed to the retiring president, who briefly replied.

At this stage a controversy regarding the question of the admission of women to the Society was started, and after some spirited speaking, the leading opponents of the recent action of the council stated that they were perfectly prepared to concur with the wishes of a majority of the Society as ascertained by means of a *plébiscite*, or a special general meeting to be convened at an early date.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The number of entries for the Honour School of Natural Science this year is 41, which compares favourably with past years, the highest number of candidates who obtained a place in the class list in any previous year being 31 in 1891 and 1886. There are also 51 candidates for the preliminary examinations in Science. Comparing these numbers with those of the candidates in other subjects, we find Literæ Humaniores 136 candidates, History 108, Law 70, Theology 65, and Mathematics 14. Of the 41 candidates who seek Honours in Natural Science 5 offer Physics, 21 Chemistry, 13 Animal Physiology, 1 Botany, and 1 Geology. It is remarkable that there is no candidate offering Animal Morphology.

It is understood, although it is not yet officially announced, that Merton College will give a biological Fellowship in October next, the examination for which will be held at the end of September or early in October.

A meeting of the demonstrators and assistants at the Museum was held on Saturday last to discuss their position as regards the rest of the University, and it was decided to memorialise the Visitatorial Board on the subject.

CAMBRIDGE.—Prof. Foster will deliver the Rede Lecture in the Senate House on June 14 at noon. The subject of the lecture is "Weariness."

Mr. F. Darwin, Deputy Professor of Botany, announces two courses of lectures, to begin during the ensuing Long Vacation, an elementary one by Mr. Willis, of Caius College, and a more advanced course by Mr. Wager, of the Yorkshire College, Leeds.

The Special Board for Medicine have issued new schedules in Physics and Elementary Biology for the First M.B. Examination. In regard to the former a practical examination in Experimental Physics is for the first time explicitly included in the scheme.

By means of the bequest of £300 to the University by the late Mr. Henry Tyson, of Kendal, a gold medal in Mathematics and Astronomy has been founded. The award will be made on the results of the examination for Part II. of the Mathematical Tripos.

The Engineering Laboratory Syndicate have approved Mr. W. C. Marshall's plans for an engineering laboratory, and submitted them to the Senate for adoption. They propose that the most urgent needs of the Department of Mechanism shall be met by proceeding with such portions of the work as it may be possible to execute with the funds at their disposal. About £3500, in addition to the amouut already subscribed, will be required to complete the building, and a further expenditure of not less than £1000 on necessary apparatus should follow. The Syndicate trust that the development of the school may not be long delayed for want of these sums.

The Tripos Examinations Syndicate have put forward a scheme by which nearly all the Triposes will begin after the last Sunday in May, and the Honours lists will be published by the end of June. This will involve the postponement of the general admission to the B.A. degree until the first week of July, which falls in the Long Vacation. The proposal is only tentative, and it will inevitably give rise to animated discussion.

Mr. E. W. MacBride, Scholar, of St. John's College, has been nominated to occupy the University's table at the Plymouth Marine Biological Laboratory in June.

Honorary degrees are to be conferred on the Maharajah of Bhaonagar, Lord Herschell (as Chairman of the Governors of the Imperial Institute), and Lord Roberts of Kandahar and Waterford; Prof. Zupitza, the eminent philologist, and Mr. Standish Hayes O'Grady, the Celtic scholar, are to be similarly honoured.

SCIENTIFIC SERIALS.

The Quarterly Journal of Microscopical Science for April, 1893, contains:—Description of a new species of Moniligaster from India, by W. Blaxland Benham (Pl. xxxii. and iii.). The species is from the Nilgiris and is named *M. indicus.*—Note on a new species of the genus Nais, by W. Blaxland Benham (Pl. xxxiii.). The worm was found in a ditch in the neighbourhood of Oxford; it is of a dull brownish colour, about a quarter of an inch in length, and is called *N. heterochæta*, from the fact that of the normally two chætæ in the dorsal bundles one is of a "crochet" shape, the other is capilliform.—On a new organ in the Lycoridea, and on the nephridium in *Nereis diversicolor*, O. F. Muell., by E. S. Goodrich (Pl. xxxiv. and xxxv.). The new organ consists of a pair of large, highly-differentiated, ciliated patches of cœlomic epithelium, which are found in every segment, except the first and the last few. These "dorsal ciliated organs" seem to occur throughout the Lycoridea, having been found in all the genera of that family examined by the author. Some notes on the minute structure of the nephridia of the Nereids are added.—On the nephridia and body-cavity of some Decapod Crustacea, by Edgar J. Allen, (Pl. xxxvi. vii. viii.). 1. The green gland of Palæmonetes (and Palæmon) at the time of the hatching of the larva has not developed a lumen. When the larva leaves the egg the lumen commences to open and the gland consists of an end-sac and a U-shaped tube, of which the distal portion gives rise to the bladder. The bladder then enlarges greatly, growing at first inwards towards the middle ventral line, then upwards, within the œsophageal nerve-ring and anterior to the œsophagus, to the middle dorsal line, where it meets its fellow of the opposite side. The two bladders grow backwards over the stomach and beneath the dorsal sac, subsequently fusing together in the middle line to form the unpaired nephro-peritoneal sac. 2. The shell-glands are the functional excretory organs at the time of the hatching and during the latter part of the embryonal period. They open at the bases of the second maxillæ, and each consists of an end-sac and a Y-shaped renal tube, which have the typical structure of a crustacean nephridium. 3. A dorsal sac, which is completely enclosed by an epithelial lining, persists in adults of Palæmon, Palæmonetes, and Crangon. 4. At its anterior end the dorsal sac is surrounded by a mass of tissue which appears to have the power of producing blood corpuscles. 5. The dorsal sac is formed as a hollowing-out in masses of mesoderm cells, which lie on either side of the cephalic aorta. 6. The body-cavity of these Crustaceans varies in different regions: (*a*) In the anterior part of the thorax it consists of a true cœlom (the dorsal sac and nephridia) and a hæmocœle; (*b*) in the posterior part of the thorax and in the abdomen, the body cavity is entirely a hæmocœle.—Note on the cœlom and vascular system of the Mollusca and Arthropoda, by Prof. E. Ray Lankester. A reprint of an abstract of an important paper read at the 1887 meeting of the British Association, and published in these pages (vol. xxxvii. p. 498). The author adds a request for specimens of Lernanthropus to enable him to complete his researches. Five species of this genus are recorded from the Mediterranean in Carus' "Prodomus Faunae Mediterraneæ."—Contributions to a knowledge of British marine Turbellaria, by F. W. Gamble (Pl. xxxix.-xli.), records 71 species, of which 28 are now added to the British fauna. Plate xxxix. contains coloured figures of ten species.—Peculiarities in the segmentation of certain Polychætes, by Florence Buchanan (Pl. xlii.).—Review of Bolsius' researches on the nephridia of Leeches by A. G. Bourne.

In the notice of the January number of the *Q.J.M.S.* the too brief account of Mr. Arthur Willy's paper on the Protochordata is we regret deemed calculated to produce a mistaken impression; it should read "that the author in consequence of new observations on the Ascidians, found it necessary to repudiate the theory of van Beneden and Julin, as to the pre-chordal vesicle of Ascidians and Amphioxus, which he had previously, without having made personal observations on the Ascidians, provisionally adopted."

THE number of the *Nuovo Giornale Botanico Italiano* for April contains three papers:—Sig. S. Sommier gives the results of a botanical tour in the region of the Lower Obi, in Siberia, including lists of the flowering plants, Vascular Cryptogams, Muscineæ, Lichens, Fungi, and Algæ obtained. A new species of fungus is described, *Helotium Sommierianum*, parasitic on *Lycopodium clavatum*. Dr. N. C. Kindberg contributes a list of mosses gathered in Southern Switzerland and Italy. Dr. E. Baroni gives measurements of the pollen-grains of various species of *Papaver*, *Chelidonium*, and *Eschscholtzia*.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 4.—"On the Thickness and Electrical Resistance of Thin Liquid Films." By A. W. Reinold, M.A., F.R.S., Professor of Physics in the Royal Naval College, Greenwich, and A. W. Rücker, M.A., F.R.S., Professor of Physics in the Royal College of Science, London.

The paper gives an account of experiments made for the purpose of determining the thickness of black soap films formed of solutions of varying composition. Two methods of experiment were employed: (1) an optical method, in which the mean thickness of about 50 plane black films contained in a tube was deduced from observations of interference phenomena; and (2) an electrical method, in which the thickness of a cylindrical black film was derived from a measurement of its electrical resistance. The optical method involves the assumption that the refractive index of a thin film of liquid is the same as that of a large quantity of the same liquid.

Reasons are given for the belief that the refractive indices in question, if not identical, differ only slightly, and hence that the thickness of a film as determined by the optical method is the true thickness.

In the electrical method the assumption is made that the specific conductivity of a liquid does not alter when the liquid is drawn out into a thin film.

If the results obtained by the two methods agree, the conclusion is that the specific resistance of a film is not affected by its tenuity; if they differ widely from each other, a change in the specific conductivity of the liquid must have taken place.

The authors showed, in 1883, that for a solution of hard soap containing 3 per cent. of KNO_3, with or without the admixture of glycerine, the mean thicknesses of black films, as measured by each of the two methods, were in close agreement. For such solutions, then, the specific conductivity is the same whether the liquid be examined in considerable bulk or in the form of a film $12\mu\mu$ in thickness. The accuracy of this result has been confirmed by a large number of observations made during the last three years.

If the proportion of KNO_3 added to the solution be diminished, the thickness of a black film, whether measured optically or electrically, is found to undergo a change.

The results obtained by the optical method show that

(1) For a given solution of hard soap the thickness of a black film increases as the percentage of KNO_3 is diminished, being $12 \cdot 4\mu\mu$ for a 3 per cent. solution, and 22·1 for a solution containing no salt. This is confirmed by experiments on soft soap.

(2) When no metallic salt is dissolved in the solution the thickness of a black film increases as the strength of the soap solution diminishes. The thicknesses are 21·6, 22·1, 27·7, and $29 \cdot 3\mu\mu$ when the proportions of soap to water are respectively 1/30, 1/40, 1/60, 1/80.

(3) If the solution contain 3 per cent. of KNO_3, variation in the proportion of soap dissolved produces very little change in the thickness of a black film.

Electrical Method.—It has been stated that for a soap solution containing 3 per cent. of KNO_3 the thickness of a black film as measured electrically is practically the same as that measured optically. If, however, the proportion of KNO_3 be diminished, the thickness (measured electrically) increased in a far larger ratio than would be inferred from the optical method. If the proportion of salt be diminished to zero, the thicknesses thus calculated are much greater than the greatest thickness at which a film can appear black. In such cases, therefore, the electrical method does not give the true thickness of the black, and the hypothesis that the specific conductivity of the film and of the liquid in mass are identical is untenable.

The following table shows the change in apparent thickness due to diminution in the quantity of dissolved salt:—

Hard Soap.

Percentage of KNO_3.	3	2	1	0·5	9
Mean apparent thickness of black film (measured electrically)	10·6 ...	12·7 ...	24·4 ...	26·5 ...	154

The large value obtained for the apparent thickness in the case of the unsalted hard soap solution is confirmed by experiments on a solution of unsalted soft soap, which gave a mean apparent thickness of $162\mu\mu$.

In different films the measured thicknesses of the black differ widely from each other, the limits being roughly $8 \cdot 3\mu\mu$ and $230\mu\mu$. This large variation is due in some cases, at all events, to a real variation in the thickness. Two different shades of black are (in cases where the solution contains little or no salt) frequently seen in a film. They are separated from each other by a line of discontinuity which is irregular in shape. Comparative measurements on the two shades of black have been made, and the results indicate that the electrical thicknesses of the two kinds of black are approximately as 2 : 1.

The results of numerous experiments carried out with the object of determining the *cause of the great increase in electrical conductivity in black films made from unsalted soap solutions* have shown that the increase of specific conductivity in question—

(1) Is independent of moderate changes of temperature.

(2) Is not due to the absorption or evaporation of water by the film.

(3) Is not due to change in the composition of the liquid by electrolytic decomposition produced by the current used to measure the electrical resistance of the film.

(4) Is not affected by a very large change in the quantity of CO_2 in the air around the film.

(5) Is practically unaltered if the films are formed in an atmosphere of oxygen.

The next question to be answered was whether the large changes in specific conductivity affect black films only, or whether similar phenomena can be detected in the case of thicker films.

The conclusions arrived at were (1) that the specific conductivity of a film increases as the thickness decreases, and (2) that this increase is less in the case of a film to which a salt has been added and is *nil* when the proportion of salt is as much as 3 per cent.

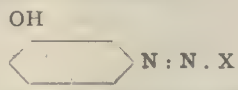
The paper concludes with a discussion as to the cause of the increase of electrical conductivity in thin films. The authors point out that it may be attributed either to a modification of the chemical constitution of the film brought about by its tenuity, or to the formation of a pellicle on the surface or to both causes combined.

Physical Society, May 12.—Prof. A. W. Rücker, F.R.S., President, in the chair.—A paper on the drawing of curves by their curvature, by C. V. Boys, F.R.S., was read, and demonstrations of the method employed given. Whilst giving a course of lectures on capillarity, in 1891, the author wished to explain the principles upon which the form of a water drop depended, and finding Lord Kelvin's rule (*Proc. R. Inst.*, Jan. 29, 1886) cumbersome, devised the modification now described. The construction depends on the fact that the total curvature is proportional to the hydrostatic pressure, *i.e.*, proportional to the depth below the plane surface of the liquid. To avoid the trouble of finding reciprocals, a rule was divided so that the distance from what would be the zero of the scale are the reciprocals of the numbers attached to them, and the curvature of an arc, being the reciprocal of its radius, can be read off immediately by the rule. To meet cases where the curvatures of surfaces are, in opposite directions, the zero, or ∞, is put at the middle of the rule and divided both ways. The chief gain depends on the abolition of cumulative errors due to compass settings, which is effected as follows: The rule is made of a thin slip of transparent celluloid with a small hole at the centre or ∞. A small brass tripod with needle feet is placed so that two feet just penetrate the paper and the third rests on the longitudinal straight line of the strip, which passes through the centre hole, thus forming a temporary but rigid centre about which the rule can rotate. A pen or pencil through the hole at ∞ traces out an arc whose curvature is equal to the reading of the scale where the needle point presses. When the rule crosses the axis of rotation of a generating curve, the numbers representing both curvatures are visible, and the position of the needle-point corresponding to a given total curvature can readily be found. A small arc is then drawn. Holding the strip firmly on the paper, the tripod is moved a little so that the sum of the two readings at the needle point and where the rule crosses the axis has the value corresponding to the position of the tracing point, and another arc drawn. Repeating the process, a very perfect and accurate curve results. Details for drawing nodoids, unduloids, catenoids, and other curves are given in the paper, and many beautiful examples, which had been executed by Miss Stevenson, were exhibited at the meeting. The author also pointed out that the locus of points about which the strip successively turns is the evolute of the curve drawn by the tracing point. Prof. Perry considered the method a new departure of great value. When he (Prof. Perry) drew the capillary surfaces of revolution in 1875, he found that cumulative errors produced considerable discrepancies. Prof. Greenhill said one would now be able to secure better diagrams of transcendental and other curves than heretofore, and he thought Mr. Boys' method would supplant the laborious processes now used to determine the paths of projectiles. Where the resistance varied as the square of the velocity the elevation for maximum range depended on the initial velocity, and for a cube law both elevation and range tend to finite limits as the initial velocity increases. Prof. Minchin inquired whether the catenary could be best drawn by using a scale of equal parts instead of one divided reciprocally. The President greatly appreciated the saving of labour effected by Mr. Boys' method, and thought the apparatus should be shown at the forthcoming exhibition of mathematical instruments in Germany.—Prof. O. J. Lodge, F.R.S., read a paper on the foundation of dynamics, in which he examines the objections raised by Dr. MacGregor (*Phil. Mag.*, Feb. 1893) against the views of Newton's Laws of Motion and the Conservation of Energy, expressed by the author in 1885. The first part of the paper treats of the nature of axioms. An axiom or fundamental law is regarded as a simple statement suggested by familiar or easily ascertained facts, probable in itself, readily grasped, and not disproved or apparently liable to disproof, throughout a long course of experience. On such bases the conservation of energy and of matter rests. Neither can be proved generally, but like other fundamental laws they fit into a coherent and self-consistent scheme, and are therefore worthy of acceptance until they are shown to be wrong. The second part relates to the first and third laws of motion. Dr. MacGregor objects to the first law on the ground that uniform motion is unintelligible unless its direction and velocity are specified with reference to a set of axes, and directly axes are introduced, difficulties occur as to their motion, because there is no satisfactory criterion of rest. Such notions the author deems artificial and unnecessary, except where it is required to define the absolute magnitude and direction of the motion. Reasoning from his own experiments, he believed the ether was at rest, for he had not found it possible to move it by matter. The first law, he said, had been considered unnecessary, as being only a particular case of the second. While admitting the latter fact, he maintained that its separate statement was desirable, on account of its simplicity, and its affording a practical definition of the mode of measuring time. As regards the third law being deducible from the first, he pointed out that if it could be axiomatically asserted that the centre of mass of a rigid system moves uniformly unless an external force acts on the system, then the third law follows. Newton apparently considered it best to state the third law as an axiom, but to many persons it is not obviously axiomatic (some engineers do not accept it), hence its deduction from the other two laws is useful. Part III. of the paper deals with the deduction of the law of conservation of energy from Newton's third law, and universal contact-action. Dr. MacGregor objects to the author's definition of energy as the name given to "work done," and contends that this definition assumes conservation. On this point Dr. Lodge invited criticism, meanwhile pointing out that his definition was analogous to the customary definition of the potential function, and a name for the line integral of a force considered as a quantity that can be stored. On the basis taken, two bodies can only act on one another whilst in contact, hence, if they move, they must move over equal distances; but their action consists of a pair of equal and opposite forces, therefore their activities are equal, and whatever energy one loses the other gains, *i.e.*, energy is transferred from one body to another without change in quantity. In Part IV. the dissipation of energy, the nature of potential energy, and the second law of thermodynamics, are considered. In discussing transference and transformation, "potential energy" is used to indicate the energy of a body under stress, and "kinetic energy," that due to sustained motion. Each corresponds to one of the factors of the product Fv, "activity." So long as one factor is absent no activity can manifest itself, but directly the missing factor is supplied, transference and transformation begin. This was shown to hold in an example of an air-gun with its muzzle plugged, chosen by Prof. MacGregor as an instance of transference of potential energy without transformation. The law of dissipation of energy is stated thus:—"If a body has any portion of energy in such a condition that it is able automatically to leave the body, that portion usually does so sooner or later." Instead of the ordinary form of the second law of thermodynamics the following statement is proposed:—"The portion of energy which a body can automatically part with is alone available for doing work." In discussing this subject the author points out that the common notion that heat engines are much less efficient than water or electric engines is a mistake, arising from the fact that in the one case the efficiency is calculated on the total energy, whilst in the latter cases only the available energy is considered. Two appendices accompany the paper, one the objectivity of energy and the question of gravitation, and the other on more detailed discussion of the transmission of energy in difficult cases.

Chemical Society, May 4.—Dr. Armstrong, President, in the chair.—The following papers were read:—The hydrates of sodium, potassium and lithium hydroxides, by S. U. Pickering. By cooling solutions of sodium hydroxide, the author has succeeded in isolating a number of crystalline hydrates; their formulæ and freezing-points are given in the following table:—

$NaOH, H_2O$	freezes at	64·3°
$NaOH, 2H_2O$	,, ,,	12·5
$NaOH, 3·11H_2O$	,, ,,	2·73
$NaOH, 3·5H_2O$	,, ,,	15·55
$\alpha NaOH, 4H_2O$	,, ,,	7·57
$\beta NaOH, 4H_2O$	,, ,,	− 1·70
$NaOH, 5H_2O$	,, ,,	−12·22
$NaOH, 7H_2O$	,, ,,	−23·51

The hydrate containing 3½ molecules of water is the only one of the eight which has been previously described. In the case of potassium hydroxide two new hydrates have been isolated; these have the formulæ KOH,H_2O and $KOH,4H_2O$, and freeze at 143° and −32·7° respectively. The previously known dihydrate freezes at 35·5°. Lithium hydroxide monohydrate, which was already known, was the only hydrate of this hydroxide isolated.—Detection of arsenic in alkaline solution, by J. Clark. Arsenic acid is not reduced to hydrogen arsenide by zinc dust and caustic potash, or even by sodium amalgam in alkaline solution. No trace of arsenic volatilises on heating sodium arsenate with a large excess of aluminium and caustic soda. The statement of H. Fresenius, that Gatehouse's modification of Fleitmann's test indicates arsenic acid, is hence erroneous; Fresenius's results are probably due to the use of impure aluminium or of arsenic acid containing arsenious acid. The author concludes that none of the methods hitherto proposed for the generation of hydrogen arsenide from alkaline solutions, are available for the detection of arsenic acid.—Improvements in Reinsch's process, by J. Clark. Although Reinsch's process is sensitive to minute quantities of arsenic, and removes all traces of that element from organic mixtures, there are two objections to its use in medico-legal cases. With small quantities of arsenic, the stain obtained is sometimes not easily identified, as the coated copper when heated is apt to give a sublimate of cupric chloride and organic matter instead of arsenious oxide; the method is also not suitable for quantitative estimations, as the whole of the arsenic cannot be volatilised from the copper by means of heat. The author's improvement on Reinsch's process consists in digesting the coated copper with cold caustic potash and hydrogen peroxide, and distilling with ferrous chloride and hydrochloric acid. The arsenic is precipitated in the distillate and weighed as sulphide, whilst any antimony present may be detected in the residual liquor.—The action of light in preventing putrefactive decomposition and in inducing the formation of hydrogen peroxide in organic liquids, by A. Richardson. Several observers have noted that the development of putrefactive organisms is checked by the combined action of sunlight and oxygen; this sterilising influence of light in presence of oxygen has apparently always been regarded as the outcome of an action exerted by the organism. The author has made a number of experiments with urine, in order to ascertain whether, when sterilisation has been effected by light, any oxidising agent, such as hydrogen peroxide, is formed, and whether such substance may not be the sterilising agent. No hydrogen peroxide is produced by the action of oxygen on sterilised urine in the dark, but an appreciable amount of the peroxide is formed on exposing such urine to light; the production of the peroxide is hence independent of the presence of organisms. Substances, such as manganese dioxide, which destroy hydrogen peroxide, greatly facilitate organic growth; the addition of hydrogen peroxide to fresh urine renders the liquid much less liable to change under the influence of organisms, whilst if added to urine in which fermentation has already set in, the peroxide is rapidly decomposed.—The supposed saponification of linseed oil by Dutch white lead, by J. B. Hannay and A. E. Leighton. The author shows that the statement made by several technical writers to the effect that white lead acts on the oil with which it is ground, is erroneous.—Notes on capillary separation of substances in solution, by L. Reed. The author has made experiments on the separation of salts in solution by selective absorption in bibulous paper, using a method differing somewhat from those employed by previous workers. If a drop of a fairly dilute aqueous salt solution is allowed to spread on bibulous paper, a pure water margin is obtained surrounding a sharply defined interior space containing stronger salt solution. The width of the exterior zone is apparently dependent on the nature and concentration of the solution employed; some solutions, such as those of chrome and ammonia alums, give no pure water zone.—Note on a meta-azo-compound, by R. Meldola and F. B. Burls. A comparison of meta-azo-compounds of the formula



where X is an *unsubstituted* hydrocarbon radicle, with the corresponding ortho- and para- series, would be of interest as throwing light on the question of the constitution of organic colouring matters, the "quinonoid" bonds not being present in the meta-compounds according to the present method of formulation. The authors have hence prepared metaphenolazo-α-naphthylamine with the intention of converting it into naphthaleneazo-metaphenol; they have not yet isolated the latter substance and are therefore extending the investigation to other compounds of the same series.—The influence of moisture in promoting chemical action. Preliminary note, by H. B. Baker. The author has continued his investigations on the influence of moisture on chemical action. Ammonia was dried as completely as possible by freshly ignited lime; on then subjecting it to the action of phosphoric anhydride very little of the gas was absorbed. Hydrogen chloride was dried first by sulphuric acid and finally by a week's contact with phosphoric anhydride. On mixing ammonia and hydrogen chloride, dried in this way, *no ammonium chloride fumes were produced* and no contraction was indicated by the mercury gauge attached to the apparatus: it may therefore be concluded that ammonia and hydrogen chloride do not combine when dry. Union at once occurs, however, on introducing a small quantity of moist air. In like manner sulphur trioxide was found not to unite either with lime, barium monoxide, or copper oxide. Furthermore, no brown fumes were produced on mixing dry nitric oxide with dry oxygen.—The genesis of new derivatives of camphor containing halogens by the action of heat on sulphonic chlorides, by F. S. Kipping and W. J. Pope. When the sulphonic chlorides derived from camphor recently described by the authors, are heated at temperatures not very far above their melting points, decomposition occurs and sulphur dioxide is evolved whilst haloid derivatives of camphor remain. In the case of camphorsulphonic chloride, a chlorocamphor melting at 137–138°, is thus obtained. From chlorocamphorsulphonic chloride, a well-crystalline dichlorocamphor melting at 118–119° is formed, whilst bromocamphorsulphonic chloride yields a compound which crystallises in long prisms and melts at 142–143°. These three derivatives of camphor appear to be different from any known compounds and their further study will, it is hoped, throw light on the complex question of isomerism in the camphor series.

May 5, Extra Meeting.—Dr. Armstrong, President, in the chair.—This being the anniversary of the death of Prof. A. W. von Hofmann, the President, after opening the proceedings with a short speech, called upon Lord Playfair, Sir F. Abel and Dr. Perkin to deliver addresses commemorative of Hofmann and his work.

Anthropological Institute, May 9.—Prof. A. Macalister, President, in the chair.—Mr. C. Dudley Cooper exhibited and described the skull of an aboriginal Australian.—A paper by Mr. Charles Hose on Borneo was read. The Baram District, with which the author was most intimately acquainted, is situated in the Northern portion of Sarawak, and the races inhabiting it may divided into four sections:—(1) The low country people and the inhabitants of the coast; (2) the Kayans and Kenniahs, inhabiting the head waters of the Baram River and its tributaries; (3) the Kalabits, living inland; and (4) the Punans, no nomadic tribes, found at the head waters of all the great rivers in Central Borneo. Each of these four divisions comprises a number of sub-divisions speaking different dialects, which can, however, be traced to the same origin. All the various races, except the Punans, employ dogs in hunting. The houses usually stand about twenty feet above the ground supported by huge posts of hard wood; they are some four hundred yards in length, and often hold more than a hundred families. In times gone by the first post put into the ground was passed through the living body of a slave—usually a young girl—but wild animals are now used instead of human beings for this purpose. Mr. Hose exhibited and described a large collection of native implements, weapons, and other objects, and the paper was further illustrated by a number of photographic views shown by the limelight.—Prof. Macalister exhibited a skull from North Borneo.—Mr. F. W. Rudler exhibited a wooden fire syringe from the Malay Peninsula, with a bean tinder box.—Mr. R. G. Leefe contributed a paper on the nivates of Tonga.

Geological Society, May 10.—W. H. Hudleston, F.R.S., President, in the chair.—The following communications were read:—The felsites and conglomerates between Bethesda and Llanllyfni, N. Wales, by Prof. J. F. Blake. The author brought forward fresh evidence in support of the views he had previously expressed as to the Cambrian age of these felsites, and as to the unconformity of the conglomerates on the purple slates. A new tunnel-section at Penrhyn Quarry was described, in which felsite was followed by St. Ann's Grit with a conglomerate-band, and there lying in the midst of the Cambrian series. After a word or two on the conglomerate on Moel Rhiw-wen, the sections on either side of Llyn Padarn were discussed in detail, and it was shown that the distribution of the rocks on the surface of the country could only be explained by the unconformable position of the conglomerates and grits, which, moreover, lie nearly horizontal. After a discussion of the conglomerates of Bettws-Garmon, a detailed section of the adit at Moel Tryfaen was given, in which it was shown that there was only a 3 ft. 6 in. band of conglomerate next the purple slates, followed by 1350 feet of banded slates and laminated grits with four distinct intercalated bands of felsite; and it was argued that the conglomerate on the summit, 55 yards across, could scarcely be represented by this thin band. Finally, the distribution of rocks on Mynydd-y-Celgwyn was shown to be satisfactorily explained by unconformity. Incidentally it was mentioned that a band of rock in the felsite at Llyn Padarn, which had been considered to be a deposited slate, was in reality an intrusive igneous rock. The conglomerates described were considered to be an overlap of the Bronllwyd Grit. The reading of this paper was followed by a discussion, in which the President, Prof. Hughes, Mr. Rutley, Mr. Marr, and the author took part.—The Llandovery and associated rocks of the neighbourhood of Corwen, by Philip Lake and Theo. T. Groom. The area described forms a part of the northern slope of the Berwyn Hills, and stretches along the southern bank of the Dee from Corwen to Pen-y-glog. The beds of the Berwyns are here thrown into a series of folds which run nearly E.-W.; and the northerly limbs of these folds are long and low, while the southerly limbs are short and steep. The folds are cut through by a number of faults which run nearly E.-W., generally along the crests of the anticlinals, and these invariably throw down towards the north. The southern bank of the Dee Valley is here formed by these faults. A second series of faults running about 20° W. of N. to 20° E. of S. is of later date. One of these, near Corwen, presents some peculiar features, since its downthrow in some places is on the east and in others on the west. The lowest beds present are bluish slates, with numerous Bala fossils. These are succeeded immediately by the Corwen Grit of Prof. Hughes. No fossils have been found in this at Corwen; but in a grit occupying a similar position at Glyn Ceiriog numerous fossils have been discovered. The Corwen Grit is succeeded by grey slates with grit-bands; and in Nant Cawrddu, near Corwen, and Nant Llechog, near Pen-y-glog, these slates are followed by banded black shales containing numerous graptolites of the *Monograptus gregarius*-zone. Above these are pale bluish slates; and nothing further is exposed till we reach the Tarannons. The Corwen Grit clearly forms the base of the Llandovery in this area, as suggested by Prof. Hughes. Some remarks were made on this paper by the President, Prof. Hughes, Mr. Groom, and Prof. Lapworth. Mr. Lake briefly replied.

Zoological Society, May 16.—Osbert Salvin, F.R.S., Vice-President, in the Chair.—Extracts were read from a letter addressed to Prof. Newton, F.R.S., by Prof. E. C. Stirling, of Adelaide, respecting the recent discovery of a large series of remains of *Diprotodon*, *Phascolomys*, and other Mammals at Lake Mulligan, in South Australia, about 600 miles north of Adelaide. It was anticipated that when these remains were received and examined very important additions to our knowledge of the extinct Mammal-fauna of Australia would follow.—Mr. Beddard, F.R.S., read a paper upon the structures termed "atrium" and "prostate" in the Oligochætous worms, in which reasons were given for believing that all these structures were reducible to one common plan.—Mr. G. B. Sowerby read the descriptions of fifteen new species of shells of the family Pleurotomidæ from different localites.—A communication was read from Mr. A. H. Everett, containing a revised list of the Mammals inhabiting the Bornean group of Islands, that is, Borneo, and Palawan, which, as Mr. Everett had shown in a previous paper, belongs zoologically to Borneo.—Mr. O. Thomas read a paper containing an account of a second collection of Mammals sent by Mr. H. H. Johnston, from Nyasaland. The present series (collected, like the former, by Mr. Alexander Whyte), consisted of about 75 specimens, referable to 30 species, of which a large proportion were additional to the fauna of Nyasaland.—Dr. P. Sonsino, of Pisa, read some notes on specimens of parasitic worms of the genus *Distomum*, of which he had lately examined specimens.

Royal Meteorological Society, May 17.—Dr. C. Theodore Williams, President, in the chair.—The following papers were read:—Mean daily maximum and minimum temperature at the Royal Observatory, Greenwich, on the average of the fifty years from 1841 to 1890, by Mr. W. Ellis. The author gives tables of the mean maximum and mean mimimum temperature of the air on each day of the year, and also tables showing the daily range of temperature and the mean of the daily maximum and minimum values.—Suggestions, from a practical point of view, for a new classification of cloud forms, by Mr. F. Gaster. The forms assumed by clouds at different levels and under various conditions have recently received considerable attention from meteorologists. The author, however, does not approve of the nomenclatures and classifications which have been proposed, as, in his opinion, they appear to be little, if any, better than the older ones they were intended to replace. He now proposes a somewhat different classification, arranging the clouds according to altitude under the following headings:—(1) Surface clouds, or those which appear commonly between the earth's surface and a level of about 2000 feet; (2) Lower medium clouds, including all varieties which usually float at an elevation ranging from 2000 to about 10,000 feet; (3) Higher medium clouds, or those commonly found at altitudes varying from 10,000 to about 22,000 feet; (4) Highest (or cirriform) level clouds, or those at elevations exceeding 22,000 feet. The author gives the names of each variety of cloud included in the classification, together with an account of the principal characteristics of each as far as appearance goes.—Notes on winter, by Mr. A. B. MacDowall. In this paper the author discusses the question of periodicity in winter at Greenwich and Paris, and the relation of summers to winters.

PARIS.

Academy of Sciences, May 23.—M. Lœwy in the chair.—The Permanent Secretary announced the death, at Berlin, of Herr Kummer, Foreign Associate, and M. Hermite gave a review of the work of the celebrated geometrician. Herr G. Wiedemann was elected correspondent for the section of physics, in the place of Herr W. Weber, deceased.—On the kinetic theory of gases, by M. H. Poincaré. A correction of Maxwell's proof of the law of adiabatic expansion.—Note by M. Berthelot, accompanying the presentation of his work, "On the Chemistry of the Middle Ages."—On some rare or new natural phosphates; brushite, minervite, by M. Armand Gautier. A new lime and alumina phosphate was found among the concretionary phosphates of the *Grotte de Minerve*. Microcrystalline like most of these substances, soluble in dilute mineral acids, in weak potash lie, and in alkaline ammonium citrate, except a slight clayey residue, it has a different composition from the other natural aluminium phosphates, and has been called Minervite to recall its place of discovery.—Determination of the water contained in soil carrying various crops after a period of great drought, by M. Reiset.—Observation of the total solar eclipse of April 16, 1893, made at Joal (Senegal), at the observatory of the expedition of the Bureau des Longitudes, by M. G. Bigourdan.—On the investigation of the solar corona apart from total eclipses, by M. H. Deslandres.—On a highly sensitive manometric apparatus, by M. Villard.—The heat spectrum of fluorspar, by M. E. Carvallo.—Dynamical phenomena due to the residual electrification of dielectrics, by M. Charles Borel.—On chloroborate of iron and on a method of preparing chloroborates isomorphous with boracites, by MM. G. Rousseau and H. Allaire. The method consists in letting a volatilised metallic chloride act at a red heat upon natural calcium borate or upon borosodiocalcite. In the case of iron, the product obtained corresponds sensibly to that of a boracite in which the magnesium has been replaced by iron, according to the formula $6FeO.8B_2O_3.FeCl_2$. The chloroborate of iron crystallises in transparent cubes of a greyish colour, which act upon polarised light. This optical property shows that these crystals, like those of natural boracite, present a pseudo-cubic symmetry. They dissolve slowly in nitric acid and are rapidly disintegrated by fused alkaline carbonates.—On the heat developed in the combination of bromine with some unsaturated substances of the fatty series, by MM. W. Louguinine and Irv. Kablukov. Calorimetric determinations carried out in the cases of trimethylethylene, hexylene, diallyl, allyl alcohol, and allyl bromide led to the following conclusions: The heat developed by their combination with bromine increases as one proceeds upwards in the homologous series. The presence of an atom of Br replacing H in the unsaturated hydrocarbons mentioned, considerably reduces the rapidity of the addition reaction of the bromine. In presence of the OH group the addition reaction ceases to be sharply defined and is accompanied by a substitution reaction.—On licarhodol derived from licareol, by M. Ch. Barbier.—Action of sodium sulphite upon the amidophenol salts; new method of obtaining amidophenols from their salts, by MM. Aug. Lumière and A. Seyewetz.—Ptomaïn extracted from urines in eczema, by M. A. B. Griffiths.—On δ-achroglobine, a respiratory globuline contained in the blood of certain Mollusca, by M. A. B. Griffiths. In addition to the α-achroglobine extracted from the blood of Patella, the β variety from the Chitons, and the γ variety from the Tunicata, a fourth variety, δ-achroglobine, has been discovered in the blood of certain species of Doris. 100 grammes of this substance absorb 125 cc. of oxygen at 0° and 760 mm. Its empirical formula is $C_{659}H_{792}N_{165}SO_{153}$.—On the Plankton of the northern lagoon of Jan Mayen, by M. G. Pouchet. The island of Jan Mayen possesses two lagoons formed by fresh water due to the melting of the glaciers, and separated from the sea by narrow dykes of sand and shingle. The southern lagoon is of recent date. At the time of discovery it was an open bay. The northern lagoon was explored by the steamer *La Manche* in July 1892. By means of a fine net the central portion was tested for any surface life (Plankton) that might have escaped the Austrian expedition, which had failed to discover any. As the result of prolonged work a few species were found, including a Conferva, Infusoria allied to Paramecium and Actinophrys, a Tardigrade, a Copepod, and numerous Rotifers.—Dimorphism in the development of hemosporidia, by M. Alphonse Labbé.—On the scented mists observed on the coasts of the Channel, by M. S. Jourdain. These mists occur in spring under a northeast wind, and usually in the morning. The appearance is that of a bluish-grey vapour, and the smell that of lime-kilns. The air is very dry while they last. The author thinks that they are cosmic, not local phenomena.

BERLIN.

Physiological Society, May 5.—Prof. du Bois Reymond, President, in the chair.—Dr. Schmidt spoke on the colour-reactions of the excreta, whereby the mucin exhibits certain very characteristic and distinctive differences, as compared with proteids.—Prof. Fritsch exhibited a number of lantern-slides of the electric organs of Torpedo, Malapterurus, and Gymnotus, by which he had determined the structure of the giant ganglia, the axis cylinders which arise from these and are distributed to the electric organ and the protoplasmic prolongations, which either form a means of connection between neighbouring ganglia, or else resolve themselves into an anastomosing network.—Dr. Benda also exhibited projections of micro-photographs, in linear magnification of 2000 to 3000 diameters, of the testis of Salamanders in illustration of the formation and fate of the karyokinetic nuclear rods.

Meteorological Society, May 9.—Dr. Vettin, President, in the chair.—Prof. Hellmann presented the two first numbers of reprints of important papers on meteorology and terrestrial magnetism, which he is publishing with the support of the German Meteorological Society and the branch society in Berlin. No. 1 is a *fac-simile* of the earliest German work on meteorology: Weather-book by Rynmann, dated 1510. No. 2 is also a *fac-simile* of Bl. Pascal's celebrated research by which the existence of atmospheric pressure was first determined.—Prof. Börnstein spoke on the most recent theories as to thunderstorms, of which none supply a definite solution of the problems involved, and explained a simple form of apparatus by Elster and Geitel, in Wolfenbüttel, by means of which anybody can make observations on atmospheric electricity, and invited the co-operation of the members.—Dr. Kremser gave some notes on the dryness of last April. Whereas the average fall in Prussia for April is 30 to 50 mm., the fall for last month was only 10 mm. in the extreme east, falling to 1 mm. in the central region, and to 0 mm. in the west and south-west. In Berlin a measurable amount of rain fell on only one day, the 17th, amounting to 0·5 mm., so that this month was the driest recorded since observations were first made in Berlin. Up to the present time the driest month had been October, 1865, with a fall of 1 mm. The period of drought began as early as March 21 or 22, and in many parts of Prussia had lasted for forty days, being accompanied by absence of clouds and marked temperature amplitudes of 10° to 18°.—Dr. Less gave an account of the barometric conditions over Europe during the drought. They may be divided into three periods. In the first, at the end of March and beginning of April, the highest pressure lay over France and Germany, the lowest over Russia as far as the Ural Mountains. In the second period, the middle of April, the area of high pressure had moved over towards England, while the lowest pressure had extended to the centre of Germany. In the third period a flat area of lowest pressure situated over the Atlantic had driven the area of highest pressure once more towards central Europe.—Prof. Börnstein exhibited samples of the material used in the construction of the recently-destroyed balloon "Humboldt." This balloon had become ignited, accompanied by a violent explosion, while being emptied, without any definitely ascertainable cause. The speaker demonstrated how readily the outer surface of the material could be electrified by friction, and suggested that electricity had thus been generated, and had, as a spark-discharge, ignited the gas as it escaped. This source of danger could probably be removed by placing a few long metallic wires round the valve.

DIARY OF SOCIETIES.

London.

THURSDAY, June 1.

Royal Society, at 4.30.—On the Colour of Sky-light, Sun-light, Cloud-light, and Candle-light: Captain Abney, F.R.S.—Flame Spectra at High Temperatures; Part I., Oxyhydrogen Blowpipe Spectra: Prof Hartley, F.R.S.—Note on the Flow in Electric Circuits of Measurable Inductance and Capacity; and in the Dissipation of Energy in such Circuits: A. W. Porter.—On the Metallurgy of Lead: J. B. Hannay.—On the Motion under Gravity of Fluid Bubbles through Vertical Columns of Liquid of a Different Density: F. T. Trouton.

Linnean Society, at 8.—On Polynesian Plants collected by J. J. Lister: W. B. Hemsley, F.R.S.—On the Anatomy of a New Plant—Melastomaceæ or Gentianaceæ, Genus Novum: Miss A. Lorrain Smith.—Observations on the Temperature of Trees made in Boulder, Colorado: Dr. Baur

Chemical Society, at 8.—Azo-Compounds of the Ortho Series: Prof Meldola, F.R.S, E. M. Hawkins, and F. B. Burls—The Fluoresceïne of Camphoric Anhydride: Dr. Collie.—The Action of Phosphoric Chloride on Camphene: J. E. Marsh and J. A Gardner.—The Composition of Jute produced in England: A. Pears, jun.

Royal Institution, at 3.—The Geographical Distribution of Birds: Dr. R. Bowdler Sharpe.

FRIDAY, June 2.

Geologists' Association, at 8.—Consideration of the Principal Phenomena connected with Volcanoes: Dr J. W. L. Thudichum.

Royal Institution, at 9 Study of Fluid Motion by Means of Coloured Bands: Prof. Osborne Reynolds, F.R.S.

SATURDAY, June 3.

Royal Institution, at 3.—Falstaff—a Lyric Comedy by Boito and Verdi (with Musical Illustrations): Dr. A. C. Mackenzie.

Institute of Actuaries, at 3.—Annual Meeting. - Report of the Council for the Past Year and Election of Officers and Members of Council.

MONDAY, June 5

Society of Chemical Industry, at 8.—The Movement of Air as applied to Chemical Industries: H. G. Watel.—New Cellulose Derivatives and their Industrial Applications: C. F. Cross and E. J. Bevan.

Royal Institution, at 5.—General Monthly Meeting.

TUESDAY, June 6.

Zoological Society, at 8.30.—Notes on the Anatomy and Classification of the Parrots: F. E. Beddard, and F. G. Parsons.—On Two Horns of an African Rhinoceros: Mr. Sclater.—On some Bird-Bones from Miocene Deposits in the Department of Isère, France: R. Lydekker.—On the Osteology of the Mesozoic Ganoid Fish, Lepidotus: A. Smith Woodward.

Royal Institution, at 3.—The Waterloo Campaign: E. L. S. Horsburgh.

WEDNESDAY, June 7.

Geological Society, at 8.—The Bajocian of the Sherborne District; its Relations to Subjacent and Superjacent Strata: S. S. Buckman.—On Raised Beaches and Rolled Stones at High Levels in Jersey: Dr. Andrew Dunlop.

THURSDAY, June 8.

Royal Society, at 4.30.

Mathematical Society, at 8.—Complex Integers derived from $\theta^3-2=0$: Prof. G. B. Mathews.—Pseudo-Elliptic Integrals: Prof. Greenhill, F.R.S.

Royal Institution, at 3.—The Geographical Distribution of Birds: Dr. R. Bowdler Sharpe.

FRIDAY, June 9.

Physical Society, at 5.—A New Photometer: A. P. Trotter.—Notes on Photometry: Prof. S. P. Thompson, F.R.S.—The Magnetic Field near a Wire: Prof. G. M. Minchin.

Royal Astronomical Society, at 8.

Royal Institution, at 9.—The Recent Solar Eclipse: Prof. T. E. Thorpe, F.R.S.

SATURDAY, June 10.

Royal Botanic Society, at 3.45.

Royal Institution, at 3.—Falstaff, a Lyric Comedy by Boito and Verdi (with Musical Illustrations): Dr. A. C. Mackenzie.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—Year-Book of the Scientific and Learned Societies of Great Britain and Ireland (Griffin).—Graphic Arithmetic and Statics: J. J. Prince (Murby).—Erdbebenkunde: Dr. P. Hoernes (Leipzig, Veit).—Introduction a L'Electricité Industrielle—Potential, Flux de Force Grandeurs Electriques; Ditto, Circuit Magnétique;—Induction Machines: P. Minel (Paris, Gauthier-Villars).—The Theory of Telescopic Vision: E. M. Nelson (Dulau).

Pamphlets.—Wetterbüchlein von Wahrer Erkenntniss des Wetters: L. Reynman (Berlin, Asher).—Récit de la Grande Expérience de l'Equilibre des Liqueurs: B. Pascal (Berlin, Asher).—The New Priesthood: Ouida (E. W. Allen).

Serials.—Bulletin of the New York Mathematical Society, vol. 2, No. 8 (New York, Macmillan).—Internationales Archiv für Ethnographie, Band 6, Heft 2 (K. Paul).—Bulletins de la Société d'Anthropologie de Paris, tome troisième, iv. série, 4e Fasc.; Ditto, Nos. 2,3, 4 (Paris, Masson).

CONTENTS.

THURSDAY, JUNE 8, 1893.

THE ROYAL SOCIETY ELECTION.

HAD it not been for the unnecessary and indiscreet communication to the newspapers of a letter not intended for the public eye, the difference of opinion which made itself manifest at Burlington House last Thursday might have been settled in a purely domestic manner. As it was, it gave rise to comments which, in most cases, were as absurd as they were painful to the persons concerned. But the mischief is done and it would be affectation to deny that a question of considerable moment has been raised and one which will very probably provoke in the future a good deal of discussion and consideration. Clearly, therefore, it has to be faced, and I willingly accede to the wish of the Editor of NATURE to state why I think the policy of the dissentients should not be accepted by the general body of the Fellows of the Royal Society.

I say policy, because I think it must be obvious to every one that the matters involved go a good deal deeper than the personal interests which were at stake. And here I would say at once that looking at the names of the dissentients, it is impossible to suppose that those who proposed to reject the recommendations of the Council were animated by anything but perfect good faith, and a real desire to act in the best interests of the Royal Society. Though I entirely disagree with them, I say this with the more conviction as they were nearly all my own personal friends. The harshest thing I should be disposed to say of their action is that while it had the uncompromising honesty, it also had the unreasonable narrowness of a somewhat provincial point of view.

Every one will I suppose admit that in most administrative matters the English people are above all things practical and are little influenced by considerations of either logical order or of mere symmetry. The Royal Society appears to be a notable case in point. It is unlike any analogous institution, as far as I know, in the world. It is by no means a mere Academy of Science. Looked at historically and from the point of view of actual facts, it is seen to be an association of persons of "light and leading" who wish to promote the interests of science especially in so far as they are a matter of national concern. I use deliberately the rather hackneyed words "light and leading" as descriptive of the qualifications of its members. They fall in fact into the two categories; on the one hand they consist of the most competent experts in different branches of science and on the other of prominent men in the political and social world who are sympathetic to science and desirous of promoting its progress as an indispensable phase of our life and intellectual development as a nation.

Now it seems to me that the real importance of the proceedings of last Thursday was the attack which was virtually made and with some vigour on this position. The dissentients in their printed statement completely ignored its existence. I can only make the excuse for them which Dr. Johnson made when a lady asked him to account for a very palpable blunder in his dictionary. "Ignorance, ma'am, sheer ignorance." It seems therefore worth while to show that in including in the fifteen selected candidates a man of public distinction who was not a professional man of science the Council acted in accordance with well-established tradition and precedent which has not hitherto been seriously challenged.

In other countries where Government is constituted on more bureaucratic lines than it is in this, men of science associate themselves in bodies to which non-scientific members of the community have no access. Such bodies can address the state, and are doubtless listened to with the respect due to expert authority. But the reason is mainly because science under such conditions falls into line with general bureaucratic arrangements. In England the expert as such is more usually listened to with hesitation. It is my belief that if the Royal Society were simply constituted of professional scientific men, its influence in the country would be vastly diminished. Englishmen are distrustful of experts whom they think, and I must admit too often with justice, to be cramped in their general outlook and wanting in knowledge of the world. Furthermore Englishmen are curiously shy of what they don't comprehend. A purely professional Royal Society would be apt to be treated with a kind of ironical respect but otherwise severely left alone as a thing "no fellow can understand."

Now it may be asked reasonably, would this be a desirable state of things? I think it may be shown with little difficulty that in the interests of scientific progress in this country it would not. Consider for a moment the kind of work which the Royal Society does. In the first place, and I suppose the dissentients would say that this is its only proper function, it signalises and marks out those workers in science as to whose integrity and competence it has satisfied itself. But this might be done by a small and exclusive club, and though such a body would be distinguished, it would never enjoy the distinction which attaches to the Royal Society. That distinction rests on the fact that it possesses a quasi-official position in the State. It is therefore on the one hand able to approach the Government of the day with a recognised status and authority to speak; on the other hand it is the supreme scientific tribunal from which the Government can count on obtaining a perfectly impartial judgment on questions of importance to the community. Here it may be replied that a strictly-restricted scientific Academy could equally fulfil those functions. In any other country, I have already admitted that it may be so. But here again national peculiarities must be reckoned with. In this country most important Government business is in all essential features settled in a semi-official way. Preliminary *pour-parlers* ascertain what applications would be acceptable and what will be conceded to them. The official letters which are ultimately exchanged only put on record what has been previously negotiated. It is here that the presence of what I may call a sympathetic lay element in the Society is so invaluable. A statesman or public man by becoming a fellow has solemnly pledged himself to co-operate with his colleagues. A minister therefore who is an F.R.S. cannot refuse, in common courtesy, to lend his ear to representations to which as a politician he might be very willing to be deaf.

No doubt there was a time when this lay element tended to swamp the Society and to destroy its scientific prestige. But the Royal Society is not a thing of yesterday; and accumulated experience has shown the way to the present *modus vivendi* which appears to me to have given the maximum advantage to the scientific world over which the Society presides without the remotest possibility of injurious interference.

It may be well to consider in what this lay element consists. In the first place we have the Sovereign who was the Founder and is always the Patron and may in the future as in the past take an active part in the Society's proceedings. Next there are the Princes of the Blood any one of whom may at any time be summarily proposed for election. The original statutes provided that any one of the rank of Baron or higher should be qualified for election. That privilege was however abolished in the present century, no doubt as opening the door to the lay element too widely. But the privilege was retained for the Privy Council, a body which in its constitution is analogous to the Royal Society inasmuch as access to it can only be obtained outside the Royal Family by conspicuous ability independently of mere rank or birth. And it may be noticed that the analogy is drawn even closer by the recent admission to the Privy Council of a scientific element. Each body has in fact in relation to the State its own field of activity and functions. But they are often not very dissimilar. A committee of the one body may advise the Government on the constitution of a new university; a committee of the other may equally advise it on the methods of obviating explosions in mines. We may have a Privy Councillor discussing at Burlington House Marine Signals or Colour Vision, while a late president of the Society may be occupied at Whitehall in determining whether the Eternity of Future Punishment is a binding article of the English faith.

But besides members of the Privy Council it has been the custom time out of mind to elect into the Society as ordinary fellows men of conspicuous public position and merit, with the proviso, however, that they should in their careers have shown themselves sympathetic to science. Such elections, however, differ *in toto* from the honorary and merely complimentary degrees conferred by the Universities. Such men are brought into the Society, first, in recognition of their services to science, secondly, to confirm them in their interest in it, lastly, that their cooperation may be secured in the performance of the Society's public work. The Society in order to effectively accomplish that for which it exists must be in touch with other fields of national life; it requires and turns to good account its connections with society, with the legislature, with the bench, with Government administration. By including in their number a body of distinguished public men, the Fellows of the Royal Society are able to enormously enlarge their influence and to display themselves as reasonable if hard-headed men of the world, perfectly able to play their part in affairs which concern them on equal terms with those who make the conduct of affairs their only business and by no means as mere recluses in a laboratory. Can any more effective mode be imagined for removing from scientific men that suspicion of impracticable pedantry with which men of science are too often regarded by the uninformed?

In the face of these considerations which I had thought were part of the well-known traditions of the Society I confess that the hubbub of last Thursday somewhat amazed me. It was fought over a man who is preeminently of the kind that the Royal Society has been always willing to coopt. A man of singular modesty but vast learning, a scientific historian with the keenest sympathy for science, a member of the legislature who by his own unaided merit has acquired for himself a conspicuous position amongst the statesmen of the day. If the principle of the admission of laymen is admitted at all, who could be more suitable?

The simple fact is that there was nothing anomalous in the matter. Any one who has taken part in the selection of candidates by the Council will know that there is a regular category for lay candidates presented on their public form. The Council has to make up its list with due regard to the claims of every branch of science. But I think I cannot be far wrong if I assert that in most recent years it has been the practice to select on an average one layman annually. There are at least a dozen in the existing list and the obituary notices abound with them. It is perhaps invidious to mention names but I may single out of those living Sir Henry Barkly, Sir William Jervois, Sir John Kirk, Sir George Nares, Sir Bernard Samuelson, Sir George Verdon, Sir Charles Warren. Any of these men would probably disclaim any pretension to be considered a professional man of science. But each and all of them has rendered great services to it, and the recognition of this by the scientific world is the best way to get other distinguished public men to imitate their example.

If I have discussed the question at some length it is because it seems to me to be one of vital importance to the welfare of the Society. But the dissentients took a further step which if it were to become a precedent would be absolutely disastrous. They not merely proposed that one of the candidates selected by the Council should be rejected but without consulting him proposed that another whom the Council had not recommended should be elected. It is true that in their first circular the dissentients stated that the statutes of the Society left no other course open to them. This however is an entire mistake and I am afraid is rather characteristic of the want of due consideration which characterised the whole proceeding.

It appears to me, putting other considerations aside, unlikely that in so delicate a matter any five fellows can arrive at a sounder conclusion than the twenty-one who form the Council. Any fellow who has been a member of that body must have been struck with the frankness and impartiality with which the merits of the respective candidates are weighed and discussed. And so large a proportion of the Council is changed every year that it would be practically impossible for it ever to come under the control of any one party in the Society, if there be such a thing. It appears to me therefore that all presumption is in favour of the judgment of the Council and I think that experience has shown that in the vast majority of cases it has been exercised wisely.

It will be generally agreed that in no branch of science can those who follow it arrive at a correct estimate of the merits of those who work in other branches without the responsible evidence of men with the necessary technical knowledge. Now this testimony the Council both receives and has the opportunity of carefully sifting. Having arrived at a judgment accordingly, it appears to me that that judgment should not be lightly upset unless in the almost inconceivable case of its being utterly outrageous.

Councils have erred in the past, and I suppose the Council of the Royal Society cannot claim infallibility. It might be necessary therefore for the general body of fellows to correct its action. The election of a fellow is an irretrievable step. To oppose it is a grave but it may be a justifiable procedure. But to over-ride the Council's discretion in not selecting a particular candidate is a much graver one. Non-selection is not an irretrievable injury and if in any one year it may seem to inflict some injustice on a particular candidate its redress when justified by merit is not difficult of attainment on a subsequent occasion. But if a precedent were established for taking the matter out of the hands of the Council, peace and good feeling in the ranks of the Society would soon vanish. In time every election would be the occasion of a conflict and no one who valued his self-respect would care to serve on the Council. Nor is there any reason to think that any substantial gain would accrue. A man may be rushed to the front by a wave of temporary and emotional popularity. Such a man, if the fellows acquired the habit of meddling with the Council's prerogative of selection, might be forced prematurely upon the Society. In the long run it is not improbable that those who resorted to such a practice might live to regret their precipitancy. W. T. THISELTON-DYER.

VERTEBRATES OF ARGYLL AND THE INNER HEBRIDES.

A Vertebrate Fauna of Argyll and the Inner Hebrides. By J. A. Harvie-Brown and T. E. Buckley. (Edinburgh: David Douglas, 1892.)

PERTINACITY in an endeavour to carry out the results of a fixed idea has almost always been regarded as a virtue, even when the principle involved has seemed to be hopelessly mistaken, and thus the adherents of the Stuart and other lost causes still find sympathisers at the present day; but when none can doubt the value of the idea, the pertinacity with which it is supported, provided that obstinacy is left out, becomes a virtue that in these practical days is not easily exaggerated. Such pertinacity is conspicuously exhibited by the authors of the book before us, Mr. Harvie-Brown and his worthy coadjutor, Mr. Buckley. This "Vertebrate Fauna of Argyll and the Inner Hebrides" is the *fifth* of a series of volumes, the inception of which is vastly creditable to its founder, the gentleman first named, and to all concerned in its production—even to the printer's devil and the binder's apprentice. Some of its predecessors have before received notice in these columns;[1] but it has perhaps never been made clear to the readers of NATURE that this series of books is placing the zoology of the northern Kingdom on a footing which has not been attained, nor is likely to be attained in the southern part of the island, even though there exist particular English works—but this solely so far as ornithology is concerned—of merit superior to any one of the Scottish productions, the volume on Orkney, which is of remarkable excellence, being perhaps an exception. It is not difficult, however, to account to a considerable extent for this superiority: the proportion of persons with a taste for natural history to the general population being presumably the same in both parts of Great Britain, the enormously greater population of England would naturally furnish a larger number than Scotland is able to show. This is not said in derogation of the northern kingdom. It has always been rich in botanists; and, among zoologists, the single name of William Macgillivray is enough to cover it with renown. However much his merits, and especially his originality, may have been obscured or underrated in his life-time, he has already been recognised by those who have taken the trouble to inform themselves, and especially by American writers, as the most original British worker in regard to the vertebrate division of animals, since the incomparable pair—Willughby and Ray. But of Macgillivray this is not the place to speak particularly. On some other occasion we hope we may say more of him, a man whose work by some unhappy fate failed to impress his contemporaries, and whose posthumous volume was oppressed by princely patronage—well-meant but ill-advised. He had little or no experience of "Argyll and the Inner Hebrides," and really does not now come into our story.[1]

As a matter of fact it is hard to say who among old naturalists does deserve especial mention in connexion with the Faunal District of which this volume treats. Mr. Harvie-Brown, with the caution characteristic of his nationality, abstains from putting forth the claim of any predecessor; though, as brave men lived before Agamemnon, this district may have had a zoological historian before the laird of Dunipace and Quarter. The late Mr. Henry Davenport Graham—an honest observer if there ever was one—whose pleasant contributions to the ornithology of Iona and Mull, illustrated by some of his humorous and very clever sketches, were published in 1890 as a "relief volume" of the present series, belongs of course to the existing epoch, for he died in 1872; and moreover his observations were confined to but a small portion—the islands just named—of the district. Thus as regards its ancient history from the zoological point of view, we have an absolute void, since the Statistical Accounts (both Old and New) of the county of Argyll and the Isles give as little information to the purpose as does the often-quoted but seldom-read description of Dean Monro, which was only published in 1774, 225 years after it was written.[2]

To come to closer quarters, we are inclined, though we must say so with diffidence, to question Mr. Harvie-Brown's delimitation of his "Faunal District." In principle he is undoubtedly right, though somehow or other the result does not seem to work out well. His principle was laid down in the first volume of the series—that on Sutherland, Caithness, and Western Cromarty—and is the marking out of a district by physical features rather than by political boundaries. No naturalist ought

[1] "A Vertebrate Fauna of Sutherland, Caithness, and West Cromarty," NATURE, xxxi. p. 292; "A Vertebrate Fauna of the Outer Hebrides," NATURE, xl. p. 101.

[1] His portrait is given by our authors in their volume on "The Outer Hebrides."

[2] A reprint of this very rare work was published at Glasgow in 1884 (by Thomas D. Morrison).

to hesitate for a moment in preferring a watershed to a wapentake, since the former has natural limits, while those of the latter may be the consequence of a chapter of accidents. Moreover watersheds, though sometimes difficult to trace and lay down on a map, are as a whole much more to be trusted than some other kinds of boundaries, notably more so for instance than rivers, which in biology, with very rare exceptions, do not furnish a scientific frontier; but some wise man of old has remarked that there is reason in the roasting of eggs, and the faunist certainly ought to exercise some discretion in choosing his watersheds. What difference there may be in the land-fauna of the two sides of the peninsula of Cantire, for instance, we are at a loss to conceive, and yet we have our author's line of demarcation driven remorselessly along its summit ridge from its Mull to West Tarbert, and thence northward, splitting Knapdale in like manner, and shutting out from Argyll the home of Maccallum More—Inveraray itself! If the eastern half of Cantire, with Arran, Bute, Cowall, and goodness knows what beside, are to form another separate district, something may be urged for this view, but if they are to be annexed to Carrick, Kyle and Cunningham—in a word to Ayrshire and the South-West of Scotland, we feel bound to protest against the proceeding as an unnatural union. Arran undoubtedly agrees far more in every essential faunal character with Ardnamurchan than with Ayrshire—that much we venture to affirm, even if we should be sorry to attempt a delimitation between the districts of "Argyll" and "Clyde" further to the northward, or between "Argyll" and "Forth"; but though, as we have said above, we attach great importance in many cases to watersheds, we are inclined to hold ourselves entitled to cut *across* valleys on occasion, and because Loch Lomond drains to the "Clyde" and Loch Katrine to the "Forth," it does not at all follow as a rule, that their upper levels belong to the districts which contain their "carses." In other words the basin plan of dividing a country may be overstrained. Still we gladly admit that the fault is on the right side, and considering the extraordinary way in which so many of its counties interlock, it would be manifestly misleading to attempt to treat Scotland according to the method which is on the whole suitable enough for England, where the counties are much more continent. There is the old story of the man, possibly, it is true, an ignorant southron, who wished to explore Cromartyshire, but never succeeded in finding more than bits of it!

To the naturalist islands have a peculiar fascination of their own, and it is quite pardonable therefore in our authors that, in the introductory portion of their volume, they should devote more space to the description of the Inner Hebrides than to Argyll, properly so called, especially when, as we have already stated, the delimitation of their district cuts off so much of what most people would include therein. Yet thereby they recall the celebrated story told by Sir Walter Scott of the Minister of Cumbrae, which we forbear from repeating; and we must say that in their infinite mercy they might not have so wholly overlooked the interest that appertains to the adjacent mainland. Ardnamurchan, before mentioned, receives its due, but Moidart and Morven, Ardgour and Lochaber, Ben Nevis, the loftiest peak in Great Britain, and the historic Glencoe, the gloriou Loch Etive and the beautiful Loch Awe, receive but scan attention. However our authors have given us, and we are thankful for it, the portrait of two inhabitants of the mainland—the late Peter Robertson and his pony—though, not a word being vouchsafed to show why they are thus honoured, many who take up the volume may wonder at the preference shown to them. The present writer cannot trust his recollection for equine likenesses, but if the beast figured (at p. xii. of the "Preface") was that which bore him on a never-to-be-forgotten day, more than thirty years ago, he has no objection to urge; and undoubtedly the man was worthy of being thus commemorated since, throughout Scotland, no one was more famous for his knowledge of Red Deer than the head-forester of Mona Dhu—the "Black Mount"—while his intimate acquaintance with the animal life of a characteristic Highland district was no less good, and one could not be in his company for half an hour without recognising in him the true naturalist. He was wholly different from the much-writing and much-bewritten "Field Naturalist" of the type with which we have lately become painfully familiar, the man who is all eyes and tongue but has no brains, thinking everything he sees is seen for the first time, and is worth publishing abroad because he has seen it. From one point of view this man is not wrong, since it pays well to contribute a sensational article so based to a nonscientific magazine, while he can do this in safety, for no naturalist will be at the trouble to hurt his feelings by pointing out that what he writes contains nothing more than was known before, and that his specious verbiage alone is new. "Mr. Robertson"—to speak of him as he was spoken of by those who for many years lived under his mildly despotic rule—was a man of retiring character and plain speech, possessed of that admirable manner which, if not inborn, comes only from mixing with all classes of society. He would address a prince of blood royal without a trace of servility, or a cockney sportsman without exciting suspicion of contempt. The *mens sibi conscia recti* kept him from either failing. To no smattering of science did he make pretence, and it was with wonder that he received the application to communicate the results of his experience as to Red Deer to the editor of Macgillivray's unhappy posthumous work already mentioned. Would that the whole of it had been published there! No one could listen to his conversation without perceiving that as an observer of nature he had not wasted his life, and that he had thought over, if not thought out, problems that have puzzled and still may puzzle the best informed of naturalists. But this is enough of him, and we have only said it because our authors have said nothing. We must return to what they tell us.

It is hardly to be doubted that to the naturalist the most interesting of Scottish mammals are the *Phocidæ*—the Seals, and it is curious to look back upon the obscurity in which they were involved until comparatively few years ago—not that we would have any one to suppose for a moment that there is not plenty more to be learnt about them. It is probably not yet known to the majority of British zoologists that, apart from all possible or impossible stray visitors—which may or may not be of casual appearance, such as *Phoca barbata*, *P. annellata*, *P. grœnlandica* and *Cystophora cristata*—we have, as constant residents in our waters, two species—the common *P. vitulina* and the larger and more local *Halichœrus griseus*—animals that differ as much in some of their habits as they do in conformation and appearance. Of the former species we need say little, but concerning the latter the several volumes of this series have given much information, making abundantly clear that it is a native of our seas and therefore a true member of our Fauna, a position that, through want of appreciation of recorded facts, had hitherto been doubtful. But our authors, in this volume at any rate, exhibit laudable caution in not advertising its haunts, leaving those who can "read between the lines" sufficient indication as to where they are, which we maintain to be a perfectly fair proceeding on the part of writers in regard to species subject to persecution. If the hairy coat of the Grey Seal approached in value that of his long-eared and furry cousins of the Southern Seas and North Pacific, the life of his race would not be worth a year's purchase, despite the dangerous character of the waters he frequents. Fortunately it is only his oil that is coveted by his would-be murderers, and that is not a sufficient inducement to them to follow him to some of the asylums he has found. We could tell of one where he feels so secure, from absence of molestation, that he will let a boat come within oar's length of him before he rolls off the rock on which he is basking—and then rather with the air of doing a courteous act in giving place to strangers who may want to land upon the shelf. All the same we fear that one of these days terrible return for his politeness will come upon him and his kindred even in the fortunate islands we have in mind, and we must not dwell longer on this subject lest we should reveal what ought to be a profound secret. But we are bound to admit that the Grey Seal is not the most intelligent animal in the world, hough his long, grave face gives him an expression of wisdom far beyond that conveyed by the chubby countenance of his commoner relative.

Of course the most important members of the Scottish fauna are at present the Red Deer and the Red Grouse—looking only to the amount of money they are the means of bringing into the country, though equally of course it is declared that the greater part of this amount, that which is paid for shooting rents, is not spent in the country. But we suppose the same might be alleged almost everywhere of rent of any kind, and heaven forefend us from dabbling in the mysteries of the "dismal science." Concerning Red Deer much more is to be told than people suppose. The statistics of Jura Forest compiled and privately printed by Mr. Henry Evans, of which an abstract is given by our authors in their Appendix (pp. 239–244) may well set any one thinking, especially as regards the death-rate, which if observed among human beings in any part of the world would set that district down as more unwholesome than any known elsewhere. The mortality is attributed chiefly to what is known as "Husk," which appears due to a "hair-like lung worm" (of what kind we cannot say), and reaches 20 *per cent.* and upwards among the *male* calves before they complete their first year, and when we consider that this is on an island with a comparatively mild climate, where every care is taken of the beasts, the result is indeed extraordinary. It is only when the zoologist is brought face to face with facts of this kind that he can realise what the Struggle for Life must be of which he has read so much, and the depth of his ignorance about it. No wonder then we cannot explain, what seems to be quite certain, the dwindling, that in many places has ended in the extinction, of the Ptarmigan. Our authors appear to attribute it to the moist influence of the Gulf Stream, but we are not conscious of any evidence that this is greater now than it was twenty, thirty or fifty years ago and surely the reason must be sought elsewhere.

We have allowed our notice of this very pleasant book to run to an excessive length, so that we must here surcease from commenting on many passages which really call for remark—most of them for praise and only a few for blame. We certainly should not care to involve ourselves in the mooted question of the alleged Pintail's nest or nests on Hysgeir off Canna (pp. 129–131); but we must protest against our authors' countenancing (p. 167, note) the often-exploded but ever reviving fallacy of Rooks' eggs being served up in place of Plovers'. The curious so-called "Tailless" or "Docked" Trouts ("club-tailed" would be a better name) of certain lochs are treated of by Dr. Traquair. They may perhaps be compared with the somewhat analogous case of the "Crummy" Stags of Jura and Mull, concerning which we are disappointed to find little or no information, which is the greater pity since the introduction of new blood has already diminished and will probably put an end to these interesting local "sports." A few words must, however, be added as to the illustrations, and especially to those from photographs by Mr. Norrie, which are not only well chosen, but for the most part extremely beautiful. The maps too are all effective if not always neat, and the little sketches "let in" to their margins are as pretty as they are accurate. Herein, as throughout the letter-press of the volume generally, the islands are most favoured, and there is only one of the plates which illustrates a scene on the Scottish mainland. So we part from Messrs. Buckley and Harvie-Brown, commending their assiduity, and wishing all success to their next venture, whether Moray or Shetland be its subject.

OUR BOOK SHELF.

Gun and Camera in Southern Africa. By H. Anderson Bryden. With numerous Illustrations and a Map. (London: Edward Stanford, 1893.)

IN this book Mr. Bryden records the incidents which happened in the course of a year of wanderings in Bechuanaland, the Kalahari Desert, and the Lake River Country, Ngamiland. The region is one in which much interest has been taken lately, and colonists and settlers will find in Mr. Bryden's lively pages exactly the sort of information that is likely to be most useful to them. The volume also includes many passages that will be read with pleasure by ethnologists, naturalists, and sportsmen. The illustrations—which are offered as "faithful delineations of places, objects, and people hitherto not often accessible to the camera"—add greatly to the value of the narrative.

LETTERS TO THE EDITOR.

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

Mr. H. O. Forbes's Discoveries in the Chatham Islands.

IN reply to Prof. Newton's letter, under the above title, in NATURE of last week (p. 101), in which he refers to the description by me of the Chatham Island Ralline bones under a distinct genus *Diaphorapteryx*, and observes "that one thing seems needed to make the discussion [on the probability of a land connection between the Chatham and Mascarene Islands] real, and that is the proof of the assertion that *Aphanapteryx* ever inhabited the Chatham Islands," I beg to say that in his letter there is a slight confusion of dates, which affects the question of the nomenclature. On July 29 last year I visited Cambridge for the purpose of comparing the bones from the Chatham Islands I had brought with me with the real *Aphanapteryx* remains in the Museum there. It turned out that Dr. Gadow, who was abroad, had laid them aside where Prof. Newton could not place his hand upon them, and I was, therefore, unable to see them. A week or two later, when in Edinburgh at the British Association Meeting, in a note intimating the return of Dr. Gadow, and kindly arranging for my examination of the bones, Prof. Newton adds, "I believe you will want a new generic name for what you have called *Aphanapteryx*," and suggests the name *Diaphorapteryx* instead. I was unavoidably long prevented from revisiting the Cambridge Museum, and so in describing as *Diaphorapteryx* the Chatham Island bones, at a meeting of the British Ornithologists' Club in December, 1892, I accepted the suggestion of Prof. Newton, who alone had till then seen the remains from both localities. On February 23, prior to reading my paper at the Royal Geographical Society, I again visited Cambridge, and in the most kind manner received every facility and assistance both from the Professor and from Dr. Gadow in comparing the specimens. On this occasion I was unable to recognise any sufficient characters, by which, in my estimation, to separate generically the bones from the Chatham Islands from those from Mauritius. This decision I stated at the meeting of the R.G.S. on March 13 last, and more recently in a communication to the Brit. Ornith. Club, which will appear in its forthcoming *Bulletin*. If I mistake not, however, Prof. Newton agreed with me that the Chatham Island form was nearer to *Aphanapteryx* than the latter was to *Erythromachus* of Rodriguez. Some of these remains from Mauritius have been figured by Prof. Milne-Edwards in his "Oiseaux Fossiles de France," and the remainder are fully discussed and illustrated by Dr. Gadow in a shortly-to-be-issued fasciculus of the Trans. Z.S. of London, while those from the Chatham Islands will appear shortly, I hope, in one or other of the scientific journals or Proceedings. After a careful study of all the material I have no hesitation, however, in stating meantime—as those who care will then have an opportunity of judging—that the bones from both regions are generically the same. I maintain also, that even if some osteologists should be disposed (from the somewhat larger size of the Chatham Island bones, though among them I found a number scarcely to be separated on even that ground) to make a generic distinction between them, the question would not only not fall, but I really cannot see that the argument based on their discovery in the New Zealand region would be in the least invalidated, as the forms are unquestionably so very nearly related. The importance of the distribution of the blue Waterhens, and the relationship between the Huias of New Zealand and the *Frigelupus* of Reunion—long ago pointed out by Mr. Wallace—and many other facts as far as birds are concerned recently urged by Dr. Sharpe at the Royal Institution, appears now to a fuller extent by the discovery of those unexpected forms in the Chatham Islands.

I must once more protest against the very erroneous statement that I have invoked this "tremendous hypothesis" to explain the distribution of the closely related forms of these two regions. I adduced, as I have said in my last letter, a great deal of other evidence in my paper at the Royal Geographical Society, which will appear very soon now. In addition to the facts there given I may point out the significance to this question of the results of the investigations of my lamented friend, Mr. W. A. Forbes—an anatomist of the highest acumen—on the genera *Xenicus* and *Acanthisitta* of New Zealand. He found that the affinities of the *Xenicidæ* are with the *Pipridæ* (including the *Cotingidæ*), *Tyrannidæ*, *Pittidæ*, and *Philepittidæ*—groups confined to the New Zealand, the Australian (ranging into the Oriental), the Mascarene, and the Neotropical regions, and that they have no relatives elsewhere. Nor are the following sentences from Mr. Wallace's "Geographical Distribution of Animals" without a bearing on this discussion:—"We have the pigeons and the parrots most wonderfully developed in the Australian region, which is preeminently insular, and both these groups have acquired conspicuous colours very unusual or altogether absent elsewhere. Similar colours [black and red] appear in the same two groups in the distant Mascarene islands. . . . Crests, too, are largely developed in both these groups in the Australian region only; and a crested parrot formerly lived in Mauritius—a coincidence too much like that of the colours as above noted, to be considered accidental." HENRY O. FORBES.

104, Philbeach Gardens, Earl's Court, S.W.

The Fundamental Axioms of Dynamics.

As Prof. Lodge refers in the letter published in this week's NATURE, p. 101, to my remarks on his paper on the Fundamental Axiom of Dynamics, I shall be obliged if you will allow me to state my views in your columns. Apart from all minor questions it appears to me that the main issue raised by Prof. Lodge is whether the law of the conservation of energy can be *proved* from the fundamental laws of dynamics and the assumption of contact action.

I have not the slightest objection (as he seems to suppose) to the mathematical investigation of physical facts being based on assumptions which are followed out to their logical conclusions, nor do I shrink from using such methods even when they fail in some points or lead to paradoxical conclusions. They may legitimately be accepted as convenient though imperfect mental pictures of the truth, sketches, but not finished drawings.

My objection to Prof. Lodge's "proof" is that in his attempt to avoid the unthinkable by discarding action at a distance, he adopts another equally inconceivable conception, viz. contact action.

He has already laid it down as an axiom that "material particles (atoms of matter) never come into contact." It is only by abstaining from the attempt to define the constitution of the ether that he avoids being driven to the conclusion that its various parts never come into contact either.

The assumption that he really makes is that when two bodies (including in that term both matter and the ether) act immediately upon each other, the distance between the mutually acting parts remains invariable during the action. This is not inconsistent with action at a distance. If then the phrase "contact action" be discarded the assumption of action at constant distance is a proper subject for investigation.

If the assumption be accepted the reasoning based on it is no doubt correct, but the value of the "proof" (regarded as independent or self-contained) depends entirely on the value we assign *à priori* to the fundamental assumption. I doubt whether an argument based upon it would by itself have convinced the world that the conservation of energy is a fact.

If, on the other hand, the assumption is regarded as a more or less arbitrary postulate to be justified, *à posteriori* by the fact that conclusions can be deduced from it which are otherwise known to be true, Prof. Lodge must not represent his course as the ascent of a firm ladder of argument to results which, though paradoxical, must be accepted under penalty of a *reductio ad absurdum*. On the contrary, it lies with him to justify his assumption by the use he makes of it. That the conservation of energy follows is no doubt an argument in its favour, and I for one shall look with interest for the other deductions which Prof. Lodge promises. ARTHUR W. RÜCKER.

June 2.

IF Mr. E. T. Dixon (NATURE, p. 103) will read what I have previously written on the subject of energy he will find most of his objections anticipated. I have pointed out, as he now does, that so long as potential energy is regarded solely as a "force function" the conservation of energy has no real physical meaning (pp. 532, 533. Phil. Mag., June 1881). I quite agree that potential energy belongs to a system rather than to a particle, but I do not see that the fact has any hostile significance as regards the question of *identity*.

He will also find that I have always hitherto included the connecting medium as one of the "bodies" between which actions and reactions occur. (See for instance, Phil. Mag., June 1885, pp. 483–84, and October 1879, p. 281). I do not propose to continue to do this in future, partly because I find that the word "body" is not generally or conveniently understood to mean ether as well as ordinary matter, and partly because I now realise that there is something more definite to say concerning the function of the ether as regards stress.

But Mr. Dixon seems to suppose that the denial of action at a distance means that material particles are without influence on one another until they touch; that for instance the earth cannot attract the moon unless it is in contact with it; for he says that my contention that material particles never come into contact renders nugatory the whole discussion concerning "contact action."

If this be the sort of meaning which he attaches to the phrase "action at a distance," no wonder he is unimpressed with the arguments of those who deny its prevalence in nature.

OLIVER LODGE.

MAY I make a few corrections of statements which appear in your report of Prof. Lodge's paper on the Laws of Motion (NATURE, p. 117)?

(1) I do not object to the first law on the ground of unintelligibleness, but only to the ordinary mode of enunciating it.

(2) I have not contended that Dr. Lodge's definition of energy as the name given to work done assumes conservation. On the contrary, I have expressly pointed out that it does not.

(3) I did not select the air-gun with its muzzle plugged as an instance of transference of potential energy without transformation. Prof. Lodge had cited the air-gun as an instance of the transformation of Potential Energy into kinetic during transference. I stated that if the muzzle were plugged it would serve *equally well* as an instance of the transference of potential energy without transformation. But I pointed out that both illustrations were defective and proceeded to show that in general the transformation of energy during transference is only partial.

J. G. MACGREGOR.

Hopeville, Bridge of Allan, N.B., June 5.

The Word Eudiometer.

THE following quotation from J. A. Scherer's "Geschichte der Luftgüteprüfungslehre" (Vienna, 1785), may be of interest in connection with Prof. McLeod's letter on the invention of the word "Eudiometer" (NATURE, vol. xlvii. p. 536). After referring to Fontana's Descrizione ed usi di alcuni stromenti per misurare la salubrità dell' aria" (Florence, 1775), Scherer continues (*op. cit.*, vol. i. p. 153), "Bald nach der Herausgabe der gedachten Instrumente machte Hr. Landriani ein neues bekannt, der erste, der es Eudiometer nannte. Er versichert uns er habe seinen Luftgütemesser von Abt Fontana nicht entlehnt. Daher gehört die Ehre der Reformation des Priestley'schen Instruments Hrn. Landriani, die ihm auch Fontana selbst in zwei Briefen einräumt."

Landriani's own statement quoted by Prof. McLeod is thus fully confirmed by contemporary authority. Scherer's book, which has just been purchased for the Owens College from the Kopp library, is full of interesting historical information with regard to eudiometry.

PHILIP J. HARTOG.

Owens College, May 23.

Singular Swarms of Flies.

MR. FROUDE's letter (p. 103) forcibly reminds me of a swarm of flies which overlaid every one who was on the parade at Ventnor, and drove numbers off the pier on the forenoon of a day which certainly fell on or between May 13 and 16, 1891. My diary bears only witness to the fact that I was then at Ventnor, but I shall never forget that as I went towards the black clouds I met a venerable friend, whose white hair, beard, and light coat were literally blackened with flies. The natives, who had had previous experience of such a cloud, ascribed it to the "mackerel fly." My colleagues in the entomological department of the British Museum told me I had witnessed a flight of *Bibio Marci* (St. Mark's fly), and, on reading up the subject, I found no reason to doubt that they had made an accurate diagnosis of a slightly and imperfectly told story.

I have a definite recollection of the flies' rapid disappearance, and I have very little doubt that Mr. Froude has been the witness of a cloud of the same dipterous insect.

F. JEFFREY BELL.

5, Radnor Place, Gloucester Square, W., June 2.

P.S.—The weather was very warm during the days mentioned, but the succeeding (Whit) Monday was marked by a fall of snow in several parts of England. *Absit omen!* I add this as I note that Mr. Froude suggests that the special character of the swarms may have some relation to "some condition of the atmosphere."

THE phenomenon so well and exactly described by your correspondent, Mr. R. E. Froude (NATURE, vol. xlviii. p. 103) was seen the same day and hour—that is, between 1 and 1.30, May 27—at Parkstone, near Poole, Dorset. A party which had driven over from my house, and lunched at the Harbour Hotel, saw every tree-top crowned, as it were, with a smoke-like column of flies, every column with the same slant one way, described by Mr. Froude, only it was not noticed that this was towards the sun. The strange sight was described to me by my daughter, by word and pencil, last Saturday, immediately on reaching home, and confirmed by her companions.

HENRY CECIL.

Bregner, Bournemouth, June 3.

THE ANNUAL VISITATION OF THE GREENWICH OBSERVATORY.

AT the Annual Visitation of this Observatory, which took place on Saturday, June 3 last, the Astronomer Royal presented his report to the Board of Visitors.

The present want of accommodation is felt in all the departments of the Observatory, a number of the staff being at present housed in the Octagon room, which forms part of the Astronomer Royal's official residence. The Admiralty have now authorised the completion of the central octagon by the addition of a story and the erection of the Lassell dome over it.

In place of the old cylindrical dome on the south-east tower, which was dismounted in November last, the new 36-foot dome was erected at the beginning of the year, the work of construction and erection being completed most satisfactorily by Messrs. T. Cooke and Sons.

The electric light installation for the principal instruments proposed last year has been sanctioned, and the necessary generating plant, consisting of gas-engine, dynamo, accumulators, and main leads, has been supplied. It is proposed to set these up on the ground floor of the new south wing.

Referring now to the astronomical observations, the work of observing the sun, moon, planets, and fundamental stars with the transit circle has been considerably increased, owing to the extraordinarily fine weather in the months of March and April, the number of observations being the largest ever recorded. The numerical statement is as follows:—

Transits, the separate limbs being counted as separate observations	8217
Determinations of collimation error ...	304
Determinations of level error	512
Circle observations	7179
Determinations of nadir point (included in the number of circle observations)... ...	461
Reflexion observations of stars (similarly included)	527

The annual catalogue of stars observed in 1892 contains 1710 stars.

The report goes on to say:—

As an illustration of the continuity of fine weather in March and April, it may be mentioned that 2600 transits and 2300 circle observations were made in these two months, the average corresponding numbers for the seven previous years being 945 and 877 respectively; that 70 observations of upper and lower culminations of Polaris were obtained (exclusive of isolated observations, which are only used for azimuth error and not for place of the star), the average for these months in ten years preceding being 22·2, and the greatest in any of these years 38 (in 1885), and that 24 groups of clock stars, extending over more than twelve hours, were obtained, the mean for ten years preceding in March and April being 2·6. In the last case something must be attributed to the special interest shown by the observers recently in obtaining long groups of clock stars.

The apparent correction for discordance between the nadir observations and stars observed by reflexion for 1892 is 0″·25, and has been persistently negative for some months. An investigation of the screws of the microscopes used showed that several of them are the worse for wear.

From the observations of 1892 the west latitude of the transit circle was found to be 38° 31′ 22″·10, a value differing by + 0″·20 from that adopted. Recent investigations have made it probable that the co-latitude undergoes fluctuations of short period: and in comparing the observations in the individual years 1877–86 with the final results in the Ten Year Catalogue, confirmatory evidence of these fluctuations was found. Mr. Thackeray was thus led to undertake an examination of all the observations of N.P.D. of the four close circumpolar stars since 1851. The results were found to accord well with Mr. S. C. Chandler's hypothesis (*Astronomical Journal*, No. 277), and have been communicated to the Royal Astronomical Society (vide *Monthly Notices*, liii. p. 3).

The correction to tabular obliquity of the ecliptic from solar observations in 1892 is + 0″·44, which is rather a large quantity. The discordance between the results from the summer and winter solstices is + 0″·40, indicating that the mean of the observed distances from the pole to the ecliptic is too small by + 0″·20, and thus confirming the stellar observations for co-latitude.

Computing the value from Hansen's lunar tables, the mean error of the moon's tabular place was found to be + 0·083s. in R.A. and + 1″·29 in longitude, as deduced from ninety-five observations in 1892; this agrees well with the results obtained in 1891. The mean value of these quantities for the ten years 1883–92 are + 0·044s. and + 0″·61. The mean error of the moon in N.P.D. for 1892 was − 0″·27.

Owing to great pressure of longitude and other work, the work with the altazimuth was suspended from May to October 18, 1892, the number of observations falling below that usually recorded. The total number in the year ending May 10, 1892, is—

Azimuth of the Moon and Stars	167
,, ,, Mark I.	62
,, ,, Mark II.	64
Zenith distances of the Moon...	62
,, ,, ,, Mark I.	60
,, ,, ,, Mark II.	62

The provision of the new universal transit-circle to replace the existing altazimuth, and to serve as a duplicate meridian instrument for fundamental determinations, with suitable building and dome, having been sanctioned by the Government, its construction has been entrusted to Messrs. Troughton and Simms, who are now preparing the working drawings. This instrument will be erected to the north of the Magnetic Observatory. Some difficulty seems to have occurred with regard to the siderial standard clock, which on June 26 was found to have stopped. An examination soon showed that the oil on the escape pivots had thickened. At the beginning of this year the maintaining power was strengthened, and the barometric inequality adjusted.

Owing to the fact of the new dome only being recently completed, the tube of the 28-inch refractor, together with the declination axis cones, declination circle, and clamping circle are not yet in place. The object glass is at the Observatory, and ready for mounting.

Last May the Merz refractor (12¾ inch) of the south-east equatorial was mounted in place of the Lassell 2-feet reflector, the same mounting carrying the Thompson 9-inch photographic telescope.

Since February Mr. Lewis has used this instrument for double-star work, and he has made 545 measures of position angle, and 609 of distance of 85 pairs; 32 pairs being less than 1″ apart, 26 between 1″ and 2″, 8 between 2″ and 3″, and 19 over 3″.

With regard to occultations, 26 disappearances and 7 reappearances of stars by the moon have been observed, including 7 disappearances and 3 reappearances observed during the lunar eclipse of May 11, 1892, and 10 disappearances of stars below the *Nautical Almanac* limit of brightness (6·5), approximately predicted by Mr. Crommelin. Disappearance of Uranus behind the Moon on July 3, an occultation of 73 Piscium by Jupiter on May 23, and 62 phenomena of Jupiter's satellites were also observed. All these observations are completely reduced to February 26, 1893.

Among other miscellaneous observations made may be mentioned:—Observations of comets, differences of R.A. and N.P.D. of Saturn and γ Virginis, on the occasion of their conjunction; and of Mars and Ceres at the time of their conjunction, &c.

With the Astrographic equatorial 722 plates, with a total of 1812 exposures, have been taken on 161 nights in the year ending May 10, and of these 116 have been rejected, viz. 57 from photographic defects, 6 from mechanical injury, 12 from mistakes in setting, 6 from the plate being wrongly placed in the carrier, 7 from failure in clock driving, and 28 from interference by cloud. The following statement shows the progress made with the photographic mapping of the heavens in the year, May 11, 1892, to May 10, 1893:—

	No. of Photos taken.	Successful Plates.
Astrographic Chart (exposure 40m.) ...	200	183
Plates for Catalogue (exposures 6m., 3m., and 20s.)...	367	288
Number of Fields photographed for the Chart	—	172
Number of Fields photographed for the Catalogue	—	271
Total number of Fields photographed since the commencement of the work for the Chart	—	176
Total Number of Fields photographed since the commencement of the work for the Catalogue	—	299

It has been made a practice to take a trail on each night on a catalogue plate as a check on the orientation, and during the past year 127 plates with trails have been thus secured.

With the same instrument, and included in the 722 mentioned above, were taken photographs of Nova Aurigæ (49), for zero of scales and orientation (36), lunar eclipse, May 11 (4), Comet Holmes (2), Saturn (5), conjunction of Saturn and γ Virginis (16), &c.

Experimental plates of Jupiter, Saturn, double stars, &c., have also been taken with the image enlarged about fourteen times by a secondary magnifier, consisting of a triple cemented concave lens of 1⅝ inches diameter, and 3 inches focus, supplied by Mr. T. R. Dallmeyer. The results, as the report states, are very promising.

No spectroscopic observations have been made during the past year, the regular observations for stellar motion in the line of sight having been interrupted by the dismounting of the south-east equatorial, and there being great pressure in the solar photographic work. The telescope and camera of the Dallmeyer photoheliograph were again removed on September 9, 1892, from the wooden dome, where the new buildings obscured the horizon, to the first floor of the new museum, where they were re-mounted on stand No. 3, which was simply placed on the floor and found sufficiently steady. From this position it was possible to photograph the sun during about two hours each day.

In the year ending May 10, 1893, photographs of the sun have been taken with this instrument on 180 days, and of these 410 have been selected for preservation, besides twenty-two photographs with double images of the sun for determination of zero of position.

The photographic telescope has been in regular use as a photoheliograph since January, 1893, and photographs of the sun have been obtained with it on eighty-nine days, of which 158 have been selected for preservation. In all, with one photoheliograph or the other, a record of the state of the solar surface has been secured on 220 days during the year. A new enlarging lens by Messrs. Ross and Co., which appears to be very free from distortion, was fitted to the Thompson photoheliograph on December 13, and has been used regularly for the eight-inch photographs of the sun. Taking into account the India and Mauritius photographs received from the Solar Physics Committee, solar pictures for 362 out of 366 days are available for measurement. The photographs show that solar activity has throughout the past year been fully maintained, the mean daily spotted area for the years 1890, 1891, 1892, being 100, 566, and 1230 respectively.

The great solar activity mentioned above has its reaction also in the number of computers employed, for the report says that to cope with this unexpectedly severe sun-spot maximum it has been necessary to largely increase the number of computers employed on this work, and a further addition will probably be required, if, as seems likely, the solar activity continues to increase.

With regard to the magnetic observations, the registration has been carried on as in former years, the new photographic processes recording with clearness and delicacy many rapid magnetic movements that occur during magnetic storms.

The disturbance of the earth current registers due to the trains running on the City and South London Electric Railway still continues, and is of about the same magnitude as before. The substitution of a non-magnetic silver pointer for the upper magnetic needle in the galvanometers for the earth current apparatus, as mentioned in the last report, has proved very successful, the scale values, which used to vary considerably, having since remained remarkably constant.

In view of the approaching introduction of a dynamo into the Observatory grounds for electric lighting, experiments have been made to determine the possible effect on the magnetographs of the dynamo unshielded and with triple iron shield. These experiments were carried out at Messrs. Johnson and Phillips's factory, Charlton, the deflection of the declination magnet of the portable unifilar magnetometer being observed at distances of 20 and 40 feet respectively due west (magnetic) of the dynamo, the poles of which were in the east and west direction (magnetic), thus giving the maximum deflecting effect. At the Royal Observatory the poles of the dynamo will be north and south (astronomical), and it will be placed at a distance of about 170 feet from the magnets and nearly due south (magnetic). Making due allowance for this, the experiments at Charlton would give the following results:—

Effect on	Declination Magnet	or	Horizontal Force Magnet.
Dynamo unshielded	4″		·00008
Dynamo with triple shield ...	0″·5		·00001

the effect on the horizontal force magnet being expressed in parts of the whole horizontal force. The corresponding displacements of the magnetograph registers would be only 1/200th of an inch for declination and 1/400th of an inch for horizontal force, in each case with triple shield to the dynamo.

The following are the principal results for the magnetic elements for 1892:—

Mean declination (approximate)	17° 18′ west	
Mean horizontal force ...	3·9613	(in British units)
	1·8265	(in metric units)
Mean dip	67° 18′ 42″	(by 9-inch needles)
	67° 19′ 45″	(by 6-inch needles)
	67° 21′ 7″	(by 3-inch needles)

Meteorological observations have been continuously maintained during the past year, and the reductions are in the following state:—

The observations of barometer, thermometers, anemometers, rain-gauges, and sunshine-recorder (corrected, where necessary, for instrumental error) are reduced up to the present time. On the photographic sheets all the time-scales are laid down, and the hourly ordinates are read out for the dry and wet bulb thermometers to the end of the year 1892, and for electrometer to the end of July 1892. The table of principal changes in the direction of the wind for 1892 is complete.

The mean temperature of the year 1892 was 48°·1, being 1°·4 below the average of the 50 years, 1841–1890. The highest air temperature in the shade was 85°·9 on June 10, and the lowest 17°·6 on December 27. The mean monthly temperature in 1892 was below the average in all months excepting May, August, and November. In March it was below the average by 4°·4, in October by 4°·6, and in December by 3°·0.

The mean daily motion of the air in 1892 was 265 miles, being 17 miles below the average of the preceding 25 years. The greatest daily motion was 687 miles on January 29, and the least, 48 miles on December 28. The greatest pressure registered was 11·8 lbs. on the square foot on October 9.

Bright sunshine was recorded on 1277 hours during the year, this being 7 hours below the average of the preceding 15 years. The sun being above the horizon for 4465 hours, the mean proportion of sunshine for the year was 0·286, constant sunshine being represented by unity.

The rainfall amounted to 22·3 inches in 1892, this being 2·2 inches below the average of the fifty years 1841-1890.

In the determination of the longitude of Paris, four observers, two French and two English, took part in the work, as in 1888; three of them were the same as before (Colonel Bassot, Commandant Defforges, and Mr. Turner), but Mr. Hollis replaced Mr. Lewis, whose special attention was required in the Time department. The plan of operations adopted in 1888 was only modified in the following particulars: two clocks were used instead of one, at each end of the line, and all the clocks were placed in rooms kept at nearly constant temperature. The Sidereal Standard was used by the English observer at Greenwich throughout. The English observers used the small chronographs procured for the Montreal longitude, with one pen only, thus avoiding the troublesome correction for parallax of pens.

In the Astronomer Royal's general remarks, he mentions that "the work of the Observatory during the past year has been carried on under circumstances of exceptional difficulty. In the first place the operations for the determination of the longitudes of Paris and Montreal involved the absence of the Chief Assistant and of another assistant for protracted periods during last summer and autumn. Secondly, for six months the Observatory was left entirely without the services of a clerk, and the appointment of a permanent officer to undertake cash and other clerical duties has not yet been made; thus the scientific work of the Observatory has seriously suffered in consequence. It has not been possible for me, while harassed with constant interruptions on matters of administrative detail, to carry out the scientific investigations connected with the Observatory, which properly fall within the province of the Astronomer Royal. Thus, during the past year, I have had repeatedly to lay aside the important subject of the measurement of the plates of the astrographic chart in order to deal with details of cash accounts and other similar matters, which properly pertain to the functions of a clerk. In this connection I may mention that some years ago I proposed a photographic corrector, which, at a comparatively small cost, would render an ordinary astronomical refracting telescope available for photography; but, though a trial instrument has been made, and though I have partly worked out the details of a more complete form, I have never been able to command sufficient leisure, tolerably free from interruptions, to enable me to complete the rather troublesome optical calculations. Such a corrector could be usefully applied to the new 28-inch telescope as well as to other large instruments; but under present conditions I fear that there is little prospect of my being in a position to work out the idea."

"The growth of the Observatory buildings, involving the introduction of large masses of iron, raises the question of the possible disturbing effect on the magnets in their present position. Though the masses of iron would be at such a distance that they could not sensibly affect the registers of magnetic changes, which are purely differential, it is possible that the aggregate effect on the absolute determinations of the magnetic elements might become appreciable. Under these circumstances it is desirable that an auxiliary magnetic station for determination of absolute values of the magnetic elements should be established in the immediate neighbourhood of the Observatory, at such a distance that there would be no suspicion of disturbance from the iron in the buildings." W. J. S. L.

REV. CHARLES PRITCHARD, D.D., F.R.S.

ANOTHER and a familiar figure has passed from among us, diminishing the strength of the tie that links the present generation to the science of the past. Almost a contemporary of Airy and of Herschel at Cambridge, Prof. Pritchard has seen the school, which they may be said to have inaugurated, lose its members one after another, to be himself among the last. But in no sense can it be said that he outlived his reputation, or that he was not a worthy disciple and an admirable exponent of that school. Nor was he content to remain simply a disciple. His ambition was to stand in the front rank, and to contribute his quota to the further progress of science. And this is the more remarkable and the more praiseworthy when it is remembered that he was considerably advanced in life before he devoted himself to any special science.

For Prof. Pritchard's early life had been spent, and worthily spent, in an endeavour to exhibit an improved method of education in the then upper middle-class schools. Of the success that attended his efforts, one of his old pupils, the present Dean of Westminster, has recently given an appreciative account. Dean Bradley has contrasted the dull methods that prevailed generally some sixty years since, even in schools of repute, with the vigour and enthusiasm which characterised the newer teaching, whose importance Prof. Pritchard early recognised and enforced. For thirty years he led the life of an active schoolmaster, and that he was successful in his vocation is fully established by the long list of the names of his pupils, famous in every walk of life. For private and personal reasons he retired from this career, and then his ambition was to take active clerical duty in some country parish. But in this he was disappointed, for as he has told the writer of this notice more than once, that though he was a divine in mind and heart, he was made an astronomer by Providence. But his loyal attachment to the Church of England and his scientific training placed him frequently in a position to render services to both science and religion. This is shown by the thoughtful and eloquent sermons that he has frequently preached on the occasions of the meeting of the British Association, as well as by his Hulsean Lectures at Cambridge, or in the capacity of Select Preacher at Oxford.

In 1870 the Savilian Professorship of Astronomy in Oxford fell vacant through the decease of Prof. Donkin. At the urgent recommendation of Sir John Herschel, Lord Hatherley, who was at the time Lord Chancellor, was induced to exercise his influence among the trustees of the Savilian estates, and Prof. Pritchard was elected to the vacant chair. How worthily he filled this office is known to the readers of this journal. It is sufficient to recal that he induced the University, shortly after his appointment, to supply an astronomical observatory, for at this date there was no observatory under academical control, and not only was research impossible, but very inadequate provision was made for the teaching of his class. The modest establishment originally contemplated by the University was materially increased by the munificence of the late Dr. De la Rue, in a way which admirably supplemented the judicious expenditure of the University. In later time a lecture-room and library had to be provided, and Prof. Pritchard probably felt that in the possession of a small, but tolerably complete, observatory, he gained rather than lost, from the fact that it was called into existence in quite modern times. Here it was his good fortune early to recognise the important part that photography was destined to play in the new astronomy, and before the gelatine plate had thoroughly revolutionised the art, he was at work on bright objects like the moon, to which photographic methods could then be applied. His success justified his foresight, and though in his subsequent career he frequently turned aside to pursue other lines of inquiry, he always returned to his original plan of investigation by means of photography.

In one of these excursions into more varied inquiries he was tempted to investigate the magnitude of the brighter stars on a plan which had occurred to him while at Clapham, and was, I believe, the practical outcome of a suggestion of the Rev. W. R. Dawes. This was the process of extinction by means of a wedge of neutral-tinted glass, used differentially. The method was carried out practically with great success, and the results of his work, embodied in a *Uranometria Nova Oxoniensis* received the reward of the medal of the Royal Astronomical Society, and procured for him, what he valued quite as highly, an honorary fellowship from his old college of Saint John's, at Cambridge. To secure the necessary completeness in this inquiry, Prof. Pritchard undertook to visit Egypt to determine the amount of atmospheric absorption. It was a source of great gratification to him to know that the more protracted inquiry of Dr. Müller led to practically the same result, and confirmed his investigation in every material particular.

Another of his researches, but one which he always held to be incomplete, was an effort to determine the relative co-ordinates of the stars of the Pleiades with a view to ascertaining the mutual proper motions. This group of stars had for him a great fascination, and to within a few days of his death he was at work endeavouring to supplement this inquiry by photographic methods. His favourite motto was—

> spem nos vetat inchoare longam
> aetas,

but certainly he never acted by the implied caution. To undertake some fresh work as soon as, or before the last was finished was his constant aim, and his zeal was generally equalled by his success. He undertook very little from which he did not get some positive result, for his method was to work tentatively, and to relinquish the inquiry if it did not appear promising. In this way he took up what he regarded as the greatest work of his life, the determination of the parallax of stars of the second magnitude. In this investigation he showed the keenest interest, and much of the work was performed not only under his directions, but actually by himself, and the Royal Society, recognising the importance of this work, and also Prof. Pritchard's earnest and protracted devotion to astronomy, awarded him the Royal Medal last year. W. E. P.

NOTES.

THE annual meeting of the Royal Society for the election of Fellows was held in their apartments at Burlington House on Thursday last, when the following gentlemen were elected into the Society:—Prof. William Burnside, Prof. Wyndham R. Dunstan, William Ellis, Prof. J. Cossar Ewart, Prof. William Tennant Gairdner, Ernest William Hobson, Sir Henry Hoyle Howorth, Edwin Tulley Newton, Charles Scott Sherrington, Edward C. Stirling, John Isaac Thornycroft, Prof. James William H. Trail, Alfred Russel Wallace, Prof. Arthur Mason Worthington, Prof. Sydney Young.

AMONG Fellows of the Royal Society whose names appear in the list of birthday honours are Dr. B. W. Richardson, F.R.S., Capt. A. Noble, C.B., F.R.S., and Mr. Charles Todd, C.M.G., F.R.S. Dr. Richardson, who has been knighted, is well-known as a writer on hygienic and medical subjects, and Capt. Noble, who is created a Knight Commander of the Bath, is an authority on explosives. Mr. Todd has been promoted to Knight Commander of the Order of St. Michael and St. George. In the announcement of the honour that has been conferred upon him, he is described as Postmaster-General and Superintendent of Telegraphs of the colony of South Australia. It should be pointed out, however, that Mr. Todd is also the Government Astronomer at Adelaide and that he has published numerous contributions to meteorology and astronomy. It almost appears as if Mr. Todd's standing as an astronomer and man of science has been wilfully avoided, for we can hardly think that the Colonial Office is in blissful ignorance of his scientific work. The only scientific man in Government employ whose services have been recognised is Mr. David Morris, the assistant director of the Botanic Gardens at Kew, who has been made a Companion of the Order of St. Michael and St. George.

THE ladies' *conversazione* of the Royal Society was held last night in the Society's apartments at Burlington House.

THE President of the Society of Antiquaries has issued invitations for a *conversazione* at Burlington House, on the 14th instant.

IT is expected that, at the meeting of the Royal Astronomical Society to-morrow evening, Prof. Thorpe and Mr. Alfred Taylor will give an account of the expeditions to observe the recent total solar eclipse. Prof. E. E. Barnard, of the Lick Observatory, will also be present, and will address the meeting.

THE annual *conversazione* of the Society of Arts will take place at the Imperial Institute, South Kensington, on Friday, June 30, from 9 to 12 p.m.

ON June 26, 1793, died Gilbert White of Selborne, a man who has done perhaps more than any other of his countrymen to awaken a taste for natural history and encourage its pursuit. A writer in the June number of *The Zoologist* gives a sketch of the life of this naturalist, and points out that now is the time to erect some kind of monument to his memory. The sole memorial which at present exists is a marble tablet on the chancel wall of the church in which he officiated. This is not as it should be. A marble bust was erected to Richard Jefferies, in Winchester Cathedral, a few months after his death, while Gilbert White, also a Hampshire man, has remained unhonoured for a century. As to the claim of the author of the "Natural History of Selborne," to a memorial there can be no doubt, and it is to be hoped that a committee will be formed to take the matter in hand, and carry it to a successful termination. Unfortunately no portrait of Gilbert White is in existence, so there is a difficulty in designing a monument with a statue unless it be decided to allow the sculptor to carve the features from his imagination. Under these circumstances, the preferable plan would be to erect a monument emblematical of the avocation of a naturalist, such, for example, as the monument to the naturalist, John James Audubon, which was unveiled at New York on April 26 last. Whether the monument should be erected at the little village of Selborne, or in the borough-town of Petersfield, ought soon to be decided. We trust that when an appeal for funds is made, there will be a hearty response to it.

WE regret to have to record the death of Dr. Carl Semper, Professor of Zoology and Comparative Anatomy in the University of Würzburg, on May 29.

IT has been resolved by the Government of India that in the future two-thirds of the officers of the Geological Survey shall be primarily engaged in the explorations necessary for the completion of the geological map, and the remaining third on the investigation of mineral fields. According to the *Times*, the exploration in the latter case will be confined to such preliminary examination as may be necessary to supply general information regarding their character and extent to capitalists and promoters, upon whom will rest the responsibility for more detailed prospecting.

AN International Electrical Congress will be held in connection with the Columbian Exposition, at Chicago, in August. There will be three sections, one dealing with pure theory, another with theory and practice, and a third with practice only. Papers are solicited upon electrical subjects, and should be sent to Prof. T. C. Mendenhall, Washington, D.C., not later than August 1. Electrical standards and units will be considered by a body consisting of those specially designated as representative delegates from the various Governments.

THE second meeting of the International Maritime Congress is to be held in the rooms of the Institution of Civil Engineers next month. The chief object of the congress is the reading and discussion of papers on matters relating to the promotion and security of maritime traffic and commerce. After the meeting it is proposed to visit the docks along the Thames, and some of the provincial seaports.

THE annual general meeting of the Institution of Civil Engineers was held on May 30. Before proceeding to the ordinary business, H.R.H. the Duke of York was elected an honorary member. The ballot for Council resulted in the election of Mr. Alfred Giles as President; of Sir Robert Rawlinson, Sir B. Baker, Sir Jas. N. Douglass, and Mr. J. W. Barry, as Vice-Presidents; and of Dr. W. Anderson, Mr. A. R. Binnie, Sir Douglas Fox, Sir Chas. A. Hartley, Messrs. J. C. Hawkshaw, C. Hawksley, Alex. B. W. Kennedy, Sir Bradford Leslie, Mr. J. Mansergh, Sir Guilford Molesworth, Mr. W. H. Preece, Sir E. J. Reed, Messrs. W. Shelford, F. W. Webb, and W. H. White as other Members of Council.

THE weather during the latter part of last week continued particularly dry over the greater part of these islands, owing to an anticyclone which lay over the Atlantic embracing most part of the country, but shallow depressions ormed over Scandinavia and the Baltic, and under their influence some slight showers occurred in the extreme north and north-west. At the end of the week however the anticyclone temporarily shifted somewhat southwards and eastwards, thunderstorms became prevalent in the north, east, and south-east, and rain fell at most stations, amounting to over half an inch in the north-east of Scotland, but generally speaking the amounts were slight elsewhere; on Tuesday, the 6th inst., the anticyclone again embraced the whole of the southern portion of our islands. During the first part of the period frost occurred on the ground in many parts of England; and although the maximum temperatures have not been high generally, they have at times exceeded 70° in different parts of Great Britain, but in the extreme north the highest readings have generally been below 60°. The *Weekly Weather Report* of the 3rd inst. showed that the temperature was slightly below the average in some of the wheat-producing districts, and rather above it in the grazing districts. Rainfall was below the mean everywhere; the deficiency since the beginning of the year ranged from 2·3 inches in the north of Scotland to 6·0 inches in the west of Scotland. Bright sunshine was only above the average in the west of Scotland, the south-west of England, and the Channel Islands. In the latter district the duration was as high as 70 per cent. of the possible amount.

THE Meteorological Council have issued the fourth volume of Hourly Means of the readings obtained from the self-recording instruments at their observatories for the year 1890. The tables contain hourly means or totals for periods of five days, months, and for the year, and, with the exception of the wind observations, daily values are also given. Breaks in the hourly readings are rare, but occur at times from failure of photography, stoppage of clocks, and in the case of the wet-bulb thermometer, owing to frost; such cases, however, are carefully examined and the losses can usually be made good by interpolation, with a very near approach to accuracy.

SIR C. TODD has published the meteorological observations made at the Adelaide Observatory and other places in the colony during the year 1890. The maximum shade temperature at Adelaide was 105° on January 18, and the minimum 34°·2 on July 17; the greatest range in 24 hours was 38°·8 on January 4th, and the lowest temperature on grass was 25° on July 17. Throughout the colony generally very oppressive weather was experienced in January and February, with heavy tropical rains over northern areas, and the winter also was very wet. The extraordinary rainfall (especially in the first three months) was the chief feature of the year, which was the wettest on record, some stations having a fall of over 100 inches.

A CORRESPONDENT calls our attention to a peculiar phenomenon witnessed at Aboyne on the morning of May 26. "Stretching along the falls of Morven and Culblean, and slightly below the top of the former, was a magnificent ribbon, exhibiting the full spectrum of colours from red to violet—in fact, a perfect 'rainbow,' but without the slightest curve. The sun was shining brightly in the east, while it was raining on Morven, which, of course, accounts for the colours; but I am unable to account for the absence of the arch." The lowest part of the ribbon showed the least refrangible colours.

A NUMBER of experiments to determine the temperature of the steam arising from a boiling salt solution have been made from time to time, but the conclusions have frequently been of a conicting character. The difficulty of arriving at trustworthy results lies in the fact that the walls of the steam-chamber must be above 100° C., and yet below the temperature of the solution, and that, at the same time, a sufficient quantity of steam must escape from the solution to ensure that these walls shall have no material cooling effect upon the steam. These desiderata are all met by an arrangement employed by Prof. Sakurai, and described in the Journal of the College of Science, Imperial University, Japan, vol. vi., part i. From experiments on solutions of calcium chloride, sodium nitrate, and potassium nitrate, it appears that the temperature of the steam escaping from a boiling solution is exactly the same as that of the solution itself.

To measure the viscosity of liquids they are let flow, under given conditions of pressure and temperature, through a capillary tube, and the time of passage is determined. This is rather unsuitable for very viscous liquids, such as concentrated glycerine; and Herr Brodmann has devised a method (*Wied. Ann.*) for determining co-efficients of friction, where these exceed a thousand times that of water. The liquid flows by gravity through a vertical tube from a wide vessel above, filled to a certain height, into a small shallow vessel below, standing on one scale of a chemical balance, the other scale being weighted so that it is down. A time comes when this preponderance ceases. The moment of passage of a certain mark is noted, a weight is added to the weight-scale, and the process is repeated. The difference of time between two of these passages corresponds, after some corrections, to the direction of outflow of a quantity of liquid equal in mass to the added weight.

A NOTE in *Électricité* gives the substance of a letter to the Génie Civil, in which the correspondent shows that there is a difference of potential between the water and gas pipes in all houses, and that if one terminal of a telephone is joined, say, to the water-pipe, on lightly touching the gas-pipe with the other, a crackling sound is heard in the telephone indicating the passage of a current. By replacing the telephone by a galvanometer, it is found that the negative pole is formed by the gas-pipe, and that the galvanometer deflection is permanent and constant in amount during several months, though there is a slight diurnal variation. The author attributes these currents to a slow chemical change in the pipes, which thus form the plates of a battery. However, these observations suggested that the pipes must be fairly well insulated from each other, and might act as conductors for telephonic communication, and he has succeeded in carrying on a conversation, without any other connecting conductor between two houses at a distance of a hundred metres apart. In this experiment the microphone, without any induction coil, was joined to three bichromate cells. It is very easy to see if the experiment will succeed, as it is only necessary to set a small induction coil to work, joining its terminals to the water and gas-pipes, then in all neighbouring houses in which, on joining a telephone to the pipes, the sound of the coil is heard communication is good. Even if speech cannot be satisfactorily transmitted, it would be possible to communicate by the ordinary Morse signals.

A HIGHLY sensitive manometer, suitable for measuring small variations of high pressures, is described by M. Villard in No. 21 of the *Comptes Rendus*. It consists of a U-tube one or two mm. in diameter and about 20 cm. long, one end of which leads into a closed glass cylinder about 50 sq. mm. in section and 8 or 10 cm. long or longer, according to the degree of sensibility required. The other end opens into another wide tube ending in a narrower portion, which may be bent back. A narrow copper tube fixed inside this portion by about 3 cm. of marine glue forms a most efficient mouthpiece and offers an almost indefinitely large resistance to the passage of gaseous matter. Enough mercury is contained in the U-tube to fill one of its branches. The filling is to a great extent self-acting. The mouthpiece need only be connected to a compressed gas reservoir. The gas bubbles up through the narrow tube and fills the cylinder at the pressure required. A slight expansion subsequently enables the mercury to reenter the narrow tube, and the position of the thread of mercury is then read off on a scale. In one of the instruments constructed, which has a reservoir of 5 cc. capacity, a change of level of 1 mm. at 20 atmospheres corresponds to a change of pressure amounting to 1 in 2500, so that it may safely be said that at 50 atmospheres the same change of level indicates a change in pressure of one-fiftieth of an atmosphere. But this amount of sensitiveness may be increased by making the reservoir longer, and since it is possible to take readings to 0·1 mm., the instrument may be said to indicate differences as small as 1 in 25,000. The variation in height of the mercury must of course be allowed for, and the tube and reservoir accurately gauged before the instrument is set up. After use at a high pressure it can be opened to the air, when the compressed gas will escape in bubbles through the wide tube. It is found that the instrument is easily made strong enough to work with safety at 100 atmospheres.

A REPORT on "The Hawks and Owls of the United States," with special reference to the economic status of the various species, has been prepared by Dr. A. K. Fisher for the U.S. Department of Agriculture. Of the seventy-three species and sub-species described only six prove to be injurious, and three of those are extremely rare. The contents of about 2700 stomachs of hawks and owls were examined, and omitting the six species that feed largely on poultry and game, 56 per cent. contained mice and other small mammals, 27 per cent. insects, and only $3\frac{1}{2}$ per cent. poultry or game birds. This result shows that a class of birds commonly looked upon as enemies to the farmer really rank among his best friends. The report contains twenty-five coloured plates.

AT a meeting of the Norfolk and Norwich Naturalists' Society, held on May 30, a resolution with regard to the Wild Birds Protection Bill now before the House of Lords was unanimously passed, and the president requested to forward the same to the Earl of Kimberley, one of the Vice-presidents, asking his cooperation with its objects. The result of the proposed amendments would be that the County Council should be empowered to order the protection of certain specified districts easily defined, rather than the eggs of specified species, which, in many instances, so closely resemble those of other species (as for instance, those of the Teal and Gargany Teal, and the Ruff and Redshank) that their identification would be so difficult to establish as to render a conviction practically impossible.

IN the fourth annual report of the Missouri Botanical Garden, which has just been published, Mr. W. Trelease gives the results of further studies of yuccas and their pollination. Mr. Albert S. Hitchcock also contributes a description of plants collected in the Bahamas, Jamaica, and Grand Cayman.

MESSRS. BLACKIE AND SON have added another to their already large number of science text-books. "Chemistry for All," by W. Jerome Harrison and R. J. Bailey, is a tersely-written account of the chemistry of common things, in which equations, formulæ, chemical symbols, and arithmetical calculations are eschewed. There is little new in the book, either in the text or illustrations.

MESSRS. MACMILLAN AND CO. have just published a fine work by Mr. G. W. Caldwell Hutchinson, entitled "Some Hints on Learning to Draw." A few excellent, though brief, remarks on elementary anatomy precede the description of drawing the human figure, but artists do not yet seem to realise the equal importance of knowing something about the elements of physical science before conceiving pictures of natural phenomena.

MESSRS. GAUTHIER-VILLARS have issued two small volumes by M. P. Minel on "L'Electricité Industrielle." One deals with potential lines of force and electro-magnetic units, and in the other, magnetic circuits and induction machines are considered. The object of the author has been to bring together the theoretical principles necessary to the proper understanding of dynamo-electric machinery and electric lighting.

A USEFUL little book by M. Henri Coupin on "L'Aquarium d'Eau Douce" has recently been published by Messrs. Baillière. It is well illustrated, and should be interesting to young naturalists. The author describes how to capture, preserve, and study some of the common types of plants and animals found in fresh water.

A TRANSLATION of Dr. Migula's "Introduction to Practical Bacteriology," by M. and H. J. Campbell, has just been published by Messrs. Swan Sonnenschein and Co. The German edition was reviewed in these columns on June 30, 1892.

THE Geological and Natural History Survey of Minnesota have issued their twentieth annual report. Among other papers contained in the report is one by Mr. N. H. Winchell on "The Crystalline Rocks, some preliminary considerations as to their Structure and Origin," and Dr. A. C. Lawson gives the results of a survey of the raised beaches of the north shore of Lake Superior.

A USEFUL syllabus of an elementary course of botany has been received from the author, J. Bentley Philip. It is published by James G. Bisset, of Aberdeen.

PROF. HERDMAN writes to us:—"During the Whitsuntide vacation the Liverpool Marine Biology Committee spent two days in dredging from Port Erin, and the rest of the time in work on the shore and in the Biological station. On one day the weather was sufficiently fine to allow of the steamer working on the seventy fathom depression which lies to the west of the Isle of Man, half way to the Irish coast. The bottom there is a fine stiff grey-blue mud or clay, which, it has been suggested, may be of glacial origin. We searched very carefully through dredgefuls of this unpleasantly tenaceous cold mud in the hope of finding some stones or shells which might settle the matter, but in vain. The animals on this ground include the Crustaceans *Calocaris macandreweæ* and *Pasiphæa sivado*, a Polynoid (*Panthalis oerstedi*) in enormous muddy tubes and *Lipobranchius jeffreysii*, Echinoderms *Amphiura chiajii* and *Brissopsis lyrifera* (in quantity), *Virgularia mirabilis*, and the Molluscs *Isocardia cor* and *Rissoa abyssicola*. On a previous trip, shortly before this, one of our party obtained fifteen living specimens of *Isocardia cor* on this ground. The rest of the dredging on the two days was carried on nearer Port Erin, along the west side of the Isle of Man, at depths of twelve to forty-six fathoms. Among the more noteworthy forms obtained were the Echinoderms *Thyone raphanus* and *Echinocardium flavescens*, a calcareous sponge *Ute glabra* (found before at Guernsey), the Ascidians *Eugyra glutinans*, *Polycarpa comata*, and a considerable number of the rare *Forbesella tessellata* (which present such variations in shape, general appearance, colour and texture, along with identity in anatomical characters, as to enable me to say that Forbes's *Cynthia tessellata* and *C. limacina* are undoubtedly one and the same species), and the mollusca *Oscanius membranaceus*, *Coryphella landsburgi*, and *Cyclostrema millepunctatum*, Friele, which is new to British seas. One of our reporters on Mollusca (Dr. Chaster) tells me that Canon Norman, who has seen our specimens of the *Cyclostrema*, and compared them with one of Herr Friele's type specimens in his collection, writes that the species has only been taken by the Norwegian North-Atlantic Expedition at Stat. 192 (Lat. 69°46′ N., Long. 16° 15′ E.), off the northern part of Norway, at a depth of 649 fathoms. *Anomalocera pattersonii* was very conspicuous in the surface nettings, and additional specimens of the new *Lichomolgus* (L.

maximus, Thomps.) inhabiting *Pecten* were obtained, along with many other Copepoda which have not yet been examined."

Two further papers upon his researches with the electric furnace are contributed by M. Moissan to the current number of the *Comptes Rendus*. In the first it is shown that crystals of quartz and zircon are almost instantly fused at the high temperature of a powerful electric arc, the liquids brought to vigorous ebullition in a few moments and actually distilled, passing over into the receiver in the form of a dense fume. M. Moissan further demonstrates how easy it is at this high temperature to obtain pure zirconium and pure silicon by reduction of the liquefied oxides with carbon. The current employed was one of 360 ampères. When fragments of rock crystal were placed in the crucible of the furnace and subjected to the arc they rapidly melted, and in seven minutes the liquid boiled vigorously; the vapour of silicon dioxide which escaped condensed in the cooler portion of the furnace to a bluish-white fume, which deposited in the receiver in the form of small opalescent spheres, visible to the unaided eye. These spheres of silica were solid throughout, and usually exhibited a depression at some portion of the surface, indicating contraction upon passing from the liquid to the solid state. They were readily soluble in hydrofluoric acid. It is of interest that M. Moissan has discovered similar opalescent spheres of silica upon glass globes which have been employed in electric lighting to diffuse the light from arc lamps, indicating that slow volatilisation of the silica of the glass had occurred. It is doubtless to this cause that the opalescence which usually occurs after such globes have been in use for some time is due. The specific gravity of the spheres is 2·4, slightly less than that of quartz. At the temperature of the arc given by 360 ampères liquid silica is very readily reduced by carbon, a crystalline regulus of silicon being obtained containing more or less carbon.

WHEN zircons or any other form of zirconia are submitted to the high temperature of the same arc they likewise fuse, and in about ten minutes the liquid boils vigorously, and zirconium oxide passes over as a white fume into the receiver, where it condenses in the form of a white powder. Any liquid remaining in the crucible after switching off the current solidifies to a crystalline mass, and scattered about the walls of the furnace numerous perfect little artificial zircons are observed, identical n colour, lustre, and other properties with natural zircons. Both these and the powder condensed in the receiver readily scratch glass. Liquid zirconia, like silica, is readily reduced by carbon. If the oxide is fused by the arc in a carbon crucible, a button of metallic zirconium is found at the close of the operation beneath the residual solidified zirconia. If zirconia is mixed with powdered carbon a metal is obtained containing 4-5 per cent. of carbon. This carbide can be refined by re-melting with more zirconia when the pure metal is obtained. Zirconium is a very hard metal, readily scratching glass and ruby. Its density is 4·25.

THE second paper of M. Moissan describes the preparation of metallic tungsten, molybdenum, and vanadium. Tungsten is readily obtained in the form of powder by reduction of heated tungstic acid in a current of hydrogen, but the powder thus obtained has been hitherto found to be practically infusible. M. Moissan now shows that tungsten may be readily prepared in solid ingots in the electric furnace. A mixture of tungstic acid and carbon is placed in the crucible, and after ten minutes' subjection to an arc of the tension above stated a button of over a hundred grams of the metal is produced. If care has been taken to ensure excess of tungstic acid, pure tungsten is btained in the one operation. Otherwise a carbide is obtained which requires refining by re-melting with a further quantity of tungstic acid. The tungsten thus obtained is a very brilliant metal of specific gravity 18·7. M. Moissan has further observed that if a much more powerful arc is employed, the percentage of carbon in the carbide of tungsten first obtained is very largely increased. Thus when a current of 1000 ampères was employed the percentage of carbon rose to 18, indicating an attempt to form a true binary compound. Metallic molybdenum has likewise been obtained by M. Moissan by the reduction of its oxide with powdered charcoal at the temperature of the arc afforded by a current of 360 ampères. The metal is not, however, quite free from carbon, and requires refining.

THE preparation of metallic vanadium has presented considerable difficulty. It will be remembered that Sir Henry Roscoe found it impracticable to reduce vanadic acid by carbon, and eventually isolated the pure metal by reduction of the dichloride in a stream of hydrogen. M. Moissan finds that even after twenty minutes' action of the arc from the 360 ampères current, only a trace of reduction is apparent at the surface of the mixture of oxide and charcoal. Upon increasing the tension of the arc by employing a current of a thousand ampères complete reduction occurs, but the metal produced combines, as in the case of tungsten, with a large quantity of carbon. It would appear, therefore, that at this high temperature these refractory metals combine with carbon to form definite binary compounds.

NOTES from the Marine Biological Station, Plymouth.—Last week's captures include the Actinians *Sagartia miniata* and *venusta*, the Nemertines *Amphiporus hastatus* and *Malacobdella grossa*, the Polychæte *Myrianida maculata* (with a posteriorly proliferated chain of buds), and the Schizopods *Siriella frontalis* and *jaltensis*, the latter species in considerable numbers. Floating Cœlenterates have been particularly plentiful. Medusæ of *Aurelia aurita* (now 4 to 7 ins. in diameter) have frequently been noticed. The Anthomedusæ have been represented by *Sarsia tubulosa*, *Bougainvillea ramosa*, and, more plentifully, by *Amphinema Titania*; the Leptomedusæ by countless numbers of *Phialidium variabile*, together with a smaller proportion of *Thaumantias Thompsoni* (Forbes) and *Laodice cruciata*, Ag. (= *T. pilosella*, Forbes). A few young *Clytia* medusæ have been occasionally taken, but *Obelia* medusæ have been very scarce. The Ctenophore *Hormiphora plumosa*, in various stages of growth, is now abundant. Several specimens of the parasitic larva of the Actinian *Halcampa chrysanthellum* have been taken. The beautiful veliger *Echinospira diaphana* has once been noticed; larvæ of the Crustacean *Porcellana* are plentiful. The following animals are now breeding:—The Hydroid *Clava cornea*, the Mollusca *Murex erinaceus* and *Aplysia punctata*, the Schizopoda *Macromysis inermis* and *Siriella jaltensis*, the Decapod *Palæmonetes vulgaris*, and the Echinoderm *Asterina gibbosa*.

THE additions to the Zoological Society's Gardens during the past week include a Barbary Ape (*Macacus inuus*, ♀) from North Africa, presented by Mr. A. G. F. Dashwood; a Suricate (*Suricata tetradactyla*) from South Africa, presented by Mr. L. V. Harcourt; three Chinese Quails (*Coturnix chinensis*, ♂ ♀ ♀) from China, presented by Mr. W. J. Ingram; two Kingfishers (*Alcedo ispida*) British, presented by Mr. A. K. Dixon; a Harlequin Snake (*Elaps fulvius*) from Florida, presented by Mr. C. Ernest Brewerton; a Horned Lizard (*Phrynosoma cornutum*) from Texas, presented by Mr. J. Harland Coates; a Sykes's Monkey (*Cercopithecus albigularis*, ♀) from East Africa, a Leucoryx (*Oryx leucoryx*, ♀) from North Africa, a Mexican Deer (*Cariacus mexicanus*, ♂) from Mexico, a Malayan Tapir (*Tapirus indicus*, ♂) from Malacca, two Common Cassowaries (*Casuarius galeatus*, jr.) from Ceram, a Leopard Tortoise (*Testudo pardalis*), two Derbian Zonures (*Zonurus derbianus*) from South Africa, deposited; two Brazilian Cariamas (*Cariama cristata*) from Brazil, four Black-tailed Godwits

(*Limosa ægocephala*) four Flamingoes (*Phœnicopterus antiquorum*) European, purchased; a Barbary Wild Sheep (*Ovis tragelaphus*, ♂), an Angora Goat (*Capra hircus*, ♀ var.), a Japanese Deer (*Cervus sika*, ♀), a Great Kangaroo (*Macropus giganteus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE TOTAL SOLAR ECLIPSE (April, 1893).—M. N. Coculesco, in the current number of the *Comptes Rendus* (No. 22) gives a brief account of his observations made during the last total solar eclipse. The station he occupied was at Fundium. The instruments which he took with him consisted of a telescope of 0·16 m. aperture, with a wooden mounting, a fine comet seeker, a mean time chronometer, and a thermometer. An ordinary photographic camera fixed to the telescope was also employed, five fine negatives of the corona being obtained with it. The plates employed were the ordinary dry plates of gelatine-bromide of silver, and the developer that of ferrous-oxlate. The exposures were of 2, 4, 6, 7, and 5 seconds duration, but the second plate seems to have given the most details. The observation of contacts gave the following results:—

Observation.	Paris M. T. h.	m.	s.
1st contact	2	20	21
2nd ,, ...	3	42	51
3rd ,, ...	3	47	2
4th ,, ...	5	3	36

thus giving 4m. 11s. as the duration of totality. The thermometrical observations showed that on the day of the eclipse the temperature was + 28° C., at the commencement of totality 26°·6, middle of totality 24°·0, and at the end of the eclipse 26°·5. A fall of from 3½° to 4° was thus noticed from the commencement of the eclipse to the middle of totality.

METEOR OBSERVATIONS.—Mr. Denning, in the *Observatory* for June, has a note on the large meteor of April 15, 1893, and also notes on observations of fireballs. With reference to the latter he points out those observations are made by a number of casual observers, and are commonly found to be conflicting and incomplete, the accounts being based on "rough hurried impressions often vitiated by serious errors." In attempting to reduce such observations it is generally found impossible to accommodate the descriptions unless we assume that the several large meteors appeared simultaneously in different paths. These bodies, he says, deserve closer attention than is usually given to them, and accurate observations should be made with regard to their positions, directions, and durations of their flights among the stars. That meteoric astronomy would advance by rapid strides, and that many "moot points in the visible behaviour of meteor-streams would soon receive settlement" cannot for a moment be doubted.

The study of brilliant meteors is one that requires no instrument but simply a good star atlas, and we hope that many of our readers may take Mr. Denning's words to heart and try to elevate this important branch of astronomy so that it can no longer be said that "they come and go, and their transient glories serve no more important end than that of affording startling spectacles to those who are fortunate enough to witness them."

WASHBURN OBSERVATIONS.—In vol. vi. part 3 of the Publications of the Washburn Observatory are the results of the observations made by Mr. Sidney Dean Townley of telescopic variable stars of long period. The method employed was to select two stars for comparison, one slightly brighter and the other slightly fainter than the one to be measured, the difference between these two comparison stars in brightness being less than a magnitude. By this means a very accurate estimation can be made of the brightness of the star in tenths of the interval between those taken for comparison. In estimating the magnitudes of the comparison stars he has employed the limit of visibility of the finder and large telescope (apertures 8·9 cm. and 39·5 cm. respectively), commencing with the former, and going down the numerical scale. The method of recording the values obtained is similar to the notation used by Argelander and Herschel Thus of two comparison stars *a* and *b*, *a* 1 *b* shows that the star observed is very nearly as bright as *a*, while *a* 9 *b* shows that it is very nearly equal in brightness to *b*, the number 1 representing one-tenth of the difference of brightness between the two comparison stars. In the tables, the number of the stars, together with their R.A.'s and declinations, are taken from Chandler's "Catalogue of Variable Stars." About 36 variables are included in this work, the observations extending over the period 1889–1892.

FINLAY'S COMET (1886 VII.).—Comet Finlay is described as circular, 1′ in diameter, 11th magnitude, very diffuse, and with no tail. As it rises just before the morning twilight in this country, it is by no means in a good position for observation. The following ephemeris is taken from a continuation of M. Schulhof's computations, made by M. Coniel, the difference between the computed and observed places being approximately—1m. 43s. in R.A. and + 12′ N.P.D.

M.T. Paris.

1893.	R.A. app. h.	m.	s.	Decl. app. °	′
June 8 ...	1	12	56	... +4	40·6
9 ...		17	35	... 5	9·9
10 ...		22	15	... 5	39·1
11 ...		26	56	... 6	8·2
12 ...		31	38	... 6	37·1
13 ...		36	20	... 7	5·9
14 ...		41	3	... 7	34·5
15 ...	1	45	47	... +8	2·9

GEOGRAPHICAL NOTES.

AT the last meeting of the Royal Geographical Society, Dr. Joseph A. Moloney, medical officer to Capt. Stairs' expedition to Katanga, read a paper descriptive of the journey. The expedition of over 300 men landed at Bagamoyo on June 27, 1891, and marched to Lake Tanganyika through the German territory, following the well-known caravan-track through Tabora. On the way proofs were not wanting that the slave-traders were kept well supplied with gunpowder, in spite of the strict regulations which are made much of in Europe. On October 9 they reached Lake Tanganyika near its southern end, and from conversations with the missionaries and natives obtained some interesting information as to the variations in the level of the water. It appears that the outlet of the lake by the Lukuga becomes periodically choked by sand and vegetation, thus forming a natural dam, which causes the level of the lake to rise. After a time the barrier is carried away and the river issues with great force, flowing strongly for a number of years. The extreme difference in level must be about 18 feet, and the rise and fall probably occupy about fifteen years. On October 31 the caravan started from the west side of the lake. The Kaomba country first passed through was found to abound in minerals, iron and copper being extensively worked by the natives who show much skill in the manufacture of weapons and implements. Bunkeia, the capital of Msiri's territory, was reached on December 14, the journey having been of extraordinary rapidity considering the route taken. Much of the country was swampy, and there were tracts of dense tropical forests reminding Captain Stairs of the Aruwimi basin. Near Bunkeia a famine was raging, and this, together with the tragedies consequent on the conquest of Msiri, brought the expedition into a very bad state. All the Europeans except Dr. Moloney suffered severely, and Captain Stairs never fully recovered. On February 4, 1892, the survivors of the expedition set out on the return journey, and travelling by Lake Nyasa and the Shire reached the Chinde mouth of the Zambesi on June 4.

JUDGE DALY, President of the American Geographical Society, devoted his anniversary address, which has just been published, to a critical study of the portraits of Columbus. He believes that several of those popularly held to be authentic are really original paintings from the life, but the Lotto portrait which has been multiplied indefinitely by the United States Government on commemoration coins and postage stamps he looks on as of very doubtful value.

MR. CARL LUMHOLTZ publishes a letter from North Mexico in the last number of the *Bulletin* of the American Geographical Society, in which he gives some account of his studies of the Tarahumare Indians, who are cave-dwellers although not apparently connected with the ancient cave and cliff-dwellers of the United States. Mr. Lumholtz was engaged in taking down the language, and in making anthropometric measurements of this little-known tribe.

THE French weekly geographical paper, *La Géographie*, has, after five years in the ordinary garb of a newspaper, assumed a new form, each number consisting of eight quarto pages in a coloured wrapper.

MR. H. YULE OLDHAM, Lecturer on Geography in Owens College, Manchester, has been appointed to the lectureship on Geography in the University of Cambridge, formerly held by Mr. J. Y. Buchanan, F.R.S. Mr. Oldham has mainly studied the historical aspects of geography, and in his appointment the University of Cambridge obviously intends to associate its geographical teaching with the Historical rather than the Natural Science Board of Studies. It is to be hoped that the lectureship will receive more attention from the members of the University than has been given to it hitherto, and that the loss to scientific geography caused by Mr. Buchanan's retirement will be more than made up by increased interest in the less specialised aspects of the science.

MR. H. M. CADELL gives a remarkably interesting map of the site of Edinburgh in prehistoric times in the June number of the *Scottish Geographical Magazine*. The most noteworthy feature is the submergence of the 25 feet raised beach on which the greater part of Leith is now built, and the existence of seven comparatively large lakes of which the shrunken remnants only remain, or which have been entirely drained and reclaimed within the historic period. A summary of the evidence for the existence of these lakes is given in the form of a short article. It is noteworthy that the changes in the surface of the land due to cultivation and building operations have in some cases almost entirely concealed the original features. In the early human period the shores of the Firth of Forth must have been occupied by a succession of swampy lakes dominated by the steep cliffs of the volcanic hills.

SEISMOLOGY IN JAPAN.[1]

THE editor insists in a Wordsworthian manner on calling this the seventeenth volume although it is really vol. i. of the journal: he numbers it as a continuation of publications hitherto issued as the Transactions of the Seismological Society of Japan. The Society was founded in 1880 and for many years its meetings were frequent and well attended. It ceased to live in so far as subscriptions and meetings are concerned in 1892, many of its members having left the country. It may now be said to exist as much as ever it did, but without subscriptions. The transactions are in sixteen volumes of scientific papers to which a general index is published in this first number of the journal, and there can be no doubt of the great value of these papers, or of the ability and industry in experiment and speculation of the men who wrote them. During the twelve years' work of the Society much was accomplished; some order was evolved out of chaos; seismographs have been invented giving absolute measurements of earth motions, and a complete change has been effected in earthquake observation; a chair of seismology has been established in the Imperial University and there is now a bureau controlling a central observatory and some 700 outside stations, together with many seismological laboratories. This is some of the work which the Society has done.

The first paper in this journal "On the Mitigation of Earthquake Effects, and Certain Experiments on Earth Physics" by the editor, reads very strangely to any one unacquainted with the work done by Prof. Milne in the last fifteen years. For example, on the construction of buildings in earthquake countries, his experiments have led to such results that he can speak with certainty on things which used to be merely matters of vague speculation, such as the security given by depth of foundation and the great differences in the earth motions at places within a few hundred yards of one another.

Probably no one can speak with greater authority on photographic matters than Prof. Burton, who contributes an article "On the Application of Photography to Seismology and Volcanic Phenomena." The other papers are:—An abstract of "The Seismometrical Observations for the year 1890," by the editor; "An Account of Experiments on the Overturning and Fracturing of Brick and other Columns by Horizontally Applied Motion," by the editor and Prof. Omori; "On Earth Pulsations in relation to certain Natural Phenomena and Physical Investigations," by the editor; an abstract on observations by Dr. E. Von Rebeur-Paschwitz with horizontal pendulums; a note on old Chinese earthquakes, by Prof. Omori, and a note by the editor on the destructive earthquake of 1891. All these papers seem to me to be valuable and interesting; they ought to be studied by every young philosopher whose mathematical and other weapons are ready, but who is yet without mental employment. The subject is one of world-wide interest, although it may seem to be only interesting to people like the Japanese who are jogged into attention every week of their lives.

The beautiful series of photographs published by Burton and Milne about a year ago are records that can never be branded as lies or exaggerations. Even Dr. Johnson, who to his dying day denied the fact that an earthquake had occurred at Lisbon, would have been convinced by records such as these. Without these photographs it would be difficult to believe in the actual compression in area of land over a large district or in vertical wave motion, travelling along a street as if the earth were water in a canal. The Japanese cannot neglect the study of the subject and other people ought not. Our time also may come, even in England, when in a five seconds interval, three fourths of all the houses in London may tumble into ruin and a quarter of a million sterling may be lost on every square mile of English ground. It is of no use to argue from the long histories of ancient cities. Earth shakes that had no evil effect on the more or less pyramidal architecture of Assyria and Egypt would lay the dwelling houses of London in long swathes upon the ground. One laughs at Alice's White Knight who was so well prepared for sharks, but we also laugh at Mrs. Aleslime whose specific in the real time of danger was "black stockings for sharks." Whatever our own safety may be we must remember that some of the most interesting parts of the world are vitally interested in this question, and the most artistic, most honest, most kindly, most generous and confiding clever people that the world has ever seen are demanding from us that we shall study this question to find out whatever means there may be for mitigating the effects of earthquakes, and more than all, taking away from them the dreadful everpresent feeling of danger, which seems in itself almost sufficient to arrest progress in civilisation.

We western people were till lately represented in Japan on this question by the Seismological Society. What one earnest worker and a few of his friends can do is being done, but in spite of earnestness and devotion, I am afraid that in one respect there must be a lessened result. The existence of the Society was of some weight in maintaining the interest of the Japanese Government on what must seem to non-scientific people a rather hopeless search for information. Even the small and exceedingly intermittent assistance of the British Association grant is of enormous moral value to Prof. Milne; and I think that if the council at Edinburgh had yielded to the representations of section A and granted the modest request of Prof. Milne for £25, they would have done more good than they can do with any equal sum in their present list. We have here a man who is untiring in experimental work, who has the power of keeping enthusiasm alive in other people to a remarkable degree, who is not a wealthy man and who yet spends some hundreds of pounds a year of his own, in making and using apparatus and in publishing a journal which has about seventeen subscribers. And all the work is good; it is thankless work as all work on the beginning of a science must be.

If every reader of NATURE who is interested in the matter and who can afford it, would only send to Prof. Milne a subscription (one pound a year) to this journal, his losses would be confined to his experimental work; the Japanese Government would more certainly continue to interest its officials in making observations, and the subscribers would glow in the consciousness of having done their duty. JOHN PERRY.

[1] *The Seismological Journal of Japan*, edited by John Milne, F.R.S. Vol. xvii. 1893.

ON LIGHT AND OTHER HIGH FREQUENCY PHENOMENA.[1]

BRILLIANTLY worded, comprehensive, and strikingly illustrated was a lecture delivered by Mr. Nikola Tesla, of which a report has just reached us. In his own words:—

[1] A lecture delivered before the Franklin Institute, at Philadelphia, Feb. 24, 1893, and before the National Electric Light Association, at St. Louis, Mo., March 1, 1893.

"In presenting these insignificant results I have not attempted to arrange and co-ordinate them as would be proper in a strictly scientific investigation in which every succeeding result should be a logical sequence of the preceding, so that it might be guessed in advance by the careful reader or attentive listener. I have preferred to concentrate my energies chiefly upon advancing novel facts or ideas which might serve as suggestions to others, and this may serve as an excuse for the lack of harmony. The explanations of the phenomena have been given in good faith, and in the spirit of a student prepared to find that they admit of a better interpretation. There can be no great harm in a student taking an erroneous view, but when great minds err, the world must dearly pay for their mistakes."

The following extracts will serve to show the character of the discourse:—

The Action of the Eye.

It can be taken as a fact, which the theory of the action of the eye implies, that for each external impression, that is, for each image produced upon the retina, the ends of the visual nerves concerned in the conveyance of the impression to the mind, must be under a peculiar stress or in a vibratory state. It now does not seem improbable that, when by the power of thought an image is evoked, a distinct reflex action, no matter how weak, is exerted upon certain ends of the visual nerves, and therefore upon the retina. Will it ever be within human power to analyse the condition of the retina when disturbed by thought or reflex action, by the help of some optical or other means of such sensitiveness, that a clear idea of its state might be gained at any time? If this were possible, then the problem of reading one's thoughts with precision, like the characters of an open book, might be much easier to solve than many problems belonging to the domain of positive physical science, in the solution of which many, if not the majority, of scientific men implicitly believe. Helmholtz has shown that the fundi of the eyes are themselves luminous, and he was able to *see*, in total darkness, the movement of his arm by the light of his own eyes. This is one of the most remarkable experiments recorded in the history of science, and probably only a few men could satisfactorily repeat it, for it is very likely that the luminosity of the eyes is associated with uncommon activity of the brain and great imaginative power. It is fluorescence of brain action, as it were.

Another fact having a bearing on this subject which has probably been noted by many, since it is stated in popular expressions, but which I cannot recollect to have found chronicled as a positive result of observation is, that at times, when a sudden idea or image presents itself to the intellect, there is a distinct and sometimes painful sensation of luminosity produced in the eye, observable even in broad daylight.

Two facts about the eye must forcibly impress the mind of the physicist, notwithstanding he may think or say that it is an imperfect optical instrument, forgetting that the very conception of that which is perfect or seems so to him, has been gained through this same instrument. Firstly, the eye is, as far as our positive knowledge goes, the only organ which is *directly* affected by that subtile medium, which, as science teaches us, must fill all space; secondly, it is the most sensitive of our organs, incomparably more sensitive to external impressions than any other.

This divine organ of sight, this indispensable instrument for thought and all intellectual enjoyment, which lays open to us the marvels of this universe, through which we have acquired what knowledge we possess, and which prompts us to, and controls, all our physical and mental activity. By what is it affected? By light! What is light?

It is beyond the scope of my lecture to dwell upon the subject of light in general, my object being merely to bring presently to your notice a certain class of light effects and a number of phenomena observed in pursuing the study of these effects. But to be consistent in my remarks it is necessary to state that according to that idea, now accepted by the majority of scientific men as a positive result of theoretical and experimental investigation, the various forms of manifestations of energy which were generally designated as "electric" or more precisely "electromagnetic" are energy manifestations of the same nature as those of radiant heat and light. Therefore the phenomena of light and heat, and others besides these, may be called electrical phenomena. Thus electrical science has become the mother science of all and its study has become all-important. The day when we shall know exactly what "electricity" is, will chronicle an event probably greater, more important than any other recorded in the history of the human race.

Transformation of Currents.

Mr. Tesla then went on to describe the apparatus employed, and the method of obtaining the high potentials and high frequency currents which are made use of in his experiments. In order to explain the transformation of currents he used the following analogy:—

Imagine a tank with a wide opening at the bottom, which is kept closed by spring pressure, but so that it snaps off *suddenly* when the liquid in the tank has reached a certain height. Let the fluid be supplied to the tank by means of a pipe feeding at a certain rate. When the critical height of the liquid is reached, the spring gives way and the bottom of the tank drops out. Instantly the liquid falls through the wide opening, and the spring, reasserting itself, closes the bottom again. The tank is now filled, and after a certain time interval the same process is repeated. It is clear that if the pipe feeds the fluid quicker than the bottom outlet is capable of letting it pass through, the bottom will remain off and the tank will still overflow. If the rates of supply are exactly equal, then the bottom lid will remain partially open, and no vibration of the same and of the liquid column will generally occur, though it might, if started by some means. But if the inlet pipe does not feed the fluid fast enough for the outlet, then there will be always vibration. Again, in such case, each time the bottom flaps up or down, the spring and the liquid column, if the pliability of the spring and the inertia of the moving parts are properly chosen, will perform independent vibrations. In this analogue the fluid may be likened to electricity or electrical energy, the tank to the condenser, the spring to the dielectric, and the pipe to the conductor through which electricity is supplied to the condenser. To make this analogy quite complete it is necessary to make the assumption, that the bottom, each time it gives way, is knocked violently against a non-elastic stop, this impact involving some loss of energy, and that, besides, some dissipation of energy results, due to frictional losses. In the preceding analogue the liquid is supposed to be under a steady pressure. If the pressure of the fluid be assumed to vary rhythmically, this may be taken as corresponding to the case of an alternating current. The process is then not quite as simple to consider, but the action is the same in principle.

Electrostatic Force.

After showing that the human body could be traversed by a powerful electric current vibrating at about the rate of one million times per second, Mr. Tesla said:—

The amount of energy which may thus be passed into the body of a person depends on the frequency and potential of the currents, and by making both of these very great, a vast amount of energy may be passed into the body without causing any discomfort except perhaps in the arm, which is traversed by a true conduction current. The reason why no pain in the body is felt, and no injurious effect noted, is that everywhere, if a current be imagined to flow through the body, the direction of its flow would be at right angles to the surface; hence the body of the experimenter offers an enormous section to the current, and the density is very small, with the exception of the arm perhaps, where the density may be considerable. But if only a small fraction of that energy would be applied in such a way that a current would traverse the body in the same manner as a low frequency current, a shock would be received which might be fatal. A direct or low-frequency alternating current is fatal I think, principally because its distribution through the body is not uniform, as it must divide itself in minute streamlets of great density, whereby some organs are vitally injured. That such a process occurs I have not the least doubt, though no evidence might apparently exist or be found upon examination. The surest to injure and destroy life is a continuous current, but the most painful is an alternating current of very low frequency. The expression of these views, which are the result of long-continued experiment and observation, both with steady and varying currents, is elicited by the interest which is at present taken in this subject and by the manifestly erroneous ideas which are daily propounded in journals on this subject.

The electrostatic attractions and repulsions between bodies of measurable dimensions are, of all the manifestations of this force, the first so-called *electrical* phenomena noted. But though they have been known to us for many centuries, the precise nature of the mechanism concerned in these actions is still unknown to us, and has not been even quite satisfactorily explained. What kind of mechanism must that be? We cannot help wondering when we observe two magnets attracting and repelling each other with a force of hundreds of pounds with apparently nothing between them. We have in our commercial dynamos magnets capable of sustaining in mid-air tons of weight. But what are even these forces acting between magnets when compared with the tremendous attractions and repulsions produced by electrostatic force, to which there is apparently no limit as to intensity. In lightning discharges bodies are often charged to so high a potential that they are thrown away with inconceivable force and torn asunder or shattered into fragments. Still even such effects cannot compare with the attractions and repulsions which exist between charged molecules or atoms, and which are sufficient to project them with speeds of many kilometres a second so that under their violent impact bodies are rendered highly incandescent and are volatilized. It is of special interest for the thinker who inquires into the nature of these forces to note, that whereas the actions between individual molecules or atoms occur seemingly under any condition, the attractions and repulsions of bodies of measurable dimensions imply a medium possessing insulating properties. So, if air, either by being rarefied or heated, is rendered more or less conducting, these actions between two electrified bodies practically cease, while the actions between the individual atoms continue to manifest themselves.

Single-wire Transmission.

It has been for a long time customary, owing to the limited experience with vibratory currents, to consider an electric current as something circulating in a closed conducting path. It was astonishing at first to realise that a current may flow through the conducting path even if the latter be interrupted, and it was still more surprising to learn, that sometimes it may be even easier to make a current flow under such conditions than through a closed path. But that old idea is gradually disappearing, even among practical men, and will soon be entirely forgotten.

It is thought useful to devote here a few remarks to the subject of operating devices of all kinds by means of only one leading wire. It is quite obvious, that when high-frequency currents are made use of, ground connections are—at least, when the E.M.F. of the currents is great—better than a return wire. Such ground connections are objectionable with steady or low frequency currents on account of destructive chemical actions of the former and disturbing influences exerted by both on the neighbouring circuits; but with high frequencies these actions practically do not exist. Still, even ground connections become superfluous when the E.M.F. is very high, for soon a condition is reached when the current may be passed more economically through open, than through closed conductors. Remote as might seem an industrial application of such single wire transmission of energy to one not experienced in such lines of experiment, it will not seem so to any one who for some time has carried on investigations of such nature. Indeed I cannot see why such a plan should not be practicable. Nor should it be thought that for carrying at such a plan currents of very high frequency are implicitly required, for just as soon as potentials of say 30,000 volts are used, the single wire transmission may be effected with low frequencies, and experiments have been made by me from which these inferences are made.

Electrical Resonance.

Some remarks and experiments were then made with regard to electrical resonance. Continuing, Mr. Tesla said:—

In connection with resonance effects and the problem of transmission of energy over a single conductor which was previously considered, I would say a few words on a subject which constantly fills my thoughts and which concerns the welfare of all. I mean the transmission of intelligible signals or perhaps even power to any distance without the use of wires. I am becoming daily more convinced of the practicability of the scheme, and though I know full well that the great majority of scientific men will not believe that such results can be practically and immediately realised, yet I think that all consider the developments in recent years by a number of workers to have been such as to encourage thought and experiment in this direction. My conviction has grown so strong that I no longer look upon this plan of energy or intelligence transmission as a mere theoretical possibility, but as a serious problem in electrical engineering, which must be carried out some day. The idea of transmitting intelligence without wires is the natural outcome of the most recent results of electrical investigations. Some enthusiasts have expressed their belief that telephony to any distance by induction through the air is possible. I cannot stretch my imagination so far, but I do firmly believe that it is practicable to disturb by means of powerful machines the electrostatic condition of the earth, and thus transmit intelligible signals and perhaps power. In fact, what is there against the carrying out of such a scheme? We now know that electric vibration may be transmitted through a single conductor. Why then not try to avail ourselves of the earth for this purpose? We need not be frightened by the idea of distance. To the weary wanderer counting the mile-posts the earth may appear very large, but to that happiest of all men, the astronomer, who gazes at the heavens and by their standard judges the magnitude of our globe, it appears very small. And so, I think, it must seem to the electrician, for when he considers the speed with which an electric disturbance is propagated through the earth all his ideas of distance must completely vanish.

A point of great importance would be first to know what is the capacity of the earth? and what charge does it contain if electrified? Though we have no positive evidence of a charged body existing in space without other oppositely electrified bodies being near, there is a fair probability that the earth is such a body, for by whatever process it was separated from other bodies—and this is the accepted view of its origin—it must have retained a charge, as occurs in all processes of mechanical separation. If it be a charged body insulated in space its capacity should be extremely small, less than one-thousandth of a farad. But the upper strata of the air are conducting, and so, perhaps, is the medium in free space beyond the atmosphere, and these may contain an opposite charge. Then the capacity might be incomparably greater. In any case it is of the greatest importance to get an idea of what quantity of electricity the earth contains. It is difficult to say whether we shall ever acquire this necessary knowledge, but there is hope that we may, and that is by means of electrical resonance. If ever we can ascertain at what period the earth's charge, when disturbed, oscillates with respect to an oppositely electrified system or known circuit, we shall know a fact possibly of the greatest importance to the welfare of the human race. I propose to seek for the period by means of an electrical oscillator, or a source of alternating electric currents. One of the terminals of the source would be connected to earth, as, for instance, to the city water mains, the other to an insulated body of large surface. It is possible that the outer conducting air strata or free space contains an opposite charge and that, together with the earth, they form a condenser of very large capacity. In such case the period of vibration may be very low and an alternating dynamo machine might serve for the purpose of the experiment. I would then transform the current to a potential as high as it would be found possible and connect the ends of the high tension secondary to the ground and to the insulated body. By varying the frequency of the currents and carefully observing the potential of the insulated body and watching for the disturbance at various neighbouring points of the earth's surface resonance might be detected. Should, as the majority of scientific men in all probability believe, the period be extremely small, then a dynamo machine would not do and a proper electrical oscillator would have to be produced and perhaps it might not be possible to obtain such rapid vibrations. But whether this be possible or not, and whether the earth contains a charge or not, and whatever may be its period of vibration, it certainly is possible—for of this we have daily evidence—to produce some electrical disturbance sufficiently powerful to be perceptible by suitable instruments at any point of the earth's surface.

Production of Light.

The light effects which it has been the chief object to investigate can be divided into four classes: (1) Incandescence of a solid. (2) Phosphorescence. (3) Incandescence or phosphorescence of a rarefied gas, and (4) Luminosity produced in a gas at ordinary pressure. The first question is, How are these luminous effects produced? In order to answer this question as satisfactorily as I am able to do in the light of accepted views and with the experience acquired, and to add some interest to this demonstration, I shall dwell here upon a feature which I consider of great importance, inasmuch as it promises, besides, to throw a better light upon the nature of most of the phenomena produced by high frequency electric currents. I have on other occasions pointed out the great importance of the presence of the rarefied gas, or atomic medium in general, around the conductor through which alternate currents of high frequency are passed, as regards the heating of the conductor by the currents. My experiments described some time ago have shown that the higher the frequency and potential difference of the currents, the more important becomes the rarefied gas in which the conductor is immersed, as a factor of the heating. The potential difference, however, is, as I then pointed out, a more important element than the frequency. When both of these are sufficiently high, the heating may be almost entirely due to the presence of the rarefied gas. [Experiments were performed showing the importance of the rarefied gas, or generally of gas at ordinary or other pressure as regards the incandescence or other luminous effects produced by currents of this kind.]

Incandescent Lamps.

Disregarding now the modifying effect of convection, there are two distinct causes which determine the incandescence of a wire or filament with varying currents, that is, conduction current and bombardment. With steady currents we have to deal only with the former of these two causes, and the heating effect is a minimum, since the resistance is least to steady flow. When the current is a varying one the resistance is greater, and hence the heating effect is increased. Thus if the rate of change of the current is very great, the resistance may increase to such an extent that the filament is brought to incandescence with inappreciable currents, and we are able to take a short and thick block of carbon or other material and bring it to bright incandescence with a current incomparably smaller than that required to bring to the same degree of incandescence an ordinary thin lamp filament with a steady or low frequency current. This result is important, and illustrates how rapidly our views on these subjects are changing, and how quickly our field of knowledge is extending. In the art of incandescent lighting, to view this result in one aspect only, it has been commonly considered as an essential requirement for practical success, that the lamp filament should should be thin and of high resistance. But now we know that the resistance to the steady flow of the filament does not mean anything; the filament might as well be short and thick; for if it be immersed in rarefied gas it will become incandescent by the passage of a small current. It all depends on the frequency and potential of the currents. We may conclude from this, that it would be of advantage, so far as the lamp is considered, to employ high frequencies for lighting, as they allow the use of short and thick filaments and smaller currents.

If a wire or filament be immersed in a homogeneous medium, all the heating is due to true conduction current, but if it be enclosed in an exhausted vessel the conditions are entirely different. Here the gas begins to act and the heating effect of the conduction current, as is shown in many experiments, may be very small compared with that of the bombardment. This is especially the case if the circuit is not closed and the potentials of course very high. Suppose a fine filament enclosed in an exhausted vessel be connected with one of its ends to the terminal of a high tension coil and with its other end to a large insulated plate. Though the circuit is not closed, the filament, as I have before shown, is brought to incandescence. If the frequency and potential be comparatively low, the filament is heated by the current passing *through* it. If the frequency and potential, and principally the latter, be increased, the insulated plate need be but very small, or may be done away with entirely; still the filament will become incandescent, practically all the heating being then due to the bombardment. . . . It should not be thought that only rarefied gas is an important factor in the heating of a conductor by varying currents, but gas at ordinary pressure may become important, if the potential difference and frequency of the currents is excessive. On this subject I have already stated, that when a conductor is fused by a stroke of lightning, the current through it may be exceedingly small, not even sufficient to heat the conductor perceptibly, were the latter immersed in a homogeneous medium.

From the preceding it is clear that when a conductor of high resistance is connected to the terminals of a source of high frequency currents of high potential, there may occur considerable dissipation of energy, principally on the ends of the conductor, in consequence of the action of the gas surrounding the conductor. Owing to this, the current through a section of the conductor at a point midway between its ends may be much smaller than through a section near the ends. Furthermore, the current passes principally through the outer portions of the conductor, but this effect is to be distinguished from the skin effect as ordinarily interpreted, for the latter would or should occur also in a continuous incompressible medium. If a great many incandescent lamps are connected in series to a source of such currents, the lamps at the ends may burn brightly, whereas those in the middle may remain entirely dark. This is due principally to bombardment, as before stated. But even if the currents be steady, provided the difference of potential is very great, the lamps at the ends may burn more brightly than those in the middle. In such case there is no rhythmical bombardment, and the result is produced entirely by leakage. This leakage or dissipation into space, when the tension is high, is considerable when incandescent lamps are used, and still more considerable with arcs, for the latter act like flames. Generally, of course, the dissipation is much smaller with steady than with varying currents.

Incandescence of Gases.

Coming now to the incandescence or phosphorescence of gases at low pressures or at the ordinary pressure of the atmosphere, we must seek the explanation of these phenomena in shocks or impacts of the atoms. Just as molecules or atoms beating upon a solid body excite phosphorescence in the same or render it incandescent, so when colliding among themselves they produce similar phenomena. But this is a very insufficient explanation, and concerns only the crude mechanism. Light is produced by vibrations which go on at a rate almost inconceivable. If we compute, from the energy contained in the form of known radiations in a definite space the force which is necessary to set up such rapid vibrations, we find, that though the density of the ether be incomparably smaller than that of any body we know, even hydrogen, the force is something surpassing comprehension. What is this force, which in mechanical measure, may amount to thousands of tons per square inch? It is electrostatic force in the light of modern views. It is impossible to conceive how a bod of measurable dimensions could be charged to so high a potential that the force would be sufficient to produce these vibrations. Long before any such charge could be imparted to the body it would be shattered into atoms. The sun emits light and heat, and so does an ordinary flame or incandescent filament, but in neither of these can the force be accounted for if it be assumed that it is associated with the body as a whole. Only in one way may we account for it, namely, by identifying it with the atom. An atom is so small, that if it be charged by coming in contact with an electrified body and the charge be assumed to follow the same law as in the case of bodies of measurable dimensions, it must retain a quantity of electricity which is fully capable of accounting for these forces and tremendous rates of vibration. But the atom behaves singularly in this respect, it always takes the same "charge."

It is very likely that resonant vibration plays a most important part in all manifestations of energy in nature. Throughout space all matter is vibrating, and all rates of vibration are represented, from the lowest musical note to the highest pitch of the chemical rays, hence an atom, or complex of atoms, no matter what its period, must find vibration with which it is in resonance. When we consider the enormous rapidity of the light vibrations, we realise the impossibility of producing such vibrations directly with any apparatus of measurable dimensions and we are driven to the only possible means of attaining the object of setting up waves of light by electrical means and economically, that is, to affect the molecules or atoms of a gas, to cause them to collide and vibrate.

Much would remain to be said about the luminous effects produced in gases at low or ordinary pressures. With the present experiences before us we cannot say that the essential nature of these charming phenomena is sufficiently known. But investigations in this direction are being pushed with exceptional ardour. Every line of scientific pursuit has its fascinations, but electrical investigation appears to possess a peculiar attraction, for there is no experiment or observation of any kind in the domain of this wonderful science which would not forcibly appeal to us. Some beautiful experiments with a vacuum tube concluded the lecture.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Observatory Syndicate have prepared a report with respect to the future work of the Cambridge Observatory.

They are of opinion that in the present condition of Astronomy provision must be made for photographic work, so that their inquiries have been directed to the discovery of the best scheme for rendering the Northumberland Equatorial available in connection with the project for a photographic establishment. The primary question as to the respective merits of reflectors and refractors for the photographic instrument had of course to be considered. On this issue there is considerable difference of opinion. For producing representations of astronomical objects, where great detail is required, reflectors are the most suitable. But where accurate measurement of the photographic plates is the object in view the balance of opinion seems clearly to show that the refractor is better adapted than the reflector. As it seems obvious that the work undertaken at the Cambridge Observatory should be based on accurate measurement the Syndicate have come to the conclusion that the refractor is the photographic telescope that should be employed. They think it right, however, to draw the attention of the University to the kindness of Mr. Common who offered to make and present to the Observatory a suitable silvered glass mirror if it were decided to employ the reflecting instrument.

It may be well to add that the Newall Telescope is devoted in the main to spectroscopic work and further that this instrument having been made for visual observation is not adapted to the special photographic work to which it is now proposed to direct the energies of the Observatory.

The scheme which the Syndicate suggest is that a new objective of eighteen inches aperture corrected for the photographic rays be provided; that the focal length of this should be about the same as that of the Northumberland objective, for which a new tube will be required; and that the two objectives, united as a pair like the present instruments at Greenwich and Oxford, should be erected on a new mounting, under a new dome, in the building at present occupied by the Northumberland Equatorial.

It will be observed that, by this scheme, the Northumberland objective will still be useful for every purpose for which it has been hitherto employed, with the great additional advantages of an excellent mounting and a good clock work. For example, such observations of comets as have been previously made here can be conducted under circumstances of much greater convenience than before. As to the special work to be undertaken by photography, it appears to the Syndicate that for the present under the particular conditions in which work here can be conducted there is no subject so promising as stellar parallax. The Director of the Observatory desires to undertake a systematic search with the aid of photography for stars which have measurable parallax, and of course so complete an apparatus as is now proposed would be available for many other researches besides that just suggested.

A preliminary estimate for the new telescope and mounting complete makes the cost £2450. To this must be added £500 for the new dome, and £150 for the measuring apparatus. If £100 be added for extras this makes a total of £3200. There is now a sum of about £1500 in the Special Sheepshanks Fund available for the purchase of instruments. In view of future contingencies, to exhaust the Sheepshanks Fund would be unadvisable and indeed it would not suffice for the purchase of an 18-inch equatorial. As such an instrument would contribute largely to the astronomical services of the Observatory the Syndicate think that an appeal to the public for subscriptions would probably be successful and such an appeal they are prepared to make.

It is therefore recommended that they be authorised to obtain estimates and plans for a new instrument as above described.

Dr. Hill, Master of Downing College, has been appointed a representative of the University at the International Medical Congress to be held at Rome next September.

SCIENTIFIC SERIALS.

American Meteorological Journal, May.—The following are the principal meteorological articles:—Meteorology as the physics of the atmosphere, by Prof. W. v. Bezold. This is a translation by Prof. C. Abbe of the first part of an important paper from *Himmel und Erde*. It describes the problems which at present are the subject of theoretical investigation, and points out what new problems have grown from looking at observational meteorology from a theoretical point of view. During the last decade attention has been chiefly devoted to the development of the so-called convection theory, which is principally based on observations at the earth's surface, but which, at higher elevations, is found to have defects. It has therefore become necessary to try and connect this theory with that of the old trade-wind theory, which for several decades has been entirely set aside. More attention is required to observations made in the higher regions of the atmosphere, together with the application to them of the principles of general mechanics, as well as of thermo-dynamics.—Charts of storm frequency, by Prof. Abbe. The author has plotted in a tabular form the number of storm centres that pass over each quadrangular degree between lat. 20° and 49° N., and long. 99° and 63° W., deduced from the tri-daily Signal Service charts, from March, 1871, to February, 1873. He states that the chart from which the table is prepared clearly shows that the storm tracks, which move from Alberta and Assinniboin south-eastward over the United States and then north-eastward towards the gulf of St. Lawrence, describe a system of parabolic curves whose tendency is to have a common point of intersection, and therefore a region of maximum storm frequency, in, or to the north-west of Nebraska.—Six and seven day weather periodicities, by H. H. Clayton. The author, who has studied the subjects of periodicities for several years, found a striking regularity between the intervals of many of the temperature maxima of the Blue Hill observations, and that almost all the maxima could be arranged in such a way that they followed each other at intervals of six or seven days. He thinks that, for a large part of the year, forecasts of temperature, on the assumption of regular rhythmic oscillations, and a knowledge of the time of their beginning and ending, may be made for a week or two in advance with nearly as much accuracy as they are now made by the Weather Bureau for thirty-six hours.

American Journal of Mathematics, vol. xv., No. 2. (Baltimore, April, 1893).—The opening memoir is one entitled "Hyperelliptische Schnittsysteme und Zusammenordnung der Algebraischen und Transcendentalen Thetacharacteristiken," by H. D. Thompson (pp. 91–123). There are numerous figures and an index of contents.—On the determination of groups whose order is a power of a prime, by J. W. A. Young (pp. 124–178), considers in some detail groups of the order specified in extension of the work on groups by Cayley (*Am. J. of Math.*, vol. i.), Kempe (*Phil. Trans.*, vol. clxxvii.), Netto (Substitutionentheorie, pp. 133–7), and Kronecker. The author's aim has been "to presuppose no knowledge of the theory of groups on the part of the reader."—The third paper, the projection of fourfold figures upon a three-flat, by T. P. Hall (pp. 179–189), is an interesting contribution to the literature of higher space, and the last page (190) contains a note on a geometrical theorem by C. N. Little. It gives a property of a Pascal line, and a Brianchon point of 6 gons formed in a specified manner.

Wiedemann's Annalen der Physik und Chemie, No. 5.—On electrical discharges: production of electrical oscillations and their relation to discharge tubes, by H. Ebert and E. Wiedemann. This portion of the work investigates the manner in which the properties of the conducting circuit determine the sensibility of the discharge-tube when placed in a given position with regard to the terminal condenser. Among the conditions thus studied were the distance between the plates of the primary condenser, the D.P. in the primary spark-gap, and the frequency of the sparks; also the influence of bridges across the wire system, the D.P. required to make the tubes glow, and the effects of the presence of other glowing tubes in the field. As regards the last, it was found that if a glowing gas was present in a portion of the condenser field the distribution of energy was quite different from that in a homogeneous field; the tubes of energy were attracted towards the gas and passed through it, showing that the gas in the state of glow has a greater permeability for the electric flux.—On the diffraction of light at the straight sharp edge of a screen, by Eugen Maey. This work was undertaken to test whether a certain diffraction phenomenon was explainable by the accepted theory of diffraction. The phenomenon in question, as described by W. Wien, consists in the fact that a finely-ground metallic edge, when illuminated by an intense white light, appears as a bright line from points deep in the geometrical shadow. A careful theoretical and experimental study of the phenomenon shows that the theory is competent to explain the fact within certain limits, but that the phenomenon is greatly influenced by small differences of excellence in the edges, a circumstance which has an important bearing upon the behaviour of gratings.—Absolute measurements on the discharge of electricity from points, by Julius Precht. In general, points may be charged highly before discharge begins. Lightning conductors require about 15,000 volts, and the finest points 2500. Ultra-violet illumination favours discharge, whereas dust and flame gases diminish it. A bundle of equal points requires a higher potential than a single one. A point discharging positive electricity wears away, whilst a point negatively electrified does not.—Also papers by O. Wiener, J. von Geitler, M. Levy, A. Kossel, and A. Raps.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 4.—"Further Experimental Note on the Correlation of Action of Antagonistic Muscles." By C. S. Sherrington, M.A., M.D.

In a previous communication (Proceedings of Royal Society, February 1, 1893) it was stated that physiological contraction, and even mere mechanical tension, of the *flexor muscles* of the knee exerts considerable physiological influence upon the activity of the antagonistic group of muscles, the *extensors.* For instance, the elicitation of the "jerk" from the extensors can be rendered difficult for a time by appropriate excitation of the flexors, and can on the other hand be much facilitated by flaccidity or paralysis of the latter.

In order to judge whether under these circumstances the briskness of the "knee-jerk" varies directly with the degree of tonus of the extensor muscles, the rapidity of onset of rigor mortis, has been chosen as a guide to the degree of tonus existing in them before death. The experiments of Brown-Séquard and Hermann have proved that section of the nerve supplying a muscle delays the time of onset of rigor mortis in the muscle, even if the section is performed only shortly before death. There was therefore examined the influence of section of the motor spinal roots on the time of onset of rigor mortis, and a delay of onset of rigor mortis was thus produced. The delay seemed as considerable as after section of the entire muscular nerve. The effect of section of the sensory roots was next examined, and found to be marked retardation of onset of rigor; the retardation was less if the spinal cord were previously severed in the region of the first lumbar segment. The effect of placing and keeping one hind limb in the pose most favourable for the elicitation of the "jerk" (knee flexed) and the other limb in the position in which the jerk is restrained (knee extended) was then investigated (always after previous severance of the spinal cord at the first lumbar segment). On the side on which the knee had been kept flexed the onset of rigor mortis was delayed in the extensor muscles, whereas on the opposite side, with the knee extended rigor was delayed in the flexors. It was inferred that the tonus of extensors is heightened by excitation of the antagonistic set, and conversely.

In regard to the mutual association of action of antagonistic muscles about other joints than the knee, it had been noticed in an earlier series of observations that during excitation of the cortical areas of the hemisphere, when isolated movements of the pollex and hallux are being initiated, the movement of response obtained is often reversed by section of the peripheral nerve or nerves supplying those muscles which predominate in the movement obtained. For example, flexion can by section of the flexor nerve be at once converted into extension. Sometimes, however, movement in the same sense, although diminished in force and extent persists even after cutting the nerve to the predominant group of the antagonistic muscles. This indicates that in some cases there occurs, together with contraction of one group of muscles, concomitant relaxation of the antagonist. This evidence of inhibition of one set of the synergetic muscular couple during co-ordinate action induced by cortical excitation is in the case of the digits of comparatively infrequent occurrence. In the case of the eye muscles it is, on the contrary, quite usual.

When, the external rectus muscle of one eye (*e.g.*, of the left eye) having been put out of action, the frontal cortex of the right hemisphere is excited, the eyeballs if previously directed to the right revert both of them to the left—*i.e.*, the excitation which evokes contraction of the right internal rectus evokes also relaxation of the left internal rectus. Again, when the internal rectus has been put out of action—*e.g.*, in the left eye—excitation of the left frontal cortex produces, if the eyes have been previously directed to the left, an immediate movement of both eyeballs to the right, the left eye frequently rotating beyond the median primary position. Here the same excitation of the cortex which induces contraction of right external rectus muscles induces synchronously a relaxation of the left internal rectus muscle. These interruptions of the tonus or of the contraction of one antagonist concurrently with augmentation of the contraction of its opponent are obtainable not only from the so-called "motor" region of the cortex, but even more strikingly by excitation of the "visual area" of occipital region of the cortex.

During voluntary movements similar phenomena occur, but appear less obvious than under experimental excitation of the cortex. Although inhibition of contraction or tonus is apparently so common a factor in the co-ordination of the antagonistic lateral straight muscles of the eyes, these muscles occasionally yield good indication of synergetic contraction as well as co-ordinate relaxation. The mutual association of the two oblique muscles seems usually of the nature of concomitant contraction, not of contraction coupled with relaxation. On the other hand, the muscles which close and open the palpebral fissure appear to work altogether independently one of the other. In their case section of the particular peripheral nerve concerned in either movement is at once followed by total disappearance of the movement, and that without reversal.

Although the cerebral cortex exercises inhibition so readily in the field of innervation of the third nerve, the dilatation of the pupil evoked by excitation of that portion of the cortex appeared whenever tested to be due to impulses discharged *viâ* the cervical sympathetic, and not to inhibition of the constriction exercised *viâ* the third nerve.

May 18.—"An Experimental Investigation of the Nerve Roots which enter into the Formation of the Lumbo-Sacral Plexus of *Macacus rhesus.*" By J. S. Risien Russell, M.B., M.R.C.P., Assistant Physician to the Metropolitan Hospital.

(From the Pathological Laboratory of University College, London.)

This formed the subject of a paper recently read before the Royal Society, in which the author described one chief type of plexus met with in *Macacus rhesus*, the main distinguishing features of which, as contrasted with the chief variation encountered, consisted in the fifth lumbar nerve root sending a branch to the sciatic nerve trunk, and the obturator nerve taking its origin from the fourth and fifth lumbar nerve roots alone, whereas of the variations met with that which occurred most frequently was one in which the fifth lumbar root did not send a branch to the sciatic nerve, and the obturator nerve received a branch from the sixth lumbar nerve root in addition to those received from the fourth and fifth lumbar roots. Between these two extremes all forms of variation were met with; but the upper limit of supply to the limb was always found to be the third lumbar root, and the lower limit the first sacral root.

Excitation Experiments.

The movement which results on excitation of any given nerve root with the Faradic current is a compound one made up of several simple movements; while excitation of any single small bundle of nerve fibres, many of which combine to form a nerve root, results in a single simple movement, and not all the movements of the compound root in lessened degree. These single simple movements bear an almost constant relation to the nerve roots, the same movements being as a rule found in any given root, and such movements always bear the same relation to the spinal level. Further, each bundle of nerve fibres representing a single simple movement in a nerve root remains distinct in its course to the muscle or muscles, producing such a movement without inosculating with other motor nerve fibres.

Muscles diametrically opposed in their action are represented in the same nerve root, but in different degrees, and when a certain group of muscles predominate in their action in one root they as a rule predominate in that root. In those instances in which the opposed movements are represented in three consecutive nerve roots the middle root of the series is that in which both movements are represented, while the root above contains the one movement, and that below contains the other.

The movements of flexion and extension are found to alternate in their representation from above down, flexion being at a higher level than extension in the highest segment of the limb, while extension is above flexion in the next, and so on.

A muscle is usually represented in two nerve roots, and to an unequal extent in these; and when variations occur, it is, as a rule, that one of the nerve roots in which the muscle is represented is different, rather than that it is represented in more nerve roots. When the same muscle is represented in two nerve roots the muscle fibres innervated by one root are not innervated by the other, so that only part of the muscle contracts when a single root is excited.

Ablation Experiments.

Division of any given nerve root produces paresis of the group of muscles supplied by it, which paresis is temporary, nearly all of it being recovered from. The amount of paresis or paralysis produced is proportional to the number of nerve roots divided; and this again varies according to whether the roots divided are consecutive or alternate ones, the effect being much greater in the former than in the latter case. Such division of one or more nerve roots does not result in incoordination of the remaining muscular combinations represented in other nerve roots; the remaining movements are merely more feeble.

Exclusion of a certain Root or Roots during an Epileptic Convulsion in the Limb.

Division of one or more nerve roots produces alteration of the position of a limb during an epileptic convulsion, which altered position depends on the muscular combinations that have been thus thrown out of action. And the effect is identical when the root or roots are divided at the time when the convulsions are evoked, and when they have been divided some weeks previously. No incoordination is produced in the remaining muscular combinations; and there is no evidence of overflow of the impulses which ought to travel down the divided root into other channels through the spinal centres, so as to reach the muscles by new paths.

"A Further Minute Analysis by Electric Stimulation of the so-called Motor Region (Facial Area) of the Cortex Cerebri in the Monkey (*Macacus sinicus*)." By Charles E. Beevor, M.D., F.R.C.P., and Victor Horsley, M.B., F.R.C.S., F.R.S. [1]

(From the Laboratory of the Brown Institution, and from the Pathological Department of University College, London.)

In the paper of which this is an abstract the authors have completed the minute analysis of the movements elicited by excitation of the excitable (so-called motor) region of the cortex cerebri in the Bonnet Monkey (*Macacus sinicus*). The portions hitherto examined having been those in which the movements of the limbs were represented, the facial area was chosen for the present research. After an historical introduction and a description of the anatomy of the region investigated, the method of notation and record of results is discussed.

Considering that in this part of the cortex cerebri there is well-defined representation of movements of both sides of the body, the question of bilaterality of representation is raised, and attention directed to its importance. The analysis of the results obtained show that there existed precise localisation for the movements of the individual portions of the face, even to that of half the lower lip.

The specialisation of the movements of the tongue was rendered easy of examination by employing the operative device of dividing the tongue in the middle line. This shed unexpected light on the representation of the movements of this organ.

Movements of the pharynx were made the subject of observation, and some degree of unilaterality was discovered in the movements of the soft palate.

Finally, attention is drawn to the fact that the marches of movements in succession are in this region very inconstant and difficult to arrange.

[1] The expenses of this research were defrayed principally by a grant from the Government Grant Fund of the Royal Society, and in part by a grant from the Scientific Grants Committee of the British Medical Association.

"On the presence of Urea in the Blood of Birds, and its bearing upon the Formation of Uric Acid in the Animal Body." By Sir Alfred Garrod, M.D., F.R.S.

The author gives in his paper a *résumé* of the opinions held with regard to the formation of uric acid in the animal economy during the last half century, and then announces his discovery of the presence of urea in the blood of birds in quantities practically the same as that which is present in the mammalian blood; by which discovery the views hitherto held as to the formation of uric acid are necessarily modified. Having afterwards shown that the kidneys have no power of removing uric acid from blood, and referred to other physiological points in connection with uric acid and urea, he sums up most of his views in the following propositions:—

First. That in mammalia and other urea-excreting animals the metabolism of the nitrogenised tissues results in the formation of urea as an ultimate product; that an appreciable and measurable amount of this substance is always found in their blood, and is constantly being excreted by the kidneys; and, further, that any cause leading to the decrease of this excretion produces an augmentation of the urea in the blood.

Second. That in birds, and other uric-acid-excreting animals, the metabolism of the nitrogenised tissues is exactly the same as in mammals, and that urea is the ultimate product of this metabolism; that urea is always present in their blood, in quantities not less than in mammalian blood, and that the urate of ammonium is a subsequent product of the union of urea with some other principle or principles, glycine probably being one of them. Consequently, it is not necessary that uric acid should be present in the blood of uric-acid-excreting animals: in health, in fact, it is not detectible. When it is present, its presence is a result of its having been absorbed after formation in the kidneys or elsewhere.

Geological Society, May 24.—W. H. Hudleston, F.R.S., President, in the chair.—The following communications were read:—Notes on Dartmoor, by Lieut.-General C. A. McMahon. The author alluded to a memoir on the British Culm Measures recently published by Mr. Ussher, in which the view is advanced that the granite of Dartmoor resulted from the metamorphism of pre-existing rocks which had in a rigid state offered obstruction to a long sustained N. and S. squeeze, and that their fusion and consequent consolidation were effected *in situ*. The author gave some of the results of a visit to the western borders of Dartmoor. He detailed some examples of eruptive granite-veins intruding into Culm beds in the immediate vicinity of the main mass of granite. The latter, in the locality described, is porphyritic down to its boundary, and the veins are also porphyritic. All the circumstances lead to the belief that these veins are real apophyses from the main mass, and that the view adopted by De la Beche regarding the origin of the Dartmoor granite is the true one. After alluding to some features in the Meldon granite-dyke not before noted, some detailed observations in the bed of the River Tavey were given, and an explanation offered of the way in which the fine-grained marginal variety of the granite, seen in that locality, has been produced. The improbability that a tremendous squeeze sufficient to fuse 225 square miles of a pre-Devonian rock into granite while the Culm Measures outside the zone of marginal contact-metamorphism are left almost untouched was commented upon, and finally, the author alluded to the often-observed pseudo-stratification of the Dartmoor granite, and urged that the cause of this is not the one suggested by De la Beche, but that it is due to sub-aerial agencies. The reading of the paper was followed by a discussion in which the President, Mr. Watts, Mr. Teall, Mr. Rutley, Prof. Bonney, and Prof. Hull took part. General McMahon briefly replied.—On some recent borings through the lower Cretaceous strata in East Lincolnshire, by A. J. Jukes-Browne. The borings described in this paper are at Alford, Willoughby and Skegness, and disclose the existence of an unsuspected anticlinal axis, bringing up Lower Cretaceous rocks beneath the

Drift. In the Willoughby boring, beneath the Drift, a brown sand was obtained, apparently the "Roach" division of the Lower Cretaceous, and below it the Tealby Clays (108 feet), oolitic ferruginous beds (18 feet), and sandstone and sand regarded as the Spilsby Sandstone. In the Alford boring the highest solid rock appears to belong to the basal beds of the Red Chalk, and below it is Carstone, and then clay. The axis of the anticlinal appears to pass between Alford and the border of the wolds, and is probably continued in a north-westerly direction beyond the village of Claythorpe. The result of the information now obtained makes it probable that the Chalk tract which lies to the south-east of the Calceby valley is completely isolated from the rest of the Chalk area. The President said that the lesson of the paper was that it was never safe to take anything for granted when one had to deal with Boulder Clay, and Mr. Strahan remarked that he agreed with Mr. Jukes-Browne's interpretation of the structure of the district.

Linnean Society, May 24.—Anniversary meeting.—Prof. Stewart, President, in the chair.—The treasurer presented the accounts duly audited, and the secretary having announced the elections and deaths during the past twelve months, the usual ballot took place for new members of Council, when the following were elected:—Messrs. J. G. Baker, A.C.L. Günther, G. R. Murray, R. C. A. Prior, and Howard Saunders. The President and officers were re-elected. The librarian's report having been read and certain formal business disposed of, the President delivered his annual address, taking for his subject "The various modes in which animal sounds are produced." On the motion of Dr. Braithwaite, seconded by Sir James Gibson Maitland, Bart., a unanimous vote of thanks was accorded to the President for his address, with a request that he would allow it to be printed. The Society's gold medal was then formally presented to Prof. Daniel Oliver, in recognition of the services rendered by him to botanical science, and having been acknowledged by Prof. Oliver, the proceedings terminated.

CAMBRIDGE.

Philosophical Society, May 15.—Prof. T. McK. Hughes, president, in the chair.—The following communications were made to the Society:—Exhibition of abnormal forms of *Spirifera lineata* (Martin) from the Carboniferous Limestone, by F. R. Cowper Reed. This species, as defined by Davidson, is normally subject to great variation of form and ornamentation, as it includes *Sp. imbricata* and *Sp. elliptica*. Specimens with intermediate characters are however common. The series of abnormal forms exhibited showed the gradual development of a sharp median groove both in the dorsal and ventral valves so as ultimately to produce a bilobed shell. From the nature of these grooves interruption of the shell-secreting action of the mantle seems to have occurred along a definite line: and the cause may have been disease, the presence of a parasite or foreign body, or pressure during life. Similar malformation is seen in some Terebratulas, &c. The normal and regular bilobation of some species of *Orthis*, *Terebratula*, &c., is comparable.—Exhibition of Post-Glacial Mammalian bones from Barrington recently acquired by the Museum of Zoology, by Mr. S. F. Harmer.—Exhibition of a specimen showing Karyokinetic division of the nuclei in a plasmodium of one of the *Mycetozoa*, by Mr. J. J. Lister.—Observations on the Flora of the Pollard Willows near Cambridge, by Mr. J. C. Willis and I. H. Burkill.—The plants occurring in the tops of willows near Cambridge have been recorded during the last few years, and amount to 80 species, occurring 3951 times altogether in about 4500 trees. Of these 80, only 18 form more than 1 per cent. of the total number of records. The rest have only a small number of records. As Loew has pointed out in a recent paper, these plants are of interest from the points of view of distribution of seeds and of epiphytism. Classifying them according to means of distribution, we find that 19 species have fleshy fruits; 1763 records (44.6 per cent.) of these occur. Three species with burrs have 651 records (16.4 per cent.); 34 species with winged or feathered fruit or seed have 996 records (25.1 per cent.); 7 with very light seeds have 421 (10.6 per cent.); and finally of plants whose means of distribution is poor or somewhat doubtful, we have 17 species with 120 records (2.9 per cent.). It is thus shown very strikingly how the various distribution mechanisms succeed, only the better ones showing in the list any numbers. The bird-distributed plants figure much higher here than in such cases as *e.g.* the flora of the churches of Poitiers (Richard), because birds visit the trees to such an extent. The observations show clearly the fact that a seed is only carried a short distance by its distribution mechanism. Plants were always found upon the soil, within 250 yards at most, of those found in the trees. An analysis was taken as far as possible of the birds' nests found in the trees, and pieces, often with ripe fruits, of many plants in the list were discovered in them, so that probably this means of distribution is of some importance. With regard to epiphytism, Loew considers these plants as exhibiting a commencement of this mode of life, and this seems probable enough. Like the regular epiphytes, they possess good methods of seed distribution. Their position does not call for any special means of supporting themselves, and the supply of humus is plentiful. *Mycorhiza*, which Loew found on many, was not observed in the few examined. The size of many of the shrubs, *e.g.* Elder, *Ribes*, Roses, &c., was very remarkable; some elders were three inches thick or more, and as much as 12 feet high. Experiments are in progress upon the growth of plants in willow humus.—Note on the plants distributed by the Cambridge dust-carts, by I. H. Burkill.—The street-sweepings of Cambridge have of late been spread on Coe Fen for the purpose of raising the level. From this material spring the plants whose seeds have been scattered in the dust of the roads. Of these, 99 species and one variety have been collected. No less than 39 per cent. are species whose dissemination has been effected directly or indirectly by Man, being either used for food or maintained in the gardens. The other species are almost all such as seed freely on roadsides, and have for the most part very light seeds.

DUBLIN.

Royal Dublin Society, May 17.—Prof. G. F. Fitzgerald, F.R.S., in the chair.—Dr. G. Johnstone Stoney, F.R.S., read a paper on the cause of sun-spots. In this communication the author recalled attention to the explanation of sun-spots which he had offered in 1867, in a paper on the physical constitution of the sun and stars, published in the Proceedings of the Royal Society, No. 105, 1868. He pointed out that the discoveries since made through the spectroscope, and the details of the photosphere revealed to us in the photographs taken by Prof. Janssen at Meudon, have brought to light striking confirmations of this explanation. The photosphere, according to the author's view, consists of incandescent sooty clouds, and the cloudy regions constitute the bright patches seen in Prof. Janssen's photographs, each of which is in general some hundreds of miles broad and several hundreds of miles long. Inasmuch as the greater part of the radiation emanates from them, they must form a stratum of minimum temperature. In the interstices between the patches and in those larger openings which are known as sun-spots, a less luminous background is brought into view. This is either a second layer of cloud which is of transparent material like terrestrial clouds, or it is a position in which both the density suddenly becomes greater and at which there is a sudden transition from transparent atmosphere above to opacity beneath. This would present the appearance of the reflecting surface of a molten ocean. Now, by the "Law of Exchanges," such an ocean as is supposed by the second hypothesis, being capable of reflecting incident light abundantly, or such a cloud of transparent material as is supposed by the first hypothesis, being capable of scattering incident light abundantly, would either of them radiate much less abundantly than the sooty clouds which constitute the photosphere, and would therefore appear black in comparison, whether at the same temperature, or at higher temperatures up to a certain limit. One or other of these, then, appears to be that dark background seen in sun-spots and in the intervals between the patches of photosphere. The appearance of penumbra seen in most sun-spots and in many of the intervals between the patches of photosphere would be presented wherever the sooty clouds are thin, and not sending down the abundant showers which seem elsewhere to prevail, and which in faculæ are continuous over immense spaces.—Mr. Thomas Preston attracted the attention of the Society to a simple, direct, and perfectly general method of expressing the efficiency of a reversible engine in terms of the temperatures of the source and refrigerator. He also mentioned that the cycle originally described by Carnot requires no correction, and depends on no theory of heat. Carnot begins with an adiabatic transformation, and his cycle consequently possesses all the advantages of the "corrected" cycle proposed by Maxwell.

The commonly accepted version of Carnot's method is therefore an injustice to the celebrated author of "The Motive Power of Heat."

PARIS.

Academy of Sciences, May 29.—M. de Lacaze-Duthiers in the chair.—Studies on diffraction gratings; focal anomalies, by M. A. Cornu. Gratings, although trustworthy enough to be used for determining wave-lengths of light, yet present various anomalies which might cast some doubt upon the rigour of the optical principles upon which their construction is based. In order to study these perturbations in detail and to eliminate the attendant errors, M. Cornu constructed a machine for the automatic ruling of lines spaced according to fixed laws, so as to produce and exaggerate at will the anomalies whose origin was to be verified. Thus the systematic error in the position of the focus of spectrum images was reduced to two distinct and purely geometrical causes: In plane gratings, to the existence of a feeble curvature of the ruled surface; in a plain or curved grating, to the existence of a regular variation in the distance apart of the lines. In most cases these two causes co-exist, which makes the laws of the optical phenomenon highly complex.—On the volatilisation of silica and zirconia, and the reduction of these compounds by carbon, by M. Henri Moissan (see Notes).—Preparation in the electric furnace of some refractory metals: tungsten, molybdenum, vanadium, by M. Henri Moissan (see Notes).—On the preparation of zirconium and thorium, by M. L. Troost. An intimate mixture of zirconia and finely comminuted sugar charcoal, the former being in excess, is strongly compressed into small discs and placed in a carbon retort. It is then subjected to the action of the voltaic arc supplied by a current of 35 ampères and 70 volts, the retort being placed in a closed chamber traversed by a slow current of carbonic acid, so as to prevent the air from burning and retransforming the metal into zirconia. The reduction is immediate, and gives rise to small metallic masses which are not pure zirconium, but a true carburet of zirconium, corresponding to the formula ZrC_2. If the carbon retort is lined with zirconia the ingot is gradually freed from carbon, and leaves the pure metal behind. This has a steel-grey colour and is extremely hard. It scratches glass deeply, and is untouched by the best files. In air it is unaltered at ordinary temperatures. At a red heat it oxidises at the surface if containing little carbon, but burns brightly if containing much. It is not attacked by acids except by hydrofluoric acid, which acts even if greatly diluted. Thorium is prepared in an exactly similar way from the chloride. The reduction takes place more readily, giving rise to a carburet, ThC_2. The metal is very brittle, and less hard than zirconium. It decomposes water in the cold, evolving hydrogen and a hydrocarbon of pungent odour. In contact with air it gradually swells up and forms a powder which burns with greater rapidity and brightness than zirconium.—Observations on the volatilisation of silica, *à propos* of M. Moissan's communication.—On the phenacite of Saint-Christophe en Oisans, by MM. A. Des Cloizeaux and A. Lacroix.—On ordinary differential equations which possess fundamental systems of integrals, by M. Sophus Lie.—The total solar eclipse observed at Fundium (Senegal) on April 16, 1893, by M. N. Coculesco.—On geometrical properties which only depend upon spherical representation, by M. C. Guichard.—On surfaces with lines of curvature plane in both systems and isothermals, by M. Th. Caronnet.—Theorems relating to analytical functions of n dimensions, by M. G. Scheffers.—On a general property of fields admitting of a potential, by M. Vaschy.—On the densities of some gases and the composition of water, by M. A. Leduc.—On the rigidity of liquids, by M. J. Colin.—Action of acetic anhydride upon linalol; transformation into geraniol, by M. G. Bouchardat.—A general method for the analysis of butters, by M. Raoul Brullé.—On the physiology of the crayfish, by M. L. Cuénot.—Mechanism of the hyperplasic process in epithelial tumours; applications, by M. Fabre-Domergue.—Researches on the modifications of the excretion of urea in the course of certain surgical maladies, and especially after great operations; consequences from the point of view of therapeutics and treatment after operations, by M. Just Championnière.

BERLIN.

Physical Society, May 12.—Presidents, at first Prof. Kundt, and later Prof. du Bois Reymond.—Dr. E. Pringsheim gave an account of his further researches on the cause of the emission of light by heated gases. By the method already employed for sodium (see NATURE, vol. xlv., p. 312) he had recently tested the vapours of lithium, thallium, and potassium. At the highest temperature, at which nickel was fused, the vapours of these metals similarly gave an emission-spectrum following on the absorption spectrum as long as reduction processes were excluded. They at once showed their characteristic spectral lines as soon as the salt used, or the silicate formed from the metal in contact with the surface of the porcelain tube, was reduced either by hydrogen, by the metal itself, or by iron. The experiment of Dewar and Liveing, in which, by heating lithium with potassium and sodium in an atmosphere of hydrogen in an iron tube, they obtained the lithium-line, was explained by the speaker as due to the above-named cause, viz., a compound is formed of iron and lithium, which is then reduced and exhibits both emission and absorption. Dr. Pringsheim concluded from his experiments in support of his views that the four elements—lithium, sodium, thallium, and potassium—are not luminous when simply heated above the temperature of the flame in which they ordinarily exhibit their characteristic spectra. He believed rather that they only show emission and absorption spectra when they are in the nascent state resulting from processes of chemical reduction.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—A Treatise on Elementary Dynamics, 2nd edition: S. L. Loney (Cambridge University Press).—An Introduction to Practical Bacteriology: Dr. W. Migula, translated by M. Campbell (Sonnenschein).—Some Hints on Learning to Draw: G. W. C. Hutchinson (Macmillan).—The Hawks and Owls of the United States in their Relation to Agriculture (Washington).—The Geological and Natural History Survey of Minnesota, 20th Annual Report (Minn.).—Missouri Botanical Garden, Fourth Annual Report (St. Louis, Mo.).—Modern Microscopy: M. I. Cross and M. J. Cole (Baillière).—Geological and Solar Climates: M. Manson (Dulau).—British Forest Trees: J. Nisbet (Macmillan).—Darwin and Hegel: D. G. Ritchie (Sonnenschein).—Lectures on Sanitary Law: A. W. Blyth (Macmillan).—Fragments of Earth Lore: Prof. J. Geikie (Edinburgh, Bartholomew).—The Lepidoptera of the British Islands, vol. 1, Rhopalocera: C. J. Barrett (L. Reeve).—Hypnotism, Mesmerism, and the New Witchcraft: E. Hart (Smith, Elder).

PAMPHLETS.—Die Klimate der Geologischen Vergangenheit: E. Dubois (Nijmegen, Thieme).—Notes on the Gasteropoda of the Trenton Limestone of Manitoba, with a Description of One New Species: J. F. Whiteaves.—Sulla Dissipazione di Energia in un Campo Elletrico Rotante e Sulla Isteresi Elettrostatica: R. Arnò (Roma).

SERIALS.—Brain, Parts 61 and 62 (Macmillan).—Engineering Magazine, June (New York).

CONTENTS.

THURSDAY, JUNE 15, 1893.

APPLIED CHEMISTRY.

Dictionary of Applied Chemistry. By Prof. T. E. Thorpe, F.R.S., assisted by eminent contributors. Vol. iii., completing the work. (London: Longmans, 1893.)

THE completion of Dr. Thorpe's Dictionary, upon which both men of science and of practice may with truth congratulate him and his contributors, opens out the question how far such a work, however well done, can or cannot supply the needs at once of the layman, of the scientific man, and of the manufacturer. Perhaps this standard may be too high a one to apply to any single work, and yet I think that in many respects these three volumes will be found satisfactorily to fulfil the above requirements. That in some instances this cannot be said to be the case is not only not to be wondered at but almost to be expected, when we remember the extent of the ground covered, the complexity of the questions considered, and, above all, the difficulty which persons not actually engaged in the various industries experience in obtaining the latest details of new and improved methods and processes. In looking through this volume one is struck with the care which the editor has taken to carry out the condition that the articles on special manufactures ought to be written by scientific men who are themselves engaged in conducting the industry, rather than by those who can only look on those questions from outside. To give examples of this is easy. Take the article on Borax (Sodium Borate) written by Mr. E. L. Fleming. The reader will at once see, by comparing this with any descriptions of the process of preparing borax given in the text-books, that this article is full of data which have hitherto been either ignored or incorrectly given. Again "Sugar," written by Messrs. Newlands, extending over twenty-two pages, is a typical case of descriptions of processes written by persons well acquainted with the details of the operations and able to describe them clearly, and, what is important, care has been taken to illustrate the article by excellent figures of plant. Closely connected with this subject, and also admirably treated by Mr. Heron, a practical authority, to whom we likewise owe an exhaustive article on saccharimetry not to be equalled in any work of the kind, is a description of starch manufacture, in which the newest processes are described and the construction of the most recent apparatus well shown. Then the articles, "Pottery" and "Porcelain," written by Mr. Burton, of Wedgwoods, is another example of processes described by one who knows what he is writing about. Another remarkable instance of the same thing is that of the article, "Phosphorus," by Dr. J. B. Readman. Hitherto the detail of phosphorus manufacture has been a *mare clausum* to the scientific world—and so well have the secrets of the trade been kept, that in no treatise, whether purely scientific or otherwise, have the particulars of the production of phosphorus been hitherto made known. Now for the first time we have, from the pen of one who was himself engaged in the industry, a complete description not only of the methods adopted for making both white and red phosphorus, but likewise the manufacturing details as to yield, which are invaluable. It seems that the explanation given in the books as to the preparation of this important element has been altogether wrong. It has been generally supposed that only so much sulphuric acid is added to the bone-phosphate as will form the acid phosphate, $CaH_4(PO_4)_2$, and that this yields metaphosphate, $Ca(PO_3)_2$, when heated to redness, so that when this latter is distilled with charcoal only two-thirds of the phosphorus are reduced, and one-third remains behind as tricalcium phosphate. This view turns out to be wholly incorrect. In practice enough sulphuric acid is added to convert all the lime present into sulphate, so that it is metaphosphoric acid, (HPO_3), and not calcium metaphosphate, which on distillation with charcoal gives phosphorus, and the yield amounts to about 68 per cent. of the theoretical.

In a notice like the present it is not possible to do more than to run through a few of the most interesting articles in alphabetical order. I take first that on Oils, by Mr. A. H. Allen, of Sheffield, an authority on this somewhat difficult subject. No less than thirty-eight pages are devoted to the description of fixed oils and fats, especially with respect to their classification and identification by analysis, in which the newest and most improved methods are given. I fail, however, to find the name of Chevreul mentioned, to whom chemistry owes the first and still classical research on fats. Then I next take "Oxalic Acid and the Oxalates," a short article by the editor, whose valuable contributions, be it here said, form no inconsiderable fraction of the total 1058 pages. He has not stated the interesting fact quoted in the report published by Drs. Schunck, Smith, and myself in 1862, which, although ancient history, is still true, that from two pounds of sawdust no less than one pound of crystallised oxalic acid is obtained by Dale's process. Nor do I find any mention of manganese oxalate, which is now a marketable product, and is used as a drying agent for oils, and has the advantage over the other "driers," inasmuch as they colour the oil, whereas manganese oxalate can be used so as to yield an almost colourless drying oil. Omissions such as these are, as I have said, not to be wondered at, and I quote them with the object of pointing out that this Dictionary, admirable as it is, cannot replace such sources of information on applied chemistry as the journal of the Society of Chemical Industry, but that it must rather be considered as an introduction to such a mine of wealth as this journal—which I may call a child of my own—contains, and to add, as I feel bound to do, that some of the writers would have done well to refer more fully to its twelve volumes before completing their articles.

Next comes "Oxygen," written by Dr. L. T. Thorne, of Brin's Oxygen Company, and here I may notice a misprint on p. 83—and say that such misprints are singularly rare throughout the book, reflecting great credit on both editor and printer—which has puzzled me. In the description of Robbin's process a reference is given P.J. [2] 5. 436. I looked in vain through the *Journal für Praktische Chemie*, and only after some time discovered that P.J. should be Ph. (the *Pharmaceutical Journal*). A more important error remains to be noticed in this paragraph. How a mixture of 3 mols. of barium chloride and 1 mol of potassium bichromate, on treatment with

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sulphuric acid *in the cold*, can yield oxygen I could not understand but, on looking up the original paper, I find that for barium chloride, barium peroxide should have been printed. Here CrO_3 and H_2O_2 mutually decompose to Cr_2O_3 and water, whilst pure oxygen derived from both sources comes off. This interesting reaction is not a new one, as it was used by Brodie in 1851, and adverted to in a lecture by Faraday at the Royal Institution; nor does it appear to be capable of producing oxygen at a sufficiently low cost to be of practical value. Of course, Dr. Thorne gives an excellent description of Brin's well-known process by which oxygen is now manufactured on a large scale, but I do not find any statement of a process which bids fair to compete with Brin, viz. Fanta's improvement on Tessie du Motay's reaction, by which oxygen is evolved from manganate of soda by the action of steam. He does indeed refer to Du Motay, and gives the cost of oxygen prepared by his process at from £3 to £4 per 1000 cubic feet, whereas that by the Brin process is given as from 3*s.* to 7*s.* I cannot help thinking that this proportional cost is incorrect, as I know that Fanta's process, the patent of which appears to have superseded Bowman's, is now in practical operation at the Bradford Gas Works, and this would scarcely be the case if the cost were as great as Dr. Thorne states.

That pure oxygen can now be produced at so low a figure as 3*s.* per 1000 cubic feet is a great fact, and induces the hope that we may ere long see it at 1*s.* per 1000. In that case the use of oxygen to heighten the temperature of combustion would become general, especially for welding and riveting of steel and iron. Even now its uses are spreading, not only for the oxyhydrogen light, but for purifying coal-gas. The addition of from 0·5 to 1·0 per cent. of oxygen to crude coal-gas renders its purification more complete and easy, as thus the sulphur compounds are reduced to 12 grains per 1000 cubic feet, and lime alone suffices as a purifying agent. Moreover, the luminosity of the gas is said to be increased. This application of oxygen is on its trial at certain gasworks, but it has to be shown how far this plan of adding oxygen acts more satisfactorily than the much cheaper one of the addition of air, in spite of the small loss in illuminating power which the presence of atmospheric nitrogen entails.

Next I turn to "Paper," by Mr. E. J. Bevan, a short but good article, in which I find a description, in which one misses some illustrations, of the method of recovering the soda used in the preparation of the esparto and other fibres used in making paper. No example of the applications of science to the working up of waste products is more striking than this. Before the introduction of the Rivers Pollution Act of 1876, no paper-maker thought of recovering his soda—all the liquors went to pollute the streams on which the works are situated. Now most paper-mills recover their soda, and save thereby from 80 to 85 per cent. of this costly article, whilst at the same time they have diminished the nuisance which they caused to their neighbours on the stream below them. It is high time that every user of soda for disintegrating or bleaching fibres of all kinds should be prohibited from thus fouling the water, and that the application of the "best practicable means" clause were rigidly enforced by all local authorities interested in improving the quality of the water of our rivers.

The article on "Petroleum," by Mr. Boverton Redwood, is another instance of information given by a high authority. It extends over forty pages, is up to date, and abundantly illustrated. "Photography," by Prof. J. M. Thomson, gives a clear and concise account of the chief processes of the application of photography to lithography and mechanical printing, now becoming more and more perfect, and the article concludes by giving a list of the more important works on the subject.

The two longest articles in the volume are, as might be guessed, Sodium and its compounds, occupying 93 pages and Sulphuric Acid and its relatives, taking up 84. The manufacture of sodium is one of the most remarkable advances of the time; not long ago it could only be bought by the ounce, and at an exorbitantly high price, now an order for 100 tons will be executed by the Aluminium Company, of Oldbury, and the price is only a few shillings a pound. Castner's process for making sodium is fully described, but the excellent illustrations are only of historic interest, inasmuch as the process which they indicate has lately been superseded by a more economic one. The article on Sodium Chloride is of a most complete and trustworthy character, and has been written by Mr. J. I. Watts, of Messrs. Brunner, Mond, and Co., where he has had ample opportunities of making himself master of every detail of the processes he describes. Sulphur and Sulphuric Acid are interesting articles by Dr. Alder-Wright, who adds to his scientific knowledge practical experience of the manufacture. I cannot pretend to discuss the merits—which are great—of these articles. I will only remark that they contain information up to date, and I am glad to see that Dr. Wright has consulted the *Journal of Chemical Industry*, and has given the readers of the Dictionary an opportunity of becoming acquainted with Dr. Hurter's researches on the chemistry of the leaden chamber, published in that journal.

The important article "Water" is contributed, as it should be, by Prof. Percy Frankland. With regard to this able article, extending over fifty-five pages, I have to remark that the author, whilst giving an excellent account of the chemistry of water, seems to have forgotten that he is writing an article in a dictionary of applied and not in one of pure chemistry. Why, for example, should two pages of valuable space be taken up by a long table of the tension of aqueous vapour? Nor is it clear that so many analyses of mineral waters need be quoted, no less than fifteen pages being taken up by tabular matter. On the other hand, greater prominence might well have been given to more technical details of the various methods of water purification. Here I think that the author might have given some extracts from the volumes of the Chemical Industry Society with profit, where, as he well knows, much new and important information is to be found. There is not a single diagram or illustration in this article showing the arrangements proposed for filtration or other means of purifying water; thus, whilst the author refers to the "Stanhope" purifier, he gives no drawing to explain its construction. Prof. Tilden's important experiments on the corrosive action of water on brass and copper are not referred to, a classical subject originally investigated by Davy in 1824, and reported upon by him to the Admiralty of that day. Nor is the paper of Mr. V. C. Driffield on the practical details on the use of carbonate of soda for softening water for boilers, important to every manufacturer, mentioned. Points such as these, which I might multiply, are needed by the practical man, and ought to have found a place in such a work.

Last, but not least, I will refer to the article on "Wine," written by Prof. Thorpe, which is of interest as giving a luminous account of vintage and vinification, and of the chemical changes which the vegetable acids present in the grape undergo during the process of wine-making. I miss, however, reference to the Pasteurisation of wine and to the classical researches of the great French chemist on the diseases of wine. Perhaps, however, the editor has rightly conceived that such matters, however important, do not quite come within the scope of "applied chemistry," and that the omission is intentional. I should have liked to refer to many other matters of interest with which this volume teems, but I have compassion on your space. Again I congratulate all concerned in the production of this Dictionary, which will, I feel sure, long continue as the standard work in our language.

H. E. Roscoe.

A POPULAR ATLAS.

The Universal Atlas. Containing 117 Pages of Maps and an Alphabetical Index of 125,000 Names. (London, Paris, and Melbourne. Published for the Atlas Publishing Company, Limited, by Cassell and Company, Limited, 1893.)

THIS Atlas, published in a strong cloth binding at 30*s.* net, is certainly unique in the British Market, and in its serial form it has already obtained a deservedly wide circulation.

There is no kind of publication of which the British public is so ignorant as a map, and the fact that few purchasers can tell the difference between a good map and a bad one has produced its natural effects. One of these is that the reviews of atlases in literary journals and the daily press are usually characterised by a tone of forced praise, and rarely go beyond free quotation from the publisher's preface or prospectus. It is more difficult to review a map than a book on account of the immense amount of concentrated information it contains, and even those who are competent for the task are often inclined to shrink from the close study and careful comparison which are necessary. The quality and price of the *Universal Atlas* are so unusual that we feel justified in examining it with some care, and in offering a few suggestions for its further improvement.

The work is published for an unknown company by Messrs. Cassell. There is no hint as to who designed the atlas or drew the maps or engraved the plates, or produced the book. The only indication borne by each sheet is "Printed in Leipzig." German map-printers are good, but there are atlases made in London and Edinburgh which are much better than this; unfortunately they are also much more expensive. One effect of the present publication will, we hope, be to call forth native work designed so as to hold its own in cost as well as quality with that of Germany. Meanwhile the *Universal Atlas* deserves success as a pioneer. We strongly object, however, to the practice—not unknown to some British mapmakers—of issuing the work of trained scientific men without acknowledgment; and of republishing earlier maps without mentioning the fact. If Messrs. Cassell had bound up with the Atlas the "history," which they print as a separate advertisement, and if the name of the printer to whom the creditable appearance of the work is due appeared upon it, we would have almost unqualified praise to bestow on them. As it is, however, we must plainly say that they have not done justice either to the memory of Andree, who prepared the original maps, or to the skill of Mr. W. J. Turner, who so admirably translated them, or even to the enterprise of Mr. H. O. Arnold-Forster, the chairman and presumably the promoter of the publishing company. We regret also that Messrs. Cassell did not entrust the printing to some firm in this country; although the first cost might have been greater, we do not believe that the profit would ultimately prove less.

Not knowing who the editor of the English edition of the Atlas is, we must blame the publishers for failing to adjust the balance of representation to English requirements. Germany is treated with undue detail; the United Kingdom is not adequately shown. Large parts of Germany are given on the scale of 1:870,000; no part of Great Britain is shown larger than 1:1,000,000. No enlargements of English industrial regions, or the environs of British towns appear, although Andree's German edition contains two on the scale 1:750,000. Many of the Continental sheets, on the other hand, are crowded with valuable insets giving details of special districts. The Colonies are, on the whole, very well shown; Canada has a fair amount of space, Africa is lavishly treated, and India is clearly mapped, although the scale is comparatively small. But Queensland, New Zealand and Tasmania, British Guiana, and all the small Asiatic colonies, have been slighted. It is interesting, however, to find Fiji, Samoa, and the West Indies given on a scale making each island show as a visible disc, which displays some little topographical detail. We would suggest that the neglected parts of the empire, some of the more important South American States (the delineation of which is far too small), and the central part of the United States, should have more space devoted to them. Room might be provided by suppressing the large scale map of Alsace-Lorraine, and the rather blurred map of Hungary on p. 51 (also Bohemia, p. 52), which have the scale of 1:2,500,000, and show scarcely more detail than does the general map of Austria-Hungary, pp. 47, 48, which is on the very similar scale of 1:2,750,000.

It is undesirable to enter into a minute criticism of individual maps, for the best workers cannot avoid occasional mistakes, and the most diligent revision has hard work to keep pace with the unceasing changes of railways, populations, and boundaries. We may notice, however, that Aberdeen, Bolton, Cardiff, Croydon, Preston, and Reims have now populations exceeding 100,000, and should be designated by the special sign set apart for towns of the first magnitude. Ross and Cromarty have ceased to exist as separate counties, and the care bestowed on colouring and lettering the detached fragments of these and other counties in Scotland is consequently thrown away. The railways and telegraphs of South Africa are far behind the age, the Orange Free State being shown as if still undisturbed by the engine's whistle. The cable (p. 5) to the Cape by the west coast is only partly shown, though correctly given in the German original; and the Bermudas are now in electrical touch with the world, though this does not appear on the map. There are surprisingly few errors of spelling, and for the general purposes of the newspaper reader the atlas is eminently serviceable.

Only a few physical maps are given, including two pages of familiar and rather feeble astronomical diagrams, the use of which must be very slight. The world in hemispheres is shown with an attempt at orographical colouring on the land, and there are bathymetrical charts of the Atlantic and Pacific Oceans. The latter are somewhat remarkable. The contour lines of depth are given as 110, 1100, 2200, 2750, and 3300 fathoms, those odd numbers corresponding of course to even depths in metres, but the occasional soundings dotted over the surface are stated not in fathoms, but in feet. Similarly the one small climate map shows isotherms drawn to represent centigrade degrees, but lettered with the approximate Fahrenheit equivalents. The system of showing the winds on this map is arbitrary, and the arrangement it implies is unnatural. The physical maps might indeed be excised without serious loss.

The plan of printing the hill-shading—usually much generalised—in brown, throws out the black lettering, admirably, while the rivers and railways are very clearly shown in most cases. The importance of clear maps in following any movement or distribution cannot be overestimated, and the Switzerland (pp. 53, 54), Caucasus (p. 71), and Greece (p. 72), in this atlas are beautiful examples of artistic work, embodying ample detail without confusion.

OUR BOOK SHELF.

Types of Animal Life. By St. George Mivart, F.R.S. (London: Osgood, McIlvaine and Co., 1893.)

IT is reported of a negro preacher that, having omitted to note the source of his text, he counselled his hearers to search diligently for it, assuring them that in doing so they would find many other texts which would be for their souls' good. We are reminded of this anecdote in reading Prof. Mivart's new book on popular natural history. In our search for the types given in the table of contents we have been rewarded by finding a pleasing description of a goodly number of the higher animals. At the beginning of the fourth chapter we are told that the bull-frog has been selected as one type of animal life in order to introduce the group of *Batrachia*. Very little is said, however, about the bull-frog himself, though there is a figure of him in a deprecating attitude suggestive of some appreciation on the part of the artist of the somewhat shabby treatment this Batrachian elect has received. But there is much interesting matter concerning amphibians of all kinds, illustrated by reference to, or short descriptions of, some twenty genera. The first chapter is headed "Monkeys"; and similar headings would, we think, have been more appropriate throughout. As it is, the animal named is, in each case, merely a convenient starting-point for the consideration of the group to which it belongs. We do not know whether the chapters embodied in the book have already done service in any form in America, but the animals selected suggest that such may have been the case. We have the opossum, the turkey, the bull-frog, the rattlesnake, the Carolina bat, the American bison, the racoon, the sloth, and the sea-lion; while the chapter which deals with, or starts with, the last-named animal begins thus:—"The sea-lion is a beast the sight of which must be familiar to very many Americans." The term "animal life" of the title of the work is shown by the contents to be applied to the dactylate vertebrata only, three-fourths of the volume being devoted to mammals, or beasts as the author prefers to call them.

Unfortunately the proofs have been carelessly corrected, so that misprints (*e.g.* fleshating beasts, p. 209), errors of fact (*e.g.* that *Notoryctes* has recently been discovered in America, p. 60), grammatical errors (*e.g.* only two kinds of elephant now exists, p. 207); a redundant "and" before "which," p. 217), and inelegancies (*e.g.* python-like headed reptiles, p. 149: the blind worm is popularly reported as being deadly poison, p. 146) have been suffered to remain. Technical terms have, as far as possible, been avoided; but it is questionable whether the use of such a term as "wing-wedge bone" is advisable. Surely those who can take in such names of places as "Eschscholtz Bay," and such local names of animals as "Catamiztli," could swallow "alisphenoid" without serious mental indigestion

For the rest we have nothing but praise. A great deal of information is conveyed in a pleasant style. The illustrations, if not quite all that could be desired, are decidedly above the average. The reiterated allusion to the possibly independent origin of similar structures (or the independent origin of different structures, as it appears on p. 120) is, in our opinion, not out of place in such a book. Those who enjoy a smattering of knowledge, picked up from popular works, are apt to be so terribly dogmatic that it is well to urge them to keep their minds "free from prejudice and ready to receive all and any truth which may be demonstrable." C. LL. M.

Science Teaching in Schools. By Dr. Henry Dyer. (London: Blackie and Son, 1893.)

AN address given by Dr. Henry Dyer on science teaching in schools has been amplified and is now published in book form. The points dwelt upon appeal particularly to the managers and teachers of existing elementary schools, and of the secondary and technical schools now being organised in all parts of the country. In an appendix (which, by the way, is almost as long as the address itself) are given syllabuses of elementary science as taught under the London and Leicester School Boards, and the curricula of the evening classes of the Glasgow and West of Scotland Technical College. A commendable feature is the insertion of the courses of instruction at the Ecole de Commerce et de Tissage of Lyons and the Public Mercantile Educational Institute of Leipzig.

LETTERS TO THE EDITOR.

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

Vectors and Quaternions.

PROF. MACFARLANE claims that his "fundamental rules for vectors are based on physical considerations, the principal one of which is that the square of a vector is essentially positive." His proof is virtually this:—The expression for the kinetic energy ($\frac{1}{2}mv^2$) is an essentially positive quantity. It contains one factor $\frac{1}{2}m$ evidently positive. Hence the other factor v^2 must also be positive. "But v denotes the velocity which is a directed quantity." Unfortunately for this argument v does not denote the velocity in its complete conception—it simply measures the speed. The physicist may think of velocity as being a vector quantity; but in ordinary analysis the vector is not symbolised. We deal only with tensors and scalars. It would be well, I think, if the strict meaning of vector were clearly borne in mind. A vector is a directed line in space, and may be used to symbolise all physical quantities which can be compounded according to the well-known parallelogram law. Displacement is perhaps the simplest conception that can be so symbolised. Velocities, concurrent forces, couples, &c., are in the same sense vector quantities. Now it can be proved rigorously that quadrantal versors are compounded according to this very addition law. On what grounds, then, are they refused admittance to the order of vectors? If a vector cannot be a versor in product combinations, what is the significance of the equation $ij = k$? Regarding this Dr. Macfarlane vouchsafes no remark, save that it is possible to get along without its use. As he himself has not done so, such a possibility lies altogether outside our consideration. Again, I fail to see what "physical considerations" have to do with mathematics of the fourth dimension.

Dr. Macfarlane says that the "*onus probandi* lies on the minus men." To my mind there is no question of proof at all. That the unit vector α should fulfil the equation $\alpha^2 = +1$ is a bare assertion on the part of Dr. Macfarlane and Mr. Heaviside supported by such words as "natural, simple, conventional," and the like. The equation $\alpha^2 = +1$ is a pure assumption, having no better physical basis than the assumption that $\alpha^2 = -1$. *But in quaternions this is not the assumption.* The assumption is—as Dr. Macfarlane admits—that products are to be associative. Hamilton, in fact, invented his calculus so as to have its rules differing *as little as possible* from the recognised rules of algebra. The commutative law had to go, but the others were kept (see *Preface to Lectures*, §§ 50—56). In the system he advocates, Dr. Macfarlane loses the associative principle, and—as I think I show in my paper—gains nothing but a positive sign and an undesirable complexity in transforming by permutations.

As a calculus, quaternions may be developed quite as readily from the conception of the product as from that of the quotient. But in my paper I was arguing against Prof. Gibbs's dictum that the quaternion *as a quantity* corresponded to nothing fundamental in geometry. The extremely simple geometrical conception of a quaternion as a quotient of two vectors sufficiently meets Dr. Macfarlane's query, "Is not the product always the simpler idea?" It is certain that the quotient of any two like quantities has always a meaning; the product is often meaningless.

In the particular geometrical development of quaternions which I indicate in my paper, it can be shown that the quaternion, originally defined as the quotient of two vectors, can also be represented as the *product* (Dr. Macfarlane inadvertently misquotes "quotient") of two quadrantal versors, and this quite independent of the truth that quadrantal versors obey the vector law.

Dr. Macfarlane evidently grudges Prof. Tait (properly, Kelvin and Tait) the use of any but quaternion symbolism. Of course, when $\nabla^2 v$ occurs in ordinary non-quaternion analysis, it is used in the sense of the *tensor*, for only as such can it come in. This surely hardly needed to be pointed out. In quaternions there is no doubt whatever that $\nabla(\nabla\omega) = (\nabla\nabla)\omega = \nabla^2\omega$; and therein, as in all the higher physical applications, the flexibility and power of Hamilton's calculus are at once apparent.

In conclusion, let me say that no reasonable man can possibly object to investigators using any innovations in analysis they may find useful. But in the present case there is a very serious objection to the innovators condemning the system, from which they have one and all drawn inspiration, as "unnatural" and "weak," without in any way showing it so to be. That they can re-cast many quaternion investigations into their own mould does not prove their mould to be superior or even comparable to the original. Yet, in so far as they possess much in common with quaternions, the modified systems used by Gibbs, Heaviside, and Macfarlane cannot fail to have many virtues.

"His form had not yet lost
All her original brightness, nor appeared
Less than Archangel ruined."

Edinburgh University, May 29. C. G. KNOTT.

The Fundamental Axioms of Dynamics.

MY reasons for holding that the fact that potential energy belongs to a system rather than a particle is hostile to the idea of the identity of energy, are briefly these. If two pieces of kinetic energy, are successively transformed and added to a system as potential energy, and then some of the potential energy is retransformed into kinetic, we cannot say *which* of the original kinetic energies thus makes its reappearance; for while both were potential they had no local habitation within the system, and so could not be distinguished from each other.

The objections to including the ether as one of the "bodies" between which contact actions occur, without further explanations, are admirably stated by Prof. Rücker; but I should like to go even further than he does, and point out that if "contact action" means only "action at constant distance" it has not yet been shown how, by such action, kinetic energy comes to be transferred from one body to another. For if the bodies "move over the same distance," and have at any moment the same velocity, their kinetic energies are both increased or decreased *together*; whereas what we wish to show is how that of the one body may increase while that of the other decreases, and why the increase in the one case is equal to the decrease in the other. For example, it may be that in a perfect fluid such transference of kinetic energy actually takes place; but the question is, has Prof. Lodge explained this as a case of "contact action" or "action at constant distance"? What are the things or "bodies" which in this case are actually in contact, and which move over equal distances while the action is going on? Or between what points is the "constant distance" to be measured? Prof. Lodge has not shown in his last paper or in those in the *Phil. Mag.* how "potential energy" can be explained by contact action, nor how kinetic energy can be transferred by contact action alone. But perhaps the answers to these questions are included in the "something more definite" which Prof. Lodge now realises that he has "to say concerning the functions of the ether as regards stress"?

The third paragraph of Prof. Lodge's letter is evidently a joke. I certainly suppose that the denial of action at a distance means that material particles are without *direct* influence upon one another until they touch; *i.e.* that any influence they do exert is *indirect*, and takes place through their both touching something else. Indeed I indicated this in my last letter; but Prof. Lodge apparently hoped I would overlook his omission of the word "direct," and that so the joke would go against me!

EDWARD T. DIXON.

Trinity College, Cambridge, June 10.

Chemical Change.

IN the current number of the Proceedings of the Chemical Society, Prof. H. E. Armstrong publishes two articles on (1) the conditions determinative of chemical change, and (2) the nature of depolarisers. The former deals mainly with the presence of water as a necessary condition of chemical change, the latter with the question of the solution of metals in acids. For some time past I have been engaged with work on the former subject, upon terms of mutual understanding, with my friend Mr. H. B. Baker, whose experiments, following upon those of Prof. H. B. Dixon, have revolutionised our conceptions of chemical change. In the last four years I have also carried on investigations upon the reactions of metals with acids, especially nitric and sulphuric. I should, therefore, propose to deal more fully in a separate publication with the interesting speculations raised by Prof. Armstrong in the articles quoted above. For it has become apparent that after a century of work in chemical science we have no answer to the questions, (1) What is the nature of chemical change? and (2) What is the cause of its commencement? It is probable that both questions resolve themselves, in the long run, into the first. Of facts there is no end, but no interpretation thereof.

The subject is, therefore, ripe for discussion, not only for chemists among themselves, but also, as Prof. Armstrong aptly remarks, for physicists.

Such a discussion might be brought forward at the Chemical Section of the British Association, at Nottingham, in the current year, or, more appropriately, next year in Oxford, the home of Robert Boyle, Mayow, and other earlier chemists.

V. H. VELEY.

The University Museum, Oxford.

Mr. H. O. Forbes's Discoveries in the Chatham Islands.

REFERRING to my former note (*supra*, p. 101) I cannot find that I have been guilty of even "a slight confusion of dates," as Mr. Forbes says (*supra*, p. 126). On his last visit to Cambridge he told me he had forgotten the name I had before written, and asked me to renew my suggestion. I thank him for the kind terms in which he speaks of me, but I must be allowed to disclaim the opinion "that the Chatham Island form was nearer to *Aphanapteryx* than the latter was to *Erythromachus*."

ALFRED NEWTON.

Magdalene College, Cambridge, June 10.

Linnean Society Procedure.

AT the anniversary meeting of the Linnean Society complaint was made that the attendances at the evening meetings were greatly falling off, and fellows were urged to remedy this. The bad attendance is, I think, largely attributable to the lamentably unbusinesslike routine into which the Society's proceedings have fallen, and is not likely to be remedied until *that* is first remedied. Permit me to indicate what appear to me four primary defects in the Society's proceedings.

(1) The actual scientific business of the evening is frequently disposed of in an hour; so that fellows, who attend, sacrifice their evening for very inadequate reward.

(2) In the agenda no intimation is given as to whether the papers to be read will be *really read* by their authors, or whether merely a few sentences will be rattled through by the secretary in order that the paper can be marked as "read." It may thus happen that fellows who attend specially to hear some particular paper read and *discussed* get nothing for their pains. For instance, a short time since, some of us came up specially to hear a paper by Dr. Plowright on the *Aecidiomycetes*, but instead of being treated to a biological paper, followed by a discussion, all that we heard was a few sentences from the introduction read by the secretary! Naturally this sort of thing militates against regular attendances.

(3) Even when an important paper is intended to be read, it may not be reached at all, or if reached may be hurried over and not discussed for want of time. Why is this? Simply because the Society allows "exhibitions" to be intercalated between the formal business and the papers. These exhibitions are often of much interest, often, again, very trivial, but anyhow are quite secondary in importance to the papers, and clearly should be deferred *until the papers* have been disposed of, instead of taking precedence. These exhibitions are not advertised in the diaries of Societies; and it is rather hard that fellows, who have attended to hear an important paper on some new discovery, should go away disappointed because some inconsiderate visitor possibly is allowed to prose about a trifling exhibition for half an hour!

(4) A very grave defect is the confusion of heterogeneous subjects in one evening. If, for instance, alternate meetings were devoted entirely to botanical and zoological papers respectively, probably the attendances would be increased; but the botanists cannot be expected to display much interest in a new genus of earthworms, nor the zoologists in a monograph of *Dianthus*.

If the Council could see their way to adopting these simple reforms that I have suggested, I believe that the attendances would be much increased.

F. H. P. C.

THE GERMAN MATHEMATICAL ASSOCIATION.[1]

THIS is the Catalogue of the Exhibition that was to have been held last year in the picturesque old town of Nürnberg; but in consequence of the state of health in Germany, the meeting of the German Mathematical Association and the exhibition were postponed; and they are now to be carried out this year at Munich, in the month of September.

The last exhibition of a similar kind was that held in London in 1876, the catalogue of which shows that a large collection of apparatus, much of it of a great historical interest, was brought together.

[1] "Catalogue of Mathematical and Mathematico-physical Models, Apparatus, and Instruments." Edited, in conjunction with numerous colleagues, by Walther Dyck. Munich, 1892.

In the present collection the objects of historical interest are comparatively few in number; but, on the other hand, the various models and apparatus intended to illustrate mathematical principles and ideas show what great advances have been made in this branch, so much neglected in our own country.

Prof. Armstrong has recently described in these columns the superiority of the systematic manner in which chemical science is carried out in Germany; and the present Catalogue will show how much we have to learn in the principles of object teaching and illustration in Mathematics.

The Catalogue is divided into two parts. The first part consists of a collection of short and interesting articles.

I. "Geometrical enumeration of the real roots of algebraical equations," by F. Klein, in connection with which No. 47, the plaster model of Sylvester's Amphigenous Surface (constructed by Prof. Henrici) for showing the relations for a quintic equation, may be considered.

II. "Equidistant curve-systems on surfaces," by A. Voss.

III. "Elementary discrimination of singularities of algebraical curves," by A Brill; illustrated by instructive diagrams.

IV. "On the constructive postulates of geometry of space, in their relation to the methods of descriptive geometry," by G. Hauck; an article of great interest to students of Euclid's axioms, and of their modern developments.

V. "Historical studies on the organic description of plane curves, from the earliest times to the end of the eighteenth century," by A. v. Braunmühl; in this article the mechanical methods of the construction of curves, which are perpetually being re-invented, are traced back to their original sources, with interesting historical references.

VI. "On the methods of theoretical Physics," by L. Boltzmann, is a humorous article, describing the former antiquated methods of teaching Natural Philosophy in Germany, apparently not very different to what many of us remember in this country, until Maxwell's vivifying influence made itself felt.

Prof. Boltzmann gives with wonderful clearness Maxwell's ideas about the use of models in Physics; contrasting the views introduced by him with those held before. This article of Prof. Boltzmann is in course of translation and publication by the Physical Society.

VII. "Mechanical integration," by A. Amsler; this gives a complete account of the theoretical principles which underlie the action of Planimeters; it is illustrated with carefully-drawn diagrams.

VIII. "Instruments for Harmonic Analysis," by O. Henrici.

The Catalogue proper begins with the second part; this again is divided into three sections.

The first section contains instruments relating to Arithmetic, Algebra, Theory of Functions, and Integral Calculus, such as Arithmometers, of which the collection and illustrations appear very complete; Galton's Quicunx, illustrating the laws of probability of error; instruments for the solution of equations, Galton's Trace-computer, models of Riemann sheets by Prof. Schwarz, of functions of a complex variable by Prof. Dyck, and a very complete and profusely illustrated collection of Planimeters and Harmonic Analysers of all descriptions. The Rev. F. Bashforth's pioneering description of a Harmonic Analyser, read before the British Association in 1845, deserves especial attention. The elegant little planimeter of Messrs. Hine and Robertson, of New York, might well find a place in the exhibition. In this instrument the record of area is made by the sidelong movement of a sharp-edged wheel on its axle, and not by the rolling motion, so that all slipping of the wheel on the paper is done away with.

The great number of slide-rules is surprising. Mr. Stanley alone has sent more than a dozen.

Among the Arithmometers is the circular form of Mr. Edmondson, and one of great novelty by Prof. Selling, in which the *carrying* is performed continuously and without jerks. The instrument works in consequence with great smoothness and rapidity.

The same section contains instruments and models referring to Geometry, such as angle dividers, ellipsographs, Galton's pantograph, and several perspectographs. Pepys writes in his diary, April 30, 1669 :—"This morning I did visit Mr. Oldenburgh, and did see the instrument for perspective made by Dr. Wren, of which I have one making by Browne ; and the sight of this do please me mightily." If this instrument can be found it would be welcome at Munich ; perhaps Mr. Penrose could help in this matter.

The models for instruction in elementary geometry are very complete, and there are interesting illustrations of polyhedra and space dissection, the subject to which Prof. Alexander Herschel has devoted considerable attention. No. 150 is a collection of six tables on the "Lines of Beauty," to which Hogarth gave great attention ; this exhibit should be of interest to artists.

Under the head of Algebraical Surfaces we find among familiar models a pair of Prof. Henrici's confocal deformable hyperboloids, constructed of a number of straight sticks, tied together at the crossings. Darboux's application of these linked bars to the description of spheres and planes, and the mechanical illustration of the motion of a body under no forces, *à la Poinsot*, noted on p. 327 of the Catalogue, may be instanced here.

The plaster models of the confocal quadric surfaces designed and carried out by Prof. H. A. Schwarz and E. R. Neovius with mathematical accuracy should now form part of the apparatus of every teacher of solid geometry ; the complete series are obtainable for a moderate price through Brill, of Darmstadt.

Surfaces of the third, fourth, and higher degree, Kummer's and Steiner's surfaces, minimum and deformable surfaces, and others too numerous to mention here, are profusely illustrated in the catalogue.

Prof. Dyck's models of surfaces representing the real and imaginary parts of a function of a complex variable at and near a singular value should be studied by every reader of Mr. Forsyth's new book on the Theory of Functions. Of the curious complexity of even the simplest kinds of *essential singularities* a clearer idea is obtained by a glance at these models than by a long study of the analytical expressions.

The third section is devoted to Applied Mathematics, including Mechanics, Mathematical Physics, and instruments required in geodesy and navigation.

The mechanical models illustrate the parallelogram of forces ; the laws of falling bodies, including an arrangement exhibited by Mr. F. R. Barrell of University College, Bristol ; models of Saint Venant's torsion prisms, and so forth.

Mr. A. B. Kempe has supplied a complete account of his Linkages ; and Prof. Reuleaux's well-known collection of kinematical models is profusely illustrated here.

In mathematical physics we find apparatus for the illustration of wave motion and sound vibrations, refraction of light, interference, Mr. Boys's bullet photographs, and Mr. Bashforth's chronograph. Prof. Alexander Herschel's models are given under the head of models of crystalline structure.

Under thermodynamics are found the thermodynamic surfaces of Gibbs and Van der Waals ; and Profs. Oliver Lodge and Fitzgerald exhibit their mechanical illustrations of the laws of electrodynamical action.

Some interesting apparatus are described and illustrated in the last section on geodetic, nautical, and meteorological instruments, including General Strachey's apparatus for the determination of the height and velocity of the clouds.

It would be impossible to give within reasonable limits a detailed account of all the novel and interesting objects described in this catalogue ; but it is hoped that the present short sketch will show that the catalogue itself, apart from the exhibition, is a valuable work of reference, which should be in the hands of all interested in mathematical and mathematico-physical science.

It is expected that the postponement of the meeting to the coming September will give time for the collection of other objects of interest, which can be described and catalogued in an appendix.

A fresh manifesto has been issued by the German Mathematical Association inviting further contributions. Intending exhibitors in this country requiring information and advice, and instructions concerning packing and transport of instruments, are requested to communicate with :—

Prof. O. Henrici, Central Institution, Exhibition Road, W. ; or Prof. A. G. Greenhill, Artillery College, Woolwich.

At the meeting of the Deutsche Mathematiker-Vereinigung at Halle, it was concluded to arrange for an exhibition of models, drawings, apparatus, and instruments, used in pure and applied mathematics, for the occasion of the proposed conference in Nürnberg in the autumn of 1892.

The proposal enjoyed, from the beginning, the support of the Royal Bavarian Government, by which, through special material assistance, as by increased funds which the Imperial Ministry of the Interior liberally provided, the undertaking was assured.

The proposal of the undertaking was received with universal interest in scientific circles, and so the plan of the exhibition seems to be a natural one. A large number of mathematical, physical, mechanical, and geodetic institutes of our own universities and technic high schools, and those outside of Germany, placed the models in the institutes, as well as those of historical interest, to the disposal of the project. Announcements of participation were received from museums, private collections, and individual men of science, at home and abroad.

Besides Germany, America, France, Italy, Austria-Hungary, Holland, Norway, Russia, and Switzerland joined in the project, and especially in Great Britain a committee was composed, with Profs. Lord Kelvin, Greenhill, and Henrici at the head, to send to the exhibition the most prominent articles from the Government, as well as from private collections. Practically all the more important mechanical workshops that are particularly engaged in the production of mathematical apparatus and instruments, and also publishing-houses interested, agreed to share in the scheme.

All initial steps were taken and preparations made. An extensive catalogue was compiled, through the cooperation of numerous men of science, with a minute description and numerous illustrations of the particular objects, together with a series of comprehensive sketches of its contents ; this shows to what extent the various preparations were made.

The condition of the public health of Germany made the postponement of the meeting of the Deutsche Mathematiker-Vereinigung, and consequently the exhibition, which was almost in readiness, inevitable. The directors of the Deutsche Mathematiker-Vereinigung, however, at once concluded to realise their project in 1893.

In Munich, the place selected for the next meeting of the Deutsche Mathematiker-Vereinigung, the extensive rooms of the Polytechnic have already been kindly placed at the disposal of the directors. On account of the proportions that the exhibition has assumed, is will last longer than at first proposed. It will be open from September 1 to 30, as the session of the Mathematical Society, which lasts from September 4 to 10, will be immediately followed by that of the Society of Natural Science in Nürnberg, from September 11 to 15.

In this case, too, we rejoice in the support of the Royal Government, and hearty assurances of intentions to participate in the exhibition have been given by various scientific circles.

Again, therefore, and with confidence, do we turn to our fellow scientific men, to the various mathematical institutes in this and other countries, to publishing-houses and mechanical workshops, with the wish that, through their hearty cooperation, the project may be furthered. We add the plan and more minute information, for the successful realisation of the exhibition.

The exhibition lasts from September 1 to 30, 1893, inclusive, and comprises models, drawings, apparatus, and instruments used in pure and applied mathematics, either for purposes of instruction or investigation.[1]

The Deutsche Mathematiker-Vereinigung will take charge (free of cost) of the fitting of the rooms, the providing of tables, putting in of partitions, &c., as well as the unpacking and repacking of all articles intended for the exhibition. Moreover, the society will assume control of the articles while on exhibition, and will take particular care to preserve them, and will carry an insurance against fire. However, it can assume no responsibility against injury or loss.

Exhibitors who desire their various displays to be exhibited under closed cases must provide them at their own expense.

The expense of shipment to Munich, and, if desired, insurance, must be borne by the exhibitor. For the return the same inducements are held out as last year, viz. free freight over the chief German lines.

A comprehensive detailed catalogue of the mathematical exhibition, according to the announcement made last year, has appeared.[2]

The first part (142 pages) contains a number of essays, of general nature, having reference to problems, results, and methods of presenting geometrical concepts.

The second part (300 pages) contains, according to the suggestion given below, the enumeration and exact description of the articles intended for the Nürnberg exhibition, and gives, with numerous illustrations, a comprehensive view of the general plan of the undertaking, and a statement of what has already been accomplished.

The catalogue will also give the plan of the preparations of the present year; a detailed supplement will be added, in which we hope to perfect the non-completed parts of last year's catalogue.

As far as possible all technical explanations of the articles will be undertaken by the committee.

The committee will attend to all sales and buyings (which are in view by various mathematical institutes of our Hochschulen), and give all desired information.

During the exhibition the sold articles must not be removed from the exhibition rooms, except with special permission of the committee.

The intention to participate in the exhibition may be given by the use of the "Exhibition Announcement" until July 1.

Address: "Herrn Prof. Dr. Walther Dyck,
München, Polytechnicum."

At the same time all papers and scientific notices for the catalogue respecting woodcuts (clichés) for illustration must be sent to the same address.

The editors reserve the right of all abbreviation and change in the notes of Part II. of the catalogue that uniformity may require.

All articles proposed for exhibition must be forwarded from August 15 to 31 under the address: "Mathematische Ausstellung in München (Polytechnicum) zu Handen Herrn Prof. Dr. W. Dyck."

The return of all articles will be effected within two weeks after the close of the exhibition.

In order to more minutely define the extent of the exhibition, we give, in accordance with the arrangement of the catalogue which has already appeared, the following division of groups:—

I.—ANALYSIS.

Calculating apparatus (calculating machines, slide rules); apparatus for the solution of equations and construction of functional relations; models and drawings in algebra and theory of functions; curvometers, planimeters; other instruments for mechanical integration.

II.—GEOMETRY.

Drawing apparatus; models for elementary instruction in plane and solid geometry, trigonometry, and descriptive geometry; polyhedra (division of surfaces and spaces in polygons and polyhedra); analysis situs; plane curves; algebraic surfaces; transcendental surfaces; curves in space and developable surfaces; models in line geometry; models to illustrate theory of curvature; singularities of curves and surfaces.

III.—APPLIED MATHEMATICS.

Mechanics.

Models used in elementary instruction; apparatus and models for the demonstration of the laws and principles of dynamics (equilibrium and movement of a material point; Poinsot motion of a rigid body; apparatus for representing precession and nutation; dynamical tops; gyroscopes; models and articles showing the effect of tension, compression, flexion and torsion of solids; representation of various phenomena in hydro-dynamics); models and apparatus in kinematics with regard to their application in practice.

Mathematical Physics.

Apparatus and models to illustrate the laws of the propagation of waves; models for the explanation of crystal structure; models to illustrate the optical, elastic, and electric properties of crystals; drawings and models in thermodynamics; models and apparatus for the mechanical illustration of electro-dynamic phenomena.

Various Technical Applications.

It is to be understood that exhibitors must declare their willingness to submit to the present rules and further dispositions ordered by the committee for the interest of the exhibition.

For all further information please address the undersigned delegate of the committee. PROF. DR. WALTHER DYCK.

[1] From the field of applied mathematics only those models, apparatus, &c., will be accepted whose chief interest lies in the field of pure mathematics.

[2] The catalogue can be obtained direct from Prof. W. Dyck (München, Polytechnicum) at the price of M. 9.80 (including postage).

RELATIONS BETWEEN THE SURFACE-TENSION AND RELATIVE CONTAMINATION OF WATER SURFACES.

IN a recent paper (NATURE, vol. xlvi., p. 419) I have suggested a method for measuring the relative contamination of an anomalous water-surface in my adjustable trough without fearing an error caused by incomplete separation of the surfaces by the partition. It consists in observing not the displacement of the partition itself, but that of a floating wire laid across the surface, which follows every motion of the superficial water particles.

By this method I have now tried to find a relation between the relative contamination and the decrease of tension which begins at that relative contamination, which we will call unit.

The surface-tension was measured by the separating weight of a ring of thin wire, which had a circumference of 114 mm. and was cleaned by ignition, so that it could be afterwards entirely moistened with water. The ring was attached to a balance with a sliding weight. In this manner the normal surface-tension of water was determined to be 80 mg. per cm. at a temperature of 15° C. The values obtained by experimenters on this subject differing considerably from each other, I shall express the tensions not in absolute measure, but in fractions of the normal surface-tension of water taken as unit. Thus, I found the surface-tension of a saturated solution of camphor 0·72, and that of a strong solution of soap 0·37.

On several occasions, when fast working was required, the tension was not observed directly with the wire-ring, but with the small balance used in my former experiments, the tension corresponding to each separating weight being previously determined by comparison with the large balance.

The observations were made as follows:—A slight trace of oil was communicated to the surface of the trough by means of a wire previously heated to redness, the water-surface still remaining normal. If tallow was to be tried, I left several fragments floating on the water for a short time. When the anomalous surface had reached a sufficient length, the floating wire was put upon it about halfway between the partition and the end of the trough. Then the sliding weight of the balance was displaced successively along intervals of the scale, corresponding to equal differences of tension, and after each displacement one determined the length of surface, at which, under continued contraction, the disk or ring broke off. From these lengths the relative contaminations were afterwards calculated.

Thus I obtained the following results, T denoting relative surface tension and R relative contamination :—

Provence Oil.				Tallow.	
Interval of T. 0·05.		Interval of T. 0·06.			
T.	R.	T.	R.	T.	R.
1·00	0· 1	1·00	0· 1	1·00	0· 1
0·95	1·11	0·94	1·13	0·95	1·12
0·90	1·20	0·88	1·24	0·90	1·22
0·85	1·29	0·82	1·32	0·85	1·31
0·80	4	0·76	10	0·80	1·39
0·75	13	...	...	0·75	6
				0·72	12

It did not influence the results if I used poppy-oil instead of olive-oil, or tallow of various provenience.

The decrease of tension was rapid, and nearly proportional to the increase of relative contamination, till the value 0·82 in the case of oil,[1] or 0·79 in the case of tallow, was attained. At this point a sudden change occurred, and the further sinking took place very slowly. At the same time the "solution current" of floating tallow fragments showed a sudden lessening.

Under continued contraction the water surface at last appeared turbid, and the lowest tension I could attain in this way was about 0·63 with oil and 0·68 with tallow.

The method described is still somewhat imperfect, inasmuch as the water particles in close proximity to the sides of the trough did not participate in the movement of the rest of the surface, indicated by the displacement of the wire-mark. Therefore the results were checked by another method.

The whole surface of the trough was rendered anomalous by means of weak solutions of oil or tallow in benzol, for which purpose 23 drops of the oil solution, or 13 of the stronger tallow solution were required. If the contamination be a little too great, the normal tension may be easily restored by immersing small strips of paper. Then part of the surface was cleansed by shifting the partition from the end towards the middle of the trough about 10 cm., and one drop of the solution being evaporated on the newly-formed surface, the partition was removed and the ten-ion measured. The increase of relative contamination thus added by each drop was respectively $\frac{1}{23}$ and $\frac{1}{13}$. The means of all observations made in this manner were as follows :—

Provence Oil.		Tallow.	
R.	T.	R.	T.
0·0000	1·000	0·000	1·000
1·0000	1·000	1·000	1·000
0·0434	0·973	1·077	0·963
1·0868	0·945	1·154	0·924
1·1321	0·916	1·231	0·879
1·1736	0·891	1·308	0·832
1·2170	0·860	1·385	0·790
1·2604	0·834	1·462	0·790
1·3038	0·815	...	...
1·3472	0·815	2	0·782
...	...	4	0·760
2	0·805		
4	0·795		
12	0·760		

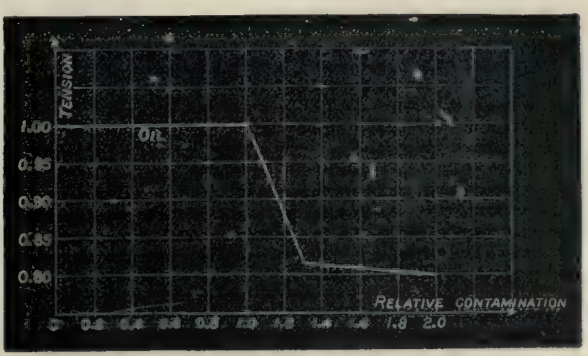
[1] When ordinary olive-oil was used the value in question was 0·78.

The results agree tolerably well with those obtained by the first method, and show still more clearly, that the tension in the beginning of the anomalous state may be approximately expressed by

$$T_0 - T = k(R - 1),$$

T_0 denoting the normal surface-tension and k a constant which is, in the case of oil, 0·60, and in the case of tallow, 0·54.

The course of the tension of a surface contaminated by oil may be more clearly seen from the following curve :

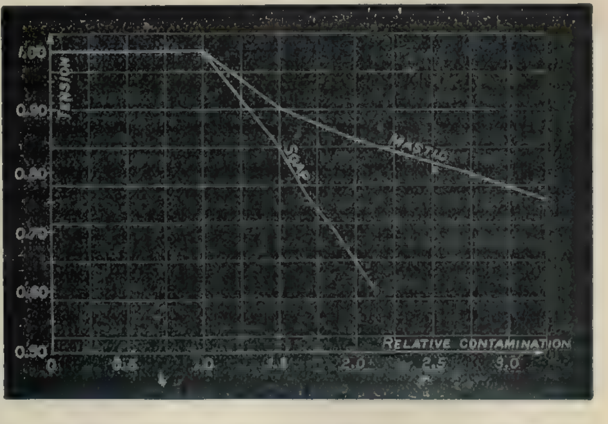


When the water-surface is not contaminated by pure grease, but by any other substance, as soap, resin, palmitic acid, the tension behaves quite differently.

If the justly anomalous surface be contracted, the tension at first sinks rapidly, but gradually begins to rise again, while the area of the surface remains constant; the latter being re-extended, the normal condition is attained at a shorter surface than before contraction. When the surface then is left for some time in the normal state, the length of the anomalous surface increases again.

Therefore the difference of tension produced by varying the area in a given ratio depends very much upon the time required for the contraction or extension.

The deeper the tension is lowered the stronger becomes its tendency to rise, till at last a further sinking



only can be observed during the motion of the partition, and this even is the case with grease at higher degrees of contamination. A sudden change of direction at a certain lowered tension I could perceive in no other curve than that of pure grease. As an example may be exhibited the curves of soap and mastic, when the contraction was as quick as possible. Mastic was introduced by means of benzol, soap directly by contact.

On strongly contracted surfaces, every substance gives a stiff, visible pellicle, composed, as it appears, of small incoherent particles.

Certain peculiarities of some substances still must be mentioned.

(1) The contamination due to colophony and palmitic acid continually diminishes, and at last seems to disappear altogether on standing, which is not the case with mastic.

(2) On the other hand, if the surface has been for a moment in contact with a piece of soap, the contamination continues to increase after the removal of the soap.

(3) Stearic acid renders the water surface stiff as soon as the tension begins to sink.

(4) A surface made anomalous by olive-oil in the course of twenty-four hours undergoes a change, by which the curve of tension is totally altered.

On the whole the phenomena are rather complicated, the tension by no means being determined by the quantity of contaminating substance in the unit of area; but depending considerably upon conditions that are still to be investigated. Especially in the experiments relative to the final tensions attainable by the various substances in the state of utmost concentration I could not succeed in getting definite results.

AGNES POCKELS.

NOTES.

A BRONZE statue of Arago, erected in the grounds behind the Paris Observatory, was unveiled by M. Poincaré on Sunday last in the presence of several members of the Institute, the observatory officials, and a few spectators. This is the third monument that has been erected to the memory of that renowned astronomer.

PROF. MAX MÜLLER has had the order of Medjidieh conferred on him by the Sultan of Turkey. This is a graceful recognition of Prof. Müller's scientific researches.

BARON VON NORDENSKJÖLD, of Stockholm, has been elected a Foreign Member of the Paris Academy of Sciences.

DR. E. B. TYLER, Curator of the Oxford University Museum, has been elected an Associate of the Brussels Academy of Sciences.

THE announcement that Mr. E. B. Poulton, F.R.S., has been appointed Hope Professor in succession to the late Prof. Westwood will be received with satisfaction by all naturalists who are familiar with this author's work. For more than ten years Mr. Poulton has displayed the greatest activity as an original investigator, more especially in connection with the subject of insect colouration, which he has advanced by many important discoveries. His contributions to insect morphology are sufficient guarantee that the purely systematic side of entomology will not be neglected at Oxford. All who are interested in the status of the University as a centre of biological research will recognise the wisdom of the electors in making their selection.

IN the House of Commons on June 8 Mr. Rentoul asked the Secretary of State for War whether he was aware that at the recent Staff College examination there was a striking change, of which no notice had been given, in the nature and scope of the mathematical examination; and whether steps would be taken to prevent any of the officers who were candidates at the examination being disqualified in consequence of this unusual procedure. Mr. Campbell-Bannerman replied that the change was due to the appointment of a new examiner, and said that, as the examination is competitive, the candidates would not be put to any disadvantage by the greater difficulty of the questions. This may be a sufficient explanation of the circumstance, but, in many cases, candidates for Government appointments have found upon reading the question paper, that important changes have been made in the character of the examination without any intimation whatever having been given to them.

A *conversazione* of the Institution of Electrical Engineers will be held in the galleries of the Royal Institute of Painters in Water Colours on Friday evening, June 23.

THE Selborne Society have made arrangements for a visit to Selborne, the home of Gilbert White, on Saturday, June 24. Lord Selborne will occupy the chair at lunch, and be supported by Lord Northbrook, the Earl of Stamford, and Sir John Lubbock, Bart. Tickets for the excursion can be had from the Secretary, 9, Adam Street, Adelphi, W.C.

THE fourth annual meeting of the Museums' Association will be held in the rooms of the Zoological Society during the first week in July. The formal proceedings will commence on Monday, July 3, at 8.30 p.m., when Sir W. H. Flower, F.R.S., the President-Elect, will deliver an address. It is proposed to devote mornings to the reading and discussion of papers bearing upon the subject of museums, and in the afternoons and evenings visits will be made to various Metropolitan museums. The arrangements of the meeting will be greatly facilitated if those who propose to attend will give early notice to Mr. F. W. Rudler, 28, Jermyn Street, S.W.

THE fifth summer assembly of the National Home Reading Union will be held at Ilkley, Yorkshire, from July 1 to July 8. The inaugural address will be delivered by the Master of Trinity College, Cambridge, and there will be lectures by Mrs. Henry Fawcett, Prof. Michael Foster, Sir Robert Ball, Mr. W. G. Collingwood, Mr. Churton Collins, and others. Short lectures on archæology, botany, and geology will be given each day, and will be followed by excursions to places of interest in the neighbourhood. There could hardly be a more pleasant road to knowledge than that afforded by such a meeting as this.

VARIOUS learned and scientific bodies of Liverpool and the district, being desirous of inviting the British Association to meet at Liverpool in 1896, sent representatives to the Mayor on June 5 for the purpose of soliciting his aid in the furtherance of their object. The Mayor would not pledge himself to any course of action, but said he would consult the Corporation upon the matter.

THE Permanent Committee of the International Congress of Zoology propose, as the subject for the S. A. I. le Tsarévitch prize, the study of the fauna of one of the great regions of the globe and the relations between this fauna and that of neighbouring regions. The award will be made at the Leyden Congress in 1895. By the rules of the Congress this prize cannot be given to a Dutch man of science. The jury will accept works bearing upon a branch or a class of the animal kingdom. Manuscripts or printed papers should be written in French and sent, before May 1, 1895, to M. le Président du Comité permanent, Société Zoologique de France, 7 Rue des Grands-Augustins, Paris.

WITH the exception of heavy thunderstorms which occurred in the central part of Ireland during the night of Friday, the 9th inst., in which 1·2 inch of rain fell, and in Merioneth the next day, the weather, as represented by the stations reporting to the Meteorological Office, has been practically rainless over nearly the whole of the British Islands. These conditions were owing to the persistence of an anticyclone over Scandinavia, the North Sea and our own area. The temperature has been somewhat high for the time of year, the highest daily maxima in the south and west having at times exceeded 75°; but in the north, and especially on the east coast, owing to the continuance of easterly winds, many of the maximum readings have been below 60°. During the early part of the present week the anticyclone decreased in intensity and began to move slowly eastward, while a depression which lay over the south-west of France moved northward, causing the barometer to fall generally over our islands, and on Tuesday night, the 13th inst., a thunderstorm occurred at Jersey, while a further rise of temperature occurred over the southern portion of the kingdom, the maximum at Cambridge reaching 81°. The *Weekly Weather Report* of the 10th inst. showed that the greatest excess of temperature occurred in Ireland and the Channel Islands, where it was 5° above the mean. The rainfall just equalled the mean in the east of Scotland and the north of Ireland only. Bright sunshine was above the usual amount everywhere; the percentage of duration ranged from 29 to 38 in Scotland, from 36 to 40 in Ireland, and from 40 to 67 over England, while in the Channel Islands the percentage was as high as 75 of the possible amount.

WE are indebted to Dr. A. Buchan for the discussion and publication (in vol. ix. of the Journal of the Scottish Meteorological Society) of a very valuable series of mean monthly and yearly temperatures for London and vicinity for 130 years, from 1763 to 1892. The only interruptions of the continuity of this long series occurred in May 1777 and July 1780, and the means for these months have been interpolated. For the 130 years the mean temperature of London is 50°·2. The highest mean temperature of any month was 74°·1 in July 1783, and the lowest 25°·9 in January 1795, the difference being 48°·2. The warmest seasons were, winter, 1779, 8°·3 above the normal value; spring, 1811, +5°·2; summer, 1783, +8°·2; and autumn, 1777, +5°·1. The coldest seasons were, winter, 1814, 6°·5 below the normal; spring, 1837, −6°·7; summer, 1816, −4°·6; and autumn, 1877, −4°·1. The year 1783 had the highest mean annual temperature, being 5°·2 above the normal for the year; and 1816, the lowest, being 3°·5 under the normal. Dr. Buchan states that much labour has been spent in searching for evidence of cycles, but that it cannot be said that the results show more than highly interesting resemblances and contrasts among the months, and that in whatever way the periods are viewed, they suggest no appearance of a cycle. But a tendency is shown of types of high and low temperature to prolong themselves during months, seasons, and years. Following this paper is an equally important discussion by the same author of the temperature of the north-east of Scotland for 129 years, from 1764 to 1892, from observations taken at Gordon Castle and other places.

AT the instance of Herr von Helmholtz, and with the support of the Berlin Academy of Sciences, Drs. Franz Richarz and Otto Krigar-Menzel have undertaken a remarkable series of experiments for the purpose of determining by weighing the diminution of gravity as we ascend from the surface of the earth. The method was theoretically the following:—To each pan of an ordinary balance is attached another pan by means of a rod about 2 m. long. Two sensibly equal masses are placed in the left upper and the right lower pan respectively. The gravitational attraction being stronger on the latter weight, a difference will be indicated by the balance. On removing the left weight from the upper to the lower pan, and the right weight from the lower to the upper, the difference acts in the opposite direction, and half the mean of the two differences gives the decrease of gravity with the height. It is almost needless to say that the experiment was one of very great delicacy and difficulty. It was performed in an earth-covered casemate of the citadel of Spandau, partly in order to utilise a mass of lead weighing about a hundred tons to determine the attraction exerted by it. The necessary preparations were begun in 1887, and the main part of the observations has only just been concluded. The difference between the values of g at two points, one 2·26 m. above the other, was found to be $6{\cdot}523 \times 10^{-6}$. The calculated value was $6{\cdot}970 \times 10^{-6}$. The difference may be due to a density of the strata below the station being less than the average.

A THERMOSTAT for the comparison of standard thermometers between the temperatures of 50° and 300° C. is described by Herr A. Mahlke in the current number of the *Zeitschrift für Instrumentenkunde*. It is used at the Physikalisch-Technische Reichsanstalt for the purpose of maintaining the thermometers to be compared at certain temperatures for which the boiling point of some substance is not available. It consists essentially of an oil-bath in a copper cylinder surrounded by another copper cylinder, the space between the two being filled with air. Heat is applied to the outer vessel. The heated air warms the inner vessel by circulating round it, there being a clearance of 2 or 3 cm. all round. Special precautions are taken to keep the level of the oil in the inner vessel constant, and the temperature of the oil uniform throughout. Both cylinders are closed with lids containing holes through which to insert the thermometers. The oil is kept circulating by means of two propellers enclosed in vertical copper cylinders open at both ends. Their axes project through the outer lid, and are provided with pulleys rotated by means of a small water motor. The whole arrangement is designed to keep the entire body of oil in motion, so as to prevent unequal heating. Surplus oil, due to expansion, and any oil-vapour that may be evolved, are drawn off through a siphon leading through the walls of the cylinders into a refrigerator. The apparatus has worked very well, the variations of temperature not exceeding the average errors in reading the thermometer scales.

THE extremely high cost of high resistances made of metallic wire causes the discovery of a cheap substitute to be a matter of considerable importance. Most of the substitutes hitherto proposed, such as liquid resistances, pencil marks on glass or ebonite, &c., are subject to the objection that they have an extremely high temperature coefficient, and in the case of the pencil mark, on account of the extreme thinness of the conducting material, the rubbing off of a few particles causes a great increase of resistance. These resistances also depend in a considerable degree on the electromotive force to which they are subjected. The *Elettricista* for May contains the description of a new material for the construction of high resistances, discovered by E. Jona which is said to be free from most of these defects. He uses an ebonite tube which is filled with a mixture of graphite and unvulcanised ebonite in suitable proportions. The mixture is then vulcanised, when it hardens and adheres to the containing tube. Metal cups fitted with binding screws are fixed to the ends. In this way a resistance of a megohm can easily be obtained in a tube 10 cm. long and of 15 mm. diameter.

IN a recently-published number of the proceedings of the Cambridge Philosophical Society there is an interesting paper by Messrs. Griffiths and Clark on the determination of low temperatures by means of platinum thermometers. Acting on the suggestion of Profs. Dewar and Fleming, that from observations on the resistance of certain pure metals (including platinum) at very low temperatures, it would appear as if the resistance vanished at absolute zero, the authors have calculated by means of Callendar and Griffiths' method the temperature at which the resistance of several platinum thermometers, whose accuracy had been severely tested, would be zero. The values obtained seemed to corroborate the conclusions arrived at by Profs. Dewar and Fleming as the mean value found for the temperature at which the resistance would be zero is −273°·96. This gives a convenient method of graduating a platinum thermometer, when a high order of accuracy is unnecessary, without the usual observation in sulphur vapour, which, in the absence of special apparatus, is a troublesome operation. For if the platinum is pure, it may be assumed that at absolute zero the resistance vanishes, and thus a measure of the resistance in steam and ice will allow of its constants being calculated.

While making the observations mentioned in the previous note the authors were led to suspect that the heating effect of the small currents necessary to measure a resistance are of more importance than is usually supposed. During their determination of the value of the mechanical equivalent of heat by means of an electric current, they measured the temperature of the bath containing the wire under experiment, at which the resistance was the same, while the difference of potential at the ends was increased from one to ten volts. Hence they were able to calculate the change of resistance (δR), and the results seem to show that $\delta R = aC^2$ where a is a coefficient depending on the nature of the surroundings. Thus, by determining the resistance of a coil with two different electromotive forces, it would be possible to find the value of a, and hence calculate the value of the resistance when $C = 0$.

The June number of the Journal of the Institution of Electrical Engineers contains a long paper by Mr. A. T. Snell on the distribution of power by alternate current motors. The paper is followed by a full report of the discussion which it raised when it was communicated to the Institution.

According to the *Electrical Review* Messrs. Cross and Mansfield have recently contributed to the Massachusetts Institute of Technology some further experiments on the excursion of the diaphragms of telephones. They find that on increasing the magnetising current, the corresponding permanent deflection increases more and more rapidly in proportion up to about $\frac{3}{10}$ths of an ampère, after which the deflection is very nearly proportional to the current. Similarly the results show that as the strength of the magnet of the telephone increases, the amplitude of the vibration likewise increases up to a certain limit and then falls off. The maximum motion of the diaphragm for a given value of the alternating line current employed is attained before the core reaches half saturation. It also appears that, in general, the amplitude of vibration of the diaphragm increases less rapidly than the current actuating the telephone.

Agriculture is rapidly becoming more scientific. In France the Société Nationale d'Agriculture lately charged a special commission to study the question of agronomic maps, designed to afford the farmer useful indications on the physical and chemical qualities of land, so that he may know how to improve it, what manures to apply, and in what quantity, &c. In an interesting report on behalf of this commission (summarised in *Rev. Gen. de Sciences*) M. Carnot represents that the time is now ripe for production of cantonal and communal agronomic maps, on a large scale; and a number of suggestions are offered as to how the work should be done.

There is now a general tendency in Russia to introduce some teaching in agriculture and horticulture into the primary schools. Both private persons and the Provincial authorities freely give grants of land to the schools and to the teachers' seminaries for their fields and orchards, and in many schools the plots of arable land and gardens attended to by the pupils become small centres of agricultural and horticultural education. In Caucasia the same tendency is even more pronounced, and no better idea can be given of the extent of this new movement than by giving the following facts relative to the primary schools of Kuban, a province of Northern Caucasia. This year ten schoolmasters have been invited to attend the lectures upon sericulture and bee-keeping at the schools of the Cossack villages, Armavir and Labinskaya. The inspector of the schools has acquired, with the modest grant of £35, thirty appliances for raising silkworms, and five arrangements for each school for pumping out honey from the beehives, and preparing the artificial wax honeycombs; in addition to which, ten schools have been supplied with apparatus for silkworm culture, while others have been supplied with seeds of plants of special use to bees. All schools which have gardens of silkworm trees have been supplied with seeds of the tree, and 20,000 young trees have been distributed among them. Fourteen schools are expected this year to carry on the silkworm culture, and ten other schools are already carrying on experiments relative to the same.

In the current number of the *Entomologists' Monthly Magazine*, Mr. R. McLachlan, F.R.S., in an article on the extinction of several species of British butterflies within recent years, and the decadence that appears to be going on with respect to others, suggests the enforcement of a close-time to last continuously during the whole of a series of five or ten years.

In a recent paper to a Christiania journal on the melting of inland ice (whereby glaciers are prevented from growing indefinitely in thickness, notwithstanding additions above the snow line), Herr Schiotz attempts to estimate the three factors concerned in the interior fusion, viz. earth heat, friction, and pressure, and arrives at the result that a more important agent than any of these (in hindering glacier growth) is solar heat melting the surface ice below the snow line (*Naturw. Rdsch.*, No. 21).

A paragraph describing a supposed earthquake felt in the Isle of Man on the afternoon of May 5 was published in several London and provincial papers. Mr. Charles Davison writes us to the effect that his inquiries show that the shocks were due, not to earthquakes, but to the firing of heavy guns from a battleship situated near the island.

During the cutting of a tunnel at the Notabile Terminus of the Malta Railway (writes Mr. N. Tagliaferro in the *Mediterranean Naturalist*) a piece of lignite, of dimensions about 11 by 4 by 1 inches, was found embedded in the blue variety of the upper globigerina limestone. The upper layers of this limestone appear to be contemporaneous with the Langhian series of the miocene beds of Italy, and were probably deposited on an ascending sea-floor at a depth of nearly 300 fathoms. The discovery of lignite in these beds is, therefore, of some importance.

Writing in *Science* of May 5, Dr. Morris Gibbs says that the results of observations of the songs of fifty different species of birds shows that the notes do not change in quality as a result of change in emotion. After robbing nests he has waited and listened, allowing ample time for the male to learn of the spoliation. In each instance the male, upon returning to the empty nest, at once burst into song, and though it is possible that the song expressed much sorrow or complaint, Dr. Gibbs could never distinguish any difference between it and the warbling he was accustomed to hear.

In the *Lancet* of June 10, Dr. Edwin Haward calls attention to a point with respect to proofs of death, which, in consequence of the growth of opinion in favour of cremation, is of great importance. Sir B. W. Richardson and himself had to decide in a particular case whether life was or was not extinct. Of ten tests applied to the body, eight indicated that death was complete. These were (1) heart sounds and motion entirely absent, together with all pulse movement; (2) respiratory sounds and movements entirely absent; (3) temperature of the body the same as that of the surrounding air in the room; (4) a bright needle plunged into the body of the biceps muscle and left there showed no sign of oxidation on withdrawal; (5) intermittent shocks of electricity passed through various muscles and groups of muscles gave no indication whatever of irritability;

(6) the fillet test applied to the veins of the arm caused no filling of veins on the distal side of the fillet; (7) the subcutaneous injection of ammonia caused the dirty brown stain indicative of dissolution; (8) rigor mortis was detected on making careful movements of the joints of the extremities and of the lower jaw. Two tests, however, indicated that life was not extinct. The opening of a vein to ascertain whether the blood had undergone coagulation showed that the blood was fluid. This is not very important, because under abnormal conditions the blood may remain fluid after death has occurred. But a criterion which has been believed to afford sure evidence of life or death was found to fail. It is known as the diaphanous test, and consists in holding the fingers of the supposed dead person in front of a strong light, and looking through the narrow spaces between two fingers just touching one another. The belief has been that if the person is alive a line of scarlet colour will be seen, and that the absence of the colour indicates death. In the case investigated, however, the scarlet line of light between the fingers was clearly visible, though death was assured by the fact that decomposition set in. Further, Sir B. W. Richardson records a case in which the test, applied to the hand of a lady who had simply fainted, gave no evidence of the scarlet line; so that, on that test alone, she would have been declared dead. Thus the diaphanous test, which has been considered by many as infallible, has been proved to be untrustworthy.

HERRN FRIEDLÄNDER UND SOHN, of Berlin, have issued their *Natural History News*, Nos. 3–9. The lists contain advertisements of recent literature on natural history.

THE Technical Instruction Committee of the Essex County Council have just issued a prospectus containing syllabuses of lectures on chemistry and biology—sciences which are specially applicable to the industries of the county.

Iron has ceased to exist as an independent journal, after living for twenty years under that title and fifty years as the *Mechanics' Magazine*. It has been amalgamated with *Industries*, and the combined journal will in future be issued under the title of *Industries and Iron*.

THE life of Sir Richard Francis Burton, by Lady Burton, will shortly be published by Messrs. Chapman and Hall. The work will recount Sir Richard's life from his birth to his death, and will comprise two volumes of about 600 pages each. A large amount of space is devoted to a description of his explorations.

WE have received the New South Wales Statistical Register for 1891 and previous years, compiled from official returns by Mr. T. A. Coghlan. The volume is a collection of eight parts which have already been issued separately. It is wholly devoted to statistics.

FROM Felix Alcan, of Paris, comes a work on the "Conquête du Monde Végétal," by Louis Bourdeau. The arrangement of the matter in the book is very good. After discussing the general theory of the growth of plants, the author passes to the study of various groups of plants of economic and of ornamental value. This branch of the subject is divided into seven parts. The operations of culture furnish matter for a special chapter, and the book is concluded with an account of the creation and preservation of artificial varieties of some types of plants. To a large extent the subject is treated historically.

THE Life Saving Society has for its chief object the development of instruction in such swimming arts as would be of assistance to a person endeavouring to save life. They have just issued a revised edition of an excellent little handbook in which an account is given of the methods recommended by the society for the rescue of the drowning and the resuscitation of the apparently drowned. It is hoped that the issue of this course of instruction will lead to the subject of life-saving and resuscitation being included in the curriculum of every school.

THE decomposition of steam by means of heated magnesium makes, according to Herr Rosenfeld (*Berichte*), a pretty lecture experiment. A short piece of a combustion tube is furnished at one end with a stopper and tube for escape of gas, and connected at the other with a vessel containing water. A little powdered magnesium (0·5 to 1 gramme) is put in the tube, and cautiously heated; then, by gently heating the water, steam passes over, and the metal merely glows. In this way is obtained a steady current of hydrogen, which can be collected over water. But if a rapid current of steam is sent over the heated metal, the latter burns with dazzling light, and the heat breaks the tube. This occurs, however, only after some time, when a good deal of hydrogen has been collected in the bell-jar.

AN interesting compound of aluminium chloride with benzoyl chloride, the chloride of the benzoic acid radicle, has been obtained in large crystals by M. Perrier, and an account of it is contributed to the current number of the *Comptes Rendus*. Such compounds are of particular importance in view of the remarkable *rôle* which aluminium chloride has been found to play in synthetical chemistry, as affording some insight into the nature of the intermediate reactions upon which the apparently catalytic action of this useful salt depends. The new compound now described is represented by the formula $C_6H_5COCl.AlCl_3$, or, if aluminium chloride is considered as represented by the usual double formula, $(C_6H_5COCl)_2.Al_2Cl_6$. It is readily prepared by heating about ten grams of benzoyl chloride dissolved in 150 c.c. of carbon bisulphide with nine grams of anhydrous aluminium chloride in a flask fitted with a reflux condenser. After three hours' ebullition and subsequent cooling a large yield of the colourless tabular crystals of the new compound is obtained. The crystals decompose somewhat rapidly in moist air, and they are instantly decomposed by water, forming an aqueous solution of aluminium chloride, hydrochloric acid, and benzoic acid. They are readily soluble, however, without decomposition, in carbon bisulphide. The formation of compounds of this nature is not confined to the chloride of benzoic acid, but would appear to be general throughout the aromatic series, and M. Perrier has already isolated in a pure state the corresponding compound containing the chloride of phthalic acid. Moreover, in the fatty series the chloride of butyric acid is found to combine readily with aluminium chloride, in carbon bisulphide solution, to form a compound of the same definite nature.

THESE compounds are not the first of the kind that have been prepared. Last year MM. Perrier and Louise described a considerable number containing the aromatic ketones, ethers, and phenols. They were all constituted upon the same type, $M_2.Al_2Cl_6$, where M represents a molecule of a ketone, ether, or phenol. The compound containing acetophenone, for instance, $(C_6H_5.CO.CH_3)_2.Al_2Cl_6$, may be obtained in good crystals by cooling the liquid formed by heating acetophenone dissolved in carbon bisulphide with aluminium chloride to 40°. Similarly the compound with phenyl benzoate, $(C_6H_5.COOC_6H_5)_2.Al_2Cl_6$, crystallises from the liquid obtained by heating the components in carbon bisulphide solution. They are all of the same character, permanent in carbon bisulphide solution or in dry air, but decomposed rapidly by moisture.

THE formation of the above compounds explains at once the important synthetical method introduced by MM. Friedel and Crafts for the preparation of the aromatic ketones by the action of the hydrocarbons upon the chlorides of the acid radicles in presence of aluminium chloride. It is most probable that a compound of aluminium chloride with the chloride of the acid radicle, $(R.COCl)_2.Al_2Cl_6$, is first formed, and that this is subsequently converted by the hydrocarbon into the compound of aluminium chloride and the ketone, $(R.CO.R)_2.Al_2Cl_6$, with elimination of hydrochloric acid. Under the conditions of the experiment this latter compound is dissociated into free aluminium chloride and the free ketone. That this explanation is very near the truth is demonstrated by the fact that by working in carbon bisulphide solution, M. Perrier has actually converted his new compound with benzoyl chloride, $(C_6H_5COCl)_2.Al_2Cl_6$, directly into the ketone compound, $(C_6H_5.CO.C_6H_5)_2.Al_2Cl_6$, by reacting upon it with benzene. The crystals of the ketone compound obtained were identical with those prepared from benzophenone itself.

WE regret that in announcing the birthday honours last week the name of Mr. Daniel Morris was printed "Mr. David Morris."

NOTES from the Marine Biological Station, Plymouth.—Last week's captures include the Actinian *Chitonactis coronata*, the Polychæta *Glycera capitata* and *Proceræa picta*, the Opisthobranchs *Candiella plebeia* and *Triopa claviger*, the Schizopod *Leptomysis mediterranea*, the Ascidian *Pycnoclavella aurilucens* and a number of *Amphioxus lanceolatus*. The character of the floating fauna has exhibited little change since the preceding week, Ctenophora and Leptomedusæ having been especially abundant. The following animals are now breeding: Various Serpulidæ, the Schizopoda *Schistomysis arenosa* and *Leptomysis mediterranea*, the Decapod *Crangon sculptus*, and the Ascidian *Botryllus violaceus*. The majority of *Amphioxus* also are full-grown and mature.

THE additions to the Zoological Society's Gardens during the past week include a Stair's Monkey (*Cercopithecus stairsi*, ♂) from East Africa, presented by Mr. F. Hintze; a Himalayan Bear (*Ursus tibetanus*, ♂) from Northern India, presented by Capt. Michael Hughes, 2nd Life Guards; a Maugé's Dasyure (*Dasyurus maugæi*) from Australia, presented by Mr. Robert Hoade; four South Island Robins (*Miro albifrons*) from New Zealand, presented by Capt. Edgar J. Evans; two Carrion Crows (*Corvus corone*), British, presented by the Hon. Wm. Edwardes; a Rose-crested Cockatoo (*Cacatua moluccensis*) from Moluccas, presented by Mr. J. B. Sutherland; a Herring Gull (*Larus argentatus*) British, presented by Miss M. A. Croxford; a Long-eared Owl (*Asio otus*), a Tawny Owl (*Syrnium aluco*), British, presented by Mr. Alan F. Crossman; two Horned Lizards (*Phrynosoma cornutum*) from Texas, presented by Mr. A. E. Jamrach; a Red-handed Tamarin (*Midas rufimanus*) from Surinam, a Yellow-footed Rock Kangaroo (*Petrogale xanthopus*, ♂) from South Australia, fourteen Horned Lizards (*Phrynosoma cornutum*) from Texas, four Tuberculated Iguanas (*Iguana tuberculata*) from the West Indies, deposited; a Malbrouck Monkey (*Cercopithecus cynosurus*) from West Africa, four Bronze-winged Pigeons (*Phaps chalcoptera*), two Australian Sheldrakes (*Tadorna tadornoides*, ♂ ♀) from Australia, four Green Waxbills (*Estrelda formosa*) from India, purchased; a Vervet Monkey (*Cercopithecus lalandii*), a Japanese Deer (*Cervus sika*, ♀) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

FINLAY'S COMET (1886 VII.).—The ephemeris of Finlay's comet for this week is as follows:—

12h. *M.T. Paris.*

1893.		R.A. (app.) h. m. s.		Decl. (app.) ° ′
June 15	...	1 45 47	...	+ 8 2 9
16	...	50 31	...	8 31·2
17	...	1 55 15	...	8 59·1
18	...	2 0 0	...	9 26 8
19	...	4 45	...	9 54·2
20	...	9 30	...	10 21·3
21	...	14 16	...	10 48·1
22	...	2 19 1	...	+11 14·5

DETERMINATIONS OF GRAVITY.—The Appendix (No. 15) of the report of the "United States Coast and Geodetic Survey for 1891" contains a set of determinations of gravity made with half-second pendulums on the Pacific coast, in Alaska, and at Washington, D.C., and Hoboken, N.J., under the superintendence of Mr. T. C. Mendenhall. On account of the difficulty and cost of a previous undertaking, the apparatus in the present determinations has been greatly reduced both in magnitude and complexity by using a pendulum vibrating to half a second and a chronometer in place of a clock. The pendulum apparatus consisted of a set of three-quarter metre pendulums, a dummy or temperature pendulum, an air-tight receiver in which the pendulums were swung, a flash apparatus, wherein an electromagnet in the circuit of a chronometer moves a shutter and throws out a flash of light each second, a telescope for observing, mounted above the flash-light apparatus and various accessories. The pendulums themselves constituted a set of three, so that discrepancies in any one of them, if they appeared, could easily be detected. Each was composed of an alloy of aluminium 10 per cent. and copper 90 per cent., a composition highly resistible to corrosion. The base station adopted was at the Smithsonian Institution in Washington, and the value assumed there for g was 980·10 dynes.

The following are the values of g as obtained at five places, a table given here including several other determinations:—

Station.	Lat. N. ° ′	Long. W. of Greenw. ° ′	Elev. above sea-level. Feet.	g at station. Dynes.	g reduced to sea-level. Dynes.
Washington, D.C.	38 53	77 02	34	[980·1000]	980·1020
San Francisco, Cal.	37 47	122 26	375	979·9507	979·9727
Seattle, Wash.	47 36	121 20	243	980·7116	980·7258
Mount Hamilton, Cal. Lick Observatory	37 20	121 39	4205	979·6456	979·8920
Hoboken, N.J.	40 44	74 02	35	980·2555	980·2576

SOLAR OBSERVATIONS AT THE ROYAL COLLEGE, ROME.—In the *Memorie della Società degli Spettroscopisti Italiani* Prof. Tachini communicates the observations of the sun made at the Royal College Observatory during the first trimestre of this year. The records of the protuberances during this period show that the monthly numbers were 138, 198, 264, a rapid increase, as will be noticed, the maxima heights being 1026″, 1149″, and 1650″ respectively for the same months. The mean altitudes increased also rather irregularly, 706″, 824″, and 1103″ being the numbers given. With regard to the spots, March contained the most numerous (358), being 94 more than January and 73 more than February. The number of groups for the first two months were, curiously enough, nearly equal (the numbers being 101 and 102), but the extensions were very different, 1968 and 2215 representing the numbers for the spots, and 870 and 1170 for the faculæ. The same number of these memoirs gives a summation of the solar observations made at the Royal Observatory at Palermo during the year 1892 by M. T. Lona and A. Mascari, and M. Abetti's observations of the conjunction of Mars with υ Tauri, and of Saturn with γ Virginis.

L'ASTRONOMIE FOR JUNE.—The opening article in this month's number contains a description of a very remarkable observation on Jupiter made by M. Lumsden on September 20, 1891. It seems that he has seen the shadow of the first satellite of Jupiter on the planet's surface, accompanied and followed by a second shadow, not so dark and sharp as the original satellite, but nevertheless very distinct and incontestable. This second shadow is said to have moved uniformly with the real one, following it at an equal distance. The observer seems to be very certain that it was not a spot, so the question is—How can this secondary shadow be explained? It was thought at first that as the other satellites were all on the same side of the primary it might have been one of their shadows, but the facts show that that was not the case. M. Lumsden suggested that perhaps it was the shadow of Satellite 1 cast by the light emitted by Satellite 4, assuming the fourth satellite to be self-luminous, but M. Flammarion's explanation is perhaps more simple, it being that since the atmosphere of Jupiter is very deep, the clouds would be at various depths, and at great distances from one another, so that sometimes the shadow of a satellite would fall either on the upper or on the lower clouds, or even on the disc itself. It is true that the distance between these shadows would be very small as seen from the earth, and in the actual observation here mentioned the distance between the shadows is comparatively large. Among other communications in the same journal we may mention M. Cornu's address on the discovery of minor planets by photography, M. Flammarion on the spring of 1893, some notes on the late total solar eclipse, and a brief reference to a proposed new astronomical station on Mount Mounier, at an altitude of 2800 metres.

GEOGRAPHICAL NOTES.

MR. F. G. JACKSON, whose proposed attempt on the North Pole by Franz Josef Land has been announced, has altered his plans. He now proposes to spend next winter in Nova Zembla, in order to familiarise himself with the conditions of Arctic life, and to test his sledges and other appliances for travelling over the ice. His more serious journey in Franz Josef Land has been postponed for a year, and will have a greatly increased chance of success.

VITA HASSAN, well known as Emin Pasha's apothecary in the Equatorial province, died recently. He had published a book on affairs in the Sudan, which throws some new light on the history of the Egyptian provinces before Stanley's expedition reached the Albert Nyanza.

A LADY traveller, Miss Taylor, of the China Inland Mission, has made a somewhat remarkable journey in Eastern Tibet, details of which will be looked for with much interest. Miss Taylor, who travelled alone, is expected soon to arrive in this country.

A GEOGRAPHICAL Club has recently been established in Philadelphia, which practically constitutes a new geographical society. It has published the first number of a bulletin containing a paper by Mr. E. S. Balch on mountain exploration, in which he endeavours to redeem mountaineering from the charge of being only a dangerous pastime.

THE coral reefs of Dar-es-Salaam, on the east coast of Africa, have been carefully studied by Dr. Ortmann, whose observations extend considerably our knowledge of fringing reefs.

THE ROYAL SOCIETY SOIRÉE.

THE President of the Royal Society received a brilliant company at the Society's rooms on the occasion of the annual ladies' *soirée* on June 7. Many of the exhibits were shown at the *conversazione* of May 10, and were noted in NATURE of May 18. Other exhibits are described in the following account:—

Mr. C. J. Woodward exhibited a bar over a resonance chamber illustrating sound interference. When a ventral segment is over the box a loud deep tone is heard. When the bar is placed so that a node is near the centre of the opening to the box no sound is heard, owing to opposite movements of the bar on either side of the node.

The Karakoram Mountain Survey Expedition exhibited Water-colour Drawings of the scenery of the Karakoram Mountains, Kashmir, India, by Mr. A. D. McCormick. These drawings were made at altitudes of from 15,000 to 20,000 feet, during the Expedition in 1892.

Prof. Osborne Reynolds, F.R.S., exhibited an illustration of vortex motion showing motion analogous to vortex rings in fluids.

Prof. Thorpe, F.R.S., exhibited autotype enlargements from photographs taken by himself, illustrative of the recent African Eclipse Expedition. The enlargements portrayed—(1) the eclipse party; (2) the observing party at Fundium, Senegal—taken immediately after the eclipse; (3) the duplex coronagraph; (4) the prismatic camera; (5) the integrating photometer; (6) the equatorial photometer.

Capt. McEvoy exhibited the hydrophone. This, in connection with a new instrument named a kinesiscope, is intended to be used at night, or in foggy weather; it has for its object the prevention of surprise attacks from torpedo-boats, or other hostile vessels, approaching anchorages, or mine-fields. It will give warning of their movements when they are several miles distant by ringing bells, flashing lights, &c. These signals in every case are verified by telephones in the circuit. The apparatus, which is electrical, may also be employed to warn vessels off dangerous points of the coast.

Dr. John Gorham exhibited a reflecting kaleidoscope, which is a new instrument adapted to produce not merely symmetric patterns of beauty, but to exemplify many of the theories in optics connected with the reflections of light. To do this changes in its construction are required to adapt it to its novel uses. The two mirrors, for instance, must be thrown open to admit the light upon them and the objects. The objects themselves must have a definite shape to cause them to reflect oblique rays of light only, while the light again must fall upon them from above, instead of being transmitted through them from below. These objects consist of strips of card bent backwards and forwards into hollows and elevations, upon which the light falls obliquely. It is then received upon the mirrors and reflected from them to the eye. Experiments were made to show:—(1) Gray tones from oblique white surfaces; (2) tints and shades of colour from oblique coloured surfaces; (3) depth, intensity, and brilliancy by repeated reflections; (4) the choice lustre, &c.

Mr. Edwin Edser exhibited an apparatus to illustrate Prof. Michelson's method of producing interference bands. Light is allowed to fall on a mirror thinly silvered, so that about half of the light is reflected and half transmitted. The two rays pursue paths which are mutually perpendicular, are reflected back by two ordinary mirrors, and on meeting interfere. The interference bands can be projected on a screen, and this fact together with the simplicity of the arrangements will make the method very useful for lecture illustration.

Mr. W. A. Shenstone and Mr. M. Priest exhibited an apparatus used for studying the action of the electric discharge on oxygen. A known volume of oxygen at known temperature and pressure is exposed to the "glow" discharge at known difference of potential. The change of pressure is read by a mercury manometer, and from this the proportion of ozone is calculated. The use of the mercury manometer, hitherto impossible, makes this method very accurate, and by means of it our knowledge of the influence of various conditions (such as difference of potential, rapidity of discharge) has been considerably extended. It is found that under equal conditions a coil is more effective than a "Wimshurst" or "Voss" machine. The using of mercury in the manometer is made possible by protecting it from the ozone by placing a rod of silver in the tube connecting the ozone generator and the manometer.

Mr. Percy E. Newberry was in charge of an exhibit by the Egypt Exploration Fund (Archæological Survey). The exhibit included water-colour drawings executed by the artists of the survey—Mr. Percy Buckman, Mr. John E. Newberry, and Mr. Howard Carter—during the past season, 1892–3. (1) Sketches of various sites visited by the officers of the survey, including views of Tell el Amarna, Sheikh Said and Dêr el Gebrawi. (2) Specimens of facsimile drawings of wall paintings from ancient tombs in the provinces of Minieh and Assiut (VI. and XII. dynasties, B.C. 3800 and B.C. 2500).

Lord Kelvin, Pres. R.S., exhibited illustrations of the molecular tactics of a crystal. (1) Bravais homogeneous assemblage of 512 single points. (2) Two homogeneous equilateral assemblages of points, red and green, with stretched springs between each point of the green assemblage and its nearest neighbour, and four struts between each of the reds and its nearest neighbour of the green assemblage; showing how any degree of resistance to compression with given rigidity can be provided for by Boscovich's theory. (3) Three-dimensional netting, analogous to the ordinary hexagonal netting of two dimensions. The stretched cords of this model are exactly in the positions of the struts of model No. 2. (4) Twelve nearest and eight next-nearest neighbours of an ideal particle at the centre of a cube, placed to show the cubic arrangement of an equilateral assemblage. (5) Cubic cluster of fourteen balls, being the least number which can show cubic form in an equilateral assemblage. (6) Probable molecular structure of Iceland spar. (7) Illustrating the molecular movement in the twinning of Iceland spar by knife according to Baumhauer. (8) Illustrating Baumhauer's artificial twinning of Iceland spar by knife. (9) Tetrahedron with adjustable edges (six independent variables). (10) Two geometrical models of:—(*a*) A dextro-chiral crystal. (*b*) A levo-chiral crystal. (11) Special tetrahedron, with perpendiculars from corners to faces, meeting in one point; to illustrate engineering of Boscovich's theory for an incompressible elastic crystal with 12 arbitrarily given rigidity moduluses.

Dr. G. H. Fowler exhibited specimens of oyster shells. The specimens illustrate:—(1) The rate of growth of the oyster. (2) Natural varieties of the shells. (3) Modifications of a variety bred under new conditions.

Prof. T. McKenny Hughes, F.R.S., exhibited abnormal and normal forms of oyster shells. The collection included oyster shells, showing the great variety of abnormal forms produced by accidental change in the position of the shells during growth, and also a selection of oyster shells, showing that among recent shells of *O. edulis* most of the forms occur which are considered of specific value in fossils.

The Joint Eclipse Committee exhibited the following photographs taken during the recent Eclipse Expeditions to West Africa and Brazil. (1) Photographs of the corona, taken in West Africa. (2) Photographs of the spectra of the corona and prominences, taken in West Africa. (3) Photographs of the corona, taken in Brazil. (4) Photographs of the spectra of the corona, and prominences, taken with the objective prism in Brazil. (5) Photographs of the stations.

Mr. W. H. Preece, F.R.S., exhibited submarine borers and specimens of submarine cables damaged by them. The *Xylophaga* and *Limnoria terebrans* have proved serious and expensive depredators in tropical seas, but while twenty years ago limnoria was practically unknown in our English waters, it has now gradually spread all around our coasts, and cables have to be served with brass tape to be protected from its attacks. Some stones pierced by *Saxicava rugosa* were also shown. They came from the Plymouth Breakwater. Several specimens of damaged cables from different parts of the world were exhibited.

The Zoological Society of London exhibited (1) a series of living Canadian walking-stick insects (*Diapheromera femorata*), hatched from eggs laid in the Society's insect-house in 1892. The "Walking-sticks" are orthopterous insects of the family Phasmidæ, so-called from their resemblance to sticks. They are strictly herbivorous, and closely imitate the plants upon which they feed, changing colour as the foliage turns in autumn. In North America the present species is said to do great injury to the oaks. These specimens are fed on hazel-leaves. (2) Living specimens of the Hornet Clearwing Moth of the Osier (*Sesia bembiciformis*), reared from pupæ in the Society's Insect-house. This moth affords one of the best known examples of "*mimicry*." Although belonging to quite a different order of insects, it resembles a hornet so closely as to deceive a casual observer, especially when it is on the wing.

Col. Swinhoe exhibited some species of butterflies, illustrating protective mimicry. Mimetic forms of the nymphalid genus Hypolimnas in India, Malayana and Africa, showing the various phases of development of mimicry in two widespread species of the same genus; also mimetic resemblances to different protected species in the females of *Euripus halitherses*, &c.

Prof. H. G. Seeley, F.R.S., exhibited fossil skulls from the Karoo Rocks of Cape Colony. These specimens were brought from Cape Colony by the exhibitor in 1889. They include examples of the chief types of fossil reptiles included in the Anomodont and Theriodont groups, preferable to the genera Dicynodon and Tapinocephalus.

Mr. Edward Whymper exhibited the Corry "protected" aneroid, a new form of aneroid, specially designed for use in mountain-travel, or for aeronauts. This form of mountain aneroid is designed to avoid the inaccuracies which result from continued exposure to low atmospheric pressure. It is enclosed in a perfectly air-tight outer case, and the internal atmosphere is kept at about a normal pressure at all times, except when an observation is to be taken, and then the cock is opened, and communication with the external atmosphere is established. After taking a reading, the pressure is restored to the normal by means of a small force pump. The conditions thus correspond to those which originally obtained, when the aneroid was graduated under the air-pump receiver.

Mr. J. W. Swan exhibited specimens of electrolytic copper, deposited bright. A series of electrolytic copper deposits, showing the great change produced in the character of the deposited metal by the addition of a minute quantity of colloid matter to an acid solution of sulphate of copper. The deposits produced from the solution containing the colloid are not only bright instead of being dull, but they are also very much harder and more elastic than ordinary electrolytic copper.

Prof. Henrici, F.R.S., exhibited (1) A harmonic analyser, constructed by G. Coradi, Zürich, according to instructions by Prof. Henrici and Mr. Sharpe. The instrument gives, on going once over a curve, the first five terms of the expansion in Fourier's series, and on going twice more over the curve, it gives five additional terms. The constant term is not given. (2) A calculating machine by Prof. Sellinger, constructed by Ott, Munich. This instrument is constructed on altogether new principles. The "carrying" is done continuously without jerks. It works very rapidly and smoothly.

In addition, Prof. J. Norman Lockyer, F.R.S., gave a lecture on the localities and instruments used during the eclipse of April 16, 1893, in West Africa and Brazil, with photographs showing some of the results obtained.

Mr. W. M. Conway also used the electric lantern to show photographic lantern slides, illustrating the scenery of the Baltoro Glacier in the Karakoram Mountains, Kashmir, India. The photographs were taken during Mr. Conway's climbing and survey expedition in 1892. Some of them were taken from the summit of the Pioneer Peak (22,500 ft.); the remainder represent the great mountains K2, Gusherbrum, Masherbrum, the Golden Throne, and others, probably the highest group of mountains in the world.

At intervals throughout the evening Mr. W. Bayley Marshall exhibited the lantern-stereoscope (invented by Mr. John Anderton). The images of a pair of stereoscopic transparencies having been superposed on a 10-foot screen, the beams of light from the two lanterns were polarised in planes at right angles to each other. The picture was viewed through a pair of analysers, similar to a small opera glass, and a true stereoscopic effect was obtained.

THERMOMETER SOUNDINGS IN THE HIGH ATMOSPHERE.

THE project, which was suggested by Le Verrier in 1874, of sending small balloons into the upper atmosphere with registering apparatus has been executed recently by M. Hermite, in Paris, with remarkable success. No fewer than thirteen small balloons, constructed with paper and varnished with petroleum, were liberated during the last four months of 1892, and penetrated to an altitude of 9000 metres. A paper balloon of 60 cubic metres capacity was sent up on December 7, but exploded at a small distance from the earth. It was therefore resolved to build a balloon of 113 cubic metres capacity in gold-beaters' skin. The launching of this balloon took place on March 21 last, at Vaugirard, with the help of the Aerophytic Union of France, of which I have the honour to be the president. The balloon was filled with 113 cubic metres of coal-gas. Its weight with netting was about fourteen kilograms. It carried in a small basket a Richard registering apparatus for temperature and pressure, and about seven hundred postal-cards, to be liberated by the combustion of a cotton string specially prepared for the purpose. This part of the operation utterly failed. Although the fire was put to both extremities of the string, it was extinguished before all the cards had been sent down, and out of four hundred which were precipitated, no more than five or six were recovered. Thus, the hope of determining the path by dropping such objects from an immense height had proved futile. But the recovery of the balloon at 190 km. from Paris was very easy, and the registering apparatus was returned to its owner in excellent working order. The diagram, which had been traced on the revolving cylinder, has been submitted to a close inspection, of which the results have been published in the *Comptes Rendus* and *l'Aerophile*, a new periodical devoted to the study of aeronautics.

The registering of the pressure had been continued down to 95 mm. of mercury, which answers to something less than 17,000 metres, if Laplace's formula is valid even for this altitude. A temperature had been registered of $-51°$ C. $= 60°$ below zero Fahr. at a level of about 14,000 metres, according to the same formula. The temperature on the ground being $+17°$, a diminution of $67°$ C. was thus found, which is about a degree for each 210 metres. The atmosphere being supposed to extend up to 180,000 metres, it is easy to see that these numbers are an indication that the cold of the upper regions is much greater than supposed according to Fourier's theory, which asserts that the greatest degree of cold observed at the surface of the earth, viz. 58° registered by Black in Northern America is about equal to the temperature of celestial space.

This remarkable observation is not however to remain long isolated, as Commander Renard, of Meudon, has built a set of registering apparatus, which were exhibited recently at the anniversary meeting of the *Société de Physique*, and will be sent up very shortly with a 113 c.m. balloon inflated with pure hydrogen. So a new departure may be said to have been taken for the scientific exploration of the air at an altitude where no human being can penetrate. The series of prizes proposed by M. Hodgkins for 1893 and 1894, and the creation of the Hodgkins medal by the Smithsonian Institution, certainly add new interest to these experiments.

M. Janssen intends to establish an apparatus for making pure hydrogen in the Meudon Observatory in order to help M. Hermite to send his sounding balloons to a higher level if possible. He will, moreover, try to measure by direct observation the altitude of the balloons sent, as long as they remain visible from his Observatory.

This last scheme was adopted by Le Verrier, who says in the *Bulletin de l'Association Scientifique de France* for October 1874: "La hauteur du ballon est toujours déduite de la mesure du baromètre et du thermomètre, au moyen d'hypothèses sur la repartition de la pression atmosphérique. Il s'agit d'écarter ces causes d'incertitude, et de mesurer directement par des opérations trigonométriques la hauteur même du ballon; ce qui permettra de vérifier les lois admises ou de les modifier. Les opérations trigonométriques à terre seront faites par les astronoms de l'observatoire sur le charge de cette partie des dépenses. La direction de l'aerostat fourni par l'observatoire est confiée à M. W. de Fonvielle." The protracted illness of the illustrious astronomer and his subsequent death, prevented the series of ascents from being tried as contemplated.

The experiments already tried by M. Hermite, namely, on March 3, prove that the balloon will remain long visible from an Observatory, if the ascent is executed on a clear and calm day with a considerable ascending force, which gold-beater's skin can support without being torn by the friction.

The ascent of March 21, when ordinary gas was employed, took place with such velocity that the balloon was seen always nearing the zenith, independently of the diverging direction of the air, the mean recorded velocity having been eight metres per second from the time of starting to the time of maximum, which was reached in three-quarters of an hour, according to the automatic barometer.

The inflating pipe (*appendice*) which the balloon carried with it, was 30 cm. diameter and 90 cm. long, and air took the place vacated by the retreating gas, when the balloon descended. Consequently it was found quite full when discovered, just the same as when the balloon was liberated. The only differenec was that the gas had been expelled and replaced by air.

Since the volume of the balloon remained quite constant during the whole of the operation, it would have been quite easy to determine the absolute distance from the observatory by measuring the apparent diameter with a micrometer. By taking simultaneously a reading of zenith distance and azimuth, it would have been quite easy, by a series of observations conducted from a single station, to ascertain the altitude of the balloon and every circumstance of its motion.

The principal object of M. Janssen will be to determine the absolute minimum of temperature at the maximum altitude, which can be done more or less precisely, and the direction or velocity of the winds blowing at different altitudes. Then the indications of the registering instruments can be submitted to the rational control which is necessary before coming to any definite conclusion.

It is interesting to notice that these preliminary results are in conformity with the Joule and Clausius theory, which asserts that celestial space is at the temperature of $-273°$ C., or even with the opinion that there is no limit to the refrigeration, as asserted by other natural philosophers.

Another question is raised by these experiments, when coupled with Dewar's and Cailletet's discoveries relating to the liquefaction or solidification of the elements of the air. If the temperature descends to such a degree it is necessary to admit that the air loses its gaseous condition and becomes changed into a series of minute crystals or drops, which follow the earth in its motion through space, and are constantly vapourised when falling in regions where the temperature is somewhat above their point of liquefaction or evaporation.

Such are some of the questions raised by this new exploration of elevated regions, rendered very easy by the unexpected facility with which balloons and instruments in working order are recovered. This has been rendered possible in France by the interest taken in the matter by public schoolmasters, who have been notified of the experiments by the newspapers, and have found special instructions printed on a paper pasted to the basket. It is certain that similar results may be obtained in every civilised country in the world, and we trust this new method will develop and improve so that unquestionable facts will be discovered with regard to the mysterious cosmical frontiers of our globe.

W. DE FONVIELLE.

DISINFECTANTS AND MICRO-ORGANISMS.

SOME important results have recently been obained by Heider, who has been experimenting with disinfectants at higher temperatures and testing the effect produced upon their bactericidal properties. The author's first contributions in this direction were published in 1891. In Heider's original communication, "Ueber die Wirksamkeit von Desinfektionsmitteln bei höherer Temperatur" (*Centralblatt für Backteriologie*, vol. ix. 1891, p. 221), temperatures of 55° and 75° C. were employed, and the spores of anthrax were selected for investigation. Although these spores, it was ascertained, survived an immersion during 36 days in a 5 per cent. solution of carbolic acid kept at the ordinary temperature of the room, they were destroyed in from one to two hours in a similar solution at 55° C. Weaker solutions of this acid (1 per cent. and 3 per cent.), even when maintained at the higher temperature for seven and eight hours, produced no effect upon the anthrax spores. On the temperature being raised to 75° C., however, three minutes' exposure to a 5 per cent. solution of carbolic acid, fifteen minutes to a 3 per cent. solution, from two to two and a half hours to a 1 per cent. solution sufficed to annihilate these spores. Other materials were also investigated at these high temperatures, and equally satisfactory results obtained. Heider has brought together all his researches on this interesting subject in an elaborate memoir, "Ueber die Wirksamkeit der Desinfectionsmittel bei erhöhter Temperatur," which has been published in the *Archiv. für Hygiene*, vol. xv. p. 341. It is pointed out how great an effect upon the powers of resistance possessed by micro organisms may be exercised by the nature of their surroundings, and that it may be taken that they are, as a rule, more refractory in their normal environment than when purposely introduced into various materials. This has been shown by Yersin, in respect to the tubercle bacillus, which succumbs more readily to certain temperatures when exposed in artificial cultures than in sputum. Heider also found that particular culture media had a remarkable effect in this respect upon bacteria, that, for example, those grown in sugar broth (3 per cent. cane sugar) proved far more capable of resisting exposure to a high temperature than those introduced into ordinary broth. In conclusion, it having been distinctly proved that the bactericidal action of the majority of disinfecting materials is markedly increased when they are employed at a higher temperature, the author recommends that in all those cases where the destruction of spores is required, instead of applying these materials in cold solutions, they should be employed hot, or even boiling. The advantages derived by so doing are not alone the greater security obtained and saving of time, but economy in the cost of material, inasmuch as effectual sterilisation may be accomplished by the use of less concentrated solutions.

THE NEW FLORA AND THE OLD IN AUSTRALIA.

A VERY interesting paper on the effect which settlement in Australia has produced upon indigenous vegetation, by Mr. A. G. Hamilton, appears in the new number (vol. xxvi.) of the "Journal and Proceedings of the Royal Society of New South Wales." Mr. Hamilton traces with great care the results which have sprung from the direct action of man. He then deals with the alteration of the flora by the introduction of a new fauna, and the modification of it by the destruction of the native fauna. Finally, he considers the introduction of a new flora, and the consequent modification of the indigenous flora through competition.

The following is the portion of the paper relating to the effects due to a new flora:—

The plants which have become naturalised in Australia naturally come under two headings, viz. those purposely introduced for use, ornament or sentiment, and those which accidentally found their way here.

Of those introduced for use or for ornamental purposes, a large number do not spread to any extent: they are children of civilisation and show no tendency to become feral. Many hardy annual garden flowers come up self-sown in gardens year after year and yet never gain a footing outside. Others again, which have the power of spreading rapidly, are never able to do so, as they are succulent feed, and cattle take care that they never multiply. Such are oats and other grains. Wheat never seems to spread at all away from the fields in which it is cultivated. But still there are numbers of useful plants which are able to hold their own and more. Among these may be mentioned the lemon, peach, Cape gooseberry, tomato, and passion fruit, all of which are wild in many parts of the Illawarra district, and continue to bear fruit. Another species of passion flower (*Passiflora alba?*) is common there and is even more plentiful than the edible species. It is bitter and nauseous, but has spread over large tracts of bush country, converting them into tangle of the densest description. The common bramble or blackberry has been introduced for the sake of its fruit, and is now beginning to be a troublesome tenant of unoccupied lands in the cooler parts of the Colony. It reaches a development far exceeding that attained in its native land.

Sweet-briar and Scotch thistles are said to have been introduced for the sake of the associations clustered round the plants in the mother country. The latter plant is reported to have been introduced into Tasmania by a patriotic Scotchman desirous of having his national plant growing near his new home. He appears by all accounts to have succeeded only too well.

But with regard to most introduced plants, there is much difficulty in discovering the method of introduction. The plants which habitually flourish in European cornfields are certainly easily accounted for—they came in the seeds imported to the Colonies. Such are corn marigold, corn spurrey, and many of the Caryophylleæ, the cornfield poppy and numerous others which will occur to every one. Then again, many noxious weeds growing among grain, were introduced to Australia in straw in packing cases. Such are the Centaureas and others. As an example of this I may note that *Bupleurum rotundifolium* first appeared in the Mudgee District in a yard where a box from England was unpacked.

But with many plants introduced, we can only reason by analogy as to the manner of their introduction. In an article on the weeds of Europe in the *Cornhill Magazine*, an anonymous writer states that a common English weed was introduced into an Antarctic island by the use of a spade which had some mould attached to the blade, and the plant has now spread all over the island. Darwin gives instances of seeds being found in balls of clay attached to the feet of birds, and even to the elytra of beetles. Still, the method of introduction of many foreign weeds must in the nature of things always remain more or less of a mystery. Many aliens have arrived in the colony attached to the wool of sheep or the hair of other animals as in the case of the Bathurst Burr—a species of vegetable stowaway.

As to the methods of spreading, they are various. Cultivation of the soil brings the weeds in its wake, and they manage to spread somehow. Some have specially constructed seeds to float through the air—any one who has seen thistle-infested country on a windy day will have a good idea how thistles spread. The Composites are especially rich in plants adopting this contrivance. Others stick to the wool and hair of animals by hooks, barbed hairs, or sticky glands. Others again have seeds so minute that a high wind will carry them, although they are not furnished with special apparatus for the purpose.

Railways and roads are active helpers in the dissemination of aliens, especially the former. The land being fenced in is protected from the depredations of stock, and thus protected the weeds flourish and spread rapidly. In 1887 I remember noticing on the Mudgee Railway near Lue that there were miles of the embankments one tangled mass of *Meliotus parviflorus*. And in the neighbourhood of Bowenfels the railway line enclosures are thickly covered with a species of *Hypochæris*: it is pretty plentiful outside but inside the land is a golden sheet of the yellow flowers. Rivers also act in the same way, and especially carry weeds when in flood and deposit them on the flooded lands. I first noticed *Ranunculus muricatus* and Fool's parsley on the river banks at Mudgee. The following year they had reached Cullenbone, and the next year had got as far as Guntawang, a distance of seventeen miles by road but at least twenty-five or thirty by the river. A curious instance of the spread of a plant from one locality to another was afforded me in 1886 and 1887. During a journey from Guntawang to Wellington, a distance of forty-two miles, I noticed at Wellington, on the river banks, great quantities of *Cassia sophora*. At that time none of the plant was found in the Mudgee District, but in the same year a mail coach commenced running from Wellington to Gulgong passing through Guntawang. The following year, two plants of the *Cassia* appeared at Guntawang, and soon after it began to be common in the district. The Rev. Dr. Woolls, at a meeting of the Linnean Society of N.S. Wales, in September 1890 exhibited plants of *Calotis scapigera* and *C. hispidula* from Concord and Burwood. These are strictly denizens of the interior and were probably brought down by sheep travelling to the sale yards. Indeed I feel pretty sure that an examination in the neighbourhood of the Homebush sale yards would show that many western plants are brought down by the sheep, etc. In collecting introduced plants, I have always been most successful by roadsides, riverbanks, and railway enclosures, and there can be no doubt but that they are the principal lines of travel for these plants.

The plants which have edible fruits containing indigestible seeds are for the most part dispersed by birds and mammals which eat the fruit and void the seeds in new localities. In this way passion fruit, blackberries, *Phytolacca*, tomatoes, solanums, Cape gooseberries, and many others are distributed.

It is a significant fact that horehound—*Marrubrium*—is always plentiful in the vicinity of a sheep station. Two other plants commonly found in the same situation are the introduced nettles, *Urtica urens* and *U. dioica*, whether from the plants being eaten by the sheep and the undigested seeds voided, or because that in sheep-manured land they find a congenial soil, I am unable to say.

Australian plants from their long isolation, and their having little competition of a severe kind, settled down into a state of balance or rather of slight oscillation, governed by a few causes, which themselves varied but little. In the older continents, however, from the intercommunication of the various nations, and from the fact that men continually add to their stock of cultivated plants, there is severe competition; the struggle for existence goes on continually and aided by natural selection and domestication some plants gain an advantage.

Among other, useful habits acquired by plants under competition is a certain plasticity of constitution which enables them to bear changes to different climates with equanimity. On this account the old world weeds when brought to Australia are able to beat the native plants. They are mostly plain dwellers, and as such accustomed to the heat of the sun in the open, and the bitter blasts of the winter, better than forest plants. When forests are cleared and brought under cultivation, the weeds soon beat the former occupants out of the field. Again many old world weeds are plants of wide range, and on this account have an advantage over those of more restricted habitat.

"Widely varying species abounding in individuals which have already triumphed over many competitors in their own widely extended homes, will have the best chance of seizing on new places when they spread into new countries. In their new homes they will be exposed to new conditions, and will frequently undergo further modification and improvement; and thus they will become still further victorious and produce groups of modified descendants." ("Origin of Species," 6th ed. p. 319.) As before remarked their success in competition implies a plasticity of organism which is an advantage to them also; on this subject Darwin says, "If a number of species, after having long competed with each other in their old home, were to migrate in a body into a new and afterwards isolated country, they would be little liable to modification or variation; for neither migration nor isolation in themselves effect anything." (*Op. cit.*, p. 319.) The isolated productions of Australia on the other hand, have had uniform conditions and comparatively small range and so they cannot make way against those that have had such competition and range.

"In the same manner at the present day, we see that very many European productions cover the ground in La Plata, New Zealand and to a lesser extent in Australia and have beaten the natives, whereas extremely few southern forms have come to be naturalised in any part of the northern hemisphere, though hides, wool and other objects likely to carry seeds have been largely imported into Europe during the last two or three centuries from La Plata, and during the last forty or fifty years from Australia." (*Op. cit.*, p. 340.) Wallace says, "There is good reason to believe that the most effective agent in the extinction of species is the pressure of other species, whether as enemies or merely as competitors." ("Island Life," p. 63)

It is well known that few Australian plants have found a footing in Europe notwithstanding the many facilities which commerce offers for their introduction, and the few American weeds which have found their way to Europe do well only in the Mediterranean region. Even in New Zealand but a few Australian plants have become naturalised, as is shown by Mr. T. F. Cheeseman's paper on the naturalised plants of Auckland (read before the Auckland Institute, November 1892).

In America, the majority of introduced weeds are European, though at first they completely beat the natives, it is noteworthy that now the natives are holding their own, and even beating the strangers, thus showing that competition has gone on long enough for some advantage to be gained by the natives. It is remarkable too that the plants of Eastern America immigrated westward with man, and conquered the western plants at first; but from a consideration of the facts the great American botanist Prof. Asa Gray was led to prophesy a return wave of western plants, and that is now actually coming.

The theory that insulated floras are less able to resist the influx of foreign plants is supported by the fact that only in the Neilgherrie Mountains in India have Australian plants been able to compete with others to any extent. It is, I believe, considered that that part of India long existed as an insular region. Therefore we see that the Australian flora, which though isolated, had a large range, is able to get an advantage over the Neilgherrie flora which was for so long developed in a small centrum.

One cause of the power of spreading of what are commonly called weeds is that they are usually plants with inconspicuous flowers, and as such are generally self-fertilised and so can get along without specialised insects to fertilise them. It is manifest that in a new country where the local insect fauna is being destroyed to some extent, the plants which have not to depend on insects for fertilisation will be the more likely to win. And even cross-fertilised plants seem to manage sometimes to find insects to perform that office for them. Moseley points out an instance in the following passage:—"The orange, lemon, and lime, which grow wild all over Tahiti do not appear to deteriorate at all in quality or quantity of fruit, although in the ferine condition. The fruit almost appears finer for running wild. . . . . Some native insect must have adapted itself completely to the blossoms of the orange tribe as fertiliser, so abundant is the fruit." ("Notes of a Naturalist on the *Challenger*," p. 524.) The same is the case in Australia, for although the orange does not seem to grow wild to any extent, lemons have made themselves at home in the Illawarra district. The flowers of the lemon and the native plant *Synoum glandulosum* are much alike in structure, and it may be that the same insect or insects fertilise them. These plants would be on equal terms in this respect, but the lemon from its wide cultivation has gained a power of bearing diverse conditions, which gives it a better footing. I may remark that *Synoum* is a common plant in Illawarra.

Among wind-fertilised plants are the grasses. The introduced species so far are not beating the natives. They are equal as far as regards fertilisation, but most introduced species are from cool temperate regions, and so the Australian species being warm temperate, are able to hold their own. The dying out of some Australian grasses is attributable to over stocking and close feeding and not to competition.

In considering the introduction of weeds in Australia there is a great difficulty viz. that it is hard in some cases to say whether c rtain plants are indigenous or alien. It is considered a safe rule to take all plants common in the colony in Robert Brown's time as truly indigenous, but as Brown only collected in the neighbourhood of Port Jackson, that course leaves some difficulty still. On this subject Baron von Mueller says in the preface to his "Census of Australian Plants" (1st Edit. 1882)—"The lines of demarcation between truly indigenous and recently immigrated can no longer in all cases be drawn with precision; but whereas *Alchemilla vulgaris*, and *Veronica serpillifolia* were found along with several European *Carices* in untrodden parts of the Australian Alps during the author's earliest explorations, *Alchemilla arvensis* and *Veronica peregrina* were at first only noticed near settlements. The occurrence of *Arabis glabra*, *Geum umbrosum*, *Agrimonia eupatoria*, *Eupatorium cannabinum*, *Carpesium cernuum*, and some others will readily be disputed as indigenous and some questions concerning the nativity of various of our plants will probably remain for ever involved in doubts." As will be seen from this, the origin of some plants will and must remain more or less a matter of personal opinion. And on referring to lists of plants of the various colonies it will be found that their authors differ in their placing of these doubtful plants. If we critically examine the Census of New South Wales plants by Mr. C. Moore, of Queensland plants by Mr. F. M. Bailey, of Victorian by Baron Von Mueller, and of New South Wales by Dr. Woolls, we shall find abundant evidence of diversity of views in this respect. But very many weeds present no difficulty at all, although the record of their plentiful occurrence in very early days may well surprise us. The Rev. J. E. Tenison-Woods ("Proc. Linn. Soc. of N.S. Wales," vol. iv., p. 133) remarks that Leichhardt found *Verbena bonariensis* so plentiful in the neighbourhood of Darling Downs, then only five or six years settled, that he named the place Vervain Plains.

The injury done by introduced weeds will be almost entirely by competition, but it is possible that in time, the Australian plants may begin to hold their own and even to some extent drive out the others. This will be more especially the case with the group of plants which are found on the barren and sandy tracts wherever the Hawkesbury Sandstone formation occurs. In such land few aliens get a footing. On the sandstone about Sydney as a rule, and in the Blue Mountains where the same soil occurs, the foreign weeds have no chance. But wherever the soil is fairly good, or where it has been broken up, there they triumph and exclude the indigenes.

To some, extent however, the weeds will work their own destruction. They increase so rapidly that competition is most severe, not between them and the natives, but between individuals of the same alien species, or between distinct alien species. *Sisymbrium officinale* was once a pest near Mudgee, the fallow and unoccupied land being covered with a thick mass of it; but after the lapse of a few years it became quite rare, and *Erigeron canadense* took its place. I think that in some cases the fact of a heavy crop of weeds occurring in a locality one or more years is a reason for expecting its scarcity in the following years. The soil becomes exhausted of the particular constituents demanded by the plants, and they fail in consequence. I had often read doleful prophecies of the damage that might be expected when the Cape weed (*Cryptostemma calendulaceum*) became common. When I first saw it appear in Illawarra, I was therefore prepared to see much land infested by it in a short time. It spread to a great extent in certain spots for a couple of years and then almost disappeared. In my garden half-a-dozen vigorous plants came up, and as I left them for the purpose of observation, they flowered and seeded plentifully. I fully expected a large crop the following year, but to my surprise not a single plant was to be found, nor has there been on

Mr. T. Kirk, in a paper on the naturalised plants of Port Nicholson, N.Z., says:—"At length a turning point is reached, the invaders lose a portion of their vigour, and become less encroaching, while the indigenous plants find the struggle less severe and gradually recover a portion of their lost ground, the result being the gradual amalgamation of those kinds best adapted to hold their own in the struggle for existence with the introduced forms, and the restriction of those less favourably adapted to habitats which afford them special advantages." (Trans. N. Z. Inst., vol. x., p. 363) And Mr. T. F. Cheeseman, from whose paper on the "Naturalised plants of the Auckland District" I have quoted the above, coincides with this opinion to some extent and says, "Speaking generally I am inclined to believe that the struggle between the naturalised and the native floras will result in a limitation of the range of the native species rather than in their actual extermination. We must be prepared to see many plants once common become comparatively rare, and possibly a limited number—I should not estimate it at more than a score or two—may altogether disappear, to be only known to us in the future by the dried specimens in our museums."[1] If this is likely to be the case in a territory so limited as New Zealand how much more is it probable in Australia with the vast extent of area, diversified surface and various climates from tropical to cold temperate.

[1] Paper read before the Auckland Institute, November 1892.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 9.—"On the Geometrical Construction of the Oxygen Absorption Lines Great A, Great B, and α of the Solar Spectrum." By George Higgs. Communicated by R. T. Glazebrook, F.R.S.

In the early part of August, 1890, the photographic work of the normal solar spectrum which I had undertaken had been carried as far as great A, or the limit of visibility in the red, and to λ 8350, or beyond z, in the invisible regions.

During the two previous months of continuously dull weather, while classifying and comparing results, I was interested, on making a close examination of the head portion of the A line, to find, the rhythmical grouping, the harmonic order of sequence, and other characteristics of the B line repeated here in every detail.

These two bands, together with alpha, are composed of a number of doublets or pairs, which approach each other on the more refrangible side with uninterrupted regularity, finally crossing, and at the limiting edges of all three bands the three last pairs overlap each other.

The differences of wave-length between the components of pairs increase in the same order.

These and other properties, which will be referred to, are still more obvious in the trains or flutings.

From its holding an intermediate rank in each of its distinguishing characters I was induced to adopt B as a typical group in a geometrical representation, and to investigate the subject by means of rectangular co ordinates.

FIG. 1.

Before a complete analysis could be made out, a micrometer had to be completed. This consisted of a platform, serving as a plate holder, which was made to travel on runners between parallel ways by means of a screw of such a pitch as to move the negative from one division of the scale to the next, for one revolution of the divided plate on the screw head, this latter being divided into 100 parts.

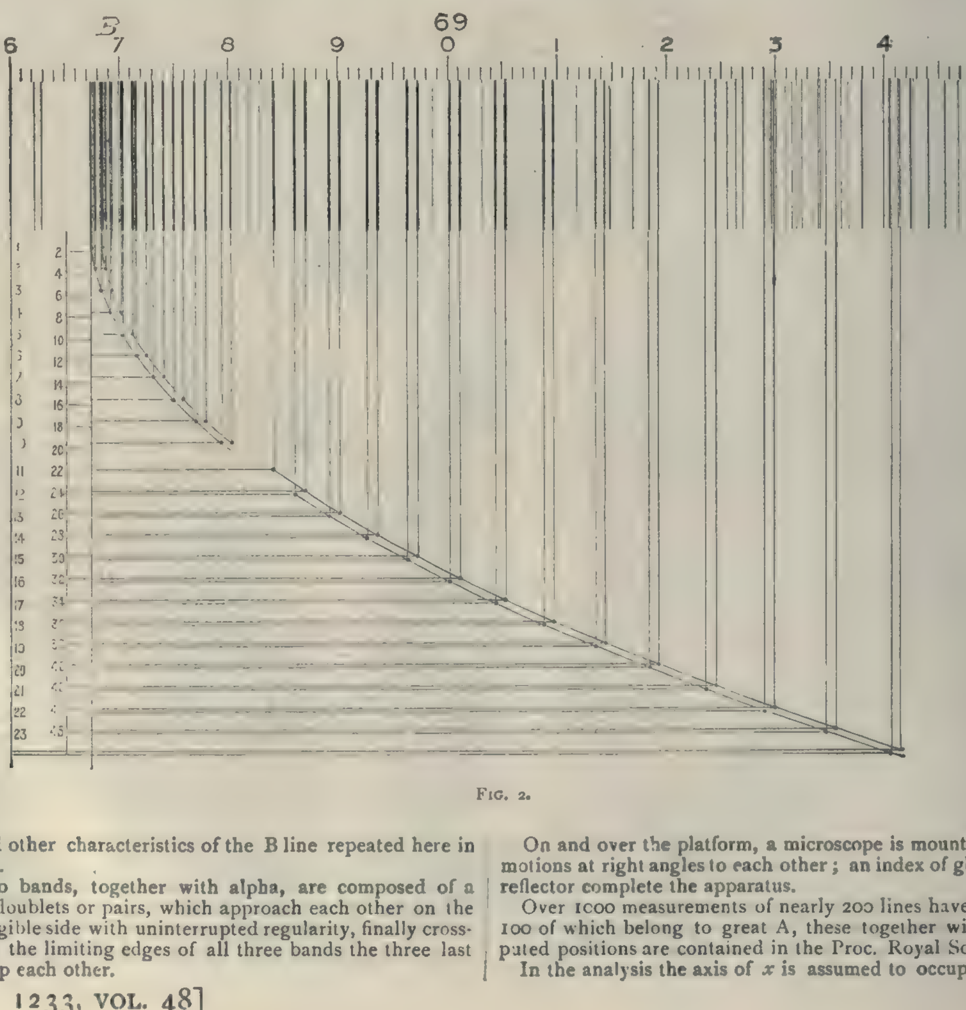


FIG. 2.

On and over the platform, a microscope is mounted with slide motions at right angles to each other; an index of glass fibre and reflector complete the apparatus.

Over 1000 measurements of nearly 200 lines have been made, 100 of which belong to great A, these together with the computed positions are contained in the Proc. Royal Soc.

In the analysis the axis of x is assumed to occupy a position coincident with, or parallel to, the scale of $1/10^{10}$ m. units, and the positions of the various lines are set off on this scale (see Fig. 2) for the group, which is divided into four series. Ordinates are then drawn in the position occupied by each line. The axis of y is divided into a number of equal parts, 1, 2, 3, n. Lines parallel to the axis of x, drawn from each of these divisions, intersect the respective ordinates. The continuous curve passing through the points of intersection is found to possess all the properties of a parabola.

Three points at least are selected to determine the position of the vertex and value of latus rectum. The distance from the origin along y is also found for an ordinate to the first line of a series.

Now, from the equation to the parabola $y^2=px$, the formula $\lambda = V + \frac{(n+c)^2}{p}$ is derived, where V = the wave-length in $1/10^{10}$ m. units of a point in the spectrum coinciding with the vertex of the curve; p, the latus rectum; n. any number of units, reckoning from the origin; c, a constant.

In practice a representation more suitable for lantern projection being desirable, two units are taken on y for each line of the series; the equation then becomes $\lambda = V + \frac{(2n+c)^2}{L}$, where $L = 4p$, and c has twice its former value.

April 20.—"Magnetic Viscosity." By J. Hopkinson, D.Sc., F.R.S., E. Wilson, and F. Lydall.

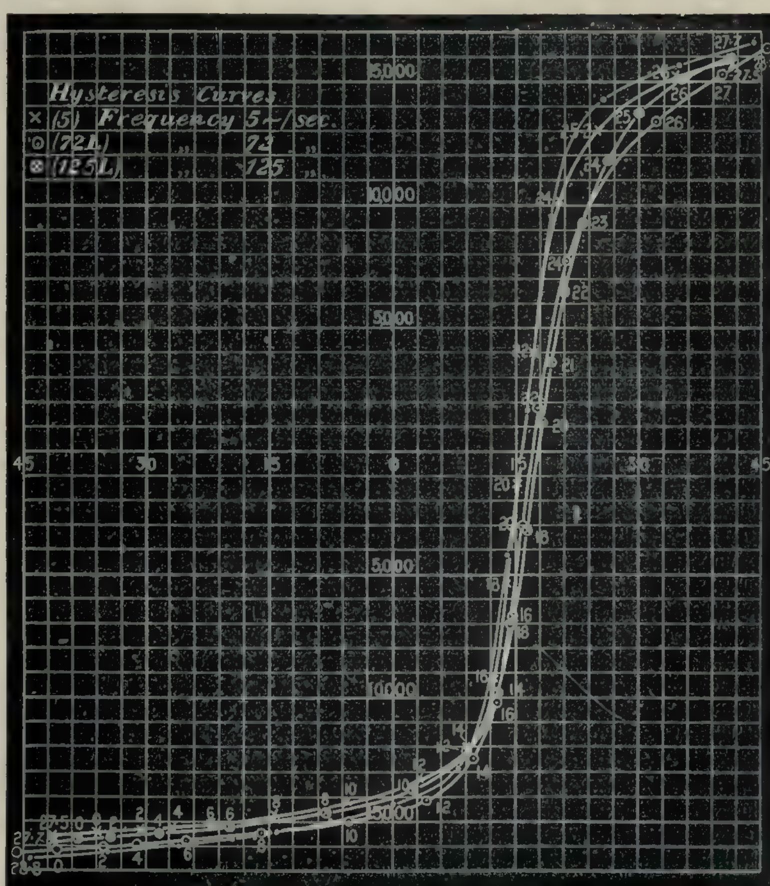
In some experiments carried out by Dr. J. Hopkinson and B. Hopkinson, an account of which appeared in the *Electrician* of September 9, 1892, it was found that when hysteresis curves were obtained for rings of soft iron and hard steel wire by means of alternate currents, and compared with curves taken with the ballistic galvanometer, in the cases where the induction was considerable, there was a marked difference which might be due to magnetic viscosity or to the ballistic galvanometer.

To settle this question the experiment was tried of completing the galvanometer circuit at known intervals of time after the magnetising force had been changed, and noting the deflection. The effect of the self-induction of the ring was approximately calculated, and found inadequate to account for the deflections obtained.

Next, the experiments previously alluded to were continued, and curves of hysteresis obtained with alternating currents of a frequency of 5, 72, and 125 v per second, the method of procedure being exactly the same. In all the curves thus obtained it was seen that the more rapid the change of magnetising force, the greater was the deviation from the curve taken with the ballistic galvanometer. The accompanying figure gives the hysteresis curves actually obtained, and show this point very clearly.

Similar experiments were carried out on hardened chromium steel, and the same effect was observed but was not so marked.

The following conclusions are drawn from the experiments:—(1) As Prof. Ewing has already observed, after sudden change of magnetising force the induction does not at once attain to its full value, but there is a slight increase going on for some seconds. (2) The small difference between the ballistic curve of magnetisation with complete cycles, and the curve determined with a considerable frequency which has already been observed is a true time effect, the difference being greater between a frequency of 72 v per second and 5 v per second, than between 5 v per second and the ballistic curve.



June 1.—"On the Metallurgy of Lead." By J. B. Hannay. Communicated by Sir G. G. Stokes, F.R.S.

In this paper the author deals with the result of seven years' researches on the metallurgy of lead.

It is shown that by repeated crystallisation any subsulphide of lead may be fractionated into metallic lead, and its monosulphide. The sp.gr. of pure monosulphide is found to be 7·766, and the methods of analysis are reviewed and corrected.

The reaction, $PbS + PbSO_4 = 2Pb + 2SO_2$, which was supposed to explain lead smelting, is shown to have no existence, as when lead sulphate and sulphide react upon each other, a volatile compound, PbS_2O_2 or $PbS.SO_2$, is formed which introduces complications, and being unknown to chemists was the cause of the errors in the accepted furnace reactions of lead.

This substance is formed whenever its constituents PbS, and SO_2, meet at high temperature, and is the cause of lead fume. Similar volatile compounds are formed by the gases CO_2, CO and H_2O. These bodies dissociate on cooling, but form colourless gases at a red heat.

All the furnace reactions of lead compounds are examined and corrected in the light of these discoveries, and the fact applied to explain the metallurgy of lead.

A new metallurgy is mapped out by which galena is treated in a Bessemer converter, and made into pig-lead, litharge, or sulphate of lead, in any proportions as may be desired, while all the silver is eliminated.

"Flame Spectra at High Temperatures. Part I. Oxyhydrogen Blowpipe Spectra." By W. N. Hartley, F.R.S.

The substances examined are supported in the oxyhydrogen flame on small plates of kyanite. This mineral contains ninety-six per cent. of aluminium silicate, and is practically infusible. The spectra were all photographed. The dispersion of the instrument being that of one quartz prism of 60°.

The spectra of a large majority of the metals and their compounds all terminate somewhere about the strongest series of water vapour lines in the ultraviolet. Typical non-metallic spectra are sulphur, selenium, and tellurium; the first yields a continuous spectrum with a series of beautiful fluted bands, the second a series of fine bands, occurring at closer intervals, and the third is characterised by bands still closer together and near the more refrangible termination of which four lines occurring in Hartley and Adeney's spark spectrum of tellurium are visible. Increase in atomic mass causes shorter periods of recurrence of bands. In line spectra it is the reverse; increase in atomic mass causes greater periods in the recurrence of lines. Charcoal and carbon monoxide yield chiefly continuous spectra; the latter, however, exhibits some carbon lines. The hydrocarbons yield the well-known spectrum of carbon bands with also those attributed to cyanogen. Of metallic elements, nickel, chromium, and cobalt yield purely line spectra; antimony, bismuth, silver, tin, lead, and gold beautiful banded spectra (spectra of the first order) accompanied by some few lines.

Iron and copper exhibit lines, and, less prominently, bands. Manganese has a beautiful series of bands and a group of three very closely adjacent lines. Aluminium gives a fine continuous spectrum with three lines, origin uncertain, zinc a continuous spectrum without lines, and cadmium a spectrum consisting of one single line only, λ 3260·2.

Of compounds, chromic trioxide yields a continuous spectrum with six lines belonging to the metal, copper oxide a fine band spectrum with two lines of the metal, magnesium sulphate gives a spectrum of magnesium oxide consisting of broad degraded bands composed of closely adjacent fine lines and one line belonging to the metal, λ 2852.

The sulphates of calcium, strontium, and barium give both bands of the oxides and lines of the elements. Phosphorus pentoxide yields a continuous spectrum with one peculiar line, seen also in the spectrum of arsenic.

The chlorides of the alkali metals give also lines of the elements with a more or less continuous spectrum, which, it is believed, is due to the metal in each case. Lithium chloride gives no continuous spectrum.

The Volatility of Metals.—One of the most interesting facts ascertained by this investigation is the volatility of all the metals examined, except platinum, and particularly the extraordinary volatility of manganese, and, to some extent, of the infusible metal iridium. Metal believed to be pure iridium is seen to have diminished after the flame has played upon it for about two hours.

Physical Society, May 26, Prof. A. W. Rücker, F.R.S., President, in the chair.—Mr. C. J. Woodward showed some experiments with a vibrating bar. On suspending the bar by two loops of cord, and placing it over a resonance box, the sound was greatly intensified. When placed crosswise, and partly over the box, a position could be found where no increase of sound resulted, whilst a little movement in either direction from this position caused a considerable increase.—The discussion on Dr. Lodge's paper, the foundation of dynamics, was then resumed. Communications on the subject from Mr. S. H. Burbury, Dr. G. Johnstone Stoney, and Prof. E. F. Herroun were read. Prof. Minchin said the first fundamental axiom of dynamics postulates the existence of *Force* as an entity distinct from *Matter*, *Space*, and *Time*, and this was the object of Newton's First Law. It also gave the criterion of the presence of force. To merely retain the law as defining *equal times* was to degrade it. As regards the supposed impossibility of defining uniform motion he said, similar difficulties occur in all sciences, even in geometry. Nevertheless a rational science of geometry existed. In dynamics we had notions of a right line and of uniform motion in it, although no criterion of either may exist. The fact that the science harmonises with ordinary experience constitutes its validity. In his opinion the extraordinary devices which had been suggested for defining directions fixed in space were unnecessary, and merely served to cover the subject with ridicule. He disagreed with Prof. Lodge in admitting the first law as a particular case of the second, for unless force was postulated (the function of the first law), the second became a mere definition, and not a law. Speaking of the third law he said the author had made a serious error in stating that it could be deduced from the first, for the centre of mass of a system might be at rest, without action and reaction necessarily being equal and opposite. The third law was not superfluous; neglecting it had led to great misconception and mystery about the Principle of Virtual Work, and D'Alembert's Principle, both of which are simple deductions from it. In opposition to Dr. Lodge, he defended the ordinary definition of Energy, and asserted that without the notions of *force* and *work*, the term *energy* loses all meaning. Speaking of transference and transformation of energy, he inquired if the proof given could be applied to the case of a body sliding down a rough rigid inclined plane, for here the stress (friction) does work on the body but not on the plane, and there was no transference. He regretted that the expression "potential energy" was used in different senses in the paper, sometimes meaning "static energy," and at others "the available portion of the kinetic energy of a body." Referring to the idea of all energy being ultimately kinetic, he asked if by accepting this the author meant to surrender the independent existence of force. If so, difficulties would arise; for example, in the kinetic theory of gases the expression for the pressure, $p = \frac{1}{3} \rho v^2$, was only arrived at by assuming the existence of force. The statement on the top of slip 9 about making a "moving body do work" was not necessarily true, as might be seen by considering the case of a sphere rolling down a rough inclined plane. Prof. O. Henrici thought axioms should be treated as true logical definitions, as for example in geometry, "two straight lines cannot enclose a space." Every new notion required its axiom. In passing from geometry to kinematics the idea of Time presented itself, and the appropriate axiom was contained in Newton's first law. On approaching dynamics Force and Mass were met with. He disagreed with Prof. Minchin in regarding force as most fundamental. Mass was more essential, for force might be abolished. On the other hand, he concurred with Prof. Minchin in thinking that the idea of a centre of mass was not axiomatic. Referring to Dr. Lodge's summary (NATURE, p. 62) he agreed with axiom (*a*) fully, and with (*b*) partially. Axiom 3 required further development. The crucial point, however, was axiom 4, "Stress cannot exist in or across empty space." This he regarded as very incomplete, and maintained that axioms defining the properties of the ether were necessary to further progress. If varieties of space be contemplated each advance required fresh axioms. Dr. C. V. Burton remarked that contact movement did not necessitate equal velocities; sliding motion was a case in point. Again, in deforming an incompressible fluid, although force and motion might exist, no work was done. Conservation could not be proved from denial of action at a distance. Speaking of the doctrine of transference and transformation of energy, he said it was a convenient working rule, but not true universally. Newton's laws were simple and consistent, but some doubt existed as to how much was definition and how much *law* or fact. Mr. Swinburne protested against the difference between theory and a working hypothesis being overlooked. All conceptions were based on experience, and ideas of ether and atoms derived from "jelly" and "cricket balls." We ought also to remember what "explanation" means, viz. describing the unfamiliar in terms of the more familiar. It was customary to describe the phenomena of fluids by reference to solids because we were more familiar with solids; an intellectual fish would probably do the reverse. The so-called "Theory of Magnetism" which breaks up a bar of iron into a number of small pieces, each possessing the properties of the original bar, he regarded as absurd. It was no "explanation" and not a "theory." Ether might be used as a working hypothesis, but must not be treated as an entity. Mr. Blakesley questioned whether transference of energy was always accompanied by transformation, and he did not see why energy should be looked upon as $(mv) \frac{v}{2}$, in preference to any other subdivision of the factors. As regards effects being proportional to their causes, he pointed out that the heating of an electric circuit, and thermoelectric action, followed laws not linear. Prof. S. P. Thompson, referring to the demonstration of the law of transference, &c., given on slip 8, said that attempts to translate it into Latin or Greek at once revealed the ambiguous character of the proof. Speaking of Ohm's law, he pointed out that R, a constant, was not an essential feature, as Dr. Lodge supposed. Ohm never said R was constant. In identifying energy, a difficulty presented itself, for one never came across it as a single thing but as a product, and in being transformed the paths of the two factors might possibly be different. Mr. Dixon said the whole of geometry and dynamics could be based on verbal definitions. The conservation of energy could be written as: Kinetic energy + potential energy = a constant, but on substituting the expressions for kinetic and potential energies, an identity resulted; therefore the original statement was not a law. Both the kinetic and potential energies of a system were functions of its configuration. Potential energy could not belong to a particle, but to a system. The president doubted whether Dr. Lodge's scheme was more simple, natural, and logical, than the ordinary one. The statement in NATURE (p. 62) that "strains were proportional to stresses" was simple enough, but it was questionable if "frequency of vibration is independent of amplitude" could be considered so. The author appeared to ignore *mass* in comparison with *force*, whereas the idea of *mass* seemed to be the more simple one. Dr. Lodge, in reply to Mr. Burbury, said two bodies never do attract one another; the thing which acted on either was the medium immediately in contact with it. Mr. Herroun had used metaphysical arguments against ether, but he (Prof. Lodge) thought it was a good thing to investigate ether. He agreed with what Prof. Minchin said about force and the first law of motion. *Force* was the more fundamental, but *mass* was best as a standard unit. As regards ether, he was prepared to say that it has no motion. It possessed electromagnetic kinetic energy, and probably all the stress energy that exists. Referring to the slipping body mentioned by Prof. Minchin and Dr. Burton he said that in speaking of the velocities of acting and reacting bodies being equal, he always meant that their velocities along the line of action were equal. The action between the sliding body and plane was a "catch and let go" one, like a fiddle bow and string. On the second laws of thermodynamics he hoped to say something in a subsequent paper. When he spoke of R being constant as the essence of Ohm's law he meant constancy as regards terms which appear in the equation $\frac{E}{c} = R$.

Linnean Society, June 1.—Prof. Stewart, President, in the chair.—Dr. J. Lowe gave an account of a newly-observed habit of the blackcap, *Sylvia atricapilla*, in puncturing the petals of certain flowers (*Hibiscus Rosa-sinensis* and *Abutilon frondosum*), specimens of which he exhibited, thus causing the exudation of a viscid secretion which proved attractive to insects upon which the bird preyed. The observations in question were made at Orotava, Teneriffe, during the month of March last.—By way of introduction to a paper by Mr. W. B. Hemsley on Polynesian plants collected by Mr. J. J. Lister, the latter gave an interesting account of the geology of the Tonga Islands, their volcanic nature, and the coral and limestone reefs with the soil formed chiefly of volcanic outpourings, on which dense patches of bush were growing. Referring then to the bird-fauna of the Tonga group, Mr. Lister compared it with that of Fiji and Samoa, and showed that it had no special affinity with the avifauna of New Zealand, and exhibited very little specialisation. Mr. Hemsley then gave an account of the plants collected there, as also in the Solomon Islands.—Mr. A. B. Rendle gave an abstract of a paper on fossil palms, in which his remarks were directed to a revision of the genus *Nipadites*, Bowerbank, and were illustrated by drawings of specimens from the London clay, Sheppey, from the Sussex coast, Selsey, Brussels, N.E. Italy, and elsewhere. The paper was criticised by Mr. Carruthers and by Mr. Clement Reid, who described the finding of specimens *in situ* at Selsey.—The secretary then read a paper by Dr. Baur on the temperature of trees, from observations taken in Colorado.—Mr. W. M. Webb gave an abstract of a paper on the mode of feeding in *Testacella*, illustrated by lantern slides prepared from original drawings of the living animal in various attitudes.

Royal Microscopical Society, May 17.—A. D. Michael President, in the chair.—Mr. G. C. Karop read a letter from Dr. R. L. Maddox on the subject of his rod illuminator.—A letter from Mr. W. H. Youdale, referring to some diseased beard-hairs, was also read by Mr. Karop.—Mr. C. Lees Curties exhibited and described a new form of camera lucida, made by Herr Leitz, of Wetzlar.—Sir David L. Salomons gave an exhibition with his projection microscope.—The President said they were extremely indebted to Sir David Salomons for the very admirable and interesting exhibition which he had given them, the value of which was not only on account of the defraction phenomena, which had been so well shown, but because of the advance which was indicated in the construction of the apparatus. He could not help observing, as the exhibition proceeded, that there was a remarkable flatness of field not generally seen under similar circumstances. There was one point on which he should like to ask for information; it sometimes happened that great concentration of light produced also a great concentration of heat, and that consequently objects in balsam, if exposed for too long a time, were apt to get spoilt through the softening of the medium. Was this difficulty got over in the present instance by using the electric arc light as an illuminant?—Sir David Salomons said he obviated it very much by using lenses cemented with balsam. The customary alum and water he found to be rather a trouble, and so he used simple distilled water, and found that it answered all the necessities of the case.

Zoological Society, June 6.—Sir William H. Flower, F.R.S., President, in the chair.—The Secretary read a report on the additions that had been made to the Society's Menagerie during the month of May, 1893, and called special attention to a young Water-Buck (*Cobus ellipsiprymnus*), born May 4, 1893, being, so far as was known, the first antelope of this species that has been bred in captivity.—Mr. Walter Rothschild exhibited and made remarks on an egg of the Duckbill (*Ornithorhynchus anatinus*), taken from the pouch of the mother; the leg-bones and egg of an extinct bird of the genus *Æpyornis* from south-west Madagascar; and series of lepidopterous insects from Jamaica and from the Bolivian Andes.—Mr. Sclater exhibited and made remarks on some skins and skulls of mammals obtained in the Shiré Highlands by Mr. H. H. Johnston, Mr. B. L. Sclater, Messrs. Buchanan, and Mr. Alexander Whyte.—A communication was read from Messrs. F. E. Beddard and F. G. Parsons containing notes on the anatomy and classification of the parrots, based on specimens lately living in the Society's Gardens.—Mr. Sclater called attention to two front horns of an African rhinoceros belonging to Mr. F. Holmwood, which were stated to have been brought by native caravans from the district of East Africa, south of Lake Victoria Nyanza. They were remarkable for their great length and extreme thinness.—A communication was read from Mr. R. Lydekker containing an account of a collection of bird-bones from the miocene deposits of St. Alban, in the Department of Isère, France. The more perfect specimens were referred mostly to new species (*Strix sancti albani*, *Palæortyx maxima*, *P. grivensis*, and *Totanus majori*), while others were regarded as undeterminable from their fragmentary condition.—Mr. G. A. Boulenger read a paper describing some new species of reptiles and batrachians, based on specimens lately obtained in Borneo by Mr. A. Everett and Mr. C. Hose.

PARIS.

Academy of Sciences, June 5.—M. de Lacaze-Duthiers in the chair.—Note on the works of Comte P. de Gasparin, by M. Th. Schlœsing.—Researches on iron of Ovifak, by M. Henri Moissan. Three specimens of native iron, discovered by Prof. Nordenskiöld at Ovifak, Greenland, were tested for any crystallised forms of carbon they might contain. The first specimen had a metallic lustre, and was nearly black. This was found to contain a small quantity of the kind of graphite which swells up in boiling sulphuric acid. It also contained ordinary graphite distinctly crystallised, which gave rise to graphitic oxide on being treated with potassium chlorate. Fused potassium bisulphate dissolved all the residue. The second specimen also had a metallic lustre, but a light grey colour, and weighed 18 gr. After treating with hydrochloric acid the residue showed fragments of schreibersite, an opaque white mass of irregular form, and a large number of highly refracting grains. On treating this residue with hydrofluoric and then with boiling sulphuric acid the volume of the carbon increased, showing the presence of swelling graphite. No ordinary graphite was found. The third specimen, which consisted of metallic globules disseminated through a stony matrix, left after treatment with the three acids a residue containing some fragments of blue sapphire, which could be picked out with the forceps. Amorphous carbon was contained in all the specimens, swelling graphite in two of them, and ordinary graphite in one. Neither black nor transparent diamonds were found in any of them.—On the genesis of natural phosphates, especially those which have derived their phosphorus from organised beings, by M. Armand Gautier.—On the multiplicity of homologous parts in its relation to the gradation of vegetable species, by M. A. Chatin. The multiplicity of the homologous organs of a given apparatus is a certain sign of organic degeneration. The more numerous the homologous parts, the more they deviate from the verticillary type of floral organs and approach the spiral type. Their reciprocal symmetry is also less regular, and their position less stable. This view is confirmed by other incontestable signs of degeneration found to go together with multiplicity of homologous parts, and is illustrated by corresponding gradation in the animal kingdom, where the myriapod is classed below the hexapod insect.—On the repeated application of Bernouilli's theorem, by M. Jules Andrade.—On problems of dynamics reducible to quadratures, by M. Paul Staeckel.—Sketch of a new theory of electrostatics, by M. Vaschy.—On some phenomena exhibited by Natterer's tubes, by M. Gouy.—Absorption of seleniuretted hydrogen by liquid selenium at high temperatures, by M. H. Pélabon. If selenium be melted in a tube containing hydrogen and then cooled, it is found to contain a large number of bubbles with a brilliant internal surface, which are absent in selenium fused in air. On reducing the mass to powder the characteristic smell of seleniuretted hydrogen is observed, and if the mass is broken up under water the latter is coloured red by the finely divided selenium liberated from the seleniuretted hydrogen by the oxygen of the air.—Organometallic combinations belonging to the aromatic series, by M. G. Perrier.—On the coccidia of the birds, by M. Alphonse Labbé.—On the Plankton of the Polar Sea, by M. G. Pouchet.—On pseudo-fecundation in the Uredinei and accompanying phenomena, by M. Sappin-Trouffy.—On two cases of parasitic castration observed in *Knautia arvensis*, Coulter, by M. Molliard.—On the sedimentary strata of Servia, by M. J. M. Lugovic.—On the eclogites of Mont Blanc, by MM. L. Duparc and L. Mrazec.—On the employment of vine leaves for feeding cattle, by M. A. Muntz. In the south of France sheep are often let into the vineyards after the vintage and allowed to strip the vines of their leaves. The vines do not appear to suffer thereby in the least. Fresh vine-leaves contain 67·0 per cent. water, 18·5 extractive matter, 3·8 nitrogenous matter, and 2·3 per cent. fatty matter. When dried, the proportions are: extractive matter, 51 per cent.; water, 15; nitrogenous matter, 11; cellulose, 8·5; and fatty matter, 5·5 per cent. In the various vineyards of southern France the amount of leaves per hectare (2·47 acres) varies from 2500 to 9500 kgr., or about the average yield of hay for the same area. Moreover, the leaves, instead of getting blown away by the wind and lost, are converted into manure by the cattle, and, in addition, the vine is much less sensitive to drought than the ordinary fodder crops.—On the effects of inoculation of human cancer or cancerous products upon animals; positive result in one case, by M. Mayet.—On the amplitude and mean duration of the extreme oscillations of the barometer at Paris, by M. Léon Descroix.—On the density and alkalinity of the waters of the Atlantic and the Mediterranean, by M. J. Y. Buchanan. Along the entire south coast of Spain the water was of the same density as the Atlantic. Eastwards of Cape Gata, where the eastward current is no longer active, the denser water of the Mediterranean set in. The mean ratio of salinity and alkalinity was 0·50 for the Atlantic, and 0·4875 for the Mediterranean, the difference being probably due to the abundance of calcareous rocks on the latter.

AMSTERDAM.

Royal Academy of Sciences, May 27.—Prof. van de Sande Bakhuysen in the chair.—Mr. Hubrecht gave a description of phagocytic and vasifactive processes by which the trophoblast of *Tupaja javanica* attacks the maternal uterine epithelium and prepares congested surfaces against which the area vasculosa and afterwards the allantois are applied. The placenta of Tupaja is double, and situated right and left of the fœtus. The trophoblast of Tupaja was furthermore compared to that of Sorex and of Erinaceus, in all of which it displays a considerable degree of activity. It was more rigorously defined as being the epiblast of the mammalian blastocyst, after deduction of what is intended for the formation of the embryo and for the internal coating of the amnion. In conclusion, certain phylogenetic speculations concerning the trophoblast were brought forward.—Mr. Schoute exhibited three new thread-models of developables related to higher algebraical equations. The first is the discriminant of the general cubic $u^3 + 3xu^2 + 3yu + z = 0$. It divides space into two parts, corresponding to points with 3 or 1 real roots. The ordinary twisted cubic forms its cuspidal edge. The discussion of the number of real roots situated between two given limits is facilitated by means of a certain tetrahedron. The second surface corresponds to the quartic $u^4 + 6xu^2 + 4yu + z = 0$. It divides space into three parts, containing points with 4, 2, or 0 real roots. By planes perpendicular to the x-axis it is cut in rational quartics with two cusps and one node. It possesses a parabolic nodal curve. And the third model realises the surface corresponding to the sextic $u^6 - 15u^4 + 15xu^2 + 6yu + z = 0$. It divides space into four parts, with points admitting 6, 4, 2, or 0 real roots. Any plane perpendicular to the x-axis meets it in a rational sextic curve with four cusps and six nodes. The cusps of the cuspidal edge are very remarkable points on this surface. In general the developable corresponding to a likewise mutilated equation of the nth order with three coefficients x, y, z, will show rational sections of the nth order with the planes perpendicular to the x axis, admitting $n - 2$ cusps and $\frac{1}{2}(n - 2)(n - 3)$ nodes, &c.—Mr. van der Waals gave a formula for the law of molecular force. By putting

$$-f\frac{e^{-\frac{r}{\lambda}}}{r}$$

for the potential of two material points, all the known laws of molecular action may be deduced. In this formula λ is a line equal to the quotient of La Place's H and K. This law may be explained by supposing (1) that the action of the point itself varies inversely as the square of the distance, (2) that the universal medium gradually does absorb the lines of force.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

BOOKS.—Mensuration of the Simpler Figures: W. Briggs and T. W. Edmondson (Clive).—Science Teaching in Schools: H. Dyer (Blackie).—New South Wales Statistical Register for 1891 and Previous Years: T. A. Coghlan (Sydney, Potter).—Conquête du Monde Végétal: L. Bourdeau (Paris, Alcan).—A Popular History of Astronomy, 3rd edition: A. M. Clerke (Black).—Problèmes et Calculs Pratiques d'Électricité: A. Witz (Paris, Gauthier-Villars).—Captain Cook's Journal, edited by Captain Wharton (E. Stock).—Bionomie des Meeres; Erster Theil—Einleitung in die Geologie als Historische Wissenschaft: J. Walther (Jena, Fischer).—Philosophical Transactions of the Royal Society of London, vol. 184 (1893), A. pp. 361–504), The Value of the Mechanical Equivalent of Heat: E. H. Griffiths (Kegan Paul).

PAMPHLETS.—The Life-saving Society Handbook, 2nd edition (London).—On the Early History of some Scottish Mammals and Birds: Prof. Duns.—From Holborn to the Strand: W. Robinson (*Garden* Office).—Report on Utilisation of the River Darling: H. J. McKinney and F. W. Ward (Sydney, Potter).—Su Alcune Disposizioni Sperimentali per la Dimostrazione lo Studio delle Ondulazioni Elettriche di Hertz: A. Righi (Roma).

SERIALS.—Gazzetta Chimica Italiana, Anno xxiii. 1893, vol. 1, Fasc 5 (Palermo).—Himmel und Erde, June (Berlin).—American Journal of Science, June (New Haven).—Bulletin Astronomique, May (Paris).—Bulletin de l'Académie Royale des Sciences de Belgique, 1893, No. 4 (Bruxelles).—Botanical Gazette, May (Bloomington, Ind.)—Journal of the Chemical Society, June (Gurney and Jackson).—Zeitschrift für Wissenschaftliche Zoologie, 56 Band, 2 Heft (Williams and Norgate).

CONTENTS.

THURSDAY, JUNE 22, 1893.

THE THEORY OF FUNCTIONS.

Theory of Functions of a Complex Variable. By Dr. A. R. Forsyth. (Cambridge University Press, 1893.)

WHAT is the theory of functions about? This question may be heard now and again from a mathematical student; and if, by way of a partial reply, it be said that the elements of the theory of functions forms the basis on which the whole of that part of pure mathematics which deals with continuously varying quantity rests, the answer would not be too wide nor would it always imply too much.

It cannot be denied that the teaching of pure mathematics in this country has followed curiously restricted lines. While in geometry and the theory of forms the student has for many years past had the advantage of excellent English text-books, the general theory of functions has been entirely unrepresented till the appearance of the treatise whose title stands at the head of this notice. Of treatises on special classes of functions, if we omit those written purely with a view to applications, Cayley's "Elliptic Functions," published in 1876, is the sole representative; while till last year there was no work on the theory of numbers. The theory of groups, and its applications to the theory of equations, is still unrepresented in native English mathematical literature, though here we have the translations of Prof. Klein's "Vorlesungen über das Icosaeder," and Herr Netto's "Substitutionentheorie," published, the one in 1888, and the other last year. At Cambridge, and probably to a great extent in other centres, the teaching and the course of study of individual students have tended on the whole to follow the lines of the available English text-books, and where these have been incomplete or entirely wanting there has, till very recent years, been no sufficient introduction to the corresponding subjects.

Why a subject of such fundamental importance for the advancement of pure mathematics as the theory of functions should have happened to fall into this latter class, it is not easy to tell. It may be said to have been first put on a secure footing by Cauchy's great memoir on integrals taken between imaginary limits, which was published in 1825. Many advances were made by a number of eminent mathematicians in the following years, and the study of the subject received a great impetus from the new and very fascinating method of presenting it which Riemann gave in his famous memoirs on the theory of functions of a complex variable (1851), and on the theory of the Abelian functions (1857).

Weierstrass and his pupils, again, developed their theory from a standpoint which is essentially distinct from that of either Cauchy or Riemann. The growth of the subject during the last thirty years has been remarkable, and it is probably safe to say that the foreign literature of the subject is now more extensive than that of any other branch of pure mathematics. The number of text-books that have been published directly on the subject is wonderful in itself, and more so when it is remembered that almost every foreign treatise on the Differential and Integral Calculus contains some introduction to the theory of functions.

If there is any justice in the preceding remarks, the want of a treatise on this subject has too long caused a serious gap in our mathematical literature; and it may be at once said that Dr. Forsyth's book supplies that want so completely that it is not likely to be felt again for a long time to come.

Among the large number of foreign treatises above referred to are several which, in their own line, it would be difficult to improve upon; but they all, or nearly all, deal with the subject from a single point of view, being indeed written with that intention. Dr. Forsyth, on the other hand, has aimed at giving a complete introduction to the theory; and it may safely be said that, with his book as a guide, the task of the student who wishes to enable himself to follow its various recent developments will have lost half its difficulty.

The bringing of the various parts of the subject, and the different points of view from which they may be approached, into their proper connection with each other has here been done in the most masterly way; while though Dr. Forsyth expressly disclaims in the preface to have dealt at length with anything but the general theory, he has carried the developments of the subject in the direction of doubly-periodic and allied functions, Abelian integrals, and automorphic functions to a point from which the student can have no difficulty in passing on to the study of any recent work done in these branches.

It is impossible in the limits of a short article to give any complete account of a book extending to over 700 pages, but some attempt may be made to describe the order of treatment. The first four chapters are devoted to the simpler properties of uniform functions, their expansion in power-series and their integration. Chapters v., vi. and vii. deal with uniform transcendal functions, giving the principal results of the investigations of Weierstrass and Mittag-Leffler. In this connection the very remarkable result due to Weierstrass is given, which is expressed by him in the following words:—"Dass der Begriff einer monogenen Function einer complexen Veränderlichen mit dem Begriff einer durch arithmetische Grössenoperationen ausdrückbaren Abhängigkeit sich nicht vollständig deckt." The writer of a recent criticism in this journal would probably say that this statement deals only with the morbid pathology of mathematics; but the pure mathematician at all events should surely know, as far as possible, what is implied in the word function.

Non-uniform functions are introduced in chapter viii. They are regarded, to begin with, as arising from the various continuations of a power-series, the most general point of view that can be taken; Riemann's method of dealing with algebraic functions and their integrals not being introduced till considerably later. The following chapter deals with the integrals of non-uniform functions; and from the particular examples given arise some of the simplest singly- and doubly-periodic functions, whose properties, when uniform, are discussed in Chaps. x., xi., and xii. This part of the subject aptly ends with a demonstration, due to the author, of the theorem that if $f(u)$, $f(v)$, and $f(u+v)$ are connected by an algebraical equation with constant coefficients, $f(u)$ must be either an algebraic, a simply-periodic, or a doubly-periodic function of u. The proof of this important theorem by

Weierstrass, to whom it is due, has never been printed; and the only published proof, besides the one which Dr. Forsyth gives, appears in a paper by M. Phragmen in vol. vii. of the "Acta Mathematica," and is on entirely different lines. Whether either proof is entirely satisfactory is a point on which differences of opinion may conceivably occur, though of course there is no doubt as to the truth of the theorem itself.

Chap. xiv., which is headed "Connectivity of Surfaces," is purely geometrical, and strictly has nothing to do with the theory of functions. It was however necessary for the author to introduce such a digression if the following chapters dealing with Riemann's theory were to be understood, since there is no treatise to which reference could be made for the various theorems and results that have to be used. The chief properties of a Riemann's surface, regarded as arising from an algebraical equation between the variables, are discussed in Chap. xv. Though there is no difficulty in conceiving the geometrical nature of a Riemann's surface from a description, the relation between the surface and the set of functions (algebraische Gebilde) whose study it is intended to simplify is not so readily grasped at first by the student; and it would not perhaps have been amiss to have dealt with this relation in one or two simple cases, at some length, as an introduction to this part of the subject. In Chap. xvi., the surface still being regarded as defined by a given equation, the properties of uniform functions on the surface, and of their integrals, is investigated.

From this point to the end of the book we have to do, more or less directly, with the fundamentally new conception of Riemann which has been so wonderfully developed during the last ten or fifteen years. The Riemann's surface, as defined by a given equation, affords a most convenient means of study of a system of connected functions. Suppose, however, the surface to be given quite independently of any equation. The possibility at once suggests itself that the surface may serve as the definition of a set of connected functions. Riemann's own demonstration that this is the case has since been shown to be faulty, but the conception is an invaluable one, and it has been placed on a secure foundation by Schwartz (and others), by means of the so-called existence theorem. Chap. xvii. is entirely occupied with the proof of this theorem, and in Chap. xviii. follow the investigations with respect to the form and nature of the integrals and uniform functions, so shown to exist, on a Riemann's surface given arbitrarily.

Chaps. xix. and xx. deal at length with the theory of conformal representation. This forms one of the most obviously interesting parts of the subject, and is also one of those which lend themselves most readily to the purposes of application; and it is to be noted that, although owing to necessities of arrangement these chapters occur near the end of the book, the author suggests that, on a first reading, Chap. xix. should be taken at an early stage.

The last chapter in the book gives an introduction to the theory of automorphic functions, the previous one being taken up by a necessary digression on groups of linear substitutions. Dr. Forsyth follows M. Poincaré in actually obtaining analytical expressions for the functions in the form of the ratio of infinite series, analogous to the expressions for elliptic functions as ratios of the theta-functions. These analytical expressions, though of great interest, are too complicated in form to be readily used for deducing the properties of the functions they represent, so that their properties must be inferred from their quasi-geometrical definition by means of a "fundamental region"; and this is essentially the method of dealing with them used by Prof. Klein.

In thus shortly stating the contents, or rather the headings, of the successive chapters some risk is run of representing the book as a mere compilation. Nothing could possibly be further from the truth. From the nature of the case it is inevitable that the greater portion of the book should be taken up with detailing the results of other writers, but Dr. Forsyth has done this in a most independent way. The book is instinct all through with an original spirit; in numerous instances, where clearness or conciseness were to be gained, the author has modified or completely altered the usually-given proofs, while, as has been already stated, the various parts of the subject have been brought together, and the many different ways of dealing with them have been used, in such a way that the theory is presented to the reader as a connected and harmonious whole. Dr. Forsyth is to be warmly congratulated on having brought to so successful a conclusion what must have been an extremely arduous task. If it is not ungracious to "ask for more" so soon, we may express the hope that he will now go on to deal, as completely and successfully, with functions defined by differential equations.

The book itself is beautifully printed and the figures, many of which must have required careful drawing, are well reproduced. The table of contents is sufficiently complete to form a sort of *précis* of the whole; and lastly, we have to be grateful for three separate indices. The first of these, an index to all the technical terms used in the book, whether English or foreign, is a most useful addition; especially for those who wish to use the book without reading right through it. W. BURNSIDE.

TINCTORIAL ART AND SCIENCE.

A Manual of Dyeing: for the use of Practical Dyers, Manufacturers, Students, and all interested in the Art of Dyeing. By Edmund Knecht, Ph.D., Christopher Rawson, F.I.C., and Richard Loewenthal, Ph.D. (London: Charles Griffin and Co., 1893.)

THE present work consists of three volumes, two of letterpress, interspersed with illustrations of plant, which run to over 900 pages, and a third volume containing specimens of dyed fabrics. It is a substantial contribution to an important branch of technology, and the authors have succeeded fairly well in meeting the requirements of the various classes of readers for whose use the work has been written. The first general impression produced on looking through the volumes is one of satisfaction that the subject is handled in a more scientific way than has hitherto been the case in such works. The only feeling of disappointment to which the consideration of the book gives rise is in no way attributable to the authors, but is due to the circumstance that so little is known about the scientific relationship between a colouring-matter and the fabric which is dyed thereby. All that is known about the theory of dyeing is ably stated in the introductory chapter, and one of the authors (Dr. Knecht) has himself made some very interesting investigations in this field. But, in spite of all that has been written, the subject of dyeing has still to be taught as an art rather than as a science. The centres of the tinctorial industry in this country, such as Leeds, Manchester, Bradford, and Huddersfield, are now provided with Technical Schools, in which the dyeing department is made a special feature. If we might venture to offer a word of advice to those who are providing for this industry, it is that adequate provision should be made for the scientific side of the subject by the equipment of laboratories and the appointment of competent specialists for carrying on original investigation in connection with dyeing. The dyeing departments in those schools which we have had the opportunity of visiting are admirably equipped for instruction in the principles of the art, but the instructor has to devote so much time to this part of the work, and the students who attend are, as a rule, so ill-prepared in general scientific training that the instruction given cannot rise much above that handicraft level against which the writer has had so frequently to protest in connection with other branches of technology. Till this defect is remedied, the results achieved by our technical schools will not be commensurate with the endowment bestowed upon their equipment.

The work which has given rise to these reflections will go far towards placing the tinctorial art on a higher scientific level. It is not, as the authors state in the preface, "a mere 'cookery-book,' containing 'rule of thumb' recipes." A detailed analysis of its contents would be out of place in these columns, but a general idea of its scope may be given. The introductory chapter, as already stated, deals with the theory of dyeing. So far as wool and silk fibres are concerned, the authors consider that the evidence is in favour of a chemical as opposed to a purely mechanical explanation :—

"According to the mechanical theory, wool dyed with magenta, for instance, would simply absorb the unchanged hydrochloride of the dyestuff, and thus assume the same colour in the solution of the dyestuff. But experiment has shown that this is not the case. It absorbs the colour base, which is, however, in itself colourless. Where then does the colour come from? We can come to no other logical conclusion than that the colour base has combined chemically with some constituent of the fibre to form a coloured salt."

But this explanation does not enable us to see how the dyed "constituent" is combined with the other constituents of the fibre :—

"This objection is easily met by assuming that what is taken up *is* in chemical combination with some insoluble constituent of the fibre and is held by the rest of the transparent or translucent substance of the fibre in a state of *solid solution*."

Thus the theory advocated is partly chemical and partly in that debateable region where chemistry and physics have recently come into apparent collision. Researches in connection with the theory of dyeing have more than a purely technical value, and we hope that Dr. Knecht will continue the good work which he has commenced. With respect to cotton the authors state :—

"With the large numbers of direct cotton colours which are placed at our disposal, and which are continually increasing in number, the question becomes more and more important from a theoretical point of view. It is not probable that it will ever be solved by vague theoretical speculations based on one or two known facts. In all probability the solution of the question will require much laborious work, including many quantitative determinations."

The technical part of the work begins with Part II., dealing with the textile fibres of vegetable and animal origin, such as cotton, flax, hemp, jute, China grass, wool, silk, &c., not omitting Chardonnet's artificial "silk" prepared from nitrated cellulose. The third part is devoted to water from the dyer's point of view, and the fourth part to washing and bleaching. Parts V. to VIII. deal with the materials used in dyeing. All these materials are classified into the three groups, Chemicals, Mordants, and Dyestuffs, and are described under the collective (and most objectionable) name of "drugs." The acids and alkalies employed by the dyer are first treated of, then the mordants, which are discussed in a very thorough manner, no less than 150 pages being devoted to them. Three parts (VI., VII., and VIII.) are devoted to the natural, artificial organic, and mineral colours respectively.

The machinery used in dyeing forms the subject of Part IX., the investigation into the tinctorial properties of colouring matters that of Part X., and the concluding part treats of the analysis and valuation of the materials used by the dyer. There is an appendix of miscellaneous subjects such as weights and measures, thermometer scales, specific gravities, light and colour, &c.

The foregoing synopsis of its contents shows that the work is well calculated to fulfil the object which the authors had in view, viz. to serve "as a book of reference or *vade mecum* to the educated dyer." But it is not really for an individual class that this book is written; it appeals to several distinct kinds of readers. It may safely be asserted that there are few, if any dyers, in this country, however "educated," who could with equal intelligence follow every section of the work under consideration. The practical dyer who is most skilful in applying colouring matters to fabrics is generally hazy in his notions of chemistry, and absolutely ignorant so far as concerns the finer questions of the "constitution" of the complex products which chemistry has placed at his disposal. In order to understand properly the chemical portions of this manual a very sound foundation of chemical science must have been previously laid. On the other hand, a person who is thoroughly acquainted with the chemistry of dyestuffs would be worse than useless—he might be actually destructive—in the dye-house unless he had been trained in the application of colouring matters on a large scale. We are sometimes told that the practical dyer need know nothing of chemistry; that he would not do his work any better when possessed of such knowledge. There are still to be met with here and there so-called "practical" men who go further and assert that the possession of too much chemical knowledge would unfit the dyer for his work. But public opinion appears to be undergoing a healthy change in this as in other departments of technology. It may be long before we produce the ideal technologist who is equally acquainted with the chemical nature of his materials and the mechanical methods of applying them. It appears, however, that this combination of knowledge is just what is wanted in the industry. The joint authorship of the present manual perhaps supplies the best illustration of this principle that could be furnished.

A word or two as to the illustrations, of which there are no less than 116 incorporated with the text. We notice with some regret the prevailing fault so common in technical manuals: no scale of size is in any case given. This perhaps is of no consequence to the practical dyer who is already acquainted with the "plant," but as the work is also intended for students the omission is serious. Much of the machinery also is of foreign make; it is to be hoped that this has not the same significance as the fact that by far the greater number of artificial colouring matters described in the seventh part are of foreign manufacture. In the art of dyeing this country still holds a very good position, and it is satisfactory to find that the authors have not had to go outside Yorkshire for the dyed patterns forming the third volume of their work.

Perhaps the best recommendation that we can offer in favour of the present manual is that there is nothing which in our opinion calls for very serious criticism. The chemical formulæ might, in many cases, have been more economically packed; in some instances "bonds" have apparently dropped out (benzoflavine, p. 469; nile-blue, p. 486, and the oxazines generally; anthracene, p. 577, &c.). The authors formulate the so-called "bicarbonates" on p. 68 on the type $M''O(CO_2)_2$. The utility of the third volume would have been much enhanced if the pattern sheets had been paged and indexed separately, so as to have facilitated reference to any particular pattern. The appendix on light and colour (p. 881) wants amplifying in view of the importance of this subject to the tinctorial industry, and some account of Abney's researches on colour should have been given. This section would also have been made more intelligible by the introduction of a few illustrations of absorption spectra and the practical method of mapping them.

About seventeen years ago we had occasion to notice a work of a somewhat similar nature in these columns (vol. xiii. p. 283). No more striking illustration of the advancement in the art of the dyer could be furnished than by comparing that work (Crace-Calvert's "Dyeing and Calico Printing," by Stenhouse and Groves) with the "Manual" of Dr. Knecht and his colleagues. Other works have appeared since that time, some of real value, others mere compilations pandering to the examination fetish. It would be invidious to institute comparisons; suffice it to say that the present work will compare favourably with any treatise in this department of applied science.

R. MELDOLA.

A NEW MANUAL OF BACTERIOLOGY.

A Manual of Bacteriology. By George M. Sternberg, M.D., Deputy-Surgeon-General U.S. Army. (New York: William Wood and Co., 1892.)

A YOUNG and rapidly-growing science continually demands a series of new text-books for the use of those students who would keep themselves abreast of the times, and it is, perhaps, inevitable that, with the growth of knowledge, the text-books should assume more and more alarming proportions. The present work—a portly tome of nearly nine hundred pages—comes to us from across the Atlantic as the latest, the largest, and, let us add, the most complete manual of bacteriology which has yet appeared in the English language. The volume combine in itself not only an account of such facts as are alread established in the science from a morphological, chemica and pathological point of view, discussions on suc abstruse subjects as susceptibility and immunity, bu also full details of the means by which these results hav been obtained, and practical directions for the carryin on of laboratory work. It is thus, as stated in the pre face, at once a manual for reference, a text-book fo students, and a handbook for the laboratory. And i the mind of the reader there may arise the questio whether the attempt to combine the three has no resulted in a volume of somewhat too portentous a size.

Dr. Sternberg is well qualified for the task he ha undertaken. Himself a well-known worker in bacterio logy, and director of the Hoagland Laboratory i Brooklyn, his work is no mere compilation of the result of others, but embodies also the fruits of his own origina thought and observation. The amount of labour involve in bringing together from the literature of differer countries the facts necessary for a manual of this kin may be estimated from the fact that the bibliograph alone fills over a hundred pages and contains 258 references. The illustrations are numerous, clear, an accurate; many of them are printed in colours, and ther are some good reproductions of microphotographs.

The work is practically divided into four parts, an of these the first is mainly occupied by an account o methods and of practical laboratory work, preceded b short sections on the history of the subject, on classif cation, and morphology. These are clear and concis the basis of classification adopted being practically tha of Baumgarten, in which the different genera are groupe under the three main headings of "micrococci," "bacilli, and "spirilla." The practical directions include stainin methods, the preparation and sterilisation of cultur media, and the various modes of cultivation, togethe with directions for experiments on animals. These sul jects are dealt with very fully, and will be found to em brace all that can be required for laboratory work. short section on microphotography concludes this par Many English ears will resent the term "stick-culture which is used as the equivalent of the German "stic cultur"; and, indeed, in other instances it would hav been possible to employ more euphonious translations o the original German terms. It may also be noted th in describing Chamberland's filter that gentleman's nam is incorrectly spelt in every instance.

The second portion of the book deals with the biolog and chemistry of bacteria, and the important subject o disinfection and antiseptics. Details are given of th modifications which may be artificially induced in th biological characters of bacteria, and especially of tho by which attenuation of virulence can be produced i pathogenic species. The section on the products of vit activity contains an account of the various fermentatio and decompositions known to depend on bacterial actio and is followed by one on the ptomaines and toxalbumir produced by certain species. The subject of disinfecti is then treated at some length, embracing a descriptio of the effects on micro-organisms of dry and moist hea of acids, alkalies, various salts, and coal-tar product which is fully up to date and leaves little to be desire The whole concludes with a useful summary of means practical disinfection, based mainly on the report of the Committee on Disinfectants of the American Public Health Association.

The third part, the most important division of the book, deals with pathogenic bacteria in detail, and is prefaced by a description of their modes of action, and of the ways in which they may gain access to the system. Here too we find a discussion on the difficult subjects of susceptibility and immunity, to which indeed Dr. Sternberg has elsewhere made important contributions. The discussion is lengthy and impartial, and well deserves careful reading. Relying on recent experimental evidence, the author reaches a guarded conclusion that acquired immunity depends on the formation of antitoxins in the bodies of immune animals. Subsidiary weight is given to the view, which he formerly upheld, that the cells of the body may acquire tolerance to the toxic products of pathogenic organisms, and also to the doctrine of phagocytosis, to which he gives a partial assent. A recent lecture by Metschnikoff on the latter subject is reproduced *in extenso*. It is impossible here to follow in detail the descriptions of the different pathogenic bacteria. The order in which they are discussed is necessarily somewhat arbitrary, but is convenient, and follows the broad grouping into micrococci, bacilli and spirilla. Amongst the pyogenic organisms Fehleisen's *Streptococcus erysipelatos* is frankly placed as identical with *Streptococcus pyogenes*, an arrangement with which many will not agree. Altogether no less than 158 organisms are described as pathogenic for man or the lower animals, and according to their relative importance the descriptions are in large or small print—an arrangement convenient for the student. A section follows on bacteria in diseases not clearly proved to be of bacterial origin, and the whole concludes with a classification of pathogenic organisms from a pathological standpoint.

The fourth part of the book deals with saprophytic bacteria, special chapters being devoted to bacteria in air, in water, in soil, in or on the human body, and in food. The total number of saprophytes described is 331. The merit of a work of this kind depends less on the number of species described than on the clearness and accuracy of the descriptions, and Dr. Sternberg has spared no pains to make these as complete as possible. To facilitate the recognition of species a chapter on bacteriological diagnosis has been added, in which the different organisms are grouped according to their form, cultural characters, and other peculiarities. This section will be an important aid to the student in identification. A lengthy and well-classified bibliography brings the work to a conclusion, and the whole is well indexed. The author is to be congratulated on the success with which he has accomplished a difficult and laborious task.

TEXT-BOOKS OF ZOOLOGY.

Lehrbuch der Zoologie. By Prof. Richard Hertwig, of Munich. (Jena: Gustav Fischer, 1891.)

Zoology of the Invertebrata. By Arthur O. Shipley, Fellow of Christ's College, Cambridge. (London: A. and C. Black, 1893.)

IT is a difficult matter to say much that is readable about text-books which are produced by teachers with a view to the limited requirements of their own pupils. Some text-books are, so to speak, obviously addressed to the world—are intended by their authors to be consulted both by the advanced student who is himself a teacher, and by all serious followers of the science dealt with. Others have their justification in being epitomes of a professor's or lecturer's teaching, suitable to his immediate pupils. The former class challenge criticism, and have a high standard of interest; the latter class are hardly fit subjects for appreciation, and possess a very limited importance.

Prof. Hertwig's text-book of Zoology is one which will no doubt be found serviceable by his pupils, and by the younger students of German universities. It is constructed on the usual lines, and contains nothing either in treatment or illustration which the author would probably wish to submit to his colleagues as novel or important. It has not the stamp of originality and freshness which gives a character and significance to Prof. Berthold Hatschek's unfinished text-book. It is well illustrated by the aid of the new "process" methods, and must be estimated as much by the judgment displayed in the omissions necessary in so condensed a work as by the actual statements which it embodies. The latter are, though not novel, sufficiently up to date.

Mr. Shipley's book on the Invertebrata appeals to an even more limited circle than Prof. Hertwig's. Professedly it is addressed to those who only wish to learn a very little about zoology, and who will be content to dispense with all bibliography, and even with reference to the names of authorities for the statements and for the systems of classification which Mr. Shipley incorporates as accepted fact. Presumably Mr. Shipley's book is intended for Cambridge students who take zoology in Part I. of the Tripos, and do not proceed to Part II. The book will no doubt prove useful to these students. To others, a more critical, more comprehensive, and more authoritative treatment of the subject must be recommended. To those who are not acquainted with special circumstances which may have determined the author's procedure, it must appear a matter for regret that when producing a volume so well printed and largely illustrated he did not make it more thorough. It is not possible to discuss the opinions adopted by Mr. Shipley upon several questions of interest, because he himself does not treat them argumentatively, but rather as matters of information to be accepted by the pupil from his tutor. Zoology, when deprived both of history and of argument, is singularly uninteresting, and will perhaps in this shape gain approval as a subject of school-education.

E. RAY LANKESTER.

OUR BOOK SHELF.

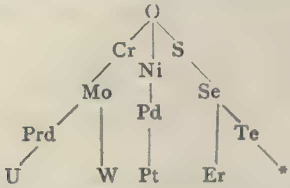
Das Genetische System der chemischen Elemente. Von W. Preyer. (Berlin: R. Friedländer und Sohn, 1893.)

THE treatment of the material contained in this book is based on the idea that the elements have been produced from hydrogen, or ether, or primordial matter, by a process of condensation.

The fourteen horizontal rows of the periodic table are regarded as representing fourteen different degrees of condensation of the initial substance, and the rows are then connected together so that they fall into five different groups, each of which group constitutes a generation.

The system works out in such a way that each element in the first row of the periodic table becomes the parent of all the elements in its own vertical series.

Oxygen, for instance, is the root of the following geneaogical tree:—



Chromium, nickel, and sulphur, in this way belong to the second generation. Molybdenum, paladium, and selenium to the third generation, and so on. The constants of the elements, such as atomic weights, densities, atomic volumes, specific heats, atomic heats, and their electrical and magnetic properties, their valency, &c., are then discussed with the view of justifying the mode of treatment adopted. It is here shown that on arranging the elements according to the author's system, besides the well-known relations between properties and atomic weights, additional simple numerical relations are traceable between the magnitudes of the atomic constants themselves, and also between these magnitudes and the numbers denoting the degree of condensation of the groups to which the elements belong. The use to which these may be put as a means of controlling the values of atomic weights and predicting the properties of undiscovered elements is indicated.

The second and not the least useful part of the book contains a collection of physical constants, from which the data used in the first part were chosen.

The book is a suggestive contribution to the literature on a subject which since the time of Prout has been prolific of speculation, but which even yet seems slow to condense and take a form sufficiently definite to warrant its being raised to the rank of a theory. J. W. R.

The Future of British Agriculture. By Prof. Sheldon. (London: W. H. Allen and Co., Ltd., 1893.)

THE opening chapters of this little book are devoted to the solution of the questions, "Will wheat-raising pay in Great Britain?" and "Is wheat to be no longer king?" After indicating the reasons which led to the enormous reduction of land under wheat—a decrease of something like 42 per cent. within the last twenty-five years—Prof. Sheldon comes to the conclusion, that, notwithstanding the importation of foreign wheat, and the fact that an ever-increasing demand for milk (of all farm products the least suitable for importation) necessitates larger areas of grass land, wheat-growing will not only continue, but may soon reach its former position, an event which he would not consider to be "a sign of unadulterated good." In connection with the question of wheat-production in the United States, there is one statement, made on the authority of leading American statistical experts, which we venture to think requires qualification, namely, "that in less than twenty years from 10 to 15 per cent. of the people's food will have to be *imported* into the United States." This is a point on which there may well be diversity of opinion, but, as pointed out by Messrs. Lawes and Gilbert in their recent paper on "Allotments and Small Holdings," the conditions will be quite changed with increased population, rotation will gradually become general, yielding various food products for home consumption; the soil will be better cultivated, yielding much larger crops of wheat where it is grown; straw and manure will no longer be burnt or wasted; and, lastly, there are still considerable areas of rich prairie land to be brought under the plough. So that it is probable that increased density of population will less rapidly diminish the capability of production for export than may, at first sight, be supposed.

Perhaps the most interesting chapters are those on dairy farming; and it will afford a good deal of consolation to the dairy farmers of this country to learn that Prof. Sheldon believes "the competition of the United States is within measurable distance of its limit."

The book concludes with a chapter on a most important subject—tenant farmers' interests. The author states his view of the matter in his usual clear and forcible manner, and incidentally refers to what he terms "exploded, impossible 'Protection'," and to "that new economic craze, 'Bimetallism'."

We welcome the book as a valuable contribution to our agricultural literature, and as a useful guide to those branches in which the author is especially qualified to instruct.

LETTERS TO THE EDITOR.

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

Mr. H. O. Forbes's Discoveries in the Chatham Islands.

I WRITE a final line on this subject to express my regret that I should have misunderstood Prof. Newton and attributed to him (NATURE, p. 126 above) opinions in regard to the relationship between *Erythromachus* and *Aphanapteryx* which he does not hold.

On a point of accuracy, however, in regard to the "slight confusion of dates," allow me to say that I am sure no one will admit more readily than he that this had occurred, when I remind him of his letter to me of December 22, 1892 (now before me), in reply to a note of mine requesting him to be so good as to repeat his suggestion in regard to the name for the new genus, which I was about to describe, as I had mislaid his former note. "I have no memorandum," he says, "of what I suggested to you, but only an indistinct recollection that it was *Diaphorapteryx* . . . or something like that." This was, therefore, the date of the re-suggestion, and not my visit to Cambridge on February 23, 1893. *Diaphorapteryx* was described as a new genus in the Bull. Brit. Ornith. Cl., December 31, 1892.

HENRY O. FORBES.

The Fundamental Axioms of Dynamics.

A VERY brief reply to such of your correspondents as have favoured my paper with direct or indirect criticisms will at the present stage of the discussion be sufficient.

Referring first to Prof. Rücker's letter on p. 126, I acquiesce in the greater part of it—especially in its concluding paragraph, but it may clarify matters if I explain (1) that I do not contemplate *parts* of the ether, but regard it as an absolute *continuum*. Not the slightest advantage is gained by pushing action and distance back a step or two—it must be exterminated. (2) That I have no faith in "action at constant distance" other than distance zero. The reason such a phrase ever appeared in my papers is because that is all I am able to deduce from the assumption of the conservation of energy. It requires identity of energy to prove absolute contact. Hence I prefer to work backwards, and, assuming universal contact action or the denial of action at a distance, to deduce therefrom both the conservation and identity of energy.

Prof. McGregor contradicts three statements in the Report of the meeting of the Physical Society (p. 117), a report which is usually admirably done, and which was well done in this case. Though not responsible I reply to his three points categorically:

(1) He was *understood* to object to the Newtonian statement of the first law—not to the fact or law itself.

(2) A reference to the first two pages of his paper in the February *Phil. Mag.* will show him, I think, that he has now partially forgotten what he said on the second head.

(3) It is to be admitted at once that the phrase "equally well," not "well," was employed.

Now, turning to Mr. Dixon's letter (p. 149), it does not seem to me that he is perfectly candid. He accuses me in his concluding paragraph of an unfair practice by omitting the word "direct," but no such word occurred in his letter on p. 103, to which I was replying; nor is what he now says consistent with the surface meaning and intention of the second paragraph in his former epistle, so far as I can judge. A withdrawal of that hasty and misleading paragraph is what I had expected from him.

In the first paragraph to his recent letter he explains why he considers that the fact that potential energy belongs to a system is hostile to the idea of identity, but his proof does not appear to me valid unless the phrases "belongs to" and "has no local habitation within" are considered identical. If he can show that a given portion of potential energy "has no local habitation within a system," he will undoubtedly be usefully attacking the proposition that it possesses identity, but I do not see that he has even attempted such a proof at present.

OLIVER LODGE.

Popular Botany.

I VISITED Tyne Dock yesterday, in order to attempt to solve the question put by Mr. A. W. Bennett in your issue of the 1st inst.

The plants which caused the fatality grow in a small hollow close to a newly-opened road. The surviving child is but five years old, and therefore much too young for any evidence of hers to be convincing.

There seems little doubt, however, that the hemlock, *Conium maculatum*, brought about the death of the other two children. Large quantities of this, looking very attractive just now, are growing on the spot, together with smaller quantities of *Heracleum sphondylium*, *Anthriscus sylvestris*, and a very few plants of *Bunium flexuosum* at the margin of the hollow. No other umbelliferous plant is growing near. Yesterday, troops of children were gathering the young and pretty leaves of the hemlock, and making them up into bouquets with grasses and flowers.

The children, who died from the effects of eating the plant were aged respectively four and five years, and probably, in common with thousands of others in the district, would not recognise cabbage if they saw it growing, which very likely they never did. I have met many very much older children here who are as ignorant of common garden and field plants.

Gateshead-on-Tyne, June 12. JOHN BIDGOOD.

The Big and Little Monsoons of Ceylon.

IT is well known to all Anglo-Indians, even the least scientific, that the summer monsoon is ushered in by two periods of rain-burst, called respectively the chota and burra barsât. The former occurs sometimes in April or May, and the latter in June or July, the precise dates varying not only with the locality but with the year. The chota barsât only lasts a few days, and is looked upon as the advance guard of the burra barsât, or great rains.

The conditions which tend to produce the chota barsât have not, so far as I am aware, been studied in detail, but are probably similar in character though on a smaller scale, and more local than those which regulate the inception of the burst of the monsoon, as it is popularly termed. It can be readily understood that as soon as the solar rays are sufficiently powerful to heat up a portion of the land area, and by lowering the pressure to determine an inrush of surrounding marine air, condensation and precipitation will occur much in the same way as in the burra barsât when the air over the whole peninsula has become heated, and the saturated air from the equatorial Indian Ocean rushes in in a large and continuous stream towards the low pressure area thus formed. In the former case the conditions are not only more local and ephemeral owing to the small amount of vapour formed over a comparatively cool sea, but are mixed up with the residue of the cold weather disturbances, which are due to anti-monsoon conditions.

Mr. Blanford, in his admirable monograph on the rainfall of India, has compared the direct solar action which sets the monsoon in action to the pull of the trigger, by which the intrinsic latent energy of the resulting air-stream is shot forth. In the case of the chota barsât the comparison holds equally good only the resulting charge is feebler.

Now it has been recently maintained that while the distribution of temperature anomalies in the Indian peninsula regulates the inception of the little monsoon and its accompanying chota barsât, it is only when the central Asian plateaux become warmed up so as to produce an inflow beyond the Himalayan barrier, which must consequently affect the upper as well as the lower atmospheric strata, that any general deep movement of the equatorial vapour-laden air occurs on a scale sufficient to produce general monsoon rains. That in fact there are two movements, one in the lower air, and the other in the air above the first 5000 or 6000 feet, and that it is only when the two occur coincidently that we get the grander phenomena which accompany the burst of the big monsoon, as they term it in Ceylon. Some such theory appears necessary to account, not merely for the peculiar suddenness of the burst, but also for its variable date of arrival in different years. Until, however, we know more of the meteorological conditions of Central Asia and Thibet, this hypothesis must remain in a tentative state. Meanwhile, however, it is undoubtedly valuable to find that these two periods of rain-burst are not only distinct enough to be referred to under separate names over a large part of India, but in Ceylon are considered so important as to have their dates separately recorded by the Marine Master attendant at Colombo. In the excellent Ceylon *Mercantile and Planting Directory*, edited by the late Mr. A. M. Ferguson, and now carried on by his successor, Mr. J. Ferguson, a list is given of the dates of commencement of the little and big monsoons, from 1853 down o 1892 inclusive.

As a general result it is found that the average dates for the little and big monsoons are April 20 and May 19, and that when nothing particularly abnormal occurs, the big monsoon may be expected to follow the little one in about a month.

There are, however, considerable variations from this normal, the little monsoon date ranging through 52 days, and the big monsoon from May 1 to June 19.

On looking over these variations it struck me that they would probably be found to correspond to some extent with the rainfall of adjacent localities in India, especially the Carnatic. The result of a comparison of the anomalies is shown below—

	CEYLON.[1] Date of arrival of the big monsoon, before or after its average date, May 20. + Before – after days.	CARNATIC.[2] Mean rainfall anomaly in inches (40 stations). Inches.
1864	+ 5	– 5
1865	– 11	– 5
1866	– 2	– 4
1867	– 30	– 9·4
1868	– 14	– 4·6
1869	– 28	– 0·3
1870	+ 9	+ 1·8
1871	+ 7	+ 5·5
1872	+ 18	+ 11·5
1873	– 4	– 0·1
1874	+ 15	+ 7·3
1875	– 8	– 5·2
1876	– 17	– 13·2
1877	+ 4	+ 8·3
1878	+ 1	0
1879	0	+ 2·3
1880	+ 5	+ 7·0
1881	– 9	– 2·1
1882	0	+ 4·4
1883	+ 10	+ 5·2
1884	+ 5	+ 11·6
1885	– 16	– 1·1

A mere glance at these figures shows at once a remarkable parallelism both in signs and numbers. Thus in eighteen years the signs are alike, neutral in three, and unlike only once. As it is well known that the rainfall of the Carnatic was found by Mr. Blanford to vary in a cycle of eleven years, closely corresponding with that of the sunspots,[3] the same ought to hold for the anomalies in the dates of arrival of the big monsoon at Colombo. As a matter of fact the relation appears to be still

[1] From the Ceylon Directory, 1892.
[2] From the Rainfall of India, Part II., Indian Meteorological Memoirs, 1887.
[3] Mr. Blanford computed the probability of such a cycle as compared to an invariable average to be as 655 : 1. Indian Meteorological Memoirs, vol. iii. part 2, p. 244.

stronger. Thus, excluding insignificant decimals from the sunspot figures, and taking the mean of three and a half cycles for the Ceylon dates from 1854 to 1891, and from 1864 to 1885 for the sunspots in pairs of years from Wolf's tables (the only sunspot data I have available) we get the following comparison :—

		Ceylon[1] monsoon dates. Mean abnormals.	Sunspots. Mean abnormals.
1856	1867–'78	− 7·5 min.	−38 min.
1857	,,	− 3·2 ,,	−34 ,,
1858	,,	− 1·0 ,,	−15 ,,
1859	,,	− 4·0 ,,	+27 ,,
1860	,,	+ 2·0 ,,	+44 max.
1861	,,	+10·0 max.	+37 ,,
1862	,,	+ 4·0 ,,	+26 ,,
1863	,,	+ 3·0 ,,	+ 9 ,,
1864	,,	+ 1·0 ,,	− 9 ,,
1865	,,	− 4·0 ,,	−21 ,,
1866	,,	± 0·0 ,,	−30 ,,

Better sunspot data would certainly not invalidate the connection. The lag behind the maximum sunspot data and the apparent tendency to precede the minimum has always been noticed in other phenomena. Moreover, from the analogy between the abnormals of the two elements compared both in quantity as well as sign the same remarks as to the reality of the cycle made by Mr. Blanford in his work (cited ante) p. 254 apply *pari passu* to that in the Ceylon dates.

A similar relation holds good for the little monsoon which may be put into words as early dates in years with increasing sunspot numbers and late dates in years with diminishing sunspot numbers, with a decided maximum of twelve days early in the year immediately succeeding that of maximum sunspots. Even the period between the two bursts shows symptoms of a similar relation to the sun's condition, the mean maximum interval, forty-three days, corresponding to the year of minimum sunspots, and the minimum twenty days occurring two years after that of maximum sunspots. The relation, however, is clearest in the figures for the burst of the big monsoon and seems to show that apart from all indirect influences such as accumulation of snows on the Himalayan outer ranges, and unusual winter rainfall on the plains or the reverse, there is a real fluctuation in the dates of the burst of the big monsoon or burra barsât connected with the sun's condition which appears to be more direct than that exhibited by the amount of rain which falls during its continuance and appears to indicate, as indeed is borne out by what we know from other sources, that in years of many spots the conditions which usher in the summer monsoon rains are earlier developed, and, as the amounts show, probably continue more regularly than in years of few spots.

Granting this as a working hypothesis two important results follow.

(1) The parallel march of the Ceylon dates and the rainfall of the Carnatic shows that the former could be employed to forecast the probable amount of monsoon rainfall about to be enjoyed in the latter district.

(2) That by using the mean abnormal of the year in its position in the sunspot cycle as the true mean instead of the mean of the whole period, the true abnormal for the year can be better estimated and the probable general character of the weather foretold.

As an example let us take the well-known diurnal variation of barometric pressure, whose amplitude in the tropics is so large that it bears a sensible ratio to the abnormal fluctuation produced by a passing disturbance.

In estimating the true abnormal at some particular hour of the day we must evidently compare the value with reference to the normal *at that hour*.

Similarly for the sunspot period in the case under consideration. If there is reason to believe that the period exists we ought to treat it as a reality, and in constructing graphic abnormals take the curve of the progressive cyclic normal as our abscissa axis instead of a straight line representing an endless repetition of the mean of the whole period. The principle is adopted as regards varying locality in drawing synoptic abnormal charts. It should be equally imperative in cases where the element of time is considered.

Thus in 1894, if the monsoon burst in Colombo twelve days before its time it would be abnormal to the extent of +2. On the other hand, if it were twelve days late, it would be abnormal to the existing mean to the extent of −22, and even to the new mean formed by incorporating this fresh value, to the extent of −16, and we might in such a case infer that some unusual cause was in operation which would certainly bode ill for the Madras agriculturists.

I have put these facts and considerations forward simply as a preliminary inspection of two phenomena which not only occur in Ceylon, but are more or less common to the Indian peninsula, and to show how conditions, the relations between which can at present only be exhibited in an empirical form, may yet be employed as a means of forecasting the character of a season, and also ultimately by further investigation help to elucidate the whole machinery by which the grand weather changes are produced by terrestrial physical conditions in conjunction with alterations in the state of the sun's surface as well as its varying declination. A large field on either side of the equator, embracing one-fourth of the entire area of the world, exists, from which observations are very much wanted to complete our knowledge of the causes of phenomena which, while they are evidently closely related to action-centres (using Teisserenc de Bort's significant expression) at some distance from the equator, are yet, probably to some considerable extent, dependent upon conditions prevailing over the entire equatorial belt, which may, for all we know, fluctuate in stricter unison with solar changes than those which occur in higher latitudes.

E. DOUGLAS ARCHIBALD.

[1] These figures are simple means *unsmoothed*.

Singular Swarms of Flies.

WITH the writer's permission I send you herewith a letter which I have received concerning the subject of my letter which appeared in your issue of June 1.

During the week following the date of my letter I repeatedly saw swarms of similar kind; but smaller and less marked, seldom visible much more than fifty yards away; always under similar atmospheric conditions, which were chronic during the period in question. The swarms always showed much the same slant from vertical (some 30° or so), the direction of the slope in plan being towards such slight draft of air as was perceptible.

R. E. FROUDE.

Gosport, June 12.

I FIND in NATURE, June 1, an inquiry you make about flies forming clouds, resembling smoke.

They are usually produced by the gnats called scientifically *Chironomus*, and have been often mentioned in entomological literature.

I give below several references I can lay my hand on, but there are probably many more recent ones, which I have not noticed—

German, Magazin für Entomologie (in German), vol. i. p. 134–140, 1813.

Clapton, J. C. Dale, in Magaz. Nat. Hist., 1833, p. 544. (In Ireland and England.)

Patterson, Ann. and Mag. of Nat. Hist., vol. x. 1842, p. 6–9.

I have seen such clouds myself more than once. Cases have occurred when the smoke-like appearance has caused a fire alarm to be sounded.

C. R. OSTEN SACKEN.

Heidelberg, Germany, June 4.

OFFICIAL CATALOGUE OF THE EXHIBITION OF THE GERMAN EMPIRE AT THE COLUMBIAN UNIVERSAL EXHIBITION IN CHICAGO.

GERMANY, not unmindful that America is her best customer, will be worthily represented at Chicago. An elaborate catalogue, in the German language, has already appeared, and an English translation will shortly be published. We have been favoured with an advance copy of the latter, which is by no means a mere enumeration of exhibits. It contains a general introduction, and a number of original articles by leading experts, "intended to supply for each department a concisely descriptive survey of its development and present condition." There is also, in German and English, a special Guide to the collective exhibition of the German chemical industry, containing historical and statistical notices of every exhibiting firm. Generally the effort of the editor, and the commission which he represents, has been to convey to the American people and to the world a faithful picture of a state of development of the industrial arts in Germany, which may well inspire,in the English reader, impressions of a mixed order, pleasure in the contemplation of a great national growth, based upon a true conception of the right methods, and regret that in our own country a similiar consummation still appears a great way off. The selection, as editor of this publication, of the eminent chemist, Dr. Otto N. Witt, professor of technology at the great Berlin Polytechnicum, is in itself a forecast of its scope and purpose, and an evidence of the position which the man of pure science occupies in official Germany. To summarise in the briefest manner the work which he and his collaborators have given to the world would carry us far beyond the limits of this article. There are two points, however, of paramount interest, to which we desire to call attention, the one social-political, not to say socialistic, the other industrial—both of national importance.

Among the provisions made and establishments created by the newly-founded empire avowedly in the interest of national industry and commerce, such as the Imperial Post Office, the Imperial Bank, the Imperial Patent Office, none bear the stamp of originality in the same degree as the great system of compulsory insurance, "the object being to secure for that portion of the population which is dependent upon the work of its hands, and is rarely in a position to save money or properly to administer its savings, a provision for the days when through accident, sickness, or advancing age the worker is incapacitated from further earnings. Insurance is applicable in three different forms. In assurance against illness, introduced in 1883, the means are provided, two-thirds by the insured and one-third by their employers, in weekly contributions, to an amount not exceeeding 3 per cent. of the average wage. It entitles the insured to free medical treatment and a fixed allowance over a given period. It includes 7,000,000 persons in more than 20,000 clubs, and involves an annual expenditure of more than 100 million marks. The system of insurance against accident, which came into existence in 1884, is intended *to transform the personal liability of the employer, in case of accident during the execution of work into an economical charge upon the entire trade concerned*, to secure to the worker an indemnity *in all cases*, and to put an end to troublesome lawsuits between employer and employed. At the present time 15 millions of persons are insured, and 10 millions of marks have been paid in indemnities. The insurance against incapacity for work, and the old-age pension fund, inaugurated in 1891, complete this system of workers' insurances. It insures an income to those unable to earn a living, without reference to age, and an old-age pension to septuagenarians, without reference to any capacity for earning which they may still retain. The necessary means, in addition to a yearly Imperial contribution of 50 marks per income, are supplied in equal proportions by the insured and their employers. This form of insurance includes 12 millions of persons, and has, up to the present time, involved an outlay of 30 millions of marks. On the whole, there has been, in connection with the objects of the operatives' insurance, an expenditure of well-nigh half a milliard of marks, which has exclusively benefited the working-classes."

Thus, in the course of eight years, the German Government and people have given practical form to these grave social problems, which, in our own country, are still waiting for solution. Whether the German system is based on sound principles it is not for the present writer to decide. It is admitted that it imposes a heavy burden upon industry, and yet most of the exhibiting firms appear to bear it with equanimity. Nay, it is refreshing to note that the obligations imposed upon manufacturers by the Legislature have not in any way dried up the springs of voluntary charitable effort. Most of the large firms, in addition to the requirements of the law, make generous provision for their workpeople in the shape of baths, refreshment-rooms, dormitories, supplies of fuel at cost price, model cottages at low rent, allotments, and various funds in cases of sickness and death, funds for widows and orphans, &c., &c. It must be borne in mind, as a set-off to all this benevolence, that wages are low. The average remuneration in chemical factories, for example, is something less than £1 per week for a ten hours day.

The other point suggested by a perusal of the catalogue is the rapid and, in some cases, triumphant progress of German industry. For our present purpose it will be sufficient to consider two departments of chemical manufacture—namely, the industry of general and fine chemicals and that of artificial colouring matters. They are typical of the spirit which pervades every branch of technical activity in Germany. The former, we are told, has developed to an extent unknown in any other country in the world. Imperial statistics show that in 1891 there were in Germany 521 factories engaged in the manufacture of chemico-pharmaceutical preparations, their 14,842 workpeople drawing 12,615,700 marks in wages. The exports in 1890 of chemical preparations, not specially named, exceeded the imports by 5000 tons, valued at more than 15,000,000 marks. If to these are added the chemicals quoted by name in the official list, we obtain a total excess of exports over imports amounting to 25,690,000 marks; and as the home consumption must at least be equal, we arrive at a grand total of 52,000,000 marks annually.

More remarkable still is the history of the great dye industry, which, as is well known, originated in England with the labours of Hofmann, Mansfield, and Perkin, closely followed in France by those of Verguin and Girard and de Laire. What has become of it? The chemical catalogue tells us that nine-tenths of the production of artificial dye-stuffs in the world must be credited to Germany.

There are altogether some 20 factories belonging to this industry in Germany, nearly all of which can claim to be important. Three of the largest are represented at Chicago. One of them, with a capital of 6,000,000 marks, employs 600 men and 90 women; another, with a capital of 12,000,000 marks, occupies 1600 men with a technical staff of 300, and produces nearly every known dye stuff, the alizarine dyes included. A third, with a capital of 16½ million marks, is said to be the largest chemical factory in the world. It began twenty-eight years ago with a staff of 30 men, and now employs 4000. These three factories have played a conspicuous part in the building up of the industry of artificial colouring matters.

To what causes must these great results be traced? Many minor causes are mentioned in the catalogue. Let us, however, go at once to the root of the matter. The two main factors are organisation and the consequent intimate connection between pure science and manufacture. When, at the beginning of the century, Germany lay crushed at the feet of Napoleon, it was felt by German patriots that nothing but the complete re-organisation of the country could lead to its emancipation. Since those days, side by side with the military forces, the scientific forces of the country have been carefully and patiently organised. At the instigation of Liebig, great State laboratories for pure scientific research were erected all over the country, and from these have issued an army of highly-trained workers, whose services manufacturers have vied with each other in securing. Nothing is more striking, in the special notices of the exhibiting firms, than the large number of competent and often distinguished chemists employed in all the factories at all connected with the chemical trade.

Firms with 40 workmen sometimes employ as many as 5 or 6 chemists, and the three great colour firms referred to above employ together 178. In the words of Dr. Witt: "In chemical research the chemical industry of Germany possesses a never-failing helpmeet, and such is the intimacy between chemical research and chemical manufacture, that the periods of most rapid development of the one have always been epochs of prosperity with the other." And again: "It may be asserted that not only is the strength and productive power of German chemical industry based upon the intimate connection between science and practice above described, but that in that intimacy lies the surest safeguard that German industry will long continue to hold the prominent position which, with such strenuous exertion, it has ultimately achieved. When the question is asked why the chemical industry of other lands, still more favoured perhaps by nature, has in the end been surpassed by the German, the answer is that Germany has had the good fortune to call her own a number of the greatest intellects in the domain of pure scientific research, who have quickened the pace of theoretical chemistry. But, as before stated, it is the latter which constitutes the vital element of chemical manufacture. Only the country which, at any period, shall assume the leadership in pure scientific chemical investigation, will also be in a position to wrest from German chemical industry the palm to which it is at present entitled."

We do not shut our eyes to the fact that nations, like individuals, must work out their own character and destiny, nor do we for a moment inculcate a slavish copying of the German model. We have in this country a great deal of science and a great deal of industry, and many attempts have been made to bring about an effective cooperation of these two cardinal elements of productive energy. We cordially recognise that particular industries and individual firms have, by private ent:rprise, developed themselves upon a thoroughly scientific basis, and we also welcome the fact that substantial additions have been made in recent years to the laboratories and institutions where a scientific training can be obtained. At the same time we cannot escape from the admission that, in the friendly struggle for industrial supremacy, Germany has not only made astonishing progress both in the development of industries of long standing, and in the inception of new ones of enormous fruitfulness, but that she has been the first as a nation to solve the great problem of the cooperation of science and manufacture. We leave it to more competent hands to point out the course which now lies before us. In our own humble opinion the days of *laisser faire* have gone never to return, and the time has come when the Government of the country, backed by the country, must take—as is the case in Germany—a larger share than it has done hitherto in the systematic organisation of our scientific and industrial forces. A nobler and a more patriotic task could hardly be attempted.

THE REDE LECTURE.

At Cambridge, on June 14, the Rede lecture was delivered by Prof. Michael Foster, Sec. R.S., his subject being "Weariness." The lecture was illustrated by experiments, conducted by Dr. Shore, with the assistance of Mr. Hardy. The following report of the lecture is from the *Times*:—

Prof. Foster said that among the many shortcomings which limited the power, and so the usefulness, of the machine which we call the human body, two stood out prominent among the rest: these were, on the one hand, inertia or laziness, the unwillingness to stir, and, on the other hand, weariness, the getting tired. He proposed to lay before his audience some account of such knowledge as the physiologists of to-day possessed, and it was but little, concerning the physical basis of this weariness, which so greatly shortened the power of man. He began with a simple yet illustrative case—the weariness which comes from the much repetition of a simple movement, a simple muscular act, as when a man lifts a weight with his hand. Analysing the act physiologically, he showed the changes which took place in the brain, the nerve, and the muscle. Taking the muscle first, he showed that weariness of muscle comes, in the first place, from too rapid expenditure of capital; secondly, from the accumulation in the muscle of the products of the muscle's own activity. There were many reasons for thinking that this latter cause of weariness was at least as potent as the former. The brute force of our food was the measure of our muscular strength, but the one could become the other only through the aid of many other things which might be wholly empty of energy, and the failure of these, no less than the absence of the former, entailed at first premature weariness, afterwards failure and death. The nerves and the brain shared in even the simplest and rudest muscular work. The nerves themselves, the mere bundles of fibres which carried the nervous impulses from the brain to the muscles, were never tired. Coming to the brain, the lecturer showed by a simple experiment a case of fatigue, demonstrating that the fatigue was in the brain and not in the muscle; a weariness of the particular part of the nervous system which was called into play.

By an illustration in colours he showed also how weariness not only lessened work but bred error. The study of the central nervous system had led, and was leading, physiologists to the conclusion that the material changes on which its activity depended were very analogous to those taking place in a muscle, only, of course, from a chemical point of view, not so massive. And all they knew went to show that in the brain, as in muscle, weariness was the result on the one hand of an expenditure of capital disproportionate to the accumulation, and on the other hand to a clogging of the machinery with the products of activity. The simple apparatus he had used might be successfully employed to illustrate general conditions as affecting weariness. If, taking always the same weight, they counted the number of times the weight was lifted and measured the height to which it was raised each time in succession before the movement was stopped by weariness, they could ascertain how much work had been done before the machine was so stopped. Proceeding in this way some interesting results as to what hastened or retarded fatigue had been obtained. Practice and habit, it was needless to say, were of prime influence. The depressing effects of a damp, muggy day, or the exhilarating effects of a bright, clear day, might in this way be measured in foot-pounds of power lost or gained, as might also the lowering influence of a cigar and the heightening effect of a glass of beer. One point perhaps he might dwell upon, and that was the influence of that part of the brain which was more immediately concerned with what was spoken of as mental work. An Italian professor determined, by means of the apparatus of which they were speaking, the amount of work which he could on a certain morning do before he was stopped by weariness. He then set himself to two hours' hard mental work, and the form of work he chose was that of examining candidates for their degree. The professor, as soon as the two hours' examination was over, went back to his apparatus and found that his power of bending his finger was enormously cut down. The nervous system was a candle which could not profitably be burnt at two ends at once. When the work done involved the activity, simultaneous or successive, of many muscles of many parts of the nervous system, the several efforts by accumulation became prominent, and simple weariness passes into what was called "distress." Here the result depended not so much on the direct effects of the work on the parts which were actively employed, not so much on the changes wrought in the muscles or in the nervous machinery at work, as on the success with which other members of the body came to the aid of those actually engaged in labour. The internal life of the body, no less than the external life, was a struggle for existence, a struggle between the several members, a struggle the arena of which was the blood. And it would seem that the onset of distress was chiefly determined by the failure of the organs to keep the blood adequately pure. Something depended on the vigour of the muscles themselves, something on the breathing power of the individual, something also on the readiness with which the heart responded to the greater strain upon it; but beyond and above all these was the readiness with which the internal scavengers freed the blood from the poison which the muscles were pouring into it. Undue exertion was exertion in which the muscles worked too fast for the rest of the body. The hunted hare died not because he was choked for want of breath, not because his heart stood still, its store of energy having given out, but because a poisoned blood poisoned his brain and his whole body. So also the schoolboy, urged by pride to go on running beyond the earlier symptoms of distress, struggled on until the heaped up poison deadened his brain, and he fell dazed and giddy, as in a fit, rising again, it might be, and stumbling on unconscious, or half conscious only, by mere mechanical inertia of his nervous system, falling once more, poisoned by poisons of his own making. All our knowledge went to show that the work of the brain, like the work of the muscles, was accompanied by chemical change, and that the chemical changes were of the same order in the brain as in the muscle. If an adequate stream of pure blood were necessary for the life of the muscle, equally true, perhaps even more true, was this of the brain. Moreover, the struggle for existence had brought to the front a brain ever ready to outrun its more humble helpmates, and even in the best-regulated economy the period of most effective work between the moment when all the complex machinery has been got into working order and the moment when weariness began to tell was bounded by all too narrow limits. If there were any truth in what he had laid before them, the sound way to extend those limits was not so much to render the brain more agile as to encourage the humbler helpmates, so that their more efficient cooperation might defer the onset of weariness.

NOTES.

FROM the *Times* we learn that a volcanic outbreak has occurred at Fukushima, in Northern Japan. Large volumes of dust and vapour have been emitted, and the country for miles around has been covered with volcanic ash. Landslips of great extent have occurred in the same neighbourhood, and are supposed to be caused by the volcanic action.

DR. H. J. JOHNSTON-LAVIS sends us the following information:—After many years in which the crater of Etna has been in a solfataric state lava has again risen, and now occupies it. This is a very rare condition of things in that volcano. Earthquakes continue in the north of Sicily, but on the flanks of Etna there is marked quiescence, which might be expected when the main chimney is free.

ON June 13 a select committee of the House of Commons resumed the hearing of evidence in connection with sea fisheries. Prof. Ray Lankester urged that a proper survey should be instituted round the coasts, in order to ascertain the movements and habits of fish in the areas resorted to by fishermen. An adequate commercial return could be expected from such a survey, for new fishing grounds might be discovered. To carry on this work, the present Government Grant of £1000 a year, received by the Marine Biological Association, ought to be trebled, and a grant of £5000 should be made for a deep-sea vessel. Dr. Günther expressed the opinion that hatcheries should be established for the protection and extended cultivation of sea-fish, and Mr. Holt testified to the considerable depletion of the fisheries in the North Sea, to prevent which a size-limit for different kinds of fish was recommended, rather than an absolute close-time of four months in the year.

A PHOTOGRAPHIC exhibition usually includes mechanical appliances and improved outfits specially designed to catch the eye of the artless amateur photographer. But there is to be a new departure in this, as in many other customs. In October next an exhibition of photographic pictures, to be called the "Photographic Salon," will be held at the Dudley Gallery, Piccadilly, and it will be concerned, wholly and solely, with photographs of pictorial merit, leaving the means by which such results can be obtained to be otherwise advertised. Those who desire to have their pictures hung in this academy of photographic art should communicate with the secretary before the beginning of September.

A NUMBER of lectures will be delivered in connection with the Gilchrist Trust, from September to December, in the Great Assembly Hall, Bethnal Green. Prof. V. B. Lewes will open the series with a lecture on "The Atmosphere and its Relation to Life." He will be followed by Sir Robert Ball, on "Other Worlds," Dr. Andrew Wilson on "The Brain and Nerves," the Rev. Dr. Dallinger on "Spiders: their Work and their Wisdom," and Dr. J. A. Fleming on "Magnets and Electric Currents."

LOVERS of the piscatorial art will welcome the suggestion that the 300th anniversary of the birth of Izaak Walton, on August 9, shall be commemorated by some memorial. There is a marble bust of Walton at his birthplace, Stafford, and a statue at Winchester, where he is buried, but in London, the home of his adoption, his claim to have his name and work written on a memorial tablet has hitherto been neglected. Mr. Marston, of the *Fishing Gazette*, thinks St. Dunstan's Church, Fleet Street, would be an appropriate building whereon to affix a mural decoration. In commemoration of the tercentenary, a special edition of "The Complete Angler" will be published by Messrs. Bagster in September. Mr. J. E. Harting, librarian to the Linnean Society, is editing the volume, and adding to it notes from the point of view of a naturalist.

AN international anthropometrical congress will be held at Chicago, from August 28 to September 2, under the auspices of the World's Congress Auxiliary of the Columbian Exposition. It is requested that the titles and abstracts of papers on anthropology be forwarded as early as possible to Prof. C. Staniland Wake, Department of Ethnology, in order that the programme may be arranged.

MR. A. O. WALKER informs us that about 8.15 p.m. on June 15, three shocks in rapid succession were felt at Colwyn Bay. The shocks present the characteristic features of true earthquakes, but evidence from a wider area is required to decide the question.

THE thunderstorms which occurred in some parts of our islands about the middle of last week were accompanied generally by very little rain; in parts of Kent, for instance, the total rainfall since the beginning of March has only amounted to about three-quarters of an inch, or 13 per cent. of the normal amount. The temperatures have been exceptionally high, the maxima ranging from 80° to 88° in many parts of the kingdom, while on Monday the 19th instant, the temperature reached 91° at Greenwich. This is the highest reading which has occurred there in June since the year 1858, and it has not been exceeded in any part of the summer during the last five years. In the early part of the present week shallow depressions passed over these islands causing the recurrence of thunderstorms in many parts. These were accompanied by smart showers in a few places, and by a considerable fall in the temperature, the maximum in London on Tuesday being 24° lower than on the previous day. The *Weekly Weather Report* of the 17th inst. showed that the mean excess of temperature ranged from 3° or 4° in England, to 6° in Scotland, and to 7° in the north of Ireland. There was no rainfall whatever over the greater part of England and Scotland.

The Vatican Observatory has issued the third volume of its *Pubblicazioni*, containing xxiii + 442 quarto pages and thirty plates. The plan followed by Padre Denza is the same as in the previous volumes, and the work is produced in the same excellent style. After quoting some historical documents relating to the observatory, an account is given of the last general meeting of the superintending Council and of the principal astronomical and astrographic researches carried on at the observatory. Although the magnetical and geodynamical sections are not yet in order, several papers of special interest in these important subjects are published. The meteorological section contains hourly observations and results for the year 1891; in this branch we specially notice a paper on the classification of clouds by Sr. F. Mannucci, photographic assistant at the observatory, illustrated by fourteen photographs taken at the observatory and neatly printed by Dujardin of Paris. The classification adopted is that proposed by Messrs. Abercromby and Hildebrandsson, and consists of ten different kinds of clouds, divided into five principal groups, according to the heights at which the various forms are usually found. The last part of the work contains an account of the proceedings of the ordinary meetings held in the year 1892.

Probably few people are aware that there still exists in this country a manufactory of gun and tinder-box flints, yet such is the case. Mr. Edward Lovett, in the *Illustrated Archæologist* for June, gives an interesting description of the flint industry which has been carried on at Brandon, situated on the borders of Suffolk and Norfolk, since the Stone Age. The methods employed in the mining and fashioning of flints at that remote period prevail, with little alteration, unto this day. In order to break flint into pieces of convenient size, the worker places the mass on his knee, and, by a dexterous blow with a hammer, shivers it into fragments as easily as if it were chocolate. The pieces are then split into flakes, and these, in turn, are fractured into little squares which, with very slight trimming, become the finished gun-flints. Most of the gun-flints are exported to Zanzibar and other ports in communication with the interior of Africa, but, besides these, large quantities of flints for tinder-boxes are still made at Brandon. Tinder-box flints chiefly go to Spain and Italy for use in isolated districts. It is a curious fact, however, that the flint-and-steel method employed by prehistoric man in making fire is better than matches in uncivilised regions, and very moist climates.

At a recent meeting of the Société Française de Physique a note from Dr. Stephane Leduc was read, in which the correspondant points out that the physiological effects of alternating currents obtained from electrostatic machines are very different to those up to now observed with ordinary alternating currents of high tension and frequency. Thus, if the terminals are held in the hands nothing is felt, although a continuous stream of sparks is passing between the dischargers. If, however, the current is localised at one point on the skin by means of a rounded point, directly this point passes over a nerve, either sensory or motor, the nerve is excited throughout all its length beyond the electrode. The sensation felt in the sensory nerves allows of their distribution being accurately followed, while the least displacement of the electrode on the surface of the skin causes a cessation of all these effects. These currents can in this way be used to localise the seat of nervous excitation with much greater accuracy than has been hitherto possible.

The results obtained by Blondlot in his extensive research on the capacity of polarisation have been confirmed by some recent experiments of M. Bouty (see Proceedings of the Société Française de Physique). M. Bouty has chiefly studied the case of melted electrolytes, of extremely dilute solutions of salts and of solid electrolytes, and his results have very conclusively shown that the initial capacity of polarisation (K) is independent of the direction of the polarising current. When a platinum electrode has been immersed in a melted electrolyte for twenty-four hours it possesses, for a given temperature, a constant initial capacity of polarisation, which increases rapidly with temperature, while the maximum polarisation decreases. In the case of electrodes of platinum in concentrated solutions of most salts (those of platinum excepted) the value of K is very nearly the same for all, and varies little on account of dilution, while there appears to be no connection between the value of K and the specific resistance of the solution.

A curious optical illusion is described by M. Bourdon in the *Revue Philosophique*. If an object moves before our eye, kept fixed, it undergoes, in passing from direct to indirect vision, an obscuration, a change of coloration; and the opposite effect occurs when the object comes into the field of direct vision. It is natural to suppose that this plays a part in the perception of motion, and one fact proving that it does so is, that if we render a slow-moving object suddenly invisible, *e.g.* by means of a shadow, its velocity of displacement seems much increased. M. Bourdon describes an arrangement in which a long pendulum with white thread is swung from a cross bar on a vertical support, which is illuminated from a lamp, while a screen is introduced to give a shadow (the order being, observer, lamp, screen, vertical support, pendulum, dark wall). The white thread in its swing passes into the shadow of the rod and screen, and each time it enters or reappears its velocity seems increased considerably. It seems as if attracted into the shadow, and as if it entered into the light with a sudden shock. It is necessary that the thread should cease to be visible when it enters the shadow. With a red thread the illusion also occurs, perhaps somewhat less vividly. A simpler plan than the above is to hang a pendulum from the ceiling, shading with a screen.

A new method of determining the hardness, or rather perhaps the friability of substances, has been described by Hr. August Rosiwal at a meeting of the Vienna Academy. The measurements consist in comparing the losses of weight sustained by the bodies under investigation by scratching them with a given weight of polishing material mounted on a metallic or glass base until the material loses its efficiency. The polishing materials used were dolomitic sand, emery, and pure corundum. The diamond was assigned its place in the scale of hardness by comparing its efficiency as a polishing material with that of corundum. It was found to be 140 times as hard as corundum. Tested by this method, the constituents of Mohs's scale have the following numerical values:—Diamond 140,000, corundum 1000, topaz 194, quartz 175, adularia 59·2, apatite 8·0, fluorspar 6·4, calcite 5·6, rocksalt 2·0, and talc 0·04. The great advantage of the method consists in the ease with which the hardness of mixtures of minerals in the various rocks is determined.

PROF. OBERBECK, of Greifswald, has been studying the spreading of oil on liquid surfaces on a larger scale than that of ordinary laboratory work. The experiments, which are described in the current number of *Wiedemann's Annalen*, were carried out in the Bay of Rügen, upon which the Prussian university town is situated. The professor sailed out into the bay for a distance of 2 km. or so, accompanied by an experienced mariner, and armed with bottles holding from one-tenth to half a litre of machine oil or rape-seed oil in measured quantities. Sitting in the stern of the vessel, he poured the contents of the bottles at intervals into the water in a thin continuous stream, the vessel meanwhile moving at a uniform rate in the same direction. After about an hour the oiled tracks were revisited. The brilliant colouring had disappeared, and the oil had spread out into well defined rectangular light-grey patches, easily distinguished from the rest of the sea by the absence of ripples and their consequent superior reflecting power. Their area was estimated, with the aid of the experienced mariner, by the time occupied in sailing past. In the case of the half-litre bottle the patch measured 300 by 30 metres, thus giving an area of 18,000 square metres corresponding to one litre of oil. A more accurate measurement was made subsequently by means of a line of buoys marking the deep-water channel. This gave an area of 18,857 square metres. Hence the thickness of the film of oil was 53 millionths of a mm. It is, of course, possible that the oil had spread still further and had only ceased to influence the ripples on the surface. In that case the film must have been even thinner.

THE applications of electricity to every-day life seem to be almost infinite; the latest development being an electrical horsewhip described in *Électricité*. This is said to be designed for the use of a "sportsman," and consists of a celluloid handle containing a small induction coil, together with a battery, the circuit being closed by means of a spring push. Two wires carry the current to the extremity of the whip, which is furnished with two small copper plates having points fixed to them of sufficient length to penetrate the coat of the horse, and yet not being sharp enough to inflict a wound.

IN a note contributed to the Accademia dei Lincei, Augusto Righi gives a short description of a form of apparatus he has used for producing Hertzian oscillations of short wave-length and exhibiting their properties to an audience. The oscillator consists of two rods furnished with balls at either end and placed between the discharger of a Holtz machine, leaving a gap of about 4 centimetres at each end, and one of about 3 mm. at the middle. The two rods pass through the sides of a glass vessel containing oil, so that the middle pair of knobs are surrounded by oil. The resonator consists of a nearly complete circle of wire, the gap being filled by a Geissler tube. With the above apparatus the author has carried on a series of experiments on the reflection, refraction, and interference of these electrical waves.

AN abstract of a paper by C. H. Morse appears in the *Electrician*, giving an account of the damage to the water-pipes in Cambridge (Mass.), caused by the electrolytic action of the return current from the electric cars. Pipes composed of lead, iron, galvanised iron, brass, and rustless iron were in turn tried and found to deteriorate quickly. Such an amount of current was found to be flowing along the pipes that, upon attempting to make a joint by putting oakum round the pipe, an electric arc was formed and set the oakum on fire. The damage has to a great extent been checked by connecting the gas and water-pipes together, and also to the negative pole of the dynamos which supply the power to the railway.

AT the beginning of this year (says the *Revue Scientifique*, June 17) there were 1168 submarine cables in existence, of which 880 belonged to different dominions and 288 to private companies. The former possessed a length of 16,652 miles, and the latter had a length of 144,743 miles, thus the total length was 161,395 miles. Fifty-four of these cables belong to the state in France, the length being 3979 miles; and Germany owns 46 cables, having a total length of 2025 miles. There are 14 Anglo-French cables, 10 Anglo-Belgian, 8 Anglo-Dutch, and 13 Anglo-German. Of the cables possessed by private companies the Eastern Extension, Australasia, and China Telegraph Co. head the list with 25 cables and a mileage of 18,205; the Great Northern Telegraph Co. follow with 24 cables, having a total length of 6948 miles; then come the West India and Panama Telegraph Co. with 22 cables extending through 5240 miles: and the Western and Brazilian Telegraph Co. with 15 cables stretching over 5408 miles. The French Society of Submarine Telegraphs possess 14 cables having a total length of 3754 miles.

THE "shell-beds," or shelly clays, in the north of Scotland—at Clavia near Inverness, and on the east coast of Aberdeenshire, have been investigated by Mr. Dugald Bell, and the results of his researches were communicated to the Glasgow Geological Society on May 25, under the title "The alleged proofs of submergence in Britain, during the Glacial Epoch." Mr. Bell holds that it is doubtful if this clay were really in place, as part of an ancient sea-bottom, during the glacial epoch. He thinks also that the "red clay" of East Aberdeenshire, described by Mr. Jamieson, cannot be accepted as a satisfactory proof of submergence, indeed, in some respects, its characteristics seem to be inconsistent with that theory.

FROM the *Pioneer Mail* we learn that Mrs. J. S. Mackay has a superb snow leopard at Kulu, in the Punjab. Though the animal is nearly full-grown, he is practically free and lies about the house all day like a huge cat, or romps with his mistress. His ultimate destination is the Zoological Gardens of London. Should he be brought over alive he will be the only animal of his kind in Europe.

IN a paper, "Sulla presenza di batteri patogeni nella saliva di alcuni animali domestici" (Fiocca: *Annali dell' Istituto d'Igiene Sperimentale della R. Università di Roma*), an examination of the saliva of numerous horses, dogs, and cats is recorded. The saliva of the horse was found to contain diverse bacilli, also streptococci, staphylococci, and one spirillum. Amongst these organisms three were discovered which possessed pathogenic properties; and one of these, a bacillus, was very frequently found, for out of fifteen different samples of saliva inoculated into guinea-pigs it was only once absent. This organism is distributed in soil, and it is very possibly also frequently present on grass and hay, and hence its prevalence in the saliva of horses. The saliva of the cat presented a very different appearance from that of the horse, being very rich in cocci and minute bacilli. A new bacillus (*Bacillus salivarius felis*), extremely characteristic of cats' saliva, was isolated and found to be specially pathogenic to rabbits and guinea-pigs, these animals dying from its effects in twenty-four hours. The dog's saliva was found to contain the largest variety of bacteria, amongst the pathogenic forms isolated being the *B. pseudo-œdematis maligni*, and the *Staphylococcus pyogenes aureus*.

SOME investigations on the antagonistic effect produced by the *Bacillus fluorescens liquefaciens* on other organisms have been made by Olitzky (*Ueber die antagonistischen Wirkungen des B. fluorescens liquefaciens und seine hygienische Bedeutung*, Bern, 1891). Cultures of this bacillus were either streaked on to nutritive agar-agar side by side with other organisms, or the latter were separately inoculated on to culture material in which this bacillus had grown, but which before being used for the second time was re-sterilised, the growth being thus destroyed, but the *products* remaining. It was found that the tubercle bacillus and the pneumococcus of Fraenkel were quite unaffected, whilst the *B. prodigiosus* only refused to grow in the re-sterilised culture material. On the other hand the *Staphylococcus pyogenes aureus*, the anthrax bacillus, and the typhoid bacillus were greatly impeded in their development, and no growths whatever made their appearance in the re-sterilised culture material. The cholera bacillus and the *B. pyocyaneus* were also affected, but to a smaller extent.

SHORTLY before his death, Mr. Darwin informed Sir J. D. Hooker, F.R.S., that "the difficulties he had experienced in accurately designating the many plants which he had studied, and ascertaining their native countries, had suggested to him the compilation of an 'Index to the Names and Authorities of all Known Flowering Plants and their Countries' as a work of supreme importance to students of systematic and geographical botany, and to horticulturists." "At his request," adds Sir J. D. Hooker, "I undertook to direct and supervise such a work." The Clarendon Press announces that Part I. of this "Index Kewensis" is now ready, that Part II. is well advanced, and that the completion of the whole work may be expected next year.

THE first part of Prof. A. Newton's "Dictionary of Birds" has just been published by Messrs. A. and C. Black. It extends from aasvogel to the gare-fowl, or great auk, and runs into 304 pages. The work is founded upon a series of articles contributed by Prof. Newton to the ninth edition of the "Encyclopædia Britannica." Important additions have been furnished by Dr. Hans Gadow, and for other contributions Mr. R. Lydekker, Prof. C. S. Roy (who has written an interesting article on "Flight"), and Dr. R. W. Shufeldt are responsible. A commendable feature is the inclusion of many names of birds, such as the *caracara*, *koel*, and *mollymawk*, which are frequently found in books of travel but are not explained in an ordinary dictionary. Compound names of the *crow-shrike* and *thrush-titmouse* kind have, however, been omitted.

MR. R. L. JACK, the Government Geologist of Queensland, has prepared a report on the Russell River Gold Field. The report is accompanied by a geological map of the district.

WE have received a dissertation by Mr. E. M. Blake, in which he discusses the application of the method of indeterminate coefficients and exponents to the formal determination of those integrals, of certain systems of differential equations, which are expressible as series.

THE Harvard University Bulletin for May is a long list of accessions to the University Library. This list includes, in addition to recently-published books and pamphlets, a number of extensive and important works of earlier date. Nearly one hundred and fifty books in the list are concerned with science and the arts.

MESSRS. MACMILLAN AND CO. have published a second edition of "Lessons in Elementary Biology," by Prof. T. Jeffery Parker. The whole of the book has been thoroughly revised, and two of the lessons have been largely rewritten. A number of new figures have also been added.

MR. W. H. HUDSON, the author of "Idle Days in Patagonia," recently reviewed in these columns, has completed a book called "Birds in a Village," which will be published in a few days by Messrs. Chapman and Hall. The book does not profess to be a serious contribution to ornithology, but is intended rather for the general reader. Among other chapters of interest is one on the introduction of exotic birds, and another on bird-life in London. In the concluding portions of the book the subject of bird-protection is dealt with at considerable length.

A REFERENCE list of the land and freshwater mollusca of New Zealand has been prepared by Messrs. C. Hedley and H. Suter, and appears in the "Proceedings of the Linnean Society of New South Wales," vol. vii., December, 1892. The authors are of the opinion that as the New Zealand fauna becomes better known, its insular character stands out more prominently. Foreign genera, which have been imposed on the fauna, have been eliminated one by one, and many genera which might have been expected to occur, since they are prevalent in neighbouring countries, have not yet been detected. Crosse remarked that "The terrestrial and fluviatile molluscan fauna of New Zealand approximates more to that of New Caledonia, in spite of the considerable distance that separates the two countries, than to that of Australia" (*Jour. de Conch.* xxviii. p. 37), and the authors think his idea has hardly received the attention which it merits.

THE "Tourist Guide to the Continent," published for the Great Eastern Railway Company, has reached its fourteenth year of issue. It is edited by Mr. Percy Lindley, and includes descriptions of things and places of interest in Holland, Germany, Belgium, and Switzerland.

AFTER Mr. Francis Galton, F.R.S., had completed his work on "Finger Prints" he came into possession of the impressions of the fore and middle fingers of the right hand of eight different persons at Hooghly, Bengal, made in the first instance in 1878, and secondly in 1892. These prints have afforded the text for a discussion as to the persistence of patterns, and the result of the decipherment is now published as a supplementary chapter to the above-named book. Though the prints were not obtained by the best means, a comparison of the reproductions of them shows clearly that the "sign-manual" furnishes unquestionable evidence as to a person's identity, and further, the testimony is of such a character that any juryman would be able to appreciate its weight.

WE have received a communication from "Waterdale," in which he calls attention to the fact that he subsequently corrected many of the errors pointed out in the review of his researches which appeared in vol. xlvii. p. 601.

A CORRESPONDENT desires to know where to find any celebrated and artistic hedgerows of elms within about thirty or forty miles of London. Perhaps one of our readers will furnish the required information.

MESSRS. FUNK AND WAGNALL, New York, have just issued a complete prospectus of "A Standard Dictionary of the English Language," a work that has been in preparation for several years, and is now nearly completed. The dictionary will contain 280,000 words in about 2200 pages of medium quarto, and will be embellished with more than 4000 illustrations specially prepared for it. One of the many distinguishing features is the comprehensive provision that has been made for definitions by specialists in various arts and sciences. Handicraft terms have been gathered with great completeness and grouped under the different trades, and by applying a similar system of grouping to the names of fruits, flowers, weights, measures, stars, &c., the facts concerning this class of words are given in a very complete manner. For example, under *constellation* are given the names of all the constellations, and under *apple* are found the names of nearly four hundred varieties. Judging from the specimen pages, and the list of men eminent in science and literature who are concerned in the compilation, the dictionary will be the handiest, simplest, and most trustworthy publication of its kind.

THE *Johns Hopkins University Circular*, No. 106, is chiefly taken up with morphological notes from the biological laboratory of the Johns Hopkins University. Prof. William K. Brooks contributes two important notes on the Salpa embryo, and Mr. M. M. Metcalf describes an apparently new species of Octacnemus, a deep-sea, Salpa-like tunicate. A memoir on the genus Salpa, by Prof. Brooks, will shortly be published. It will contain about three hundred and fifty quarto pages, with sixty coloured plates. The memoir is based for the most part upon material collected by the United States Fish Commission.

"ELECTRIC Light Installations and the Management of Accumulators," by Sir David Salomons, Bart., has reached a seventh edition. This edition has been, to a large extent, rewritten, and is now published by Messrs. Whittaker and Co. under the title "The Management of Accumulators," as the first volume of a series dealing with electric light installations.

Two further papers upon azoimide, N_3H, are contributed to the current number of the *Berichte* by Prof. Curtius. In the first, a brief but important communication, it is shown that azoimide may be prepared directly from hydrazine, $\begin{matrix} NH_2 \\ | \\ NH_2 \end{matrix}$ by the action of nitrous acid.

$$\begin{matrix} NH_2 \\ | \\ NH_2 \end{matrix} + ON{\cdot}OH = \begin{matrix} N\diagdown \\ \| \quad NH \\ N\diagup \end{matrix} + 2H_2O.$$

It is only necessary to lead the red oxides of nitrogen evolved from a mixture of nitric acid and arsenious oxide into an ice-cold aqueous solution of hydrazine hydrate until a vigorous evolution of gas, due to decomposition, commences. A dilute aqueous solution of azoimide is thus obtained with which most of the reactions of the substance can be performed. It is preferable, however, to first condense the red gaseous mixture by means of ice and salt, and to pour the blue liquid, a few drops at a time, into the cold hydrazine solution until the evolution of gas begins. The experiment is unattended by any danger, and is therefore admirably adapted for lecture purposes. Now that hydrazine is so well known and so readily obtained, the sulphate being already a commercial article, this mode of obtaining azoimide will doubtless be adopted by most lecturers for class demonstration, especially as the reaction is one of such fundamental theoretical importance.

IN the second communication Prof. Curtius describes an interesting new organic synthesis of azoimide. When hydrazine hydrate is caused to act upon a salt of diazobenzene, a fugitive compound is obtained of the constitution indicated by the formula $C_6H_5N : N.NH.NH_2$. This compound might be expected to decompose in two ways, breaking up either at the double linkage or at the single linkage between the NH and NH_2 groups. According to the former mode there would be a migration of two hydrogen atoms from two different nitrogen atoms to a third nitrogen atom with production of aniline and azoimide, $C_6H_5N : N.NH.NH_2 = C_6H_5NH_2 + N_3H$. According to the latter mode of decomposition one hydrogen atom would migrate and form ammonia with the last amido group, leaving diazobenzene imide, thus: $C_6H_5N : N.NH.NH_2 = C_6H_5N_3 + NH_3$. As a matter of fact both decompositions occur, the latter somewhat predominating. It is quite easy, however, to isolate 10 per cent. of the theoretical yield of azoimide. Equi-molecular saturated aqueous solutions of hydrazine sulphate and diazobenzene sulphate are mixed and poured into a 3 per cent. solution of sodium hydrate. A turbidity is at once produced, which eventually coalesces into an oil. This is extracted with ether and ammonia, expelled from the aqueous solution by boiling. The liquid, which contains the sodium salt of azoimide, is then rendered slightly acid with sulphuric acid and distilled, when azomide passes over along with the steam. The ethereal extract contains the aniline together with diazobenzene imide produced according to the second mode of decomposition.

NOTES from the Marine Biological Station, Plymouth.—The arrival of Midsummer renders desirable a summary of the records which have been made in this paragraph during the past six months of the breeding seasons of marine animals at Plymouth. The records have approximately indicated the *commencement* of the breeding seasons; but it should be premised that in the great majority of instances the period of reproduction is prolonged throughout the summer months, and is already at an end only in a few isolated cases. The following have been recorded:—The Gymnoblastic Hydroids *Tubularia bellis*, *Clava multicornis* and *cornea*, *Eudendrium ramosum* and *capillare*, together with the Anthomedusæ *Rathkea octopunctata* (now over), *Bougainvillea ramosa*, *Amphinema Titania*, *Sarsia prolifera* and *tubulosa*, *Podocoryne carnea* and *Corymorpha nutans*; the Calyptoblastic Hydroids *Halecium* (*halecinum* and *Beanii*), *Plumularia setacea* and *pinnata*, *Antennularia ramosa* and *antennina*, *Sertularella* (*Gayi*), *Sertularia argentea* and *pumila*, *Hydrallmania* (*falcata*), *Gonothyræa Lovéni*, together with the Leptomedusæ *Obelia lucifera*, *Clytia Johnstoni*, *Irene pellucida*, *Phialidium variabile*, *Laodice cruciata*, *Thaumantias octona*, *Forbesii*, and *Thompsoni*; the Ctenophore *Hormiphora plumosa*; the Actinians *Cereanthus* (*Arachnactis*,—now over), *Halcampa chrysanthellum*, *Cereus pedunculatus*, *Bunodes verrucosa*, *Urticina felina* and *Actinia equina*; the Nemertines *Cephalothrix linearis* and *bioculata*, *Amphiporus dissimulans*, Riches (= *pulcher* of previous record, March 30), *Nemertes Neesii*, and *Lineus obscurus*; the Polychæta *Phyllodoce maculata*, *Cirratulus cirratus*, *Polydora* (*flava ?*), *Sabellaria spinulosa*, and various *Terebellidæ* and *Serpulidæ*. The Polynoïd larvæ which swarmed in the Sound in the early Spring are no longer to be obtained. The Mollusca, Crustacea, Echinodermata and Chordata will be summarised next week.

THE additions to the Zoological Society's Gardens during the past week include three Peba Armadillos (*Tatusia peba*, ♂ ♂ ♀) from South America, presented by Mr. Woodbine Parish; two Brazilian Cariamas (*Cariama cristata*) from Paraguay, presented by Mr. A. E. Macalister Hadwen; five Spotted-billed Ducks (*Anas pœcilorhyncha*, 4 ♂ 1 ♀) from India, presented by Sir E. C. Buck, C.M.Z.S.; a Guillemot (*Lomvia troile*) British, presented by Mr. T. A. Cotton, F.Z.S.; two Chiff-chaffs (*Phylloscopus rufus*), two Yellow Wagtails (*Motacilla flava*) British, presented by Miss McGill; a Naked-necked Iguana (*Iguana delicatissima*) from the Caicas Islands, West Indies, presented by Lady Blake; a Lobed Chameleon (*Chamæleon parvilobus*) from Barberton, Transvaal, presented by Dr. Percy Rendall; two Capybaras (*Hydrochærus capybara*) from South America, purchased; an English Wild Bull (*Bos taurus*, var.), a Burrhel Wild Sheep (*Ovis burrhel*, ♀), a Derbian Wallaby (*Halmaturus derbianus*, ♀) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

A NEW VARIABLE *u* CYGNUS.—In photographing the region of α Cygni, Dr. Max Wolf (*Astronomischen Nachrichten*, No. 3168), on examining the plates, has found a new variable, its position for 1893·0 being R.A. 20h. 47·2m., Decl. + 45° 49′. The star, he says, is very easy to find, lying as it does in the south right-angle corner of a right-angled triangle, the stars in the other corners being B.D. stars + 45°·3300 and + 45°·3302.

The brightness, as obtained from the plates, gave the following numbers:—

				m.
1890	...	Dec. 12	...	13
1891	...	June 1	...	12
1891	...	Sept. 7	...	12
1893	...	May 14	...	12·5

Finlay's Comet (1886 VII.).—The following ephemeris for this comet is continued from *Astronomischen Nachrichten*, No. 3164:—

12h. M.T. Paris.

1893.		R.A. app. h. m. s.		Decl. app. ° ′
June 22	...	2 19 1	...	+11 14·5
23	...	23 47	...	11 40·6
24	...	28 33	...	12 6·3
25	...	33 19	...	12 31·6
26	...	38 4	...	12 56·5
27	...	42 50	...	13 21·0
28	...	47 35	...	13 45·1
29	...	52 20	...	14 8·7

The comet during this week lies towards the southern part of the constellation of Aries, passing near Aries 38 on the 26th.

A Bright Comet?—A telegram which we have received from Kiel contains the following data obtained on June 5 and 12 with regard to a probable comet:—

1893.		R.A. h. m.		Decl. ° ′
June 5	...	9 57·1	...	+14 21
12	...	10 4·3	...	+20 56

This object lies somewhere in the region of η Leonis.

Observations of Nebulæ.—In *Astronomischen Nachrichten*, No. 3167-68, Dr. Rudolf Spitaler communicates the observations of nebulæ that he has recently made with the 27-inch Grubb refractor of the Observatory in Vienna. He also compares the brightnesses obtained by him with those in Dreyer's new General Catalogue of Nebulæ and Clusters. In addition to the mean places of these objects and of the comparison stars employed for the years 1891 and 1892, he gives several notes and a plate illustrating many of the nebulæ.

The Yerkes Telescope.—*Astronomy and Astrophysics* for June gives some particulars about the Yerkes telescope, from which we make the following few notes. The great tube pier and clockwork are being built by Messrs. Warner and Swasey, the makers of the Lick 36-inch. The column will be made in five sections, each section except the base one (which will weigh about 18 tons), weighing about 5½ tons each. The column rises 31 feet 4 inches from the base. The pier head weighs 5½ tons; thus the total weight of the column and head reaches about 45 tons. The polar axis, which is of steel, is 15 inches in diameter, 13 feet long, and weighs about 3½ tons, the declination axis measuring 12 inches in diameter and weighs 1¾ tons. The length of the sheet steel tube (exclusive of eye end) measures 62½ feet, its greatest diameter reaching 52 inches, and weighs 6 tons. The focal length of the objective is about 64 feet. All quick and slow motions and clamps can be operated either from the balcony, eye end, or floor, by hand or by electricity as may be required. The floor will be an elevating one like that at the Lick. The telescope weighs in all 75 tons, and an idea of its size may be gathered from the fact that "when the telescope is pointed to the zenith, the object glass will be 72 feet in the air, or about as high as a seven-story house."

The Smithsonian Report for Year Ending 1892.—Among the many interesting points to which Mr. S. P. Langley, the secretary of the Smithsonian Institution, refers to in this report, we note the following: The Smithsonian Astrophysical Observatory still occupies the "temporary wooden shelter on the grounds." Although the money for the permanent building is in hand, the Institution is only waiting for the action of Congress to provide a site. With respect to the work that is being done and is proposed for the future, Mr. Langley makes a special reference. The branch of astronomy to which the resources of the Observatory will be devoted will be that of exploring the great unknown region in the infra-red end of the spectrum by the method recently improved by Mr. Langley himself. The secretary refers also at some length to the recent gift of 200,000 dollars to the Institution by Mr. Thomas George Hodgkins, of Setauket, N.Y., the interest on 100,000 dollars of which is to be used for the general purposes of the Institution on the "increase and diffusion of knowledge among men," provided that the interest on the remainder be used in the investigation of the properties of atmospheric air considered in its very widest relationship to all branches of that science. The report contains the result of several communications on the subject. At some length are treated also reports on the National Zoological Park, which, by the way, seems to be in a not very flourishing condition, on the financial aid given to Research, the National Museum, Bureau of Ethnology, &c., which we must pass over, as they do not appertain directly to the subject of this column. One point we must refer to is the proposed plan of publishing a work on the moon which shall represent the present knowledge of her physical features. The Institution is already in communication with some of the leading observatories of the world, and it is hoped that "a series of photographic representations of hitherto unequalled size and definition, which shall represent the moon's surface as far as possible on a definite scale, and *entirely* without the intervention of the draughtsman." We heartily wish the co-workers in this scheme success, for have we not now, with the present state of photography and fine instruments, a good basis to work upon.

THE MORPHOLOGY OF THE VERTEBRATE EAR.[1]

I. THIS elaborate and important monograph monopolizes the first two parts of the sixth volume of the *Journal of Morphology*. It is the second of a projected series on "Vertebrate Cephalogenesis." Its predecessor was published in the same journal two years ago, and the instalment now under consideration has been anticipated by three shorter communications (Nos. 5, 7, and 8 of the literature cited) of a distinctly sensational character. The 320 pages of contents are illustrated by 26 simple woodcuts; and by 12 magnificent folding plates, printed in colour, and bearing the charmed names of Werner and Winter.

The monograph is subdivided into six sections, with a recapitulatory one, and is based upon the morphological study of the ears of adequate representatives of leading classes and orders of vertebrates, and upon experimental observations chiefly involving the pig and cat. The author's work bears every trace of extreme caution in manipulation, and he lays much stress upon deceptive effects produced by the action of reagents—for example, the knobbing and apparent collar-formation met with in the hair-cells of the avian basilar organ. In seeking to correct certain kindred errors which have arisen during the work of his predecessors, the author concludes (i.) that Retzius' "nerve plates" of the avian labyrinth are "products of the maceration process"; (ii.) that the "horseshoe figure," which the same investigator attributed to the mammalian hair-cell, is an "optical effect"; (iii.) that the continuity between the pillar-fibres and basilar membrane described by Noel "does not exist"; and (iv.) that the basilar membrane itself—defined as "a modified portion of the skin of the head which forms first and last the floor upon which the sense organs rest"—is not elastic enough "to serve for the transmission of the delicate undulations which it has been supposed to transmit." While denying the presence of "spiral nerves" in the cochlea, he concludes that they "exist in the living condition as delicate walled but relatively large lymph channels"; and concerning the very involved question of relationship between the nerve fibres and hair-cells, he asserts that the ultimate filaments are "continuations of the nerve into the hair processes." The "membrana tectoria" of the mammal is said to be but a "cupula terminalis-like structure produced by the gluing together of the hairs of the sensory cells of the organ of Corti, and the breaking away of the whole from the cells which bear them"; and it is incidentally remarked that as found in ordinary preparations it is but "an artifact produced by the use of reagents." However much disposed to accept this very revolutionary deduction, we await confirmation of certain of the author's detailed observations, before fully acquiescing in the belief that "the membrana tectoria, the membrana reticularis, Loewenberg's net, and the three or four main trunks of the system of spiral nerves of the cochlea" so-called, are one and all pure artifacts.

In the course of his inquiry the author has been led into a re-examination of the detailed relationships of the auditory nerves; and in this department he has done a lasting service by sufficiently emphasizing Breschet's long-recorded discovery that the auditory nerve of man is "divided into two branches, each of which supplies semicircular canal organs" (*i.e.* that

[1] "A Contribution to the Morphology of the Vertebrate Ear, with a Reconsideration of its Functions." By Howard Ayers, Director of the Lake Laboratory, Milwaukee, Wis., U.S.A.

the posterior ampulla is innervated from the cochlear nerve), the unfortunate bearings of which upon certain much more recent physiological speculations he is not slow to point out (p. 148). The thanks of all teachers are similarly due to the author, for having introduced the peculiarly appropriate term "ama" for that second and non-sensiferous enlargement of the canals met with in the lower and the highest classes of vertebrates, and for the substitution of "external" for the misleading "horizontal" canal.

One very remarkable discovery, which the author deals with only too casually, is that "in many forms of Elasmobranchs the ear contains scarcely any crystals, and not unfrequently sand grains." The interest of this, by analogy to Hensen's well-known experimental observations upon the Decapod Crustacea, will sufficiently appeal to all zoologists; and we sincerely hope the author will early furnish us with particulars concerning it.

II. Revolutionary as may be some of the author's conclusions above cited, the refrain of the major part of his morphological inquiry is, on the whole, no less so. It runs as follows:—"There can be no doubt that the internal ear develops from superficial canal organs"; that it is primarily subdivided into anterior and posterior portions; and that a "fateful distortion," under which the great development of the cochlea drags the posterior half downwards, has "perhaps more than anything else" deceived us and "retarded our progress in the knowledge of the significance" of its parts. Thus it is that the author gives definiteness to a view which, although it unconsciously dawned with Leydig's recognition of structural similarity between the auditory and tegumental-canal sense-organs of the Ichthyopsida, was first definitely formulated by Beard. He takes his stand upon Beard's brilliant generalization, as modified by the acceptance of Froriep's interesting correction (p. 314), and by certain considerations arising out of his own inquiry. In the performance of this task the author has been shoulder to shoulder with Mr. Allis, co-editor and joint founder of the *Journal of Morphology*, and author of one of the most remarkable papers which its pages have yet borne, viz. that upon "The Anatomy and Development of the Lateral Line System in Amia Calva," duly noted in these pages (NATURE, Aug. 29, 1889), and nothing is more apparent than that he has sought to extend the laws of growth which Allis discovered for the lateral line organs to the internal auditory one. His leading deduction that the last named structure consists of "a symmetrical group" of the organs in question chiefly rests upon the following discoveries and allegations, apart from any question of general structural resemblance between the two, viz. (i.) the lineally recurring (antero-posterior) symmetry of the parts of the labyrinth; (ii.) the duplication of the endolymphatic ducts in Cyclostomes and some Elasmobranchs; (iii.) the double and repetitional nature of the auditory nerve—that being regarded as a derivative of "two distinct cranial nerves," consisting of an anterior (utricular) fasciculus in anastomosis with the facial, and a posterior (cochlear) one, either in astomosis with the glossopharyngeal, or totally independent; and (iv.) an attempt to show that the *macula acoustica neglecta* is an "abortive second horizontal canal organ." Although inclined to accept the general tenor of the author's broader morphological conclusions, we cannot concur in the last cited one. He formulates it almost entirely upon the study of nerve distribution; and, by his own showing (pp. 28, 29) the sensiferous area in question might well have had an independent origin. The conclusion does not, however, materially affect the author's dictum, and in respect to it he seems to have been carried away by a bias in favour of Allis, which elsewhere reappears (pp. 275, 277, and 283), and culminates in the unwarrantable assertion (p. 308) that "the semicircular canals of the ear are simply remnants of the canal system of the surface" (p. 318) "not known to have any other function than the one inherited from their ancestors, viz. that of serving as mechanical protectors of the sense organs," and that they are to be classed with such structures as valves in the horizontal veins . . . the vermiform appendix . . . and atavistic muscles" (*sic*). Having sought to show that the "canal organ has been gradually losing ground" during the progress of descent with modification, the author argues (p. 235) that the future human ear "will not retain much else than the cochlea"! What of the adherents to the bagpipe? We would recommend a periodical examination of their ears to the author's notice. Statements of the order here commented upon are indicative of haste and over-enthusiasm, while others, to the effect that (p. 47) "the cells involuted with the sensory structures "merely" serve as a lining of the auditory canal chambers," and that the otoliths, which they secrete (p. 309) "are to be considered as essentially foreign bodies . . . tolerated because of the impossibility of getting rid of them . . . and the result of the secretive action of the ectoderm cells, which in ancestral forms produced the surface scales," are little short of nonsensical.

With Fritsch, the author regards the Savi's vesicles of the *Batoidei* as derivatives of "the widespread open canal type" of organ; and by no means the least striking portions of his treatise are those in which he attempts to prove (i.) that the semicircular arch of *Myxine* is "composed of the anterior and posterior vertical canals of the Gnathostome vertebrate ear"—deducing an argument in favour of the non-degeneracy of the *Marsipobranchii*, and (ii.) "that a comparison of the ears of Myxine, Petronnyzon, Dasyatis, Torpedo, and Man clearly shows the connection of the [endolymphatic] duct with the utricular and sacular chambers to be a fundamental condition, and not a secondary acquirement."

III. That the physiological aspects of the author's inquiry might be expected to be no less sensational than the morphological ones, is sufficiently clear from his earlier surmise (pamphlet No. 7 of literature cited) that (p. 8) "when one considers the truly wonderful auditory powers" of the mocking bird, "it becomes evident that we must seek for some explanation which does not involve the piano-string hypothesis," and that (p. 9) "it is perfectly obvious that we do not need an internal ear in the vertebrate organization for the perfect exercise of the function of equilibration, since in Amphioxus the organ is absent, and in higher forms the auditory nerves may be destroyed without destroying this function." Little wonder, then, that the author should denounce both the "statical" theory of Goltz, and the more recent "dynamical" one of Cyon, Crum-Brown, and later experimentalists. His attitude towards the majority of his predecessors is best expressed in his remark that "all the phenomena following canal section in mammals and in birds are nothing more than the results of brain lesions such as are entirely inadequate to explain" them.

Availing himself of the observations of Munk, that, whereas in the dog, destruction of the ear, which may lead up to fatty degeneration of its inner constituent, is "always followed by dizziness and equilibrative disturbances, such disturbances do not appear when the cochlea is preserved," and of others akin to them he concludes that, provided the semi-circular canals "have a function, it is not either statically or dynamically equilibrative." Reference is made to Steiner's important observation that whether (in the shark) "the semicircular canals were removed or not," disturbance of the otoliths covering the utricular sense organ, invariably instituted rolling movements, usually towards the side disturbed; but the author is silent concerning Engelmann's attempt to assign distinct functions to the cristæ and maculæ with their associated otolithic masses. Indeed, his opening statement (p. 237) that "we have very slender foundation for forming final judgments of the functional relations of any parts of the internal ear, and that at present what we imperatively need is not speculation, but *experimentation*," well defines our position to-day, when the sum of the author's own experimental observations are taken into account. The physiological section of his work is much weaker and less extensive than its morphological ally.

IV. The author is to be congratulated upon an unusually speculative treatise, embodying a substratum of solid work. As a "paper" it is, in its bulkiness, a sort of awful example fit to rank with that of his countryman Mark on the egg of *Limax campestris* (*Bull. Mus. Comp. Zoöl.*, vol. vi., 445 pages in all). The publication of such voluminous treatises in any but book form, provided with an analytical index, is unjust to both author and reader. It is a gross mistake, and the author has but himself to thank if he escapes proper recognition in consequence. Much of the said bulkiness of the present treatise is due to the incorporation of needlessly lengthy citations from foreign writers, which, permissible in a book, are out of place in a "paper" intended for specialists possessing a full knowledge of current literature. We could have wished, instead of these, a recognition and an explanation of topics untouched; for example, of the circular condition of the posterior canal among the depressed Batoidei, which the author's remarks on pp. 13, 16, 222, and 223 by no means sufficiently express, and which is inexplicable on his belief that "the mechanical forms active in the modelling of the ear are for the most part the inherited tendencies of cell growth acquired as legacy from the canal organs of the surface." Among important topics which the author ignores, and upon which we could have wished his opinion, are Chatin's alleged discovery of all intermediate stages between the rod-bearing and ciliated cells of the Batrachian auditory epithelium, and the views of Engelmann, Chun, and Yves Delage, arising from the experimental study of the otoliths in Ctenophora, Mollusca, and Crustacea. The latter are by no means reconcilable with the author's bold assertion that "the functions of the otoliths are entirely unknown." In dealing with the "chalk-sacs" of the amphibia, the author remarks (p. 21) that their "morphological as well as physiological significance" is still unknown. He ignores the fact that Lenhossek has shown them to be tubular glands and named them; and this is very remarkable, as, while he makes no mention of that author's paper, he acknowledges one by Coggi, in which it receives ample recognition. G. B. H.

PERSPECTIVE AND COLOUR.

IN *Brain*, Parts LXI. and LXII., which have just been published, occurs an interesting article by Prof. Einthoven (of Leyden) on the production of shadow and perspective effects by difference of colour. The following is an account of the phenomena:—

Difference of colour may, under certain circumstances, be the cause of an apparent difference in distance.[1] To observe the phenomenon, it is only necessary to glue different coloured figures, such as letters of blue and of red paper, to a screen of black velvet and to look at them from a suitable distance. In the experiment about to be described, Roman capital letters of about eight by four centimeters were used, the screen being placed at about three meters distance from the observer.[2]

Under these conditions it appeared, both to Prof. Einthoven and to others who he interrogated, that the red letters were nearer than the blue. Obviously, the phenomenon might be explained by difference in accommodation. In order to see the red letters distinctly, a greater amount of accommodation is necessary than in focussing the blue ones, and the greater sense of effort might account for the notion of the red letters being nearer. This accommodation hypothesis, plausible as it seems, cannot however be accepted as a satisfactory explanation of the phenomenon. Several observations tell against it, notably this: that there are about as many persons who see the blue letters before the red, as there are those who see red before blue. In the second place, the apparent difference in distance—so distinct to binocular vision—disappears almost wholly with the closure of one eye. Looked at with one eye only, and for some length of time, the letters appeared to be lying in the same plane, but each time that the other eye was opened the difference in distance obtruded itself irresistibly.

The amount of difference remains constant, and can be estimated with considerable accuracy, in the same way as in making a stereoscopical observation. The question therefore suggested itself, whether we had not here to deal with real stereoscopy? The answer to this question is an affirmative. Brücke[3] has shown by means of a simple experiment that the retinal images of differently coloured points are shifted with respect to one another. Looking with one eye at a narrow vertical strip on a black background, the upper and lower thirds of the strip being red and the middle third blue, Brücke observed that the blue part deviated to one side, the two red parts to the other side. By covering either eye alternately, a deviation of the blue and red parts in opposite directions will be observed; and, on both eyes being used, the notion of a difference in distance is proved by the combination of the two images in such a way that the parts that deviate to the nasal side constitute the nearer image; the parts that deviate to the temporal side, the further image. The stereoscopical effect is, however, more distinct and convincing with the coloured letters than with the strip used by Brücke.

The cause of the relative removal of the differently coloured images lies in the eccentricity of the pupil, as may be demonstrated experimentally. The pupils may be made highly eccentric by covering them partially. Partial covering on the nasal side is equivalent to a removal of the pupil to the temporal side, and conversely, covering the temporal side is equivalent to removal to the nasal side. With a nasal eccentric pupil a shifting of the differently coloured images in one direction will be observed; with a temporal eccentric pupil the shifting will be in the other direction.

The effect of an artificial eccentricity of the pupil is surprising when both eyes are used. Anyone who sees the red letters before the blue has only to cover his pupils symmetrically on the temporal side, when he will observe the red letters retreat and soon appear to be behind the blue. On covering his pupils symmetrically on the nasal side, the red letters come forward more and more, and seem at last (experimenting at a distance of four or five meters) to remain several decimeters in front of the blue. A person who sees the blue letters before the red, has only to cover his pupils on the nasal side, when he will observe that the distances change, the red coming forward and the blue shrinking back.

Lately, however, Dr. A. D. Waller has found that on repeating the experiment with a seemingly slight modification, he obtained the same effects with one eye alone. He used as a test object rings of blue paper on a red ground, or of red paper on a blue ground, and found that the nasal pupil of the left eye gives the same appearance of circular trenches or hillocks as does the temporal pupil of the right eye.

This observation has been the motive to a more thorough study of the phenomenon.

On looking with the right eye and a temporal pupil at red rings on a blue paper, the rings appear as circular hillocks when the paper is held to the left, and also sloping in that direction. One seems to be looking against the dark edges of a thick red ring fixed upon the blue paper. With a nasal pupil the red rings appear as circular trenches.

The phenomenon is the more striking in proportion to the purity of the colours used. The pupil must be made sufficiently eccentric and in a suitable direction by means of a black screen that covers it from one side, or better still, by means of a stenopæic apparatus. The pupil must not be too narrow, and the whole eye should be wide open and well-directed, so as to avoid any partial covering by the nose, eyelid, or lashes. Lastly, it is not desirable to keep the eccentricity of the pupil constant for more than a brief period. For if one stares at the rings a long time with unmoved pupils, all appreciation of distance is lost, as in so many cases where only one eye is used, and the rings may even seem to lie in a plane that intersects the plane of the blue paper perpendicularly. If, on the contrary, one shifts the screen or the stenopæic apparatus now and then the rings appear to rise and sink, and, under the above-mentioned conditions the rising will be with temporal pupil, the sinking with nasal pupil, and in a way almost as striking as if they were seen stereoscopically.

Prof. Einthoven proves mathematically that the explanation of the phenomenon is found in the appearance of shadows.

THE FLORA OF GREENLAND.

IN 1891 Dr. William H. Burk accompanied, as botanist, the party which escorted Lieut. Peary to his winter quarters in McCormick Bay. A number of plants were collected and taken to America, but they had barely been determined before an expedition was organised to search for Lieut. Peary, and Mr. William G. Meehan was appointed botanist to it. This was just a year ago. Mr. Meehan was also fortunate enough to obtain specimens, and a catalogue of the plants collected in both cases was communicated to the Academy of Natural Sciences of Philadelphia on April 11. Some idea as to the character of the catalogue will be obtained from the following introduction to it:—

The range of territory covered by Dr. Burk and Mr. Meehan was between about latitude 63° and above 78° or between Godthaab and Littleton Island.

As nearly the whole collection was repeated by each collector, it may be taken as a fairly complete flora of that portion of the territory of Greenland.

Before starting in their respective journeys, both Dr. Burk and Mr. Meehan were instructed to examine as far as possible

[1] Donders. *Wetensch. bijbladen. Med. Gasth. v. Ooglijders*, 1868.
[2] W. Einthoven, "Stéreoscopie dépendant d'une différence de couleur." *Archives Neérlandaises.* t. 20.
[3] Vorlesungen über Physiologie Wien, 1884, 3 Aufl. B. 2, S. 95.

the influence of ice sheets on the geographical distribution of plants. Prof. Thomas Meehan, the father of the latter, in a "Catalogue of Plants collected in July, 1883, during an Excursion along the Pacific Coast in South-eastern Alaska,"[1] had given reasons for believing that plants did not merely advance in the wake of retreating glaciers, or push into growth from material brought down in their advance, but that when caught under the mass of flowing ice, would remain for an indefinite period, retaining vitality, and push again into growth when the ice retreated. Prof. Meehan was led to this conclusion from finding no annual plants among those collected in the immediate wake of retreating glaciers in Alaska, while the actual number of species of perennials collected in such locations would be as great as if much time had been given for a floral advance. He had but little opportunity for actual observation as to the plants brought down with the earth carried on the ice, but so far as this went only *Epilobium latifolium* and *Dryas octopetela* were found in this condition, and scarcely any plants were observed on recently deposited moraines. These and some other facts led to the hypothesis that the plants were not migratory, but had held their position through the whole icy period.

These facts were supported by the determination of the existence of much the same flora in isolated spots of land recently bared by the névé of the inland ice, as grow away from the margins of the ice sheet, while the finding of living willow trunks, grass, and perennial plants of many years' growth close to the edges of retreating glaciers, seem to place the point beyond any reasonable doubt, especially when, after careful survey, through the construction and positions of the glaciers, there was the absolute certainty that the plants could not have been deposited by lateral, medial, or terminal moraines, though they might have been by ground moraines—a circumstance which would settle Prof. Meehan's position affirmatively beyond dispute, since the ground moraines are borne under the flowing ice rivers. Abundant vegetation was also found in nunataks—peaks of land projecting above the glaciers or ice cap—but little significance was placed on this circumstance, since all such nunataks visited were within a reasonably close proximity to the main land masses, and the vegetation might readily have sprung from seeds blown there by the winds or brought by mud on the feet of birds. But the demonstration of aged living plants in the other situations named must have a strong bearing on the discussions involved as to the influence of the ice age on the distribution of plants over the surface of the earth.

The abundance of lichens is characteristic of the flora of Greenland. Rocks supposed from a distance to be naturally coloured are found on closer inspection to derive their hue from a complete investiture of some lichen. In this particular the crimson cliffs, beginning at Cape York and extending many miles northward, are a conspicuous example. These cliffs, rising sheer from the water's edge to heights of from seventeen hundred to two thousand feet or more, though of grey granite, show no spot of the intrinsic colour even on being nearly approached, but present a uniform red appearance over their whole surface from a large orange red lichen which covers them.

In view of Schwendener's theory that lichens are but symbiotic forms of algæ and fungi, it is to be regretted that the probably rich fields afforded by the latter named great families in this region have yet to be investigated.

Mosses are even more abundant than lichens. They grow in such vast quantities in spots, that their light or dark greens are visible often for some miles away, brightening the otherwise bleak shores wonderfully. Their persistence in growth under apparently adverse circumstances is also remarkable. No obstacle save the sea seems sufficient to stop their progress. Even dead glaciers have been and are being buried under the steady march of these cryptogamous plants. Mosses fulfil the same duty in Greenland that other forms of plant life perform in more favoured climes, and the amount of rich vegetable matter being deposited by them may be of great value in the future of that great arctic island.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Rev. Bartholomew Price, Master of Pembroke College, has been added to the electors to the Savillian Chair of Astronomy on the present occasion.

SIR HENRY HOWORTH, F.R.S., has had the honorary degree of D.C.L. conferred upon him by Durham University.

OXFORD has conferred the degree of M.A. upon Dr. W. B. Benham, Aldrichian Demonstrator.

MR. W. FISHER, late Conservator of Forests in the North-West Provinces of India, has been appointed Assistant Professor of Forestry at Cooper's Hill.

SCIENTIFIC SERIALS.

American Journal of Science, June.—Electro-chemical effects due to magnetisation, by George Owen Squier.—Nikitin on the quaternary deposits of Russia and their relations to prehistoric man, by A. A. Wright. A summary of the views laid before the International Congress of Archæology in Moscow, 1892, by the Russian geologist, Mr. S. Nikitin, regarding the palæolithic and neolithic epochs in European Russia, and their coincidence with the geological divisions of pleistocene and modern.—Rigidity not to be relied upon in estimating the earth's age, by Osmond Fisher. A criticism of Mr. Clarence King's estimate of the probable age of the earth on the ground of its assumed rigidity not being an established fact. The argument derived from tidal action is fully discussed. Had the solid part of the earth so little rigidity as to allow it to yield in its own figure very nearly as much as if it were fluid, there would be very nearly nothing of what we call tides—that is to say, rise and fall of the sea relatively to the land—but sea and land together would rise or fall a few feet every twelve lunar hours. This would be the case if the geological hypothesis of a thin crust were true. This is the argument for tidal rigidity as enunciated by Kelvin. But this does not take into account the horizontal motion of the water. It rests upon the equilibrium theory of tides as against the canal theory. The latter has been symbolically worked out by Prof. G. H. Darwin. If the earth's interior be assumed to be a liquid of small viscosity, the bodily tide at its equilibrium value will have a height of $1\frac{3}{4}$ feet. This will diminish the hydrodynamical tide by not more than a fifth of its value, and it is quite possible that the tides we actually experience may be tides thus diminished by the fluidity of the earth's interior.—On the treatment of barium sulphate in analysis, by J. I. Phinney. The author shows that alkaline chlorides contaminate barium sulphate thrown down in the presence of an excess of sulphuric acid, and that the process of purifying by hydrochloric acid is inefficient. The only good method for purification is either to fuse, according to Fresenius, with sodium carbonate, extracting and reprecipitating as sulphate, or to evaporate from solution in concentrated sulphuric acid according to Mar.—On the nature of certain solutions and on a new means of investigating them, by M. Carey Lea. The solutions in question are those of sulphates which were tested for free sulphuric acid by a solution of iodoquinia, a very delicate and trustworthy test. Solutions of heavy metallic sulphates, with the exception of ferrous sulphate, contain no free acid. All sesquisulphates examined were dissociated in solution. So were acid salts and alums, with the exception of chrome alum.—Also papers by Messrs. Fairbanks, Moses, Penfield, Johnson, and Pupin.

Bulletin of the New York Mathematical Society, vol. ii. No. 8 [May, 1893, New York]. This number opens (pp. 175–178), with a review by Miss C. A. Scott of Prof. W. B. Smith's "Introductory Modern Geometry of Point, Ray, and Circle" (see NATURE, vol. xlvii. p. 532). We endorse her closing remarks that the usefulness of the book would be greatly increased if he were to translate his work into ordinary mathematical English.—Prof. Echols contributes an interesting note, biographical and otherwise, entitled Wronski's expansion (pp. 178–184). The expansion was presented by Hoëné Wronski in 1810, to the French Academy of Sciences, and is as follows:—$f(x) = a_0 + a_1\omega_1 + a_2\omega_2 + \ldots$ *ad infinitum*, where $f(x)$, ω_1, ω_2, ... are arbitrary functions of x, and a_0, a_1, ... are independent of x. The law of formation of the coefficients he calls "la loi suprême."—Dr. Cole, in a note on the substitution groups of 6, 7, and 8 letters (pp. 184–190), furnishes a list of over forty omitted groups supplementary to the lists given by Messrs. Askwith and Cayley in vol. xxiv. of the *Quarterly Journal of Mathematics*.—The *Mathematical Bibliography*, by A. Ziwet (pp. 190–192) gives in some detail an account of the new *Revue Semestrielle des Publications Mathématiques*, &c., issued by the Mathematical Society of

[1] Proceedings of the Academy of Natural Sciences of Philadelphia, 1884.

Amsterdam, to which attention has been drawn in our columns. The notice is on the whole favourable to this new venture.—The notes and new publications are well up to date.

Meteorologische Zeitschrift, April.—On the hypotheses of the oscillations of the so-called maximum zone of the aurora, and the peculiarities of the development of the aurora in this zone, by A. Paulsen. In 1872 Prof. Fritz asserted that the winter minimum of the aurora diminished with increase of latitude, and in 1880 M. Tromholt endeavoured to show that the maximum zone is in a state of continual oscillation, as it makes not only a yearly and eleven-yearly movement, but also a daily periodical change of position. Also that auroræ are more frequent in the morning hours than in the evening, and therefore that the maximum zone shifts to the northward during the night. The object of Dr. Paulsen's paper is to refute these assertions, and he quotes observations to show that the movement of the zone of greatest auroral display during the course of the night is not towards the north, and states that no single phenomenon exists that can be explained by a daily oscillation of the maximum zone, but that, on the contrary, all that we know about the daily range of the aurora points to the fact that no such movement can exist.—Relations of daily synoptic weather charts to the general circulation of the atmosphere, by E. Herrmann. Starting from the point of view that the resultants of the forces of the earth's rotation and of centrifugal force, in a stationary condition of the atmosphere, must be normal to the areas of equal pressure, the author shows how the normal distribution of pressure is solely a result of the difference of rotation of the atmosphere round the earth's axis, and of the rotation of the earth itself. On the basis of the distribution of pressure acccording to Maury's zones, there result three zones in each hemisphere:—An equatorial zone of easterly winds, a zone of westerly winds, and a polar zone of easterly winds, with corresponding changes of pressure. It follows from the decrease of temperature towards the pole that at a certain height the zone of westerly winds extends over the zone of easterly winds. The daily positions and extent of the zones are determined by the distribution of pressure in all latitudes, and their existence is a necessary consequence of the principle of the preservation of areas, but applied to the whole atmosphere, and not to individual particles as Ferrel has done. The author urges the importance of the continuance of synoptic charts, and of the desirability of telegraphic reports from Iceland and the Azores.

Bulletin de l'Académie Royale de Belgique, No. 4.—The most interesting paper is one by G. Van der Mensbrugghe on negative hydrostatic pressure. It is well known that any horizontal layer of a liquid in equilibrium supports a hydrostatic pressure equal to the weight of a column of liquid, whose base is equal to the area of the layer considered, and whose height is the vertical distance of the layer from the surface. The author investigates the pressures existing in layers lifted up *above* the level, whether by atmospheric pressure, capillarity, or otherwise. In this case the hydrostatic pressure will be similarly calculated, but will be negative, so that it must be subtracted from the external pressure upon the surface of the liquid in order to obtain the true pressure on the layer. This conclusion is illustrated by a series of striking experiments. A test-tube was filled with water and withdrawn, mouth downwards, from the tank, leaving the mouth an inch or so below the level. A U-tube was closed with the thumb at one end, while the other was inserted in the test-tube. On releasing it, air was sucked into the test tube and the liquid reduced to the exterior level. A long cylindrical tube of paper, similarly filled with water and withdrawn, was flattened more and more towards the top, owing to the atmospheric pressure exceeding that of the liquid inside. The same reasoning applied to cases where the liquid was raised by capillary action, the distribution of pressure being the same as if the tubes had been closed at the capillary surfaces. A wide tube was provided with a closely-fitting cork, through which was passed a very fine tube. The liquid was held suspended in the wide tube owing to the capillary action of the surface in the thin tube, which was 4 cm. above the level. On introducing a U-tube as before, the water was again expelled by the air rushing in, and reduced to the external level.

Bulletin de la Société des Naturalistes de Moscou, 1892, No. 3.—Sources for the flora of the Kieff educational district (Kieff, Volhynia, Podolia, Tchernigov, and Poltava), by Comte Bourdelle de Montrésor, being a full bibliography of all publications relative to the subject.—Contributions to the ornithology of the Transcaspian region, according to the researches of M. Thomas Barey, by J. Stolzmann. M. Barey travelled in the region in 1889–91 for the Branicki Museum of Warsaw. Of the 230 species mentioned in the detailed list now given, 17 are new for the region.—On the alkalies of the blood and the lymph, by J. M. Syechenov. Blood being not only the store for the food materials of the organism, but also the medium for breathing, it is desirable to ascertain the means of maintaining the composition of blood which is necessary for that purpose. The fact that the carbonate of sodium from the pancreatic and intestine juice enters the blood, is considered as a process for feeding the blood with necessary alkalies.—The Upper Tithonic deposits of Central Russia; note by N. Krischtafowitch.—Glaciers in Russia, by H. Trautschold. Remarks against the glaciation of middle Russia, based upon the old conception of only mountain glaciers being able to produce glacial effects.—The *Olcostephanus nodiger* zone near Milkovo in Podolsk, government of Moscow, by D. Stremoukhoff. New species, *O. milkovensis*, described.—Note on some special cases of the problem of several bodies, by Th. Sloudsky.—Short report upon geological and botanical excursions in Yaroslav and Vologda, by Dr. Zickendrath.—On the neurokeratin, by Dr. J. Ogneff. This substance, in the sense established by Kühne and his followers, does not exist either in the peripheral nerves or in the brain; when obtained from the brain it represents a varied mixture of unsoluble remainders from the tissues composing the brain; the molecular substance (retina, brain) on the one side, and the neurokeratin-net in the peripheral nerves on the other side, cannot be considered as homological formations.—(*id.* No. 4). A list of the mammals and birds from the Aral steppes, by A. M. Nikolsky—New species, *Astragalus uralensis*, by Dr. Litvinov.—Note on the cold of January, 1893, by B. Sresnewskij.—To the memory of N. J. Kokscharoff and A. W. Gadolin, by V. Vernadsky.

SOCIETIES AND ACADEMIES.

LONDON.

Mathematical Society, June 8.—Mr. A. B. Basset, F.R.S., vice-president, in the chair.—The chairman announced that the Council had unanimously made the fourth award of its De-Morgan gold medal to Prof. F. Klein, of Göttingen, on the ground of his many contributions to the advance of mathematical science. The following communications were made:—Complex integers derived from $\theta^3 - 2 = 0$, and on the algebraical integers derived from an irreducible cubic equation, by Prof. G. B. Mathews.—Pseudo-elliptic integrals and their dynamical applications, by A. G. Greenhill, F.R.S. Writing the Elliptic Integral of the Third Kind in the canonical form—

$$I = \int \frac{Pz + nx}{(z + x)\sqrt{Z}} dz,$$

where

$$Z = 4z(z + x)^2 - \{(y + 1)z + xy\}^2,$$

then x and y are the quantities employed by Halphen in his "Fonctions Elliptiques," t. i. p. 103. Putting

$$z + x = \wp u - \wp v,$$

where

$$12\wp v = -(y + 1)^2 - 4x,$$

and

$$z_m + x = \wp mv - \wp v,$$

then

$$z_1 + x = 0,$$

$$z_2 + x = x,$$

$$z_3 + x = y,$$

$$z_4 + x = \frac{x(y - x)}{y^2},$$

and so on; and generally $z_m + x$ is the same as Abel's $\frac{1}{2}q_{m-1}$ if we replace Abel's x by $\frac{px}{4b^2}$, and $\frac{16b^3}{p^2}$ and $1 + \frac{4ab}{p}$ by Halphen's $-x$ and $-y$ (Abel's "Œuvres Complètes," t. ii. pp. 157, 163). Abel's recurring equation for q_m is now only another form of this elliptic function formula—

$$\wp(u + v) + \wp(u - v) = 2\wp v + \frac{\wp'^2 v}{(\wp u - \wp v)^2} + \frac{\wp'' v}{\wp u - \wp v},$$

with $u = (m - 1)v$; and the continued fraction expansion employed by Abel is not required, except, perhaps, for the determination of P. The integral I is *pseudo elliptic* when the parameter v is an aliquot part n of a period; and then

$$\mathrm{p}(n-1)v = \mathrm{p}v, \text{ or } \mathrm{p}(n-m)v = \mathrm{p}mv,$$

expressed by

$$z_{n-1} + x = 0,\ z_{n-1} = z_1,\ q_{n-2} = 0,$$

or

$$z_{n-m} = z_m,\ q_{n-m-2} = q_m.$$

The integral I can now, for odd values of n, be expressed in the form

$$2(z+x)^{\frac{1}{2}n} e^{\frac{1}{2}iI} = \{z^{\frac{1}{2}(n-3)} + Bz^{\frac{1}{2}(n-5)} + Cz^{\frac{1}{2}(n-7)} + \dots\}\sqrt{Z}$$
$$+ i\{Pz^{\frac{1}{2}(n-1)} + Qz^{\frac{1}{2}(n-1)} + Rz^{\frac{1}{2}(n-5)} + \dots\} = H\sqrt{Z} + iK,$$

where H and K are rational integral functions of z; the circular form of the integral being chosen on account of its dynamical applications. When n is even, a factor $z - a$ of Z can be inferred by forming $z^{\frac{1}{2}n} + x$; and then if $z - b$, $z - c$ denote the other factors of Z, the value of I can be expressed in the form

$$(z+x)^{\frac{1}{2}n} e^{\frac{1}{2}iI} = \{z^{\frac{1}{2}(n-2)} + Bz^{\frac{1}{2}(n-4)} + \dots\}\sqrt{\{(z-b)(z-c)}$$
$$+ i\{Pz^{\frac{1}{2}(n-2)} + Qz^{\frac{1}{2}(n-4)} + \dots\}\sqrt{(z-a)}.$$

The results for $n = 3, 5, 7, 9$ have been already given in the Proc. London Math. Society, vol. xxiv. pp. 7–10; thus for

$n = 3,\ x = 0$; $n = 4,\ y = 0$; $n = 5,\ y = x = -c$;
$n = 6,\ y = -c,\ x = -c(1+c)$;
$n = 7,\ y = -c(1+c), n = -c(1+c)^2$;
$n = 8,\ y = -c\dfrac{1+2c}{1+c},\ x = -c(1+2c)$;
$n = 9,\ y = -c(1+c)^2,\ x = -c(1+c)^2(1+c+c^2)$;
$n = 10,\ y = \dfrac{-c(1+c)}{(2+c)(1-c-c^2)},\ x = \dfrac{-c(1+c)}{(2+c)(1-c-c^2)^2}.$

But the next case of $n = 11$ presented difficulties, which were only overcome by the kind assistance of Dr. Robert Fricke, of Göttingen, and a reference to his article in the *Math. Annalen*, t. 40, p. 478. It was found that the relation

$$z_{11} + x = 0, \text{ or } z_5 = z_6,$$

equivalent to Halphen's $\gamma_{11} = 0$, or

$$(xy - x^2 - y^2)(y - x)^3 - xy(y - x - y^2)^3 = 0,$$

could be satisfied by

$$x = -c(1+c)(1+c+q),\quad y = -c(1+c) - \frac{cq}{1+c},$$

where

$$q(q+1) = c(1+c)^3,$$

or

$$1 + 2q = \sqrt{(1 + 4c + 8c^2 + 4c^3)}.$$

The relation between this c and the parameters τ and τ' employed by Klein and Fricke ("Modulfunctionen, t. ii. p. 440) or the parameters η and W employed by Dr. Kiepert (*Math. Ann.* t. xxxii. p. 96), was finally found to be

$$\frac{1 + 4c + 2c^2 - 5c^3 - 2c^4 + c^5}{c^2(1+c)^2} = \frac{1 - 10\tau + \tau'}{2\tau^2}$$
$$= \tfrac{1}{2}(\eta^2 + 6\eta - 16 + W).$$

Given τ and τ', or η and W, the five roots of the quintic in c will correspond to the five parameters,

$$(2, 4, 6, 8, 10)\frac{\omega}{11}.$$

Conversely, given c the values of

$$\mathrm{p}(2, 4, 6, 8, 10)\frac{\omega}{11}$$

can be found; as also the values of τ and τ', or η and W. According to Dr. Fricke's theory (*Math. Ann.* t. 40) the case of $n = 19$ should have a solution similar to that of $n = 11$. The general problem of the *pseudo-elliptic* integral is thus reduced to the determination of x and y, considered as the coordinates of a point on the curve

$$z_n + x = 0, \text{ or } z_{n-m} = z_m,$$

or

$$\gamma_n = 0 \text{ (Halphen)},$$

as functions of a parameter c; and when this is effected the values of $\mathrm{p}\dfrac{2s\omega}{n}$ can be found; and thence, in the manner of Kiepert, Klein, and Fricke, the various corresponding modular functions can be determined. In the dynamical applications to the motion of a top or gyrostat, the azimuth ψ can be divided into two parts, ψ_1 and ψ_2, where, according to the notation of Routh's "Rigid Dynamics,"

$$\psi_1 = \tfrac{1}{2}\frac{G + Cr}{A}\int\frac{dt}{1 + \cos\theta},\quad \psi_2 = \tfrac{1}{2}\frac{G - Cr}{A}\int\frac{dt}{1 - \cos\theta},$$

θ denoting the angular distance of the axis of the body from its highest position; and ψ_1, ψ_2 are thus two elliptic integrals of the third kind, having their poles at the lowest and highest positions of the axis, the positions of stable and unstable equilibrium. In ψ_1 we may put the parameter $a = p\omega_3$, where ω_3 denotes the imaginary half-period, and p is a proper fraction; also ψ_1 is pseudo-elliptic when $p = \dfrac{2r}{n}$, where r and n are integers. When n is an odd integer, the value of ψ_1 can be expressed in the form

$$(1 + \cos\theta)^{\frac{1}{2}n} e^{in(\psi_1 - p_1 t)} = H\sqrt{\Theta} + iK,$$

where H and K are rational integral functions of $\cos\theta$, of the degree $\frac{1}{2}(n-3)$ and $\frac{1}{2}(n-1)$, and

$$\Theta \text{ denotes } \sin\theta\frac{d\theta}{dt}.$$

But in ψ_2 the parameter is of the form

$$b = \omega_1 + q\omega_3,$$

where ω_1 is the real half-period; and to deduce a pseudo-elliptic expression for ψ_2 corresponding to $q = \dfrac{2r}{n}$, the factors of Θ must be known; say

$$\cos\theta - \cos\alpha,\ \cos\theta - \cos\beta,\ \cos\theta - \cosh\gamma,$$

α and β being the inclinations between which θ oscillates. Then, when ψ_2 is pseudo-elliptic,

$$(1 - \cos\theta)^{\frac{1}{2}n} e^{in(\psi_2 - p_2 t)} = H'\sqrt{\{(\cos\beta - \cos\theta)(\cos\theta - \cos\alpha)\}}$$
$$+ iK'\sqrt{(\cosh\gamma - \cos\theta)},$$

or

$$= H'\sqrt{\{(\cosh\gamma - \cos\theta)(\cos\theta - \cos\alpha)\}} + iK'\sqrt{(\cos\beta - \cos\theta)},$$

where H′ and K′ are rational integral functions of $\cos\theta$. By multiplication of these two equations for ψ_1 and ψ_2, we find an expression for

$$(\sin\theta)^n e^{in(\psi - pt)}$$

where $p = p_1 + p_2$; the values of the *secular terms* p_1 and p_2 being most readily determined by a differentiation and verification. Changing the sign of i in ψ_2, and denoting $\psi_1 - \psi_2$ by χ, $p_1 - p_2$ by q, we should find, as a verification,

$$(\sin\theta)^n e^{in(\chi - qt)} =$$
$$[L\sqrt{\{(\cos\beta - \cos\theta)(\cos\theta - \cos\alpha)\}} + iM\sqrt{(\cosh\gamma - \cos\theta)}]^n,$$

where L and M are constants, corresponding to an elliptic integral of the third kind, with a parameter

$$b - a = \omega_1.$$

The cases of $n = 3$ and 5 are worked out at length in the paper. The pseudo-elliptic expressions for ψ_2 are immediately available for the construction of *algebraical herpolhodes*, as the parameter in this mechanical problem is always of the form

$$\omega_1 + q\omega_3;$$

while the pseudo-elliptic expressions for ψ_1 can be utilised in the construction of solvable cases of the tortuous curve assumed by a revolving chain. In the herpolhode the case of $n = 3$ is realised when "the focal ellipse of the momental ellipsoid rolls on a plane at a distance from the centre equal to the difference of its semi-axes;" and when $n = 4$, "the distance of the fixed plane is equal to the distance from centre to focus of this focal ellipse." By Prof. Sylvester's theorems on correlated bodies, the motion of the bodies having momental ellipsoids confocal to this focal ellipse, can be inferred immediately. In the equations of the Precession and Nutation of the earth, or of the motion of an elongated projectile in an infinite frictionless liquid, the function Θ will be composed of four linear factors; so that in the construction of pseudo-elliptic algebraical cases of this motion, a return to Abel's original method may prove preferable, especially when n is an even number.—On the expansion of certain infinite products (II.), by Prof. J. L.

Rogers.—Note on some properties of Gauche cubics, by Mr. T. R. Lee. There are two principal theorems in the note, one being an analogue of the theorem of Desargues, and the other affording a test by which it may be determined whether a given line is a chord of a cubic or not.—Note on the centres of similitude of a triangle of constant form *circumscribed* to a given triangle, by Mr. J. Griffiths.

Physical Society, June 9.—Prof. J. Perry, F.R.S., Vice-President, in the chair.—Mr. A. P. Trotter read a paper on a new photometer. The author has modified his illumination photometer, described Proc. I.C.E., vol. cx. paper No. 2619, so as to adapt it to the measurement of candle-power. The principle employed is to view a screen illuminated by one source through an aperture in a second screen illuminated by the other light, the aperture becoming invisible when the illuminations are equal. After using perforations of various patterns, a series of narrow slits cut in thin paper were found to give the best result. The plain screen is mounted behind the slotted one in a box sliding on the photometer bench, and they are arranged so that the light falls on them at equal angles. The screens are viewed from a distance of 6 or 7 feet through an opening in the front of the box, cords being provided for producing the traversing motion. Two "sights" set respectively at the middle of the length of the plain screen, and on the lower edge of the front opening, serve to show when the middle of the band of equal illumination is vertically above the pointer on the carriage. The photometer is found to be particularly valuable when it is desired to determine the maximum power of a variable source. When lights of different colour are being compared—say a gas flame and an arc—one end of the screen shows blue strips on a yellow ground, and the other end yellow strips on a blue ground; at the centre the colours seem to blend. To facilitate the comparison of such lights, Mr. Crompton, who has been working at the subject simultaneously with the author, uses one screen tinted pale yellow and the other pale blue. Details of construction of the new photometer are given in the paper, and the accuracy attainable when comparing two equal lights of about eight candles, stated to be about 1 per cent.—Prof. S. P. Thompson, F.R.S., read some notes on photometry. The first note relates to the use of two overlapping screens as an isophotal, and describes the evolution of the Thompson-Starling photometer. In this instrument a prismatic block with apex upwards rests crosswise on the photometer bench, and the inclined sides are respectively illuminated by the two sources to be compared. In testing differently-coloured lights, coloured stuffs were placed over the surfaces of the wedge. In some cases notched and overlapping cards were used to form the overlapping surfaces; an inclination of about 70° between the two surfaces was found convenient. The second note refers to the periodic principle in photometry, and in it the author discusses the various methods which have been, or may be, used for producing small differences of decreasing amount between the two sides of a photometer screen. By employing a device of this kind much greater accuracy of adjustment is possible. In one form of vibration-photometer worked out by the author, the paraffin blocks of a Jolly's photometer are mounted at one end of a spring, the other end being fixed to the carriage. The act of moving the carriage starts the blocks vibrating, thus producing the desired variations. In a third note the question of using the electric arc as a standard of light is dealt with. Since 1878 the positive crater has been used as a standard of whiteness, and last year both the author and Mr. Swinburne suggested that a given area of crater might be used as a standard of light. This proposal has since been carried out by M. Blondel. Since the intrinsic brilliancy of the crater is high, it necessitates very small apertures, or else the use of standards of large candle-power. Advantages of using powerful standards are pointed out in the paper. With a circular hole 1 m/m in diameter, a standard of about fifty-five candles could be obtained; with such a source, benches longer than usual would be preferable. At the end of the note, the errors which may be introduced by using as an arc standard a hole in a plate of sensible thickness, when viewed obliquely, are investigated, as well as those due to inaccuracy of setting the plane of a hole made in foil, perpendicular to the photometer bench. Major-General Festing, in opening the discussion on both papers, said reflection from the sides of the hole in a thick plate would tend to lessen the error calculated by Prof. Thompson. The ordinary impurities in carbon were not likely to alter the brilliancy of the crater. Capt. Abney and himself had no reason to distrust its constancy. Both the vibrating photometer and Mr. Trotter's arrangement would be very useful.—Dr. Sumpner said his photometric experience had been obtained with the Bunsen, Jolly, and Lummer-Brodhun types. With the two former the inaccuracy arising from uncertainty of adjustment was about ½ per cent. Changes of about 0·4 per cent. (average) resulted from reversing the screens. The Lummer-Brodhun instrument (which he described) was better than either of the other two, the average error being about ¼ per cent. Mr. Frank Wright thought scientific men gave too little attention to the question of light standards. Photometers could be relied on much more than any standard at present in use. The Methven screen was the most practical standard yet devised, but in his opinion no gaseous flame could be a real standard on account of the influence of the surrounding atmosphere. Prof. Ayrton saw difficulties in using long benches as suggested by Dr. Thompson, on account of the serious atmospheric absorption which occurs with light from arcs. Decreasing the intensity by dispersion or otherwise was preferable. In some tests on glow lamps now being carried out at the Central Institution, a Bernstein lamp used as a standard was mounted on a spring and vibrated. Mr. Medley showed the vibrating standard referred to by Prof. Ayrton, and gave a series of numbers showing that with this device in conjunction with the Lummer-Brodhun photometer accuracies of about ¼ per cent. were obtainable. Mr. Swinburne thought Mr. Trotter's arrangement was better than the "wobbling" photometer. As to the best length of bench, he was inclined to think the shorter the better, provided its dimensions were large compared with those of the standard light. He concurred with Mr. Wright in his remarks about the desirability of obtaining a better standard. Speaking of the arc as a standard, he said that only impurities less volatile than carbon would influence the brightness. An important factor was the emmisivity of the carbon, which might not be constant. Mr. Blakesley thought the accuracy obtainable with Mr. Trotter's photometer had been underrated, and pointed out that by using quadrant-shaped screens intersecting orthogonally on the axis of the photometer instead of straight ones, the width of the neutral band could be greatly diminished. Mr. Trotter, referring to Dr. Thompson's paper, said he had found considerable difficulty in making pinholes suitable for arc standards. It was not an easy matter to accurately measure the hole when made. In photometric measurements he had found it very important to reverse his screens. Curved screens as suggested by Mr. Blakesley had been tried, but with little advantage. They also destroyed the approximate direct-reading property of the photometer. The subject of changing the length of a bench and its effect on the gradient of illumination was discussed. With short benches one had to guard against the departure from the inverse-square law, due to appreciable size of the standard. Recent experiments had shown that the light given out by 1 square m/m of crater surface differed considerably from 70 candles.—A paper on "The Magnetic Field close to the Surface of a Wire conveying an Electrical Current," by Prof. G. M. Minchin was taken as read. In this paper the author applies the solution he gave in March last for the conical angle subtended by a circle at any point in space to determine the magnetic potential at a point near the surface of a ring of wire of finite cross section. The shapes of the lines of force near the surface, for several laws of current distribution across the section, have also been worked out.

Chemical Society, May 18.—Dr. H. E. Armstrong, President, in the chair.—The following papers were read:—Studies on the formation of ozone (ii.), by W. A. Shenstone and M. Priest. Using an ozone generator of the Brodie pattern, the authors have studied the effect of discharges of varying difference of potential upon the quantity of ozone produced. The maximum proportion of ozone that can be produced at a given temperature is nearly independent of the potential difference employed, provided that this be within 33 and 69 C.G.S. units and that the path of the discharge be not very short at any point in the generator. When this latter case occurs the maximum quantity of ozone that can be obtained has an inverse relation to the difference of potential employed. The rapidity of ozonisation is greater with a high potential difference than with a low one, and the maximum proportion of ozone is produced with a low rate of discharge. A generator made of very thin glass, the two tubes of which fit rather closely, gives the greatest yield of ozone; for the same potential difference an induction coil ozonises a larger proportion of oxygen than either a Wimshurst or a Voss machine. The authors conclude from their experiments that the silent discharge acts by decomposing oxygen molecules into their atoms, which subsequently re-combine, to a greater or less extent, according to the conditions, to form the triatomic ozone molecules; it would hence seem that ozone is not formed by the direct action of the discharge.—The relative strengths or "avidities" of some compounds of weak acid character, by J. Shields. The author has calculated the relative strengths of a number of compounds of weak acid character, such as biboric and carbonic acids, hydrogen cyanide and phenol, from the rates at which salt solutions hydrolyse ethyl acetate.—The boiling points of homologous compounds. Part I.: Simple and mixed ethers, by J. Walker. The author finds that the boiling points of members of many homologous series may be very closely expressed by the relation $T = aM^b$, where T is the absolute boiling point, M the molecular weight, and a and b are constants peculiar to each series. The formula may be stated in the following form:—The logarithm of the ratio of the absolute boiling points of any two members of a homologous series, divided by the logarithm of the ratio of their molecular weights, is constant.—The conditions determinative of chemical change, by H. E. Armstrong.—The nature of depolarisers, by the same author.

Geological Society, June 7.—W. H. Hudleston, F.R.S., President, in the chair.—Dr. Johnston-Lavis, in referring to specimens and microscopic slides showing eozoonal structure in the ejected blocks of Monte Somma, exhibited by him, said that all the criticisms of *Eozoon* have so far been destructive, no analogous structure having been found in other localities under conditions that could explain the origin of so curious an arrangement of different minerals. These altered limestones from Monte Somma correspond in all details with those of the original Canadian specimens, and in many cases, on account of their freshness, exhibit some of the pseudo-organic structural details, such as the stolon-tubes, in far greater perfection than does the true so-called *Eozoon canadense*. He had been working at the subject in conjunction with Mr. J. W. Gregory. The following communications were read:—The bajocian of the Sherborne district: its relations to subjacent and superjacent deposits, by S. S. Buckman. This paper is partly the result of excavations made by Mr. Hudleston, F.R.S., and the author at Sherborne, to determine the position of the so-called "*Sowerbyi*-zone." The author used the term "bajocian" to denote the lower beds of what has been called "upper part of the inferior oolite." He introduced a term emar (ἡμαρ) as a chronological subdivision of an "age," and considered that the beds dealt with in the paper were deposited during 12 emata, which he called, in descending order, *fuscum zigzag*, *Truellii*, *Garantianum*, *niortense*, *Humphriesianum*, *Sauzei*, *Witchellia* sp., *discites*, *concavum*, *bradfordense*, and *Murchisonæ*. A line from Stoford, Somerset, through North Dorset to Milborne Wick, Somerset, is the base-line of the district reviewed. Seventeen sections of places close to this line were given to show the relations of the beds, with the different amounts of strata deposited during successive emata, and during the same emar at different places. By means of tables it was shown that the area of maximum accumulation receded eastwards in the earlier emata, and then proceeded westwards during the later emata. A similar and corresponding faunal recession and progression was pointed out, though the faunal headquarters always remain west of the great accumulation of deposit. Adding the various maximum deposits together, the author found as much as 130 feet of strata deposited during the twelve emata = (practically) the "Inferior Oolite of Dorset." This is a far greater thickness than had hitherto been allowed to beds of this age in the district, but the fault lay partly in incorrect correlation. The Dorset strata are correlated with strata in other districts—namely, with those of Dundry and Leckhampton Hills in this country. Of these the author gave sections, and pointed out the emata during which the strata of those localities were deposited, and made some alterations in their correlation. Passing to Württemberg, the author showed that the equivalent of Waagen's *Sowerbyi*-zone is exactly represented at Sherborne. Returning to Normandy, the results were compared with the recent work done by Munier-Chalmas, who in some respects has made an even more detailed subdivision of the strata. The corrrespondence between the divisions for Dorset and those of Munier-Chalmas in Normandy and Haug in Southern France was shown in a table. The President, Prof. Blake, the Rev. H. H. Winwood, and Mr. Marr took part in the discussion that followed.—On raised beaches and rolled stones at high levels in Jersey, by Dr. Andrew Dunlop. An account was given of the higher raised beaches examined by the author on the south-eastern and eastern coast, but probably found in other parts of the island also, as indicated by the existence of rolled stones, &c. These beaches seem to prove submergence (in the case of that at South Hill, to a depth of at least 130 feet below the present level) at the end of the "first glacier period." The brick clay often lying on raised beach, and containing pebbles, was compared to loess by the author. He believed that Prof. Prestwich's theory of sudden and rapid upheaval, with a resulting tumultuous sweep of water, may be applied to Jersey; but also, if the sinking took place at the end of the Glacial Period, the peculiar conditions produced by melting ice may have played their part in producing the brick-clays. Subsequent upheaval above the present sea-level is indicated by submerged forests, sometimes lying on the brick clay. No fossils have hitherto been found in the raised beaches; but a bone of *Bos primigenius* (?) has been extracted from the brick-clay. The President, the Rev. H. H. Winwood, and Mr. Monckton spoke on the subject of the paper.

Entomological Society, June 7.—Mr. H. J. Elwes, President, in the chair.—Mr. A. Cowper Field exhibited varieties of *Smerinthus tiliæ*, bred between 1890 and 1893, under varying conditions of temperature, those which had been exposed to a lower temperature being much darker than those which had been exposed to a higher. Mr. Merrifield made some observations on the subject, and remarked that, as far as his experience went, no hard and fast rule could be laid down with regard to the production of the lighter or darker colourings, as a high temperature sometimes produced dark forms.—Mr. W. M. Christy exhibited a series *Zygæna trifolii*, including very many yellow forms, all, with one exception taken at one spot during the latter half of May, 1893, and belonging to one colony. Some of the specimens were more or less incomplete, both in structure and colour, and Mr. Barrett stated as his opinion that this was due to their having been forced by the unusually fine weather. Lord Walsingham, Mr. Merrifield, and others took part in the discussion which followed.—The President remarked on the great abundance of *Coleophora laricella* in Gloucestershire, and stated that they were committing great ravages among young larches. Lord Walsingham stated that he had seen young larches at Carlsbad completely bleached by this moth.—It was suggested by several Fellows of the Society that care should be taken to observe the occurrence of second broods of insects during the year.—Mons. Wailly exhibited cocoons of various silk-producing Lepidoptera, and stated that the larva of *Attacus pernyi*, whose food-plant is oak, had been reared in Trinidad on *Terminalia latifolia*.

Linnean Society, June 15.—Prof. Stewart, President, in the chair.—Mr. A. W. Bennett exhibited some curious examples of revivification in plants, and made some remarks on the tentacles of *Drosera rotundifolia* and *longifolia*, specimens of which were exhibited under the microscope.—Dr. Stapf read a paper on the botany of Mount Kiua Balu, North Borneo, and exhibited some of the most characteristic plants. His remarks were criticised by Mr. W. T. Thiselton Dyer, who regarded the paper as a valuable contribution to geographical botany.—Prof. W. A. Herdman, in continuation of a former paper printed in the Society's journal, gave an interesting account of several species of British *Tunicata*, some of which were previously undescribed, his remarks being illustrated by figures projected on the screen by means of the oxy-hydrogen lantern.—On behalf of Miss A. L. Smith, Mr. George Murray gave an abstract of a paper on the anatomy of a plant brought from Senegambia by Mr. G. F. Scott Elliot, the affinities of which had not been precisely determined, but which was referred either to the *Melastomaceæ* or *Gentianaceæ*. The author's views, which were illustrated by means of the oxy-hydrogen lantern, were criticised by Dr. D. H. Scott.—In the absence of Mr. Scott Elliott, a paper was read on his behalf by the secretary, on the African species of the genus *Ficus*.—Prof. F. W. Oliver, on behalf of Miss M. Benson, gave an abstract of a paper entitled contributions to the embryology of the *Amentiferæ*, illustrated by diagrams of sections made by the author.—With this meeting the session of 1892–93 was brought to a close.

PARIS.

Academy of Sciences, June 12.—M. Lœwy in the chair.—Baron von Nordenskiöld was elected Foreign Associate.—On the theory of flow over weirs without lateral contraction, taking into account the variations undergone by the inferior contraction of the falling sheet according to the height of fall, by M. J. Boussinesq.—On the heat of combustion of the principal gaseous hydrocarbons, by MM. Berthelot and Matignon.—The differences of the heat of combustion in the homologues of the formene series are sensibly constant and amount to about 157.—On the modulus function $\chi\infty$, by M. A. Cayley.—Photographic study of some sources of light, by M. A. Crova.—Presentation of an iconographic monograph upon *Bubalus antiquus*, Duvernay, by M. A. Pomel.—On a class of surfaces with rational generators, by M. G. Humbert.—On some surfaces with several modes of generation, by M. G. Scheffers.—A general property of any field not admitting of a potential, by M. Vaschy. The distribution of the force (or vector) f at the various points of the field is identical with the distribution of the resultant of two fictitious forces f_1 and f_2 defined as follows:—The force f_1 would be developed by a system of masses acting at a distance according to the law of universal gravitation; f_2 would be developed by a system of "vectorial masses" acting according to Laplace's law. The density ρ of the first masses and the components μ_x, μ_y, μ_z, of the density μ of the vectorial masses would be given by

$$4\pi\rho = \frac{\partial X}{\partial x} + \frac{\partial Y}{\partial y} + \frac{\partial Z}{\partial z},$$

and equations of the type

$$4\pi\mu_x = \frac{\partial Y}{\partial z} - \frac{\partial Z}{\partial y},$$

where X, Y, Z, are the components of f, and the "vectorial mass" contained in an infinitely small volume $d\infty$ is $\mu\, d\infty$, where μ is the "density."—On terms of a superior order in the deviation of the compass, by M. E. Guyon.—On a remark of M. Guyon relative to the calculus of stability of vessels, by M. Ch. Doyère.—On the photographic properties of the salts of cobalt. Hydrated peroxide of cobalt dissolved in oxalic acid gives a solution of very unstable cobaltic oxalate, which is easily reduced to the cobaltous state by the action of light. This action may be utilised to produce photographic prints. A cobaltous salt is precipitated with sodium peroxide; the cobaltic hydrate formed is carefully washed in hot water, collected, and treated in the cold with a saturated solution of oxalic acid; the reaction, which must take place in the presence of an excess of cobaltic hydrate, is finished in several hours, and gives a green solution with which gelatinised paper may be impregnated. Printing is done very quickly. After sufficient exposure the proof is developed by means of a 5 per cent. solution of potassium ferricyanide, and fixed by simple washing. The image obtained is pale red. It is intensified and given a more agreeable colour by treating with an alkaline sulphide, which converts the ferricyanide of cobalt into the sulphide. The process is distinguished by its simplicity, rapidity and cheapness.—On Stas's atomic weights, by M. J. D. van der Plaats.—On chromodisulphuric, chromotrisulphuric, and chromosulphochromic acids, by M. A. Recoura.—Action of oxygen upon sodammonium and potassammonium, by M. A. Joannis.—On soft sulphur moistened in the state of vapour, by M. Jules Gal.—On the estimation of manganese by the oxydimetric methods, by M. Adolphe Carnot.—On the product of asymetry, by M. Ph. A. Guye.—On the alcoholic fermentation of Jerusalem artichokes under the influence of pure yeasts, by M. Lucien Lévy.—On a new series of colouring matters, by M. A. Trillat.—On the assimilation of the gaseous nitrogen of the atmosphere by microbes, by M. S. Winogradsky.—Observations thereon, by M. Berthelot.—On the doubling of carbonic acid under the influence of solar radiation, by M. A. Bach.—On *Micronereis variegata*, by M. Émile G. Racovitza.—On the oil of the eggs of the Algerian Pilgrim Cricket (*Acridium peregrinum*), by M. Raphael Dubois.—Influence of moisture on the development of the nodosities of the Leguminosæ, by M. Edmond Gain.—On the concordance of the phenomena of cellular division in the lilies and in Spirogyras, and on the identity of the causes producing them, by M. Ch. Degagny.—On the specific gravities of isomorphous crystals, by M. Georges Woulf.—On the axinite of Oisans, by MM. Albert Offret and Ferdinand Gonnard.—On the eruptive rocks of Servia, by M. J. M. Lugovic.—On *Polygonum sakhalinense*, regarded as fodder for cattle, by M. Doumet-Adanson.—On the toxicity of stereoisomeric acid tartrates, and a general formula for measuring their toxic power, by M. C. Chabrié.—The electric brush discharge as a treatment for refractory cutaneous pruritus, by M. H. Leloir.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Semi-azimuths; a New Method of Navigation, Part 1: E. W. Buller (Norie and Wilson).—A Dictionary of Birds. Part 1: A. Newton (Black).—Lehrbuch der Petrographie, Erster Band: Dr F. Zirkel (Leipzig, Engelmann).—Grundzüge der Physiologischen Psychologie, Erster Band: W. Wundt (Leipzig, Engelmann).—Lessons in Elementary Bi logy, 2nd edition: Prof. T. J. Parker (Macmillan).—The Protection of Woodlands: H. Fürst, translated by J Nisbet (Edinburgh, Douglas).—An Introduction to the study of Geology: Dr. E. Aveling (Sonnenschein).—The Great Eastern Railway Company's Tourist Guide to the Continent, new edition (London).—Electric Light Installations. Vol. 1: The Management of Accumulators, 7th edition: Sir D. Salomons (Whittaker).—The Dynamo: C. C. Hawkins and F. Wallis (Whittaker).—Etude sur les Tremblements de Terre: L. Vinot (Paris, Berger-Levrault).—Enunciations in Arithmetic, Algebra, Euclid, and Trigonometry: P. A. Thomas (Macmillan).—Decipherment of Blurred Finger Prints: F. Galton (Macmilan).—An Elementary Treatise on Analytical Geometry: W. J. Johnston (Oxford, Clarendon Press).—Census of the Colony of Tasmania, 1891, Parts 1–8 (Hobart, Grahame).

PAMPHLETS.—Les Astronomes: A. Tischner (Leipzig, Fock).—Prehistoric Naval Architecture of the North of Europe: G. H. Boehmer (Washington).—Report on the Bendigo Gold-Field: E. J. Dunn (Melbourne, Brain).—Société d'Encouragement pour l'Industrie Nationale: Annuaire pour l'Année 1893 (Paris)—Sul Magnetismo di Monte Dr. E. Oddone e S. Franchi (Roma).—Ergebnisse der Meteorologischen Beobachtungen im Reichsland Elsass-Lothringen im Jahre 1891 (Strassburg).—Lines on the View from Petersham Hill, Richmond: W. H. Oxley and E. Kirk (Richmond).—Ueber die Entwickelung der Theerfarben-Industrie: Dr. H. Caro (Berlin, Friedländer).

SERIALS.—Journal of the Institution of Electrical Engineers, No. 106, vol. xxii. (Spon).—Bulletin of the Geographical Club of Philadelphia, Vol. 1, No. 1 (Philadelphia).—Astronomy and Astro-Physics. June (Northfield, Minn.).—Rendiconto dell'Accademie delle Scienze Fisiche e Matematische, serie 2ª, vol. vii. fasc 5° (Napoli).—The Illustrated Archæologist, No. 1 (C. J. Clark).—Journal of the Franklin Institute, June (Philadelphia)—Economic Journal, June (Macmillan).—Transactions of the Leicester Literary and Philosophical Society, July and October, 1892, and January, 1893 (Leicester).—Lucifer, Vol. xii. No. 70 (London).

CONTENTS.

THURSDAY, JUNE 29, 1893.

ELECTRO DYNAMICS.

Dynamo Electric Machinery. Fourth Edition. Revised and enlarged. By Silvanus P. Thompson. (London: E. and F. N. Spon, 1892.)

A COMPARISON of the size of the fourth edition of this book with that of the first, which appeared in 1884, supplies a good illustration of the rate at which the use of dynamo electric machinery, and our knowledge of its laws, have advanced during the past eight years. The 408 pages in 1884 have grown to 832, with a collection of twenty-nine excellent plates in addition at the end of the book, representing another 60 pages; in fact, the book has now become so portly that it would have been well had the matter been put into two volumes.

Each of the last three editions has been bulkier than its predecessor, but the increase of size of the second and third represented the simple adding of new material without the pruning away of antique and practically obselete matter which is so necessary in a text-book of a rapidly advancing industry. The last edition, on the contrary, has been rewritten, and the author's well-known capacity for hard work and information collecting has enabled him to produce a treatise which contains the latest knowledge and the existing practice of the dynamo designer and the dynamo constructor of to-day.

The book opens with a wonderfully complete collection of historical notes, but we fear that the author's love of history has led him to give a little too much credit to the early workers. It is the fashion with some, and especially with those of classical tendencies, to credit the Chinese with the invention of gunpowder, the compass, and a variety of other useful commodities; to condemn Galileo, Columbus, and Harvey as plagiarists; and to extol Pliny or Aristotle, or other gentlemen of that somewhat remote period, as having foreseen and foretold every scientific principle and device.

But as these prophecies of the ancients were somewhat marred by their utter unsuggestiveness until the discoveries of the moderns had set the historian searching for a meaning which the writers of the prophecies were themselves probably quite ignorant of, we do not regard the trousered investigator as a dealer in second-hand articles.

Nobody knows better than Dr. Thompson that a knowledge of the properties of rubbed amber, or the discovery of the loadstone, was not all that was necessary to construct a 1000 horse-power dynamo with a commercial efficiency of 93 per cent., but nevertheless he fails, we think, to sufficiently distinguish between a chance mention of some notion and the subsequent independent recognition of an important commercial principle. If fame could really be achieved by a person's mingling a grain of wheat with a ton of chaff, what a temptation it would be to spend one's time recording every notion that struck one (no matter how improbable it looked), in the hopes that a hundred years hence some indulgent historian would search through the weary waste, in the hope of discovering with his rosy spectacles an apparent anticipation of some device that practice had then brought to a successful issue.

The historical notes are in fact not critical enough, and show a desire to make things comfortable all round for everybody. For example, the conventional illustration of the Pacinotti machine is given, but the author does not point out, indeed we do not remember to have seen it pointed out, that the original illustration of the Pacinotti generator differed from the conventional illustration in that the collecting-brushes were placed in the worst position, so as to make the machine as powerless as possible. May this have been the real reason why this machine "fell into temporary oblivion"?

If another example were wanted, we might take the following sentence, which, although not occurring in the section called "Historical Notes," enters as a note of an historical character on page 59, in the section, "Combinations to give Constant Pressure." The sentence is, "The combination of a permanent magnet with electro-magnets in one and the same machine is much older than the suggestions of either Deprez or Perry, having been described by Hjorth in 1854." Undoubtedly that is true, only Hjorth used the combination because, not being aware of the instability of the magnetism in a properly designed dynamo, he thought permanent magnetism was necessary to start the magnetic excitation; whereas Deprez and Perry superimposed what was practically a permanent field for a totally different reason and in a totally different way.

The chapters on "Magnetic Principles," the "Magnetic Circuit," "Forms of Field Magnets," are excellent. We do not, however, see much advantage in the introduction of what the author calls the *diacritical* current. The formulæ are thereby simplified, no doubt, but the simplification is effected at the sacrifice of accuracy; for first, the permanent magnetism in the field has to be ignored, and secondly, as there is no absolute maximum induction in iron, there can be no exact value of this *diacritical* current, which produces half the maximum induction.

The author is not quite happy in his choice of symbols. E is defined as representing the entire electro-motive force in the armature, e as the difference of potentials from terminal to terminal. Presumably, then, e_1, e_2, &c., applied to the separate coils of the armature, represent the potential differences at the terminals of the several coils. But that is exactly what e_1, e_2 do not mean, for they stand for the electro-motive forces of the coils. The suffix m attached to the letter for current or resistance denotes field magnet coils, but only when these are series coils. If the coils be shunt coils, the suffix s is attached to the letter. S, however, stands not for the number of shunt coils, as one would expect, but for the number of series coils, the former being called by a different letter altogether, viz., Z. In fact, Dr. Thompson's rules for the use of suffixes have the precision that is possessed by the rules for the spelling of the English language, the delight of every foreigner who studies them.

The description of "Combinations to give Constant Pressure" (pages 57, &c.), and of "Constant Potential Dynamos" (pages 277, &c.), might be well brought together, seeing that both parts of the book deal with the same contrivances, only a little mathematics is added when the subject is taken up the second time. The equations that are given were very useful in the early days when the combinations were first worked out, as they showed what combinations were theoretically possible to produce the desired result. But it is questionable whether these equations are of much use at the present time, or if they are given, it should be clearly explained why equations originally obtained on the assumption that the permeability of iron was constant led to conclusions distinctly valuable in the case of machines intended to produce constant pressure, but quite useless for suggesting a method of compounding a dynamo to produce constant current.

The chapter on lap, wave, and ring winding of armatures is most instructive. The original idea of cross connecting the coils of a gramme ring, so as to only require two brushes with a multipolar dynamo, the author attributes to Mr. Mordey, but we were always of opinion that Prof. Perry's patent of 1880 contained the first suggestion of this now well-known arrangement.

Chapters xiii., xiv., xv., xvi., xvii., and xviii., on "Practical Construction of Armatures," "Commutators, Brushes, and Brush Holders," "Mechanical Points in Design and Construction," "Elements of Dynamo Design," "Arc Lighting Dynamos," and "Examples of Modern Dynamos," taken in conjunction with the twenty-nine plates at the end of the book, contain a wonderfully compressed, and most admirable, *résumé* of British and foreign practice, and make one feel proud that they have been written by an Englishman.

In Chapter xx., on electromotors, the laws of maximum activity and maximum efficiency are carefully distinguished, and it is pointed out that, while Jacobi, Verdet, Müller, and even Weidemann stumbled, the true ideas of Thomson and Joule were put forth correctly by Achard in January 1879. In 1883 was advocated the proposal to employ a forward lead of the brushes with a motor, and a backward lead with a dynamo, so that the magnetisation of the armature might help instead of opposing that of the fields magnets. With reference to this idea the author says, "The fascinating notion of using the armature to magnetise has proved a failure in practice," a statement undoubtedly true historically, but lacking in prophetic inspiration, seeing that this proposal of May 1883, to utilise instead of counterbalancing the magnetism of the armature is now warmly welcomed in May 1893, after Mr. Sayers has shown how the "destructive sparking" can be annihilated.

Chapter xxii., on "The Principles of Alternate Currents," is much too meagre for any one who does not already know more of the subject than is contained in the chapter itself. A student reading the book would be inclined either to skip this chapter altogether and go on to the next, on "Alternators," or turn to some other book for what Chapter xxii. professes to give. The account of the construction of alternating current dynamos contained in Chapter xxiii. is as comprehensive as the description of the principles in the preceding chapter is meagre. The abstract of Dr. J. Hopkinson's investigation on the coupling of alternators is clearly given and easily understood, when the misprint of N A for N H on page 691 is corrected. The device of commutating the current round the field of an alternate current motor, so that when the motor synchronises the excitation is produced by a pulsating direct current, is due originally to Prof. Forbes, and not to Mr. Mordey, as the author states on page 702.

The author is very perplexing in his naming of alternating currents. He calls the current produced by an ordinary alternator a *two phase* current, but why we have no idea. At any one moment the current in all parts of the circuit is in *one phase;* at different times the current has, of course, every possible phase in succession. The current must therefore be called a *one phase* current, or a single current having every possible phase in succession, if the author prefers that; but there is no more reason to call such a current a *two phase* current than to call it a twenty-two phase current. When again we come to the arrangement devised by Ferraris, and illustrated in Fig. 455 (page 405), we have two distinct circuits, the currents in which always differ in phase. We have therefore a two phase arrangement. The author however calls this a "*four phase transmission.*" Lastly, however, when there are three circuits in which there are three distinct currents, the phases of which at any one moment are always all three different, the author, for some reason, is content to call this a "three phase current" like ordinary mortals.

Chapter xxv., on alternate and direct current transformers, is good, but might be made a little fuller, seeing that so very much work has been carried out on transformers during the past few years. The methods of testing transformers are becoming as important as those for "Testing Dynamos and Motors," which forms the subject of Chapter xxviii. The last chapter, on the "Management of Dynamos," contains many valuable hints, derived in some cases from the author's own experience.

The table at the end of the book, headed "Wire Gauge and Amperage Table," we have gazed at with feelings of admiration tempered with doubt. Admiration—because, if all the columns of numbers given in this table be correct, then, while we have spent much time experimenting and calculating in order to obtain information about the heating of one or two bobbins of wire traversed by a current, the problem for bobbins wound with all kinds of wire to all sorts of depths up to 4½ inches has in some way or other been solved. Doubt—because we fear that, in solving this problem, some sort of simple proportion may have taken the place of the complicated mathematics which it is necessary to employ on account of the flow of heat taking place across many layers of copper and cotton interspersed.

To say that this book is the best on its subject in the English language is to say too little, since we know of no book in any other language on the same subject that can be compared with it. The few peculiarities that we have drawn attention to must be regarded less in the light of blemishes than as giving the book individuality, for we recognise our best friends, when we meet them, by their characteristic peculiarities. Dr. Thompson's treatise should be, nay, probably is already, in the hands of every one who deals with dynamo machinery from an educational or from a manufacturing point of view.

It is interesting to notice how the author, in common with other writers, is unconsciously searching for a good abbreviation for the important, but somewhat cumbersome, expression—difference of potentials. Sometimes he calls it pressure, but he apologises for that, as he says it is popular. Sometimes he calls it potential, which we think is rather the expression to be apologised for, since it is wrong, the potential of a body having years ago been defined as being the difference between its potential and that of the earth. Sometimes he calls it the volts, but to speak of the volts of a dynamo being too high is like telling your tailor that a coat has too many inches when you mean it is too long. Voltage again appears to us as bad as amperage, a name which, by the bye, enters into the heading of the last table in the book. If we talk of the amperage instead of the value of the current in amperes, why not speak of the microfaradage of a condenser instead of its capacity in microfarads, or of the feetage of a tall man as being 6½? The names current, resistance, capacity, &c., require a short analogous name for difference of potential. Years ago Mr. Latimer Clark suggested that the name *potency* was going a-begging. How would this do as short for potential difference if the industrial name, pressure, be objected to? But, the shortest abbreviation of all is the initials of the words potential difference and our own, P. D.

CAPTAIN COOK'S JOURNAL.

Captain Cook's Journal during his First Voyage round the World, made in H.M. Bark "Endeavour," 1768–1781. A literal transcription of the original MSS., with notes and introduction. Edited by Captain W. J. L. Wharton, R.N., F.R.S., Hydrographer of the Admiralty. Illustrated by maps and facsimiles. (London: Elliot Stock, 62, Paternoster Row, 1893.)

CAPTAIN WHARTON has rendered excellent service to naval and colonial history, and to geographical science, by editing a transcript of Captain Cook's journal of the voyage of the *Endeavour*, which was undertaken chiefly for the purpose of observing the transit of Venus across the sun's disk, and which led to the founding of the Australian Colonies by Great Britain. As is well known, the published accounts of that voyage are two, and neither of them satisfactory. The only very complete one is that compiled by Dr. Hawkesworth, from the journals of Cook, and of Mr. (afterwards Sir Joseph) Banks, who accompanied the great navigator as a volunteer, taking with him an eminent scientific man, Dr. Solander, a pupil of Linné, two artists, and servants, all of his own providing. The other is a brief and defective journal kept by Mr. Parkinson, one of Banks's artists, who died before the expedition reached England. It contains rude illustrations of the scenery and peoples of the Pacific Islands, which, if faithful reproductions of the originals (which I doubt), would show that his artistic powers were contemptible. Parkinson's narrative, which was edited by his brother, was published surreptitiously. It was suppressed by authority, and is, happily, not frequently met with.

Dr. Hawkesworth, on the other hand, has been severely and justly censured for the method he adopted, namely, the fusion of the journals of Cook and Banks,[1] and for attributing to their authors inept reflections of his own, an operation for which, even had it been advisable, he had not the ability, from his obvious want of appreciation of the distinctive labours of the navigator and of the naturalist." The result is a narrative in which the performances of the actors are inextricably confounded, and the records of Cook, and doubtless also of Banks, in some cases garbled. With regard to the reflections, they are comparatively of small account, and there is little difficulty in recognising and rejecting them; they were in keeping with much of the literary style of the age, and Dr. Hawkesworth assures the reader that his whole work was before publication submitted to and approved by the members of the expedition then in England.

Unsatisfactory as Hawkesworth's account of the voyage is, it has the inestimable advantage of in some measure filling what would otherwise be a lamentable void in the annals of science, for strange as it must appear, not even a meagre life of Banks has ever been written, and but for Hawkesworth's work and "Cook's Journal," there is no published account of his indefatigable labours during the expedition. Banks, no doubt aided by Solander, kept a full journal of many events that happened during the voyage, which the commander had not the opportunity of witnessing or recording; and the admirable observations on the physical features, populations, languages, economic products, manufactures, zoology, and botany, of the islands, and coasts visited, are presumably for the most part his. Cook, indeed, especially mentions the signal services which Banks rendered, especially in the management of the natives, in acquiring their languages, in provisioning the ships, and in collecting information and objects of interest; and it needs no reading between the lines of his concise narrative to prove his appreciation of his companion, who he invariably took with him wherever he landed.

The materials for the reproduction of the journal of which Captain Wharton has availed himself with great judgment, are a complete copy of "Cook's Journal" in the possession of the Admiralty; another belonging to the Queen, that was transmitted to England from Batavia, thus containing everything of importance; and thirdly, a duplicate of this last, which having been appropriated by the Secretary of the Admiralty, Sir Philip Stephens, passed to his descendants, and from them by sale first to Mr. Cosens in 1868, and in 1890 to Mr. John Corner. The latter gentleman was arranging for the publication of his copy, with the view of devoting the proceeds to the restoration of Hinderwell Church, the parish church of Staithes, whence Cook ran away to sea, when he suddenly died, and the carrying out of his project devolved upon his son, who completed the arrangements which led to Captain Wharton's under-

[1] Sometimes alluded to as the journals of Mr. Banks and of Dr. Solander, though there is no reason to suppose that the latter individual kept any journal independently of that of Banks, of whom he was probably the amanuensis, as Mr. Orton (the ship's clerk) was of Cook.

[2] A conspicuous example of this is Hawkesworth's omission of the passage in Cook's journal (Wharton, p. 322) dwelling on the unaccountable absence of the cocoa-nut (except of its shells cast upon the beach) on the east coast of Australia, which is a most remarkable feature in the geographical distribution of that plant. A few living specimens exist at Rockhampton and Keppel Bay, but in an unhealthy state, producing no fruit, and probably introduced by Europeans.

taking the editorship. The latter informs the reader that the text is from Mr. Corner's copy, so far as it goes, with additional matter, from the date of the arrival at Batavia up to reaching England, from the Admiralty copy.

In an interesting chapter of fifty pages Captain Wharton gives a spirited sketch of Cook's life and labours from his birth in 1728 to his murder in 1779. It contains a list of the antiscorbutics supplied to the *Endeavour*, and an account of the preventive measures adopted to ward off sickness in his ship. It is not mentioned in it that this led to his election, after his return from his second voyage, to the Fellowship of the Royal Society; before which Society he communicated a paper on the above measures, and another on the tides along the east coast of New Holland. Nor that for the former of these he was awarded the Copley medal by the President and Council, the highest honour in the gift of any scientific body, and the more honourable in the case of Cook, from the fact of the medal having been instituted as an award for discoveries or researches in experimental science. It is a melancholy fact that Cook's departure on his third voyage prevented his receiving in person this the sole public recognition of his still unparalleled services.

To dwell upon Cook's professional labours would be out of place here, are they not written in his own Report? which is a model of completeness and conciseness, recalling in these respects the Wellington despatches. There is a reason for the minutest detail, down to the naming of islands, bays, straits, and inlets, with the result of these being as appropriate as are Linné's names of animals and plants.

Captain Wharton has further illustrated his work with valuable footnotes and facsimiles of some of Cook's original charts, as of the Society Islands and New Zealand, making that of the Australian coasts specially interesting by placing on the same sheets parallel with Cook's chart of 1770 one corrected up to 1890, and reduced to the same scale, thus showing the marvellous approximate accuracy of the former. It is to be regretted that no list of the charts and plates is appended to that of the chapters into which, for convenience, Captain Wharton has divided the Report. It is difficult to find some of these in a work printed on thick paper with uncut edges; and without such a list there is no assurance that a copy is perfect.

In the preface, Captain Wharton says (p. vii) "that it has several times been in contemplation to publish Mr. (afterwards Sir Joseph) Banks' Journal, but this has never been accomplished," and again (p. xxvi) that the said Journal "cannot at the present time be traced." This was, till the other day, true. Captain Wharton had spared no trouble in his endeavours to trace it; and the writer of this notice had, at intervals, for many years past pursued the same object, he having a personal interest in its discovery, as being one of the few persons living who had seen it. Its history he believes to be the following. On Sir Joseph Banks' death, without issue, in 1820, his effects passed to the Knatchbull family, with the exception of his extensive Herbarium, Library, and the lease of his house in Soho Square, which were left to the late eminent botanist, Mr. Robert Brown, who had been for many years Banks' librarian, with the proviso that the Herbarium and Library were to be eventually deposited in the British Museum. The Banksian correspondence and papers, including the Report, were thereupon confided to Mr. Brown, with the object of his writing a Life of Banks. Age and infirmities interfered with the prosecution of the work; and the materials were for the same object transferred, in the year 1833, to my maternal grandfather, Mr. Dawson Turner, F.R.S., a naturalist, and man of high literary attainments, in whose house I aided in the collation of a copy of the Journal, which he had caused to be made, with the original. In Mr. Turner's case they met the same fate as in Mr. Brown's, and they were then placed in the hands of the late Prof. Thomas Bell, secretary of the Royal Society, and who succeeded Brown as President of the Linnæan, in the hope that he would undertake a Life of Banks. After retaining the materials for some time he declined the task, but before returning them (in 1857 or 1858) he submitted them to Mr. John Ball, F.R.S., who also declined. Nothing further was known to me or to Captain Wharton of their history until last week, when (having previously been misinformed on this point) I ascertained that the original of all Banks' correspondence and of his Journal of the *Endeavour's* voyage, were in the MS. Department of the British Museum, and the aforesaid copy in the Natural History Department of the same Institution. It only remains to add the hope that this gratifying intelligence may lead to the publication of Banks' Report uniformly with Captain Wharton's admirable edition of Cook's.

J. D. HOOKER.

OUR BOOK SHELF.

The Soil in Relation to Health. By H. A. Miers, M.A., F.G.S., F.C.S., and R. Crosskey, M.A., D.P.H. (London: Macmillan and Co., 1893.)

THE attractive title of this little book speaks for itself, indicating that it is one of those numerous endeavours which are being made at the present day to supply just such an amount of information in several different sciences as will satisfy the requirements of men engaged in some particular department of practical life. In the present case it is a combination of chemistry, geology, and bacteriology which is offered for the benefit of the sanitary officer. The task undertaken by the authors is obviously a difficult one, and, if the book be regarded as a mere outline stimulating the reader to more extended and special study, they may be said to have accomplished this task with a fair degree of success. Our knowledge of the chemical and biological changes taking place in the soil has, during recent years, been so much increased, and is in some respects so complete, that it might have been anticipated that much of this book would have been devoted to a clear exposition of such matters as nitrification and denitrification, the micro-organisms of water, their removal by filtration and other agencies, the purification of sewage, &c. As a matter of fact, the account given of nitrification is incomplete, whilst of the other subjects referred to above, and which are of such cardinal importance in connection with sanitary science, we find hardly any mention whatsoever. On the other hand, there are long passages devoted to such speculative matters as the causes of epidemic infantile diarrhœa, the connection between typhoid and the depression of ground-water, the relationship between soil and the prevalence of cancer and phthisis, &c. In the chapter on water-supply we are informed that the water from the magnesian limestone is "too permanently hard to be a wholesome drinking-water," whilst a few lines further on we are surprised to read that "the total solids rarely exceed 20 grains per gallon." The chapter on the atmosphere makes no mention of the numerous investigations which have been made both at home and abroad on the aërial microbes and their distribution. The authors almost apologise for the prominence they have given to the subject of micro-organisms, but we think they might more appropriately have tendered some excuse for their unfortunate frontispiece, which endeavours to represent the microscopic appearance of the typhoid and anthrax bacilli; for whatever the excellence of the original illustrations may have been, the reproductions in the copy before us do little credit to British printing.

Practical Astronomy. By P. S. Michie and F. S. Harlow. Second edition. (London: Kegan Paul, Trench, Trübner and Co., Ltd., 1893.)

IN this book the authors have brought together all those astronomical problems which are required for field work, limiting themselves simply to these, and dealing with them at sufficient length for practical work. The volume is intended especially for the use of cadets of the U.S. Military Academy, and as a supplement to Prof. Young's text-book, and several subjects not sufficiently discussed there for this special branch of practical work are here expanded. After a short discussion on the uses of the *American Ephemeris and Nautical Almanac*, and a few words on interpolation, the authors launch out into the usual methods of determining Time, Latitude, and Longitude on Land, explaining them concisely and deducing the requisite reductions formulæ. Corrections for refraction, parallax, &c., also receive a good share in their respective places, while the instrumental errors are fully explained and discussed. Excellent illustrations of instruments (those in use in the Field and Permanent Observatories of the Military Academy during the summer encampment) are inserted and described. In addition to a set of tables collected together at the end, a few well-arranged forms, showing the methods of computing several problems, are inserted, which should prove a great help to those not accustomed to such calculations.

W. J. L.

LETTERS TO THE EDITOR.

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

The Publication of Physical Papers.

THERE is little doubt that there is much to be done towards improving the machinery connected with the publication of papers on physical science. By publication of a paper I do not mean printing and binding and sending it to libraries in inconvenient places, which are open at inconvenient hours, but bringing it under the eyes of those interested in its subject. It is hardly possible to discuss this matter without being personal to journals and societies, so perhaps direct references may be allowed.

The present position is that as societies we have the Royal Society, which nominally embraces all branches of science, and the Physical Society, which is alone devoted entirely to physics, and several important general scientific societies scattered about the present kingdom. We have also some journals. Of these NATURE must here be put first, but NATURE is by no means purely physical, and is a scientific newspaper, and not a collection of scientific papers, and, owing to the nature of the case, incomplete as regards abstracts. The *Philosophical Magazine*, with its splendid record, fills its place alone. It contains a certain proportion of original papers, and a number of others communicated by the Physical Society, with which there is evidently an arrangement. There are also purely electrical paper like the *Electrician*, which covers most branches of electrical work, and the *Electrical Review*, which publishes filtrates of papers on electrolysis and kindred subjects editorially, with the names and references left out; an annoying proceeding. Coming to the societies, the Physical Society is alone devoted to physics. The Royal Physical Society in Edinburgh need not be considered, as it indulges in ornithology and things of that sort. The Physical Society publishes well. Abstracts of the papers and discussions appear in NATURE and in most scientific or technical, and in some literary journals. The papers are often published in the *Philosophical Magazine*, and again in the Society's own Proceedings. No doubt in time this society will be to physics as the Chemical is to theoretical chemistry, but at present it does not command by any means all the most important physical papers. There is also some waste in republishing in the *Philosophical Magazine* and the Proceedings, though this does not cost much. The arrangement with the *Philosophical Magazine* prevents the immediate publication of a Physical Society paper in the scientific and technical journals at home and abroad. This is a source of weakness. A society which objects to its papers being published everywhere before appearing in its own journal does much to defeat its own ends. The Physical may be unable to help this, but in the Royal, or other wealthy institution, it is defeating the main object of the society's existence for the sake of selling a few odd copies of the Proceedings. To go back to the Physical, the result is that its papers are never reprinted either from the *Philosophical Magazine* or from the Proceedings. The *Philosophical Magazine* is not very cheap, and the Proceedings are, I think, not sold to non-members.

The Royal Society gets physical papers. I believe they are sometimes read, but do not know, not being a Fellow. The best papers are published a long time afterwards in a form which is very expensive to buy, and those who are not Fellows generally know nothing about them until they find them by chance. Royal Society papers, again, are seldom reprinted in the journals.

Then there are various other societies, like the Royal Society of Edinburgh, and the Cambridge and Dublin societies, which shroud valuable papers of all sorts in their transactions, and bury them in public libraries. The result of the present state of things is that an English physicist—it is difficult to get on without this curious word—has no simple means of following the progress of his own special study.

There are several courses which would improve matters, but none of these is perfect. The most obvious is for all physical papers of any importance to be sent to the Physical Society, and published in its Proceedings. The advantages of this need hardly be enumerated. Of course the Physical Society would develop, and would at once become one of the most important in the world. The drawback is that if this principle were carried out in all branches of science we should have a number of special societies in London, and none anywhere else, which would be a very bad arrangement. Another plan would be for the various societies to join, so that one journal, say that of the Physical Society, contained all the important physical papers read at the various societies. A society would communicate its best papers to the Physical Society's Proceedings, these Proceedings being controlled partly by representatives of all the other societies. The papers would, of course, also appear in the Proceedings of the societies to which they really belonged. One drawback to this would be that the Royal Society might object to communicating its papers to the Physical; and this might lead to competition between a special and a more powerful general society.

Another course would be for the Royal Society to act as the central body. This would be rather hard on the Physical, and would tend to reduce its standing, so that we would have no first-rate society devoted specially to physics in a country where an enormous amount of work is done in a disorganised way. There would be another difficulty. The Royal Society standard of papers is supposed to be very high, and though it occasionally publishes papers of no value, the high standard generally maintained would exclude many papers of great importance which were hardly good enough for the Royal Society. Then the Royal Society is specially devoted to pure—that is unapplied science, and there are very many papers on applied physics which are of the highest importance.

Still another course would be for a firm of publishers to bring out a purely physical paper. The stumbling-block here is the question of advertisements. According to Mr. Thiselton Dyer, scientific men are supposed to beunbusiness-like, no doubt without reason; but it may be well to remind them that most journals live on their advertisements, the reading matter being a necessary evil. It would thus be commercially impossible to run a purely physical paper, as there is no trade, except to a certain extent electrical engineering, which has much to do with physics.

It might be better to abandon the idea of a central organ for physics, and to publish a complete set of abstracts. Abstracts to be useful must be very well made, and they must be complete. It is very difficult to get good abstracts. The work is laborious and costly when efficiently done. Abstracts are only a developed index, and it would still be necessary that separate papers should be obtainable. Incomplete abstracting is a very common vice. It is not enough to have a few papers brought under a reader's notice: that is good when one is reading for general information in an indolent way, but it is useless in the far more common case in which he wants to know either all that has been done on a given subject, or whether some discovery has been hit upon before. A scientifically worked out subject index is also essential, and, as said before, the abstracts must be practically complete. JAMES SWINBURNE.

4, Hatherley Road, Kew Gardens, June 25.

The Glacier Theory of Alpine Lakes.

I HAVE read with interest the discussion in NATURE on the "Glacier Theory of Alpine Lakes," and I feel constrained to write now, more especially as Mr. Wallace has cited Tasmania as a country, among others, where Alpine lakes are associated with "palpable signs of glaciation." Having recently, with Prof. Spencer, of Melbourne University, made a visit to the central lake district of Tasmania, a few words about the lakes may not be without interest in reference to the subject under discussion.

The lake district of Tasmania is situated about the centre of the island on the great central greenstone plateau, which attains to a height of 4000 ft. above sea level in places. We camped on the shores of Lake St. Clair, and remained there during the whole month of January of this year. Lake St. Clair is about 2500 ft. above the sea, and is about 11 miles long by 2 broad. It occupies a narrow valley between the Olympus Range on the one hand and the Traveller Range on the other. A depth of 590 ft. is recorded. Its basin probably lies in sandstone (carboniferous?), the structure of the adjoining mountains being sandstone capped by greenstone (diabase).

Both Prof. Spencer and myself, being believers in the glacier theory of Alpine lakes, had half expected to find evidences of glaciation, especially as we had heard of well marked signs being found on the west coast, some 50 or 60 miles to the northwest. However, we could not find the slightest trace of glacial action. From the top of Mount Olympus, rising about 2350 ft. above the surface of the lake, we got a magnificent view of the country. The Traveller Range opposite is really the edge of a great greenstone plateau, stretching away with a roughly undulating surface for miles beyond. The surface of this plateau is studded all over with lakes and tarns of various sizes and at different levels. In other directions, too, lakes can be seen here and there nestling in the valleys. In all we counted between thirty and forty lakes and tarns from the top of Mount Olympus. Two small basins of water—the "Olympian Tarns"—rest on the flanks of the mountain itself. On the opposite side of Olympus from St. Clair lies Lake Petrarch, occupying an oval basin and apparently of shallow depth. This lake is about 560 ft. above St. Clair. On the right shore of St. Clair occurs another small lake (Lake Laura) 50 ft. above the former, and separated from it by a ridge about 3400 yards across.

A characteristic feature of this district are the "button-grass" flats. These are open, marshy expanses covered with "button-grass" (*Gymnoschœnus sphærocephalus*) and other plants. They are traversed by numerous little runlets of water, which usually unite into one or more main streams. Here and there in many of them masses of greenstone protrude. Between these "flats" are generally low ridges of greenstone covered with Eucalyptus and Banksias, &c. Many of these flats or marshes—as, for instance, those in the Cuvier Valley, at the head of which lies Lake Petrarch—reminded me very strongly of the moorland scenery in the Scottish Highlands, and the plateau, already referred to, with the lakes and tarns scattered over its surface, might be a scene in Sutherlandshire. But in all our wanderings we did not find the slightest sign of glaciation either in the form of moraines or of striated rock-surfaces. We were not able to examine the lakes on the plateau mentioned, but from its configuration I am confident that evidences of glaciation do not exist. On the west coast, notably about the Pieman River, signs of glaciation are, I believe, abundant, and numerous tarns and rock basins are associated with them. Here the neighbouring mountains are not so high as those further inland, and it was probably their proximity to the coast that was the cause, during the last glacial epoch, of glaciers being formed there and not further inland.

So then, though in Tasmania there are instances of rock-basin lakes being associated with undoubted evidences of glaciation, yet, as I have shown, the glacier theory will not account for by far the greater number of the Alpine lakes on the great central greenstone plateau. I do not propose to put forth any theory to account for these lake-basins, but have put down the above facts in the hope that they may prove of some interest in the question at issue, and to show that at least there are some exceptions to Mr. Wallace's statement that Alpine lakes only exist in glaciated regions.

I may add that Lake St. Clair has been accounted for by Gould, who explained it by supposing that a flow of basalt had dammed up the lower end of the valley in which the lake lies. I am, however, much inclined to doubt the existence of this basalt. Though we traversed the end of the lake where it is said to occur, we did not recognise any basalt.

It may also be remarked about the "button grass" flats or swamps, that they really occupy rock-basins, and may perhaps be regarded as the analogues of the peat-bogs of Scotland and Ireland. All those occurring in the same drainage area seem to be directly connected with each other, and I think there can be little doubt that many of them were formerly occupied by lakes.

Melbourne University, May 7. GRAHAM OFFICER.

THE Editor having given me the opportunity of reading Mr. Graham Officer's interesting letter, I will make a few remarks upon it.

It seems to me that, without further information as to the nature of the search for drift, erratics, or ice-worn surfaces, and judging from the statement that the plateau studded with lakes and tarns was only looked down upon from an adjacent mountain summit, we can hardly give much weight to the positive statements, "I am confident that evidences of glaciation do not exist," and—"as I have shown, the glacier theory will not account for by far the greater number of the Alpine lakes on the great central greenstone plateau." Some light may perhaps be thrown on the matter by the consideration that the undoubted marks of glaciation in many parts of Australia are believed to have been caused by, comparatively, very ancient glaciers, since some of the glaciated surfaces are overlain by pliocene deposits, while others are believed to be of palæozoic age. If the Tasmanian glaciation was also of pliocene age, most of the superficial indications may have been destroyed by denudation, or, if preserved, may be hidden by vegetation or by alluvial deposits. We must therefore wait for a much more thorough examination of the district and of other parts of Alpine Tasmania before it can be positively stated that no evidences of glaciation exist.

ALFRED R. WALLACE.

Vectors and Quaternions.

I WOULD like to ask Prof. Knott whether there would be any fatal objection to defining the scalar product of two vectors as equal to the product of their tensors into the cosine of the angle between them, so that, if the vectors are

$$ix_1 + jy_1 + kz_1,$$

and

$$ix_2 + jy_2 + kz_2,$$

the scalar product would be

$$x_1 x_2 + y_1 y_2 + z_1 z_2,$$

and not

$$ix_1 . ix_2 + jy_1 . jy_2 + kz_1 . kz_2.$$

If this is done, and, for the sake of associativeness of products, i^2 is made equal to -1, the distributive or quaternionic product of two (or more) vectors would be their vector product *minus* their scalar product. The change suggested would enable students to gradually accustom themselves to the notation of the calculus, which would in fact then form an abridged notation for the cartesian expressions and operations which enter into physical investigations.

I would ask Prof. Knott to give this suggestion his careful consideration, as I am sanguine enough to believe that in it, simple as it appears, lies the possible reconcilement of the new school of vector analysts with the quaternionists. Possibly some symbol other than S would have, at any rate at first, to be employed for this new scalar product. Perhaps, with Prof. Macfarlane, it might be called the cos-product, though that notation properly belongs to the scalar product of two vectors only, and loses its significance if applied to the scalar product of three or more vectors. No single letter symbol could be better than S, as it is distinctive and quick to write. However, the first question is whether there is any possibility of the modification being adopted.

The quaternionic product of a vector by itself would be minus its scalar square, but without any mystery attached to the fact. For the product of two vectors = vector product − scalar product, and therefore, if the vector product is zero, the quaternionic product = − the scalar product. Hence, instead of having

$$(\alpha + \beta)^2 = \alpha^2 + 2S\alpha\beta + \beta^2,$$

we should have

$$S(\alpha + \beta)^2 = S(\alpha^2 + 2\alpha\beta + \beta^2).$$

Reciprocal vectors satisfy the equation $\beta^{-1}\beta = 1$, so that $S\beta^{-1}\beta = -1$, *i.e.* β^{-1}, β are oppositely directed vectors.

The quaternion

$$\alpha\beta^{-1} = \frac{\alpha\beta}{\beta^2} = \frac{V\alpha\beta - S\alpha\beta}{-S\beta^2} = -\frac{V\alpha\beta}{S\beta^2} + \frac{S\alpha\beta}{S\beta^2},$$

showing clearly that both the vector and scalar products of $\alpha\beta^{-1}$ are opposite in sign to those of $\alpha\beta$, as must, of course, be the case since β^{-1} and β are oppositely directed vectors. This fact is obscured with the orthodox notation. In fact, so far as I have been able to test the proposed change, I have found no drawbacks, but rather an improvement. ALFRED LODGE.

Sagacity in Horses.

FROM the window opposite, as I write, I have just witnessed an interesting performance on the part of two horses. Bordering the park is a strip of land, doomed to be built upon, but meanwhile lying waste, and used for common pasturage, on which the horses under notice were leisurely grazing. A pony in a cart, having been unwisely left by the owner for a time unattended on the grass, suddenly started off, galloping over the uneven ground at the risk of overturning the cart. The two horses, upon seeing this, immediately joined in pursuit with evident zest. My first supposition, that they were merely joining in the escapade in a frolicsome spirit, was at once disproved by the methodical and business-like manner of their procedure. They soon reached the runaway, by this time on the road, one on one side of the cart, and one the other; then, by regulating their pace, they cleverly contrived to intercept his progress by gradually coming together in advance of him, thus stopping him immediately in the triangular corner they formed. Until the man came up to the pony's head they remained standing thus together quite still; when the two horses, evidently satisfied that all was now right, without any fuss trotted back again together to their grass.

The sagacious conduct of the horses, acting in such perfect cooperation, formed a pretty sight; and it was apparent that, instead of making the pony more excited, they really pacified and calmed him. Why should they not receive "honourable mention" as much as if they were proud human beings?

WILLIAM WHITE.

The Ruskin Museum, Sheffield, June 20.

TERCENTENARY OF THE ADMISSION OF WILLIAM HARVEY TO GONVILLE AND CAIUS COLLEGE, CAMBRIDGE.

BORN at Folkestone, and educated at the King's School, Canterbury, William Harvey was admitted to Gonville and Caius College as a minor scholar in his sixteenth year, on May 31, 1593. The tercentenary of this event was celebrated by Harvey's College on Wednesday, June 21, this being the earliest day after the date of his admission at which rooms were available for those coming from a distance. The guests were received and welcomed by the Master and Fellows, at five o'clock, in the large Combination Room, where tea was provided. In the smaller adjacent room were exhibited a number of objects of interest connected with Harvey, including his pestle and mortar, from the Museum at Folkestone, a rubbing from his mother's tomb, an autograph letter of Harvey, lent by the Master of Sidney Sussex College, and a coloured drawing of Harvey's coat-of-arms, recently discovered on the walls of the buildings of the University of Padua. The latter was presented to the College by the University of Padua, followed on the day of the festivity by a long congratulatory Latin telegram from the Rector, on behalf of the University, which ran as follows:—"Universitatis Patavinæ quæ cum aliis Britannis discipulis tum Harveio Caioque gloriatur, quorum alterius merita insigne Collegium vestrum nunc recolit nomenque ex altero invenit, festi in Harveii honorem indicti participem se profitetur et in renovanda cum celeberrima Universitate Cantabrigiensi vetere studiorum amicitiæque memoria summopere lætatur, pro Academico Senatu, Ferraris Rector." Also an autotype of the panel-portrait of Harvey from Rolls Park, Chigwell, Essex, presented to the College by Sir Andrew Clark, as one of a series of eight, consisting of a central portrait of Harvey's father, surrounded by those of his seven sons. Some early editions of the works of Harvey and of some of his more immediate predecessors and followers were also displayed, together with the admission book of the College, containing the original record of his admission. At seven o'clock the guests assembled once more in the Combination Room, whence they proceeded to dinner in the College Hall, led by the butler, bearing the original "caduceus," as used by Dr. Caius when President of the College of Physicians. The dinner was presided over by the Master of Gonville and Caius College, the Rev. N. M. Ferrers, D.D., F.R.S., above whose chair were displayed a copy of the bust from the Harvey Memorial, crowned with a laurel wreath, and the much-prized portrait of Harvey from the Master's Lodge. After dinner the Grace Anthem of the College, composed by Mr. C. Wood, was sung. The Master then proposed the usual loyal toasts, after which Sir James Paget proposed the toast of the evening, "The Memory of William Harvey."

He remarked that the reason why he had the honour of being asked to propose that toast was his relationship to his brother, who, he believed, made the proposal that there should be that tercentenary of the admission of William Harvey. He desired to remember that, and to speak as he thought his brother would have spoken if he had had the opportunity. He was sure that if he had been present he would have referred to the honour which was due to the college which Caius founded. He would have done that out of the deep sense of gratitude which he had for the College. For it was the Fellowship founded by Caius that led his brother to the study of medicine, and, on the occasion of that Fellowship which he held becoming vacant, to give himself entirely to it. To that he owed a great part of the happiness of his life, and he hoped he (the speaker) would not be deemed wrong if he said that indirectly he himself was also deeply indebted to Caius College, for it was through the large income which was associated with that Fellowship that his brother was enabled, out of his abundant generosity, to help him greatly in the study of his profession at St. Bartholomew's Hospital, of which Harvey was so great an ornament and honour. He wished that they knew more of the time and the work he did in Caius College. Indirectly Harvey owed to Caius himself the opportunity of being a student of the College. It was not, he thought, known whether Harvey was originally destined to be a student of medicine or physic, or whether he was led to it mainly by that which he found in that College, from the help and advantages given to the study of medicine and sciences. Harvey found there—and there alone, he thought, certainly amongst the Colleges of the University—a license for dissection. A license was obtained from the King to dissect in that College the bodies of criminals, and Dr. Venn, in the register of St. Mary's parish, had found records of two who were executed here in Harvey's time. The register said distinctly "They have been buried here after being anatomised in Caius College. He might add that the bodies were to be interred with great reverence, and the Masters and Fellows had to attend the funerals. From that College Harvey went to Padua, where he had the best learning from the best biological teachers of the time. He took the degree of doctor of medicine with the highest honour, and then he returned to the practice of his profession and the teaching of it in the University. Alluding to Harvey's discovery of the circulation of the blood, Sir James said he thought he might venture to say that that was the greatest discovery in biological science ever made by one man. He thought there never had been any one man to whom biology was so indebted as to Harvey for that discovery, and that was in the early part of his life. He supposed they could not now think of what would have been the progress of biology but for that discovery, neither could they form any just estimate of the honour due to Harvey for that discovery, which was to them now so plain, so evident, that one might wonder how it could ever have been doubted, but was then surrounded by difficulties which it seemed impossible ever to overcome. It was marvellous, if one looked back at it, to think what must have been the power of observation, the ingenuity, the constant, resolute industry of the man who could find that out, not only in the face of actual difficulties of inquiry, but in the face of those who were perfectly satisfied with their own opinions. He worked on and on until he brought out the best result he could obtain. He had shown by his discoveries, which had had even a greater influence on the progress of biological knowledge, the right method of inquiry. He had to find his results in the face of that full and perfectly-satisfied belief that all truth in such a science as that of medicine could be deduced from general principles then prevalent, and from the physiological doctrines which few men then dared to doubt. Nothing could have proved more than Harvey's results that the way to knowledge in biological science was through continual observation and experiment and recording. That was what Harvey showed, and it had never been forgotten. Again and again Harvey said in his works, and more especially in that admirable introduction to his work "De Generatione," that the way to knowledge was by observing, experimenting, and recording, and not by thinking. The same thought was expressed by John Hunter, who said, "Don't think; try." Those were words he (Sir James) would venture to say every one pursuing biology might well bear in mind. Both of those men were most earnest and profound thinkers. This could be traced in all their works, but that in which they distinguished themselves from other men of the same calling and the same pursuits was that they tried their thoughts. They tested them by every possible observation and experiment. They thought, and thought, and thought, but they were never satisfied with thinking; every thought they had was tried by experiment. When they remembered that Harvey was not only the greatest physiologist of the time, but the greatest physician, it was well to look and see as far as they could how much he himself followed that out, and he thought it would be found, unhappily, they had scarcely any record of Harvey's observations in practice. Repeatedly in his works that were published he stated that he intended to publish his medical observations. Now the whole of those, he supposed, were lost, and yet his (the speaker's) brother pointed out there was no certain knowledge at all either of the time or of the manner in which they were lost. Those observations would be of inestimable value if they could be found. They might hope that some of the younger Caius men would find out where those manuscripts were. It would be well if the MSS. could be published in *facsimile*, or in the same manner as the one done by the College a few years ago, when they at last found Harvey's lectures on anatomy and surgery. He asked them to drink to the memory of Harvey, who had made discoveries surpassing those ever made by any one man, and had showed the true and only sure methods by which biological science could be increased.

After the toast had been duly honoured the College "Carmen Caianum" was sung, the words of which were written by the President, Rev. B. H. Drury, and set to stirring music by Mr. C. Wood. An extra verse commemorative of Harvey and Glisson, also once a member of the College, was introduced into the song for this occasion.

Dr. Clifford Allbutt (Regius Professor of Physic) proposed the toast of "The Guests," and in doing so read a letter which had been received from the rector of Padua University, in which he expressed the pride of that University at having been the place where William Harvey had pursued his studies. Dr. Allbutt also referred to the sense of loss which was felt by all present at the death of Sir George Paget, who would, had he lived, have been the man of all others upon whom it would have been fitting that the duty of taking an important part in that celebration should have fallen.

Sir Andrew Clark responded, and said he desired in the name of his more distinguished fellow guests to give them his grateful thanks for permitting them to be present that evening.

Prof. Gairdner next proposed "The University," and said that the toast needed nothing on his part to recommend it. He could not conceive a greater eulogium upon the University of Cambridge than that it contained such magnificent representatives of ancient learning as their Vice-Chancellor, Dr. Peile; and at the same time eminent representatives of what he would venture to call the modern scientific method as the Professor of Medicine, Dr. Clifford Allbutt and of Physiology, Prof. Michael Foster. The University was an institution founded upon all that was best in human learning and in human experiments, and it will go on and prosper to the end of time. He proposed the health of the University and coupled with it the name of their distinguished Vice-Chancellor, Dr. Peile.

The Vice-Chancellor, in returning thanks, alluded to the great development of studies and of buildings in the University during the past thirty years. He was sorry to say that their rapid development had almost caused alarm in certain most important quarters. He read the other day one of the leading newspapers of England, which called attention to their unsatisfied spirit of innovation. He thought that that must have reference to some of their most recent developments of the engineering tripos. Yet surely it might have occurred to any one that the sciences of engineering were most closely connected with the study of mathematics, which was their chief glory in Cambridge. Possibly, also, it had reference to the development of agricultural science. Well, agricultural science was a very excellent thing. It seemed to him that, after all, some of the greatest discoveries in science had been made, not merely by students or by lecturers, but by men who had been carrying on professional work and working purely with mercantile aims. The duty of the University, he took it, was to encourage those studies as well as others. But there would always be a problem before them. At present the problem would raise the very, very old story—the limited means of the University. The problem was how far could they encourage new studies, which could never lead those who were following them to any great pecuniary rewards, although they might lead them to the rewards of learning. He thought that was a great problem. This year they had an examination in Oriental languages. There was one candidate for it; they had four examiners, and the cost of that examination, he supposed, was £50 or £60 to the University, which was perfectly right. It was just those studies which could not pay their way, which could never be supported without the help of endowments. He did not think the problem was so serious as it might seem at first. Two years ago, when his predecessor, Dr. Butler, resigned his office, he pointed out some of the needs of the University. Dr. Butler's clear and lucid statement brought forth one magnificent gift and nothing more. He (the speaker) in his turn, in the first year of his office, sent forth "a bitter cry" of the needs of the University. Yet that bitter cry brought forth nothing. Did it seem possible that after all a general cry might not be specially efficacious, while a request for special help might serve for a cry? He was happy to say that this seemed at last to solve the problem of how they could develop the newer studies with the help of those outside who were willing to support them. The engineering school had, by the labours of Prof. Ewing and Mr. Horace Darwin, received money, which he hoped would carry it on sufficiently. He believed so ancient an institution as the Observatory of Cambridge was going to ask for a new telescope to carry on its work. That being so, it seemed that partially at least the problem was solved. The problem concerning agricultural science had been solved by the liberal aid of the County Councils. Those bodies had come to their aid in the most generous manner, and given them enough to carry on their work for at least some years. He hoped, as he said before, they would see their way, not merely to maintain and develop those old institutions which had been from all times the glory of Cambridge, but also to carry on those newer studies and newer developments which would keep them in touch with the nation, and make them remembered for all times, and which, whatever developments might arise elsewhere, would make Cambridge one of our greatest centres of educational life.

In proposing the "Health of the Master and Fellows," the Right Hon. T. H. Huxley, who was enthusiastically received, said he was charged with a very pleasant duty, and one which could be happily performed without either gifts of eloquence or even those of voice, in which unhappily he was at present sadly deficient, and he would not be withdrawn from the simple discharge of that duty by the invitation which had been addressed to him by a previous speaker to enter upon the field of controversy. In proper time and place he imagined that he could hardly be said to have shown any unwillingness for the discussion of controverted questions, but in his judgment they were extremely inappropriate and out of place in a meeting of that kind, and he desired absolutely to abstain from that, and to confine himself to the business in hand, which was of a far more pleasant, and, he ventured to think, more profitable nature: it was to propose to them the health of the Master and Fellows of that College. All those who were present would understand the gratitude which they all felt for the generous and gracious hospitality which they had shown to them on that occasion, but it was a traditional hospitality, and it went back to the time when that important corporation, of which they were the present representatives, extended their hospitality to William Harvey, whose name and fame they were met to celebrate. He did not know whether the Master and Fellows of that time were aware of what they were doing in training and disciplining that young man—boy, indeed, to them—to make the best use of the faculties with which he was endowed, but he thought it lay to their credit that from that time to this, the hospitality which they extended to science—to biological science especially, and to that branch of it which was called the science of medicine very particularly—that that had been continued with unbroken openness and readiness. It was for that reason, he thought, that the large proportion of persons present in that room who were devoted to scientific studies would with the greatest possible cordiality drink the toast which he had to propose. For in this matter Gonville and Caius College occupied a position as isolated as it was honourable. He was aware that the studies of biological sciences, and more especially those which had relation to medicine, could not be cleared of the accusation then made against them of utility to mankind. He admitted to the full the charge that was made against those studies, but the present showed, and the future would show more strongly, that quite apart from the bearing of direct utility, it must be regarded as a happy instinct, if not as a purpose of intelligence, which had led that College for these 300 years to cherish and to promote those studies. It was on that ground they who were so deeply interested in its pursuits felt that they owed a debt of gratitude to the College, and he knew of no reason, except the fact that he once took an active part in those biological matters, which had led to his selection as proposer of the health of the College to them on that occasion. Sir James Paget had fully and exhaustively told them, in that admirable language which he had always at command, the great claims of Harvey upon their respect and veneration. He had justly told them that Harvey regarded himself, not merely as a discoverer, but as a propounder and champion of a new method. Dr. Venn was good enough to tell him before the dinner of a fact of which he (the speaker) was entirely ignorant: that before Harvey's time that College possessed what was called an "anatomer," a gentleman whose duties appeared to have been to dissect bodies, which were given over to him and others, to give the students of the College a practical contact with the nature of things. It was in that respect that modern science differed from ancient science; it was in that respect that Harvey was essentially modern. It was therefore to the wise provision of the founders of that College that they owed the beginning of that movement commenced in this country by Gilbert, followed up in Italy by Galileo, followed up conscientiously here by Harvey himself, which had led to the great modern development of scientific culture. They trusted that the hospitality which had hitherto been extended by that College to purely scientific investigations would be continued upon the lines laid down by Harvey. It might be that Harveys existed among them now, and the only thing they had to hope for, and to wish for was, that those Harveys of the future might not be compelled, as the Harvey of the past, to obtain a higher scientific training by going to the University at Padua. They hoped that in this University men would have the opportunity of obtaining the highest scientific culture which was to be given. That he understood was the object and purpose and desire of the Master and Fellows of that College, in inviting persons like himself to take part in that great celebration; he presumed they wished them to understand that they recognised Science as a fundamental branch of human culture, and that they would do what in them lay to promote that happy commemoration to which he ventured to allude.

The toast was drunk with enthusiasm.

The Master briefly returned thanks, and stated that it had given them very sincere pleasure to entertain so illustrious an assembly, and expressed his deep regret that Sir George Paget was not with them.

The Rev. B. H. Drury proposed the health of the younger members of the College, saying that they were the life-blood of their College to-day, the source of their vitality, without whom they would have really little cause for existence.

Mr. Keeble, Natural Science Scholar of the College, made a short and graceful reply.

At the conclusion of dinner a move was made to the Combination Room, where friendly and animated intercourse was kept up for some time, and it was late before the last of those engaged in the celebration separated for the night.

Breakfast was provided the following morning from eight to ten for those resident in College overnight, and by midday the guests had departed, leaving the courts once more to solitude, and to their hosts a keen feeling of satisfaction at the honour done to the memory of William Harvey and to the College by the recent presence of so representative and distinguished a gathering of visitors.

SOME POINTS IN THE PHYSICS OF GOLF.[1]

III.

IN Part II of this paper (NATURE, Sept. 24, 1891) the following statements were made:—

"The only way . . . of reconciling the results of calculation with the observed data is to assume that, for some reason, the effects of gravity are at least partially counteracted. This, in still air, can only be a rotation due to undercutting."

"And, as a practical deduction from these principles, it would appear that, to secure the longest possible carry, the ball should be struck so as to take on considerable spin———."

As these statements, and some of their consequences, have been strenuously denied, I must once more show at least the nature of the evidence for them.

It depends, in one of its most telling forms, upon the contrast between the length of time a well-driven ball remains in the air (as if in defiance of gravity) and the comparatively paltry distance traversed. Every one who thinks at all on the subject must see that, *without some species of support*, the ball could not pursue for six seconds and a half a course of a mere 180 yards, nowhere more than 100 feet above the ground.

In fact, if we assume the initial slope of the path to be 1 in 4, as determined for the average of fine drives by Mr. Hodge with his clinometer (NATURE, Aug. 28, 1890) the carry of a non-rotating ball will be approximately (in feet)

$$AgT^2,$$

where g is the acceleration due to gravity, T the time of flight in seconds, and A a numerical quantity depending on the resistance. The value of A varies continuously between the limits, 2 for no resistance, and 1 for infinitely great resistance. [It is assumed that the resistance is as the square of the speed.]

This formula gives, with the average observed value of T ($6^s{\cdot}5$, see Part II.) carries varying from about 900 down to 450 *yards!* The initial speed required varies from 416 foot-seconds upwards. The longest actually measured carry on record, when there was no wind, is only 250 yards. Unfortunately, in that case T was not observed, but analogy shows that it was probably much more than 7^s. Even if we take it as 7^s only, the "carry" ought to have been, by the formula (which is based on the absence of rotation), 522 yards at the very least!

I have purposely, in this example, kept to the case of an initial slope of 1 in 4; because those (and they are many, some of them excellent golfers) who altogether reject the notion that undercutting lengthens the carry, would of course in consistency refuse to believe that a long ball may sometimes start horizontally. But, to those who allow *this* statement, the fact that the action of gravity is occasionally largely interfered with, or even counteracted, is obvious without any numerical calculations. In fact, from my present point of view, initial slope is of little importance:—except, of course, in avoiding hazards. The want of it is easily made up for by a slightly increased rate of spin.

Another way of looking at the matter is to assume, from Mr. Hodge's data, 180 yards as a really fine carry, and thence to calculate by the formula the requisite time of flight. It varies from $4^s{\cdot}1$ to $2^s{\cdot}9$ according as the resistance, and therefore the necessary initial speed, are gradually increased; the former from *nil* to infinity, the latter from 132 foot-seconds upwards. Thus the observed time exceeds that which is really required when there is no spin, by 60 per cent. at the very least!

The necessity for underspin being thus demonstrated, we have next to consider how its effect is to be introduced in our equations. On this question I expressed a somewhat too despondent opinion in the previous part of this paper. A rather perilous mode of argument (which I have since been able to make much more conclusive) first suggested to me that the deflecting force, which is perpendicular at once to the line of flight and to the axis of rotation, must be at least approximately proportional to the speed and the angular velocity conjointly. But I tried (with some success) to verify this assumption by various experimental processes. These, as will be seen, led also to a numerical estimate of the magnitude of the deflecting force. [And I was greatly encouraged in this work by the opinion of Sir G. G. Stokes, who wrote:—"I think your suggestion of the law of resistance a reasonable one, and likely to be approximately true." This is quite as much as I could have hoped for.]

First: by the well-known phenomena called heeling, toeing, and slicing, which are due to the ball's rotation about a vertical axis. I have often seen a well-sliced ball, after steadily skewing to the right through a carry of 150 yards or even less, finally move at right angles to its initial direction, and retain very considerable spin when it reached the ground. Neglecting the effects of gravity, the equations of the path should be, in such a case,

$$\ddot{s} = -\frac{\dot{s}^2}{a},$$

$$\frac{\dot{s}^2}{\rho} = k\dot{s}\omega;$$

expressing the accelerations in the tangent, and along the radius of curvature, respectively. If we introduce the inclination, ϕ, of the tangent to a fixed line in the plane of the path, the second equation becomes

$$\dot{\phi} = k\omega,$$

showing that the time-rate of change of direction is proportional to the speed of rotation. The first equation gives, of course,

$$\dot{s} = V\epsilon^{-\frac{s}{a}},$$

where V is the initial speed.

The space-rate of change of direction, *i.e.* the curvature of the path, is thus

$$\frac{d\phi}{ds} = \frac{k\omega}{V}\epsilon^{\frac{s}{a}},$$

increasing in the same proportion as that in which the speed of translation diminishes; and, if we regard ω as practically unaltered during the short time of flight, the intrinsic equation of the path is

$$\phi = \frac{ka\omega}{V}(\epsilon^{\frac{s}{a}} - 1).$$

A rough tracing from this equation is easily seen to reproduce distinctly all the characteristics of the motion

[1] Part of the substance of a paper on the Path of a Rotating Spherical Projectile, read to the Royal Society of Edinburgh on June 5.

of a sliced, or heeled, ball. And, by introducing an acceleration in the plane of the path, constant in magnitude and direction, the path might be made to intersect itself repeatedly.

By the statement made above as to the whole change of direction in the course of a well-sliced ball, and with 5^s as the time of flight (for it, like the carry, is notably reduced by slicing) we have

$$\frac{\pi}{2} = 5k\omega.$$

Thus it is clear that we may easily produce rotation enough in a golf-ball to make the value of $k\omega$ as great as 0·3 or even 0·4. And this can, of course, be greatly increased when desired. This datum will be utilised later. The fact (noticed above) that the time of flight, and the carry, are both reduced by slicing, gives another illustration of the necessity for underspin when the time of flight is to be long, and the carry far.

Secondly: by a laboratory experiment which, I have only recently learned, is due in principle to Robins. (*An Account of Experiments relating to the Resistance of the Air.* R.S. 1747.) I suspended a wooden shell, turned very thin, by a fine iron wire rigidly fixed in it, the other end of the wire being similarly attached to the lower end of a vertical spindle which could be made to rotate at any desired rate by means of multiplying gear. Thin as was the wire, it was but slightly twisted in any of the experiments, so small was the moment of inertia of the wooden shell. The wire acted as a universal flexure joint; and, by lengthening or shortening it I could make the ball's mean speed, in small pendulum-oscillations, vary within considerably wide limits. I verified this result by substituting for the shell a leaden pellet of equal mass but of far smaller radius, as I feared that some part of the result might be due to stiffness of the wire, produced by torsion. But with the pellet the rotation of the orbit was exceedingly slow. Thus ω, and the average value of $\dot{s}$, could have any assigned values; and from the elliptic form and the rate of *rotation* of the orbit of the ball, the transverse force was found to be proportional to either of them while the other was kept constant. An exceedingly interesting class-illustration can be given by making the ball revolve as a *conical* pendulum, and while it is doing so giving it spin alternately with, and opposite to, the direction of revolution. The effects on the dimensions of the orbit and on the periodic time are beautifully shown. This form of experiment could be easily applied to considerable speeds, both of the translation and of rotation, if the use of a proper ball could be secured. But it cannot be made strictly comparable with the case of a golf-ball; as the speed of translation can never much exceed that for which the resistance is as its first power only. [Robins' suspension was bifilar, and the rotation he gave depended more on the twisting of the two strings together than on the torsion of either. In this mode of arrangement it is difficult to measure the rate of spinning of the bob, and almost impossible to vary it at pleasure.]

We must next say a few words as to the manner in which the spin, thus *proved* to have so much influence on the length of the carry, is usually given. I pointed out, in the earliest article I wrote on the subject, "The Unwritten Chapter on Golf" (*Scotsman*, Aug. 31, or NATURE, Sept. 22, 1887), that spin is necessarily produced when *the direction of motion of the club-head*, as it strikes the ball, *is not precisely perpendicular to the face.* Now, even when the head is not purposely laid a little back in addressing the ball, (many of the longest drivers do this without asking Why) it must always become so in the act of striking if the player stand ever so little behind the ball:—especially if, as Mr. Hutchinson so strongly urges upon him, he makes the path of the head at striking as nearly straight as possible. Mr. Hutchinson gives a highly specious, but altogether fanciful, reason for this advice. We now see why the suggestion is a really valuable one. A "grassed" club, and especially a spoon, gives this result more directly. As soon as I recognised this, I saw that it furnished an explanation of a fact which had long puzzled me:—viz. that one of my friends used invariably to call for his *short* spoon when he had to carry a bunker, so distant that it appeared impossible of negotiation by anything but a play-club. And, if the ball be hit ever so little under the level of its centre, with the upper edge of the face, very rapid underspin may be produced. This was probably at least one of the objects aimed at (however unwittingly) by the best club makers of last generation, for they made the faces of drivers exceptionally narrow. Some time ago I proposed, with the same object in view, to bevel the face by deeply rasping off both its upper and lower edges:—thus in addition saving the necessity for the "bone."

I have neither leisure nor inclination to attempt (for the present at least) more than a first approximation to the form of the path under the conditions just pointed out. Anything further would involve a laborious process of quadratures, mechanical or numerical, only to be justified by the command of really accurate data as to the values of a and V. I shall therefore at once assume that neither gravity nor the spin affects the translatory speed of the ball. (If the spin have such an effect, it will be taken account of sufficiently by a slight change in the constant of resistance; and the effect of gravity on a low trajectory is mainly to produce curvature which, in this case, is to a great extent counteracted by the spin. It is easy to see that the effects of this ignoration of gravity, in the tangential equation of motion, are to make the path rise a little too slowly at first, then too fast; to make it rise too high, and descend at too small a slope.) Hence we may keep the first equation of motion above, and write the second as

$$\dot{\phi} = k - \frac{g}{\dot{s}}$$

where ϕ is reckoned positive in the ascending part of the path; and k is written for $k\omega$, its dimensions being those of angular velocity. With the help of the value of $\dot{s}$, above, this becomes

$$\frac{d\phi}{ds} = \frac{k}{\mathrm{V}}\epsilon^{\frac{s}{a}} - \frac{g}{\mathrm{V}^2}\epsilon^{\frac{2s}{a}}.$$

In x, y coördinates, x horizontal, this is nearly

$$\frac{d^2y}{dx^2} = \frac{k}{\mathrm{V}}\epsilon^{\frac{x}{a}} - \frac{g}{\mathrm{V}^2}\epsilon^{\frac{2x}{a}}.$$

Thus the x coördinate of the point of contrary flexure is found from

$$\epsilon^{\frac{x}{a}} = \frac{k\mathrm{V}}{g},$$

so that there must be such a point, *i.e.* the path is concave upwards at starting, if kV be ever so little greater than g.

Again

$$\frac{dy}{dx} = e + \frac{ka}{\mathrm{V}}(\epsilon^{\frac{x}{a}} - 1) - \frac{ga}{2\mathrm{V}^2}(\epsilon^{\frac{2x}{a}} - 1)$$

where e is the initial slope. The x coördinate of the vertex is found by putting

$$\frac{dy}{dx} = 0.$$

Finally, the approximate equation of the path is

$$y = ex + \frac{ka^2}{\mathrm{V}}\left(\epsilon^{\frac{x}{a}} - 1 - \frac{x}{a}\right) - \frac{ga^2}{4\mathrm{V}^2}\left(\epsilon^{\frac{2x}{a}} - 1 - \frac{2x}{a}\right).$$

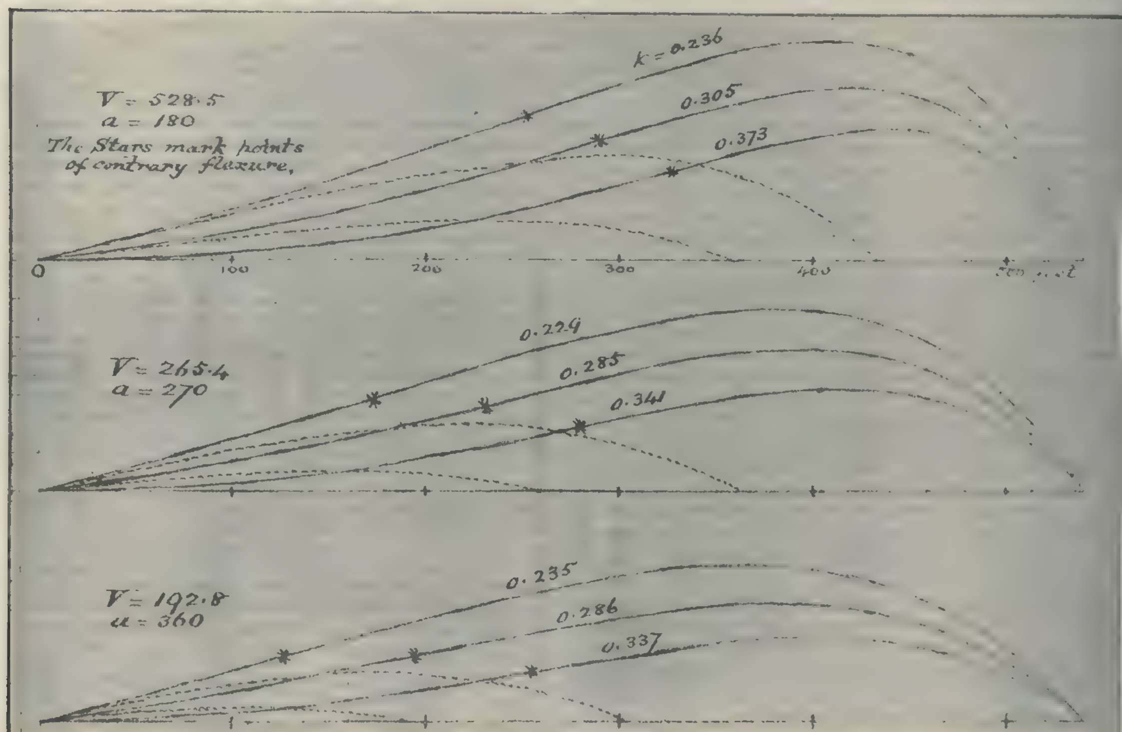
To deal expeditiously with these equations I formed a table of values of the various factors in brackets, by the help of Glaisher's data of natural antilogarithms (*Camb. Phil. Trans.* xiii, 243). Next, I utilized in the equation

$$\mathrm{V}t = a(\epsilon^{\frac{x}{a}} - 1)$$

the well ascertained data $6^s.5$ for the time of flight, and 540 feet for the carry, thus obtaining a general expression for V in terms of a. Then, in consequence of the want of accurate data, I chose three values of a, one considerably less than, the second nearly equal to, and the third considerably greater than, that which results from Bashforth's experiments with iron spheres. Thus I found the following values:—

a	V
180	528
270	265·4
360	193.

fault. I regret this for the additional reason that I should have liked to add an illustration of an extremely exaggerated path in which e is (say) zero, and k unity at the least. Under conditions of this kind there might be kinks in the path! For a similar reason I cannot attempt to work out the effect of wind with any attempt at precision, at least in the case when the drive is against the wind and the upward concavity of the path becomes in consequence much more prominent. It is easy in every case to *form* the more exact equations, but the labour of treating them even to a rough approximation would be considerable.



Next, with each pair of these numbers, and with the successive values $\frac{1}{4}$, $\frac{1}{8}$, and o for e, I found k from the condition that $y = 0$ for $x = 540$. These values of k are of course greater as e is less, and also as a is less. But all are found to lie between the limits derived, above, from the data for a sliced ball. All the constants being thus found, the curves were easily traced by a few points:—and the position of the maximum ordinate was found as above. For contrast, I have put in (dotted) the paths of drives corresponding in all respects with the others, except the absence of rotation. Poorly as these show, they are probably unduly favoured at the expense of the others, as I have taken a the same for each of the group; though it is probably reduced by the spin, so that rotation increases the direct resistance. The comparison of these with those in which rotation has a share shows that, though strength and agility are undoubtedly of importance in long-driving, even a store of these qualities equalling in amount that of a full-sized tiger is comparatively inefficient as against the skill which imparts a sound undercut. For here, as elsewhere, the race is not to the swift, nor the battle to the strong. Craft beats Kraft all the world over! La Puissance! ce n'est pas frapper fort, mais frapper juste!

From the very nature of the process I used in approximating, none of these curves can be quite trustworthy, those giving the greater elevations being most at

I am engaged at present in endeavours to find something like a proper value of a, or of V, above; so as to have reasonable confidence in my data before I engage in what promises to be a heavy task. Of course, if I can obtain a satisfactory value of one of them, that of the other would follow. But independent determinations of both would enable me to subject the theory to the most complete test imaginable. I am inclined to think that the value of a (280 feet), which I calculated from Bashforth's data, is too large (*i.e.* it makes the resistance too small) for a golf-ball:—and thus that the true path is intermediate in form between those of the first and of the second series in the cut. For the initial speeds required, even with $a = 270$, to give a carry of 540 feet *without spin*, are 462 and 653 foot-seconds for slopes of 1 in 4 and 1 in 8 respectively:—the corresponding times of flight being only $3^s.7$ and $2^s.6$.

P. G. TAIT.

NOTES.

WE are glad to record that the Council of the Imperial University of Kasan has elected Prof. J. J. Sylvester honorary member of the University.

THE Albert Medal of the Society of Arts for the present year has been awarded to Sir John Bennet Lawes and a like medal to Mr. John Henry Gilbert "for their joint services to scientific agriculture, and notably for the researches which throughout a period of fifty years have been carried on by them at the experimental farm, Rothamsted."

PROF. W. H. PICKERING, the Director of the Harvard College Mountain Observatory at Arequipa, is expected to be in London in the course of a few days.

THE distribution of prizes to the students of Charing Cross Hospital Medical School will take place at the School on July 4, at three o'clock precisely. The Right Hon. the Baron de Worms, M.P., F.R.S., will occupy the chair.

THE Dental Hospital of London will hold a *conversazione* at the Royal Institute Galleries, Piccadilly, on July 14. There will be a distribution of prizes at 8.30 p.m. by Prof. Sir W. H. Flower, K.C.B., F.R.S.

ACCORDING to Dalziel's agency, a cyclone passed over Williamstown and its immediate vicinity on June 21. Its path was six miles long by half a mile wide, and in this track not a house, barn, or tree was left standing. The wind-rush was followed by a terrific downpour of rain. About twenty persons lost their lives.

DR. NANSEN and the members of his expedition to the North Pole sailed from Christiania on Saturday, and arrived at Laurvig on the following day. After taking on board two covered boats, to be used in case the members of the expedition are compelled to leave the *Fram* in the ice, the vessel proceeded on her voyage. Reuter says that intelligence has been received from Siberia that twenty-six dogs, for service with the expedition, have been brought down to the mouth of the River Olensk. Parties have been sent out to leave stores of provisions for twelve men at two places on the islands of Kotelnoi and Liakow. These depots will be inspected in 1894 and 1895. Sealers report that the sea around these islands was quite open in 1888, 1889, and 1890, while in 1891 and 1892 there was little ice in the vicinity.

INFORMATION with regard to the social, physical, and mental condition of children is being accumulated by the committee appointed by the International Congress of Hygiene and Demography. Nearly 30,000 children, chiefly in London Board Schools, have been inspected, and important facts have been obtained as to the variation of educational requirements of boys and girls, and the causes of low mental development. It is desired to extend the inquiry among 100,000 children before submitting the statistics to a complete investigation. For this purpose Sir Douglas Galton, writing from the Parkes Museum, has made an appeal for financial help. The deep importance of the work is fully understood by educationalists, hence there should be no difficulty in obtaining sufficient funds to render the investigation as comprehensive as possible.

A SPECIAL general meeting of the Royal Geographical Society will be held on July 3 in the hall of the University of London, Burlington Gardens, to consider the proposal that ladies should be admitted as ordinary Fellows. On the evening of the same day the Earl of Dunmore will give a paper on his "Journeys in the Pamirs and Central Asia."

DR. M. MŒBIUS, of Heidelberg, has been appointed Director of the Botanic Gardens at Frankfort-a-M., and Dr. F. Pax, Director of the Botanic Garden at Breslau.

THE French Academy has awarded the Prix Desmazières to M. P. Viala, for his researches on viticulture; the Prix Montagne to M. l'Abbé Hue, for his work in lichenology; and the Prix de la Fons Mélicocq to M. Maseleff, for his work on the Botanical Geography of the north of France.

SOME interesting scientific documents changed hands at the sale this week of the library of the late Lord Brabourne. Among the lots was a quantity of the correspondence of Sir Joseph Banks, to whom Sir Edward Knatchbull, Lord Brabourne's father, was executor. An interesting autograph letter from John Hunter, dated 1792, appears to be one covering the despatch to the Royal Society of his paper on the natural history of the common bee. He hopes Sir Joseph and his worthy council will think the results of twenty years of observation and experiment suitable for publication in the transactions, and details some of the obstacles which had prevented an earlier forwarding of the paper. About 1830 the Royal Society claimed and received from Sir Edward Knatchbull the letters and papers of Sir Joseph Banks, referring to the society over which he so long presided, but evidently this particular letter was overlooked. A document, apparently in the handwriting of Duhamel du Monceau, is an appeal to Sir Joseph on behalf of Dolomieu, the French mineralogist, imprisoned at Messina, by order of the Neapolitan Court, as he was returning to Europe from serving on the scientific staff which accompanied Bonaparte's expedition to Egypt. It is signed by thirty-nine famous men of science of the time, including Cuvier, Lamarck, Laplace and Lalande.

THE weather during the past week has been of a decidedly unsettled type. On Thursday, the 22nd inst., a depression advanced over Scotland and moved slowly to the North Sea and Norway, causing some rain over most parts of these islands; in the north-east of Scotland the fall amounted to 2·2 inches in forty-eight hours, and a moderate gale blew from the north-west on our northern coasts. During the early part of the present week important depressions advanced over the western parts of the country from off the Atlantic, causing exceptionally heavy rain in the south of Ireland, the fall at Roche's Point on Tuesday morning registering 1·1 inch, while the amount was very considerable in many other parts of the kingdom. During the first part of the period the temperature was from 25° to 30° lower than in the previous week; the maxima rarely reached 70° in any part of the country, while in the north the highest daily readings were frequently below 60°, but on Tuesday the temperature rose considerably in most parts, and reached 80° at Cambridge. The *Weekly Weather Report* of the 24th inst. showed that the rainfall exceeded the mean in the east of Scotland only. Bright sunshine was above the average in Ireland and the greater part of England; the percentage of possible duration amounted to 77 in the Channel Islands.

MR. W. H. PREECE, F.R.S., in giving evidence before the joint committee of Lords and Commons on Electric Powers Protective Clauses, is reported to have shown a series of diagrams illustrating the effect upon the earth of the City and South London Electric Railway. That railway did not designedly use the earth, but the return circuit was made by means of the rails, and also by the tubes or tunnels. Currents were produced which had disturbed the observing instruments at Greenwich, and which had been traced as far as North Walsham, in Norfolk. Last year the disturbances began to increase, and his attention was called to the fact that in Clapham Road there was a chemist who had in his shop window an instrument for recording the passing movement of every train on the electric railway, the instrument being connected on one side with gas-pipes, and on the other with water-pipes in the house. He had caused the currents to be measured, and they were found to be sufficient to light a lamp or, as he had proved, to ring one of the division bells of the House of Commons. Another difficulty had occurred in connection with the railway block system. Some years ago the London and North-Western Railway lighted Holyhead Harbour by electricity. The effect of the five arc-lamps employed was to break down the block signals in the district within a mile. But the difficulty was removed by supplying metallic circuits to the signals. At Blackpool the disturbing currents from the electric tramway had lowered a block-signal on the railway and fired a time gun at the same moment, a minute or so before the time when the gun ought to have been discharged.

In the recently published number of the Proceedings of the Société Française de Physique there is an account of a standard condenser formed by two plates of silvered glass separated by three blocks of quartz accurately worked to the same thickness. The instrument almost exactly realises a theoretical condenser, as the central part is only separated from the guard-ring by a narrow line along which the silver has been removed. The only disadvantage is that the insulation is rather bad, and when the air is not perfectly dry there is a small current between the central disc and the guard-ring. To get over this difficulty the author (M. P. Curie) joins the electrometer to the continuous plate of the condenser, charges the central disc of the other plate with the battery, and connects the guard-ring with the earth. Under these conditions the field of force between the plates is no longer uniform, but the charge of the condenser is the same as in the ordinary arrangement. With this arrangement the insulation is all that can be desired, as the quartz blocks are very good insulators, and little affected by moisture in the air.

A similar condenser to that described above has been employed by M. Abraham in his determination of the ratio between the electromagnetic and electrostatic units (see Proceedings of Société de Physique, p. 332, 1893). The method employed for measuring the distance between the plates is as follows. In front of the space between the plates a finely-divided glass scale is placed with its plane perpendicular, and the lines of the graduations parallel to the plates. The silvered plates constitute excellent mirrors, and give a series of images of the divisions of the scale, the distances between which were measured by means of a microscope. This method gives the mean distance between the plates, which was found to vary each time the instrument was set up, and to differ slightly from the length of the quartz blocks employed to separate the plates.

The photographic study of sources of light by means of a carefully graduated series of exposures was first applied with great success by M. Janssen to the investigation of the minute structure of the solar surface. M. Crova has applied a similar method to the study of the carcel standard and the electric arc. A contrast between the various parts of the magnified photographic image of the carcel flame does not appear until the exposure is reduced to the minimum necessary to secure an impression, and to bring out this contrast the negative must be developed slowly and subsequently intensified. Four photographs thus obtained were exhibited at a recent meeting of the French Academy. The axis of the flame appears dark, and the zone of combustion exhibits two bright lines representing the external and internal surfaces of combustion of the hydrocarbons, with a dark line between them corresponding to the space where combustion is incomplete. Photographs of the flames of a candle, an amyl-acetate burner, and a bat's-wing gas jet were also exhibited, showing analogous phenomena. The same method applied to the arc light yielded some interesting results. As the time of exposure was reduced the arc gradually vanished, the negative carbon was reduced to a very small surface, and the positive carbon exhibited a surface riddled with dark spots, and granulated like the surface of the sun in M. Janssen's photographs. These granulations could be seen in violent motion on the ground glass screen of a camera with the lens sufficiently stopped down. It follows that it is not admissible to screen off all but a very small portion of the luminous source in order to reduce the amount of light in the same proportion as the area of luminous surface. With very small surface elements both the amount of light and the temperature, and hence also the tint of the light, may be constantly changing.

Herr von Lupin, of Munich, has recently called attention to two thermometer liquids as free from certain drawbacks of the spirit thermometer. One of these is sulphuric acid diluted with water. According to experiments by Sohncke, the quantity of water removed by distillation in the thermometer-tube was a minimum even when the free end was surrounded with ice; and (what is still more important) in a short time this very small quantity was reabsorbed. The expansion of the liquid is approximately constant. In a recent expedition by Herr Vogel to Central Brazil these minimum thermometers were used, and found to act very well. The other liquid referred to is chloride of calcium in spirit (10 to 15 per cent. of the anhydrous salt is best). This is specially recommended for medical use, because its pronounced colour enables it to be more easily read at night than the mercury thermometer. Here, too, there is no distillation-error. A further advantage is that the thermometer takes the body-temperature very quickly (in about three minutes). The regularity of expansion between 0° and 50° C. is good, though not in the same degree as with sulphuric acid; and the proportion of calcium chloride is here influential. The solution, like that of sulphuric acid, does not solidify even in the artificial cold of evaporating carbonic acid snow; and with the proportion of salt given, no salt is separated out in the bulb.

To the current number of the *Zeitschrift für physikalische Chemie* Herr Altschul communicates from Prof. Ostwald's laboratory a series of observations on the critical constants of some fatty and aromatic hydrocarbons. Unlike most observers in this field the author thus deals with chemically related substances which have a comparatively simple structure. With the ascent of a homologous series it appears that the critical temperatures increase and the critical pressures decrease at rates which gradually diminish. Chemical constitution also affects the magnitudes of the critical values, the three metameric xylenes, for example, have different constants. From his observations the author deduces the values of (a) and (b) in Van de Waals's equation, Guye's critical coefficient, &c., and traces relationships between their magnitudes.

Is colour-blindness a product of civilisation? An investigation described in *Science* by Messrs. Blake and Franklin, Physical Laboratory, Kansas University, favours an affirmative answer to the question. Of 159,732 persons tested in Europe and America, nearly four per cent. were found to be colour-blind. But when the ordinary Berlin worsteds were used to test the colour perception of a number of Indians, representing many tribes, only 3 in 418, or 0·7 per cent., were found to be deficient. These were full-blooded Indians, and all males. It appears, therefore, that, as with civilised peoples, the percentage of colour-blind males is greater than that of females.

The peculiar phenomenon sometimes observed near the Wetter Lake in Sweden, and called by the natives *Motalaströms stadnande*, the standing still of the Motala river, has been the subject of speculation ever since the times when it used to be regarded as a miracle and a portent. The Motala river emerges from the Wetter Lake, and the phenomenon in question consists in the cessation of the flow and the drying up of the bed, accompanied by a retention of water within the lake.

According to Block, this is due to a sudden sharp frost, which freezes the river to the bottom at a shallow place without allowing time for the formation of mere surface ice. It is probable that a strong east wind is a necessary condition, and that the detention of the water is aided by the reeds growing near the outflow of the lake. A collection of records of the occurrence has been made by Herr Robert Sieger in a paper on the oscillations of lake and ocean levels in Scandinavia, which appears in the *Zeitschrift der Gesellschaft für Erdkunde*. He finds six observations during the sixteenth, twelve during the seventeenth, and eighteen in the eighteenth century. He does not, however, think that the general level of the lake is perceptibly influenced by the phenomenon.

Two organisms resembling the cholera bacillus have recently been obtained by Bujwid from water during an outbreak of cholera ("Ueber zwei neue Arten von Spirillen im Wasser," *Centralblatt für Bakteriologie*, vol. xiii. 1893, p. 120). These are designated as *Bacillus choleroides* α and β in consequence of their striking resemblance to Koch's cholera organism. It is quite possible, however, that these forms may really be identical with the original cholera spirillum, and that the differences noted in cultures and microscopic specimens may be simply due to the modifications undergone by the latter after long residence in artificial culture media. Finkelnburg ("Zur Frage der Variabilität der Cholera bacillen," *ibid.* p. 113) has made careful comparative studies of cholera bacilli obtained from different centres during the recent cholera epidemic. He found that whereas those obtained from Paris and Hamburg respectively were practically identical, they presented slight but distinct deviations from the laboratory specimen of Koch's spirillum originally brought from India. Finkelnburg points out as the result of his investigations that in the course of the many years during which this organism has been cultivated outside the human body and in foreign surroundings, it has apparently undergone a gradual attenuation, and that in this process of degeneration it has lost some of its vital energy. Whether it has also suffered a diminution in its toxic properties Finkelnburg has not yet determined, but concludes by emphasising the importance of such an inquiry as calculated to throw some light on the possible future attenuation of the virus during its residence in Europe.

Mr. F. C. Selous, who has spent twenty years in South Central Africa, has now completed the book in which he describes his experiences in the country. Messrs. Rowland Ward and Co. will publish the work in the autumn.

A book by Capt. Hayes on "The Points of the Horse," and dealing chiefly with equine conformation, will be published next month by Messrs. Thacker and Co.

The trustees of the South African Museum have issued their report for the year 1892. Mr. Roland Trimen, F.R.S., the curator of the museum, reports favourably of the condition of the collection generally. The donations amount to 4857 specimens, presented by 90 donors, as against 4677 specimens presented by 105 donors in the year 1891. For a long time extended accommodation has been needed, and we are glad to note that the Parliament granted the application for a sum of £20,000 to satisfy the want. Designs for the new museum building have been invited, and the work will be proceeded with as soon as possible.

The proceedings of the Bath Natural History and Antiquarian Field Club, No. 4, contains an article by the Rev. H. H. Winwood, on some deep-well borings made in Somerset and one or two other counties. A description is given of the thickness and nature of the beds pierced in each case.

The second part of "Phycological Memoirs," being researches made in the botanical department of the British Museum, contains, among other papers, several notes on the morphology of the Fucaceæ. Mr. George Murray contributes a comparison of the marine floras of the warm Atlantic, Indian Ocean, and the Cape of Good Hope.

A series of monographs dealing with the principal gold fields of Victoria are being prepared under the direction of Mr. A. W. Howitt, the Secretary for Mines. A report by Mr. E. J. Dunn, on the Bendigo gold-fields, forms one of the number. According to Mr. Dunn, the primary features of this gold-field are that the mass of silurian strata which he investigated is made up of bands auriferous to varying degrees or barren of gold, and that the whole of the strata are bent along certain lines into anticlinal folds with intervening synclinals. The report is illustrated by numerous plans, sections, and diagrams.

The Scientific Society of the University College of Wales has issued its first report. Natural history specimens collected during the excursions have been identified, and the results recorded in the report furnish some useful information with regard to Welsh fauna and flora.

At the meeting of the Russian Chemical Society on March 16 K. D. Khroushchoff, who is well known for his remarkable synthesis of hornblende and other minerals, made a communication to the effect that he also has obtained artificial diamonds in a way similar to that of Moissan. He prepared a carbonide of silver, Ag_2C, obtained by the heating of cuminate of silver. At the temperature of boiling, silver absorbs about six per cent. of carbon, which is given out on cooling. Cooling was effected rapidly, as by Moissan, so that a crust was formed which prevented the increase of volume of the metal, and produced a considerable interior pressure. It appeared that part of the dissociated carbon had the properties of diamond—the dust consisting of minute broken crystals and laminæ, colourless and transparent, strongly refracting light, quite isotropic, and scratching corundum; on combustion they give carbon dioxide, with an insignificant amount of ash. Diamond dust obtained in this way was shown to Prof. Beketoff the day after Moissan's communication had been received at St. Petersburg.

Further interesting experiments with the electric furnace are described by M. Moissan in the current number of the *Comptes Rendus*. By attaching to the furnace a condensing tube of copper shaped like the letter U, and so constructed as to be surrounded by an outer jacket of cold water constantly changing under high pressure, M. Moissan has been enabled to distil and condense most of the elements which have hitherto been found so refractory. When a piece of metallic copper weighing over a hundred grams was placed in the inner crucible of the furnace and subjected to the arc furnished by a current of 350 ampères, brilliant flames shot forth from the apertures through which the carbon terminals were inserted. The flames were accompanied by copious yellow fumes, due to the combustion of the issuing vapour of copper in contact with the oxygen of the air. After the expiration of five minutes nearly thirty grams of copper had been volatilised. Under the cover of the furnace an annular deposit of globules of metallic copper was found, and upon examination of the condensing tube a large proportion of the volatilised copper was discovered condensed in almost a pure state. It has long been known that silver is volatile; it is now found that at the temperature of an arc of the above description silver may be brought to full ebullition in a few moments, and it distils with ease, condensing in the copper condenser in the form of small globules, whose size varies from that of small shot to spherules of microscopic dimensions, and a certain proportion is usually deposited in the form of arborescent fragments. Platinum fuses in a few minutes, and very soon after commences to volatilise, and condenses in the U-tube in brilliant little spheres and fine dust. Aluminium distils very readily, and condenses in the form of a grey powder, containing admixed spherules exhibiting brilliant metallic lustre. Tin likewise distils with facility, and the condensed product usually contains a considerable proportion of a curious fibrous variety of the metal. The distillation of gold in the electric furnace is particularly interesting. Abundant fumes of a light yellowish green colour are emitted at the electrode apertures, and the metal is deposited in the condenser in the form of a powder, exhibiting a beautiful purple sheen. The powder consists of minute regular spheres which, when examined under the microscope, appear to reflect the usual yellow colour of gold. Upon the under side of the cover of the furnace three distinct annular deposits are observed, the inner one consisting of yellow globules of considerable size, round which is a metallic deposit of smaller spheres of such a size as to reflect a bright red tint, and outside this is an annular sublimate of a deep purple colour. Manganese is remarkably volatile; a quantity of the metal weighing four hundred grams entirely volatilised in ten minutes. Iron is likewise readily distilled, and is deposited in the form of a grey powder, among which are interspersed numerous small particles exhibiting brilliant surfaces.

NOT only are the metals capable of distillation at the temperature of the electric arc. Silicon rapidly volatilises and condenses in the copper condensing tube in minute spheres and dust. Carbon becomes almost immediately converted to graphite, which distils over into the condenser and deposits in the form of light semi-transparent plates, which by transmitted light exhibit a beautiful chestnut colour. Distilled carbon would thus appear to consist of the fourth variety of the element recently described by M. Berthelot. The refractory alkaline earths appear also to be capable of distillation in the electric furnace. The experiment succeeds best, however, with a more powerful arc. Employing an arc furnished by a current of a thousand ampères, M. Moissan has distilled one hundred grams of lime in five minutes, the vapour condensing in the copper tube like fine flour. Magnesia passes over somewhat more slowly than lime, but its distillation is one of the prettiest of these remarkable experiments, the tints assumed by the escaping fumes and the brilliance of the incandescent vapour being particularly striking.

NOTES from the Marine Biological Station, Plymouth.—The following list completes the summary begun last week of the records given during the last six months of the breeding seasons of marine animals at Plymouth. Among Mollusca, the Prosobranchs *Littorina littoralis*, *Nassa reticulata*, *Buccinum* (*undatum*), *Purpura* (*lapillus*), *Murex erinaceus* and *Capulus hungaricus*, the Opisthobranchs *Lamellaria perspicua*, *Aplysia punctata*, *Philine aperta*, many Nudibranchs, and the Cephalopod *Loligo media*; among Crustacea, the Cladocera *Podon* and *Evadne*, various Cirripedia, the Leptostracan *Nebalia bipes*, several Amphipoda, the Schizopoda *Siriella jaltensis*, *Leptomysis mediterranea*, *Macromysis flexuosa* and *inermis*, *Schistomysis arenosa*, the Cumacean *Pseudocuma cercaria*, the Macrura *Crangon* (*vulgaris*), *fasciatus* and *sculptus*, *Palæmon* (*serratus*), *Palæmonetes varians*, *Pandalus annulicornis* and *brevirostris*, *Hippolyte Cranchii*, *Virbius varians*, *Pagurus lævis* and *Bernhardus*, *Galathea squamifera*, the Brachyura *Porcellana longicornis* and *platycheles*, *Carcinus* (*mænas*), *Portunus depurator*, *holsatus*, *arcuatus*, *marmoreus* and *pusillus*, *Cancer* (*pagurus*), *Pilumnus hirtellus*, *Xantho floridus* and *rivulosus*, *Eurynome* (*aspera*), *Stenorhynchus phalangium* and *tenuirostris*; among Echinodermata, *Echinus miliaris*, *Asterina gibbosa*, and *Amphiura elegans*; among Tunicata, *Botryllus violaceus* and *Styclopsis grossularia*; and among Cephalochordata, *Amphioxus lanceolatus*, have been recorded. It should also be mentioned that the following larvæ have been townetted in large numbers at certain periods:—Veligers, *Cyphonautes*, *Nauplii* and *Zoeæ*, and the various larvæ of Echinoderms.

THE additions to the Zoological Society's Gardens during the past week include two Mozambique Monkeys (*Cercopithecus pygerythrus*, ♂ ♂) from East Africa, presented respectively by Mr. J. B. Tomkins and Mr. B. J. Travers; two Llamas (*Lama peruana*, ♂ ♀) from Peru, presented by Lady Meux, F.Z.S.; a Rose-crested Cockatoo (*Cacatua moluccensis*) from Moluccas, presented by Mrs. Bason; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, presented by Mr. Lewis Baily; a Cinereous Waxbill (*Estrelda cærulescens*), two Hooded Finches (*Spermestes cucullata*), a Grenadier Weaver Bird (*Euplectes oryx*) from West Africa, an Amaduvade Finch (*Estrelda amandava*), two Nutmeg Finches (*Munia punctularia*), a Black-headed Finch (*Munia malacca*) from India, presented by Mr. W. L. Jeffrey; two Greater Spotted Woodpeckers (*Dendrocapus major*) British, presented by Miss Miriam A. Birch Reynardson; two Alexandrine Parrakeets (*Palæornis alexandri*) from India, presented by Mr. Wyndham Gibbs; two Brazilian Tortoises (*Testudo tabulata*) from Trinidad, W.I., presented by Mr. J. S. Toppin; an Ocellated Skink (*Seps ocellatus*) from Malta, presented by Col. C. H. Rooke; two Infernal Snakes (*Boodon infernalis* jv.) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; two Emus (*Dromæus novæ-hollandiæ*) from Australia, deposited; two Collared Fruit Bats (*Cynonycteris collaris*), a Burrhel Wild Sheep (*Ovis burrhel*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET FINLAY (1886 VII.).—The ephemeris for this comet for this week is as follows:—

12h. *Paris. M.T.*

1893.		R.A. (app.) h. m. s.		Decl. (app.) ° ′
June 29	...	2 52 20	...	+14 8·7
30	...	2 57 5	...	14 31·9
July 1	...	3 1 49	...	14 54·6
2	...	6 33	...	15 16·9
3	...	11 16	...	15 38·6
4	...	16 0	...	15 59·9
5	...	20 42	...	16 20·6
6	...	3 25 24	...	+16 40·9

STARS HAVING PECULIAR SPECTRA.—On an examination of the stellar spectra photographs taken at Cambridge (U.S.A.) and Arequipa it has been found (*Astronomy and Astrophysics* for June) that several of them have spectra which qualify their designation as "interesting objects."

The following list we take from the note referred to:—

Designation	R.A. 1890. h. m.	Decl. 1890. ° ′	Mag.	Description.
B.D. +49°·41	0 12·2	+49 44	9·4	Type IV.
B.D. −13·893	4 24·5	−13 17	5·8	F line bright.
A.G.C. 5429	4 43·8	−36 23	7½	Type IV.
A.G.C. 11890	8 42·4	−29 21	7½	Type IV.
—	15 27·0	−71 32	—	Type III. (H lines bright).
A.G.C. 22838	16 47·9	−44 50	8·2	Type V. (bright lines).
Z.C. XVIII.h 56	18 3·3	−63 38	9½	Type III. (H lines bright).
A.G.C. 26129	18 59·7	−38 17	8½	Type IV.
B.D. −21°·6376	23 6·3	−21 32	9·0	Type IV.

All these stars, it will be noticed, with the exception of the first two, have a large southerly declination.

Photographic charts of the region about Z.C. XVIII.h 56 have confirmed the variability of this star. Among other results, photographs of U Virginis, V Boötis, S Geminorum, T Cassiopeiæ, R Piscis Australis et Geminorum, show that these stars give bright hydrogen lines.

THE SUN'S MOTION THROUGH SPACE.—The methods that have generally been adopted for determining the direction of the sun's motion have been based on the same general principle and the position of the apex of the direction of motion has been deduced by analysing the proper motions of the stars. A new determination on different lines (a spectroscopic method) appears in the *Astronomical Journal* (No. 298), and in this Mr. A. D. Risteen, the writer, bases his method on the three assumptions (1) that the stars used in the computation have no tendency to drift in any particular direction; (2) that their absolute velocities do not depend upon their apparent positions in the heavens; (3) that their absolute velocities are not functions of their own directions. Another minor assumption is that the absolute velocity of a star is not a function of the star's brightness. The values he gets for the right ascension and declination are given in the following table, in which we include those of Bischoff, Ubaghs, L. Struve, and Stumpe.

	R.A.	Decl.
Bischoff	285·2	+48·5
Ubaghs	262·4	26·6
L. Struve	273·3	27·3
Stumpe	285·1	36·2
Risteen	218·0	45·0

The value Risteen obtains shows that the method may prove a very valuable one in future when more stars can be included (here about 42 observation-equations are used), and the result he obtains shows that at any rate the *reality* of the sun's motion (the value he gets is 10·9 English statute miles per second), and that our present knowledge of the direction of this motion is at any rate approximate.

AN ASCENDING METEOR.—Prof. von Niessl has been investigating the path of the meteor that appeared on July 7, 1892, and was seen both in Austria and Italy. The result of this computation has shown that, undoubtedly, the path of the meteor at the *latter* end of its course (*Naturwissenschaftliche Wochenschrift*, No. 26) was directed upwards. The length of its path measured 1100 kilometres from its nearest approach to the earth surface (68 kilometres above the surface) to the point where it disappeared, which was at a height of 158 kilometres. This is about the first time that the path of a rising meteor has been so accurately investigated.

THE SATELLITES OF JUPITER.—In this column for March 30 of this year we referred briefly to the very important results that were being reaped by Prof. W. H. Pickering, with the help of Mr. Douglas, at Arequipa, with reference to the peculiar forms which the satellites were found to assume at different periods of their rotation. In the June number of *Astronomy and Astro-physics* we have before us a much more detailed account of these and later observations, which seem to have confirmed those made previously in nearly all respects. In this article, which is of some length, the author deals first with the third satellite, the largest and most easily observed of the group. The results of twelve series of observations, taken on seven different nights, each series consisting of six independent observations, gave the value of $-10°·5$ for the position angle of the major axis, the satellite being on the eastern side of its orbit, and presenting an elliptical disc. The observations for the elliptical phase at the western side were not very satisfactory, owing to bad meteorological conditions, but the results suggested that "they would imply a revolution of the axis about the line perpendicular to the orbital plane, in about the same period as the satellites' rotation upon the axis itself." With regard to the surface features, there seems to be a marking having the appearance of a fork, the angle of the prongs varying from 30° to 60°. Sometimes this forked-shaped feature is turned to the left and sometimes to the right, and occasionally a double fork is seen. The position angle of the axis of the belt gave a value of $+15°·5$, and when the values obtained on January 1 and 16 are compared with those attained for the major axis on the same dates, they indicate that the two axis are inclined at between 46° to 35° to one another. The attempt to determine the direction and period of rotation indicated that perhaps the period of rotation coincided with that of the revolution of the satellite in its orbit. The surface features on the first satellite consisted of the bands lying in an approximately north and south direction, that on the second of a small patch detected only upon one occasion, and that on the fourth of a broad band (sometimes a narrow line), and also a bright spot recorded several times at the North Pole and once near the south. Later determinations of the period of rotation of the second satellite confirmed the earlier value (41h. 24m.), but sometimes discrepancies in the time of the flattening of the disc still occurred. The direction and period of rotation of satellite 4 has not been determined, but its disc has been recorded upon fourteen different dates as being shortened in the direction of the plane of its orbit, and upon eleven other days as being circular in form.

After summing up the main facts with regard to these satellites respecting their small density, directions of rotation, changes of shape, &c., Prof. Pickering shows how Laplace's "ring theory" with the following premises, suits the facts:—

(1) Jupiter was formerly surrounded by a series of rings similar to those now surrounding Saturn.

(2) The direction of rotation of these rings was direct, like that of the planet.

(3) By some force, whose cause is not explained, they were shattered, their components uniting, but still retaining the same orbit.

(4) Like the original rings, each satellite still consists of a swarm of meteorites, their consolidation having been prevented by the enormous tides produced in them by their primary.

At the conclusion of this discussion, in which Prof. Pickering takes each point individually, he has drawn up a syllabus regarding the points to which an observer can be most profitably directed in the case of each satellite, subdividing them into grades according to the difficulty of the observations.

TURACIN: A REMARKABLE ANIMAL PIGMENT CONTAINING COPPER.[1]

THE study of natural colouring matters is at once peculiarly fascinating and peculiarly difficult. The nature of the colouring matters in animals and plants, and even in some minerals (ruby, sapphire, emerald, and amethyst, for example) is still, in the majority of cases, not completely fathomed.

Animal pigments are generally less easily extracted and are more complex than those of plants. They appear invariably to contain nitrogen—an observation in accord with the comparative richness in that element of animal cells and their contents. Then, too, much of the colouration of animals, being due to microscopic structure, and therefore having a mechanical and not a pigmentary origin, differs essentially from the colouration of plants. Those animal colours which are primarily due to structure do, however, involve the presence of a dark pigment —brown or black—which acts at once as a foil and as an absorbent of those incident rays which are not reflected.

Many spectroscopic examinations of animal pigments have been made. Except in the case of blood and bile pigments very few have been submitted to exhaustive chemical study. Spectral analysis, when uncontrolled by chemical, and when the influence of the solvent employed is not taken into account, is very likely to mislead the investigator. And, unfortunately, the non-crystalline character of many animal pigments, and the difficulty of purifying them by means of the formation of salts and of separations by the use of appropriate solvents, oppose serious obstacles to their elucidation. Of blood-red or hæmoglobin it cannot be said that we know the centesimal composition, much less its molecular weight. Even of hæmatin the empirical formula has not yet been firmly established. The group of black and brown pigments to which the various melanins belong still await adequate investigation. We know they contain nitrogen (8½ to 13 per cent.), and sometimes iron, but the analytical results do not warrant the suggestion of empirical formulæ for them. The more nearly they appear to approach purity, the freer the majority of them seem from any fixed constituent such as iron or other metal. It is to be regretted that Dr. Krukenberg, to whom we are indebted for much valuable work on several pigments extracted from feathers, has not submitted the interesting substances he has described to quantitative chemical analysis.

I must not, however, dwell further upon these preliminary matters. I have introduced them mainly in order to indicate how little precise information has yet been gathered as to the constitution of the greater number of animal pigments, and how difficult is their study.

And now let me draw your attention to a pigment which I had the good fortune to discover, and to the investigation of which I have devoted I am afraid to say how many years.

It was so long ago as the year 1866 that the solubility in water of the red colouring matter in the wing-feathers of a plantain-eater was pointed out to me. [One of these feathers,

[1] A discourse delivered at the Royal Institution by Prof. A. H. Church, F.R.S.

freed from grease, was shown to yield its pigment to pure water.] I soon found that alkaline liquids were more effective solvents than pure water, and that the pigment could be precipitated from its solution by the addition of an acid. [The pigment was extracted from a feather by very dilute ammonia, and then precipitated by adding excess of hydrochloric acid.] The next step was to filter off the separated colouring matter, and to wash and dry it. The processes of washing and drying are tedious, and cannot be shown in a lecture. But the product obtained was a solid of a dark crimson hue, non-crystalline, and having a purple semi-metallic lustre. I named it "turacin" (in a paper published in a now long defunct periodical, *The Student and Intellectual Observer*, of April, 1868). The name was taken from "Turaco," the appellation by which the plantain-eaters are known—the most extensive genus of this family of birds being *Turacus*.

From the striking resemblance between the colour of arterial blood and that of the red touraco feathers I was led to compare their spectra. Two similar absorption bands were present in both cases, but their positions and intensities differed somewhat. Naturally I sought for iron in my new pigment. I burnt a portion, dissolved the ash in hydrochloric acid, and then added sodium acetate and potassium ferrocyanide. To my astonishment I got a precipitate, not of Prussian blue, but of Prussian brown. This indication of the presence of copper in turacin was confirmed by many tests, the metal itself being also obtained by electrolysis. It was obvious that the proportion of copper present in the pigment was very considerable—greatly in excess of that of the iron (less than ½ per cent.) in the pigment of blood.

Thus far two striking peculiarities of the pigment had been revealed, namely, its easy removal from the web of the feather, and the presence in it of a notable quantity of copper. Both facts remain unique in the history of animal pigments. The solubility was readily admitted on all hands, not so the presence of copper. It was suggested that it was derived from the Bunsen burner used in the incineration, or from some preservative solution applied to the bird-skins. And it was asked, "How did the copper get into the feathers?" The doubters might have satisfied themselves as to copper being normally and invariably present by applying a few easy tests, and by the expenditure of half-a-crown in acquiring a touraco wing. My results were, however, confirmed (in 1872) by several independent observers, including Mr. W. Crookes, Dr. Gladstone, and Mr. Greville Williams. And in 1873 Mr. Henry Bassett, at the request of the late Mr. J. J. Monteiro, pushed the inquiry somewhat further. I quote from Monteiro's "Angola and the River Congo," published in 1875 (vol. ii. pp. 75–77):—"I purchased a large bunch of the red wing-feathers in the market at Sierra Leone, with which Mr. H. Bassett has verified Prof. Church's results conclusively," &c., &c. Mr. Bassett's results were published in the *Chemical News* in 1873, three years after the appearance of my research in the Phil. Trans. As concentrated hydrochloric acid removes no copper from turacin, even on boiling, the metal present could not have been a mere casual impurity; as the proportion is constant in the turacin obtained from different species of touraco, the existence of a single definite compound is indicated. The presence of traces of copper in a very large number of plants, as well as of animals, has been incontestably established. And, as I pointed out in 1868, copper can be readily detected in the ash of banana fruits, the favourite food of several species of the "turacin-bearers." The feathers of a single bird contain on the average two grains of turacin, corresponding to ·14 of a grain of metallic copper; or, putting the amount of pigment present at its highest, just one-fifth of a grain. This is not a large amount to be furnished by its food to one of these birds once annually during the season of renewal of its feathers. I am bound, however, to say that in the blood and tissues of one of these birds, which I analysed immediately after death, I could not detect more than faint traces of copper. The particular specimen examined was in full plumage; I conclude that the copper in its food, not being then wanted, was not assimilated.

Let us now look a little more closely at these curious birds themselves. Their nearest allies are the cuckoos, with which they were formerly united by systematists. It has, however, been long conceded that they constitute a family of equal rank with the Cuculidæ. According to the classification adopted in the Natural History Museum, the order Picariæ contains eight suborders, the last of which, the Coccyges, consist of two families, the Cuculidæ and the Musophagidæ. To the same order belong the Hoopoes, the Trogons, the Woodpeckers. The plantain-eaters, or Musophagidæ, are arranged in six genera and comprise twenty-five species. In three genera—Turacus, Gallirex, and Musophaga—comprising eighteen species, and following one another in zoological sequence, turacin occurs; from three genera (seven species)—Corythæola, Schizorhis, and Gymnoschizorhis—the pigment is absent. [The coloured illustrations to H. Schlegel's Monograph (Amsterdam, 1860) on the Musophagidæ were exhibited.] The family is confined to Africa—eight of the turacin-bearers are found in the west sub-region, one in the south-west, two in the south, two in the south-east, four in the east, two in the central, and two in the north-east. It is noteworthy that, in all these sub-regions save the south-east, turacin-bearers are found along with those plantain-eaters which do not contain the pigment. Oddly enough two of the latter species, *Schizorhis africana* and *S. zonura*, possess white patches destitute of pigment in those parts of the feathers which in the turacin bearers are crimson. These birds do not—I will not say cannot—decorate these bare patches with this curiously complex pigment. [Some extracts were here given from the late Mr. Monteiro's book on Angola, vol. ii. pp. 74–79, and from letters by Dr. B. Hinde. These extracts contained references to curious traits of the Touracos.]

Usually from twelve to eighteen of the primaries or metacarpo-digitals and of the secondaries or cubitals amongst the wing-feathers of the turacin bearers have the crimson patches in their web. Occasionally the crimson patches are limited to six or seven of the eleven primaries. I have observed this particularly with the violet plantain-eater (*Musophaga violacæa*). In these cases the crimson head-feathers, which also owe their colour to turacin, are few in number, as if the bird, otherwise healthy, had been unable to manufacture a sufficiency of the pigment. I may here add that the red tips of the crest-feathers of *Turacus meriani* also contain turacin.

In all the birds in which turacin occurs this pigment is strictly confined to the red parts of the web, and is there unaccompanied by any other colouring matter. It is therefore found that if a single barb from a feather be analysed, its black base and its black termination possess no copper, while the intermediate portion gives the blue-green flash of copper when incinerated in the Bunsen flame. [A parti-coloured feather was burnt in the Bunsen flame with the result indicated.]

Where it occurs turacin is homogeneously distributed in the barbs, barbicels, and crochets of the web, and is not found in granules or corpuscles.

To the natural question, "Does turacin occur in any other birds besides the touracos?" a negative answer must at present be given. At least my search for this pigment in scores of birds more or less nearly related to the Musophagidæ has met with no success. In some of the plantain-eaters (species of Turacus and Gallirex) there is, however a second pigment closely related to turacin. It is of a dull grass-green colour, and was named turacoverdin by Dr. Krukenberg in 1881. I had obtained this pigment in 1868 by boiling turacin with a solution of caustic soda, and had figured its characteristic absorption band in my first paper (Phil. Trans., vol. clix., 1870, p. 630, fig. 4). My product was, however, mixed with unaltered turacin. But Dr. Krukenberg obtained what certainly seems to be the same pigment from the green feathers of *Turacus corythaix* by treating them with a two per cent. solution of caustic soda. I find, however, that a solution of this strength dissolves, even in the cold, not only a brown pigment associated with turacoverdin, but ultimately the whole substance of the web. By using a much weaker solution of alkali (1 part to 1000 of water) a far better result is obtained. [The characteristic absorption band of turacoverdin, which lies on the less refrangible side of D, was shown; also the absorption bands of various preparations of turacin.] I have refrained from the further investigation of turacoverdin, hoping that Dr. Krukenberg would complete his study of it. At present I can only express my opinion that it is identical with the green pigment into which turacin when moist is converted by long exposure to the air, or by ebullition with soda, and which seems to be present in traces in all preparations of *isolated* turacin, however carefully prepared.

A few observations may now be introduced on the physical and chemical characters of turacin. It is a colloid of colloids. And it enjoys in a high degree one of the peculiar properties of colloids—that of retaining when freshly precipitated, an immense proportion of water. Consequently when its solution in am monia is precipitated by an acid, the coagulum formed is very voluminous. [The experiment was shown.] One gram of turacin is capable of forming a semi-solid mass with 600 grams of water. Another character which turacin shares with many other colloids is its solubility in pure water and its insolubility in the presence of mere traces of saline matter. It would be tedious to enumerate all the observed properties of turacin, but its deportment on being heated, and the action of sulphuric acid upon it, demand particular attention.

At 100° C., and at considerably higher temperatures, turacin suffers no change. When, however, it is heated to the boiling-point of mercury it is wholly altered. No vapours are evolved, but the substance becomes black and is no longer soluble in alkaline liquids, nor, when still more strongly heated afterwards can it be made to yield the purple vapours which unchanged turacin gives off under the same circumstances. This peculiarity of turacin caused great difficulty in its analysis. For these purple vapours contain an organic crystalline compound in which both nitrogen and copper are present, and which resists further decomposition by heat. [Turacin was so heated as to show its purple vapours, and also the green flame with which they burn.] This production of a volatile organic compound of copper is perhaps comparable with the formation of nickel and ferro-carbonyl.

The action of concentrated sulphuric acid upon turacin presents some remarkable features. The pigment dissolves with a fine crimson colour and yields a new compound, the spectrum of which presents a very close resemblance to that of hæmatoporphyrin [turacin was dissolved in oil of vitriol; the spectrum of an ammoniacal solution of the turacoporphyrin thus produced was also shown], the product obtained by the same treatment from hæmatin; in other respects also this new derivative of turacin, which I call turacoporphyrin, reminds one of hæmatoporphyrin. But, unlike this derivative of hæmatin, it seems to retain some of its metallic constituent. The analogy between the two bodies cannot be very close, for if they were so nearly related as might be argued from the spectral observations, hæmatin ought to contain not more, but less metal than is found to be present therein.

The percentage composition of turacin is probably carbon 53·69, hydrogen 4·6, copper 7·01, nitrogen 6·96, and oxygen 27·74. These numbers correspond pretty nearly to the empirical formula $C_{82}H_{81}Cu_2N_9O_{32}$; but I lay no stress upon this expression.

I have before said that copper is very widely distributed in the animal kingdom. Dr. Giunti, of Naples, largely extended (1881) our knowledge on this point. I can hardly doubt that this metal will be found in traces in all animals. But, besides turacin, only one organic copper-compound has been as yet recognised in animals. This is a respiratory, and not a mere decorative pigment like turacin. Léon Fredericq discovered this substance, called hæmocyanin. It has been observed in several genera of Crustacea, Arachnida, Gastropoda, and Cephalopoda. I do not think it has ever been obtained in a state of purity, and I cannot accept for it the fantastic formula—$C_{867}H_{1369}CuS_4O_{258}$—which has recently been assigned to it. On the other hand, I do not sympathise with the doubts as to its nature which F. Heim has recently formulated in the *Comptes Rendus*.

It is noteworthy in connection with the periodic law that all the essential elements of animal and vegetable organic compounds have rather low atomic weights, iron, manganese, and copper representing the superior limit. Perhaps natural organic compounds containing manganese will some day be isolated, but at present such bodies are limited to a few containing iron, and to two—hæmocyanin and turacin—of which copper forms an essential part.

If I have not yet unravelled the whole mystery of the occurrence and properties of this strange pigment, it must be remembered that it is very rare and costly, and withal difficult to prepare in a state of assured purity. It belongs, moreover, to a class of bodies which my late master, Dr. A. W. von Hofmann, quaintly designated as "dirts" (a magnificent dirt, truly!)—substances which refuse to crystallise, and cannot be distilled. I have experienced likewise during the course of this investigation, frequent reminders of another definition propounded by the same great chemist when he described organic research as "a more or less circuitous route to the sink"!

I am very glad to have had the opportunity of sharing with an audience in this institution the few glimpses I have caught from time to time during the progress of a tedious and still incomplete research into the nature of a pigment which presents physiological and chemical problems of high, if not of unique, interest.

Let my last word be a word of thanks. I am indebted to several friends for aid in this investigation, and particularly to Dr. MacMunn, of Wolverhampton, the recognised expert in the spectroscopy of animal pigments.

ARTIFICIAL IMMUNITY AND TYPHOID FEVER.

THE announcement by Metchnikoff of his beautiful theory of the "mechanism," as it were, of immunity, which he conceives as dependent upon the activity of the phagocytes or migratory cells of the body in the presence of disease germs, has called forth an immense number of researches in this direction from all parts of the world. But whilst some bacteriologists are engaged upon studying critically the experimental evidence which can be adduced in support of this theory, others are busy with the practical side of the subject and are devoting themselves to the investigation of what substances are capable of conferring immunity upon animals towards any particular disease, and hardly a month passes without some contribution being made to this important inquiry. The great discovery made by Behring that the blood serum of animals rendered artificially immune against a particular disease will, on being introduced into other animals, protect them from an attack of that particular disease, has been confirmed in the case of tetanus or lockjaw by Behring and Kitasato, and as regards diphtheria by Behring. In a more recent contribution Brieger, Kitasato, and Wassermann ("Ueber Immunität und Giftfestigung," *Zeitschrift für Hygiene*, vol. xii. 1892) have, amongst other investigations, succeeded in protecting and healing mice from the evil effects of inoculations with the typhoid bacillus by the introduction of serum obtained from a guinea-pig immune against typhoid. The further study of immunity with reference to this disease is the subject of two elaborate memoirs in the *Annales de l'Institut Pasteur*, November, 1892, by Sanarelli in Siena, and Chantemesse and Widal in Paris, and the ground covered by these two investigations is to a great extent identical. Sanarelli selected guinea-pigs as the subjects for his experiments, these animals being, as is well known, more difficult to protect from the fatal results of typhoid inoculations than mice. He states that if 0·5 c.c. of therapeutic serum be simultaneously introduced with an otherwise fatal dose of a typhoid culture, these animals *without exception* develop no typhoid symptoms, whilst guinea-pigs inoculated with an equally fatal dose of typhoid, but without the curative serum, invariably die. Chantemesse and Widal have pursued the inquiry still further, and have investigated the properties of serum taken from normal animals—that is to say, from animals which have not been infected with or rendered artificially immune from typhoid. Investigations similar to those made previously by Stern have also been conducted with human serum obtained from patients who have recovered from typhoid fever and also from those who have never been attacked by this malady.

Chantemesse and Widal state that whereas the serum derived from typhoid patients and from immune animals invariably confers protection upon infected animals, that obtained from normal animals and from people who have never had typhoid, only exceptionally exercises any curative power. These authors have also compared the degree of immunity induced in animals by the inoculation of curative serum and sterilised cultures of the typhoid bacillus respectively. This latter process is another method of protecting animals against infection, and was resorted to before the experiments with serum were made. It was found that whilst the serum acts rapidly, and confers immunity when administered in small quantities, its protective power only extends over a short period of time, apparently disappearing in less than a month. The sterilised typhoid cultures on the other hand, although working more slowly and requiring to be introduced in larger doses than the serum, endow the animal with immunity over a longer space of time, animals having been found immune even after the lapse of two months. Finally, attempts were made to arrest the progress of typhoid fever in people by the inoculation of therapeutic serum obtained from guinea pigs. So far, however, these investigations have not been successful, and if it be remembered that one point of cardinal importance in the production of immunity or in healing the disease is the time which elapses between the infection and the protective inoculation, that the action of the latter is the more rapid and the more successful the sooner it follows upon the former, it is at once apparent where, at any rate, some of the difficulties lie in its successful application to human beings. Whereas the exact moment is known when the experimental infection in the animal takes place, in the human subject days or weeks may pass between the infection and the declaration of the disease.

THE CENTENARY OF GILBERT WHITE.

THE wonted tranquillity of the little Hampshire village of Selborne was disturbed on Saturday by the invasion of a band of pilgrims who came to look upon the shrine of Gilbert White, and by the sight obtained a renewed love of nature. Drawn by a feeling of regard, members of the Selborne Society, and other disciples of White, congregated from all parts of the country, and paid homage to their master. Never within the memory of the oldest inhabitant had so many people been gathered together at Selborne, and we doubt not that the villagers failed to realise what attraction there could be in a man whose characteristics, according to an old woman who remembered him, were that "he would walk about the lanes tap-tapping at the trees, and stooping every now and then to wipe the dust off his shoes." But one thing marred the enjoyment of Saturday's meeting. A band of gipsies, with a terrible barrel-organ, and all the paraphernalia of a country fair, had installed themselves not a stone's-throw from the house in which Gilbert White lived his peaceful life. And, worst of all, they possessed a steam-syren, the shriek and screech of which penetrated everywhere, even to the high Hangers, in which the Selborne naturalist supposed that swallows hibernated.

The Earl of Selborne presided at luncheon, and, in proposing "The Memory of Gilbert White," dwelt upon the sterling qualities of the man, and the remarkable character of his books dealing with the natural history and antiquities of Selborne. White's life was devoted to observing and recording natural productions and phenomena. He was gifted with shrewdness of discernment, and that one essential qualification of a true man of science—the power of faithfully chronicling all and every observation. It was thought by some that the naturalist whose centenary they were commemorating had nothing else to do but wander about, and observe the habits of birds, beasts, fishes, and insects; but that was a great mistake. He had to perform "the daily round, the common task" that falls to the lot of all, and diligently did he fulfil his duties.

Mr. Darwin proposed "Prosperity to the Selborne Society and its branches." In responding, Mr. Otter, one of the founders of the society, dwelt upon the fact that their object was to inculcate and foster a love of nature, and to wage war in defence of her beauties. To them the ruthless field-naturalist and the sporting collector of specimens were enemies.

Mr. Wakefield followed with a description of the good work done by the Thames Valley branch in preserving "beauty-spots" from jerry-builders and their kindred.

The Earl of Stamford, in proposing "Prosperity to the Hampshire Field Club," the members of which joined the London party at Selborne, remarked that he had found reason to believe that one of the figures shown in the quarto edition of White's book is a likeness of the author himself, hence it could no longer be said that no portrait of him was in existence. Mr. R. H. White, however, was of the opinion that the evidence was not of a positive character.

The question of a memorial to White was touched by the Earl of Selborne, but he thought that the best plan would be to "Look not on the picture, but the book," and leave that to be handed down to the end of time, for nothing more was needed to perpetuate the memory of the man. With this sentiment we by no means agree. A monument is not erected merely to prevent a man's name and deeds from sinking to oblivion. It should show to the people that he was one whom men delight to honour. We are apt to be far too prosaic in these matters, and to consider the raising of images and other memorials as more or less unnecessary conventionalities. This conviction has grown upon us because we have seen statues erected to comparatively obscure individuals time without number, while the works of men of science are unrecognised. It does not say much for the naturalists of this country if the centenary of Gilbert White is allowed to pass without some tangible illustration being given of their regard for the father of them all.

INTERFERENCE BANDS AND THEIR APPLICATIONS.[1]

THE formation of the interference bands, known as Newton's rings, when two slightly curved glass plates are pressed into contact, was illustrated by an acoustical analogue. A high-pressure flame B (Fig. 1) is sensitive to sounds which reach it in the direction EB, but is insensitive to similar sounds which reach it in the nearly perpendicular direction AB. A is a "bird-call," giving a pure sound (inaudible) of wave-length (λ) equal to about 1 cm.; C and D are reflectors of perforated zinc. If C acts alone, the flame is visibly excited by the waves reflected from it, though by far the greater part of the energy is transmitted. If D, held parallel to C, be then brought into action, the result depends upon the interval between the two partial reflectors. The reflected sounds may co-operate, in which case the flame flares vigorously; or they may interfere, so that the flame recovers, and behaves as if no sonnd at all were falling upon it. The first effect occurs when the reflectors are close together, or are separated by any multiple of $\frac{1}{2}\sqrt{2}.\lambda$; the

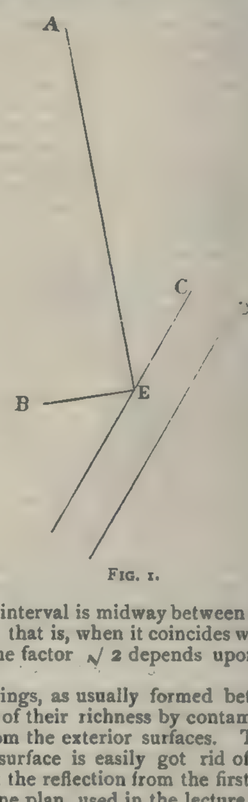


FIG. 1.

second when the interval is midway between those of the above-mentioned series, that is, when it coincides with an odd multiple of $\frac{1}{4}\sqrt{2}.\lambda$. The factor $\sqrt{2}$ depends upon the obliquity of the reflection.

The coloured rings, as usually formed between glass plates, lose a good deal of their richness by contamination with white light reflected from the exterior surfaces. The reflection from the hindermost surface is easily got rid of by employing an opaque glass, but the reflection from the first surface is less easy to deal with. One plan, used in the lecture, depends upon the use of slightly wedge-shaped glasses (2°) so combined that the exterior surfaces are parallel to one another, but inclined to the interior operative surfaces. In this arrangement the false light is thrown somewhat to one side, and can be stopped by a screen suitably held at the place where the image of the electric arc is formed.

The formation of colour and the ultimate disappearance of the bands as the interval between the surfaces increases, depends upon the mixed character of white light. For each colour the bands are upon a scale proportional to the wave-length for that colour. If we wish to observe the bands when the interval is

[1] Abstract of a lecture delivered at the Royal Institution, on Friday, March 24, 1893, by Lord Rayleigh.

considerable—bands of high interference as they are called—the most natural course is to employ approximately homogeneous light, such as that afforded by a soda flame. Unfortunately, this light is hardly bright enough for projection upon a large scale.

A partial escape from this difficulty is afforded by Newton's observations as to what occurs when a ring system is regarded through a prism. In this case the bands upon one side may become approximately achromatic, and are thus visible to a tolerably high order, in spite of the whiteness of the light. Under these circumstances there is, of course, no difficulty in obtaining sufficient illumination; and bands formed in this way were projected upon the screen.[1]

The bands seen when light from a soda flame falls upon nearly parallel surfaces have often been employed as a test of flatness. Two flat surfaces can be made to fit, and then the bands are few and broad, if not entirely absent; and, however the surfaces may be presented to one another, the bands should be straight, parallel, and equi-distant. If this condition be violated, one or other of the surfaces deviates from flatness. In Fig. 2, A and B represent the glasses to be tested, and C is a lens of two or three feet focal length. Rays diverging from a soda flame at E are rendered parallel by the lens, and after reflection from the surfaces are re-combined by the lens at E. To make an observation, the coincidence of the radiant point and its image must be somewhat disturbed, the one being displaced to a position a little beyond, and the other to a position a little in front of, the diagram.

The eye, protected from the flame by a suitable screen, is placed at the image, and being focused upon AB, sees the field traversed by bands. The reflector D is introduced as a matter of convenience to make the line of vision horizontal.

FIG. 2.

These bands may be photographed. The lens of the camera takes the place of the eye, and should be as close to the flame as possible. With suitable plates, sensitised by cyanin, the exposure required may vary from ten minutes to an hour. To get the best results, the hinder surface of A should be blackened, and the front surface of B should be thrown out of action by the superposition of a wedge-shaped plate of glass, the intervening space being filled with oil of turpentine or other fluid having nearly the same refraction as glass. Moreover, the light should be purified from blue rays by a trough containing solution of bichromate of potash. With these precautions the dark parts of the bands are very black, and the exposure may be prolonged much beyond what would otherwise be admissible.

The lantern slides exhibited showed the elliptical rings indicative of a curvature of the same sign in both directions, the hyperbolic bands corresponding to a saddle-shaped surface, and the approximately parallel system due to the juxtaposition of two telescopic "flats," kindly lent by Mr. Common. On other plates were seen grooves due to rubbing with rouge along defined track, and depressions, some of considerable regularity, obtained by the action of diluted hydrofluoric acid, which was allowed to stand for some minutes as a drop upon the surface of the glass.

By this method it is easy to compare one flat with another, and thus, if the first be known to be free from error, to determine the errors of the second. But how are we to obtain and verify a standard? The plan usually followed is to bring *three* surfaces into comparison. The fact that two surfaces can be made to fit another in all azimuths proves that they are spherical and of equal curvatures, but one convex and the other concave, the case of perfect flatness not being excluded. If A and B fit another, and also A and C, it follows that B and C must be similar. Hence, if B and C also fit one another, all three surfaces must be flat. By an extension of this process the errors of three surfaces which are not flat can be found from a consideration of the interference bands which they present when combined in three pairs.

But although the method just referred to is theoretically complete, its application in practice is extremely tedious, especially when the surfaces are not of revolution. A very simple solution of the difficulty has been found in the use of a free surface of water, which, when protected from tremors and motes, is as flat as can be desired.[1] In order to avoid all trace of capillary curvature it is desirable to allow a margin of about $1\frac{1}{2}$ inch. The surface to be tested is supported horizontally at a short distance ($\frac{1}{10}$ or $\frac{1}{20}$ inch) below that of the water, and the whole is carried upon a large and massive levelling stand. By the aid of screws the glass surface is brought into approximate parallelism with the water. In practice the principal trouble is in the avoidance o tremors and motes. When the apparatus is set up on the floor of a cellar in the country, the tremors are sufficiently excluded, but care must be taken to protect the surface from the slightest draught. To this end the space over the water must be enclosed almost air-tight. In towns, during the hours of traffic, it would probably require great precaution to avoid the disturbing effects of tremors. In this respect it is advantageous to diminish the thickness of the layer of water; but if the thinning be carried too far, the subsidence of the water surface to equilibrium becomes surprisingly slow, and a doubt may be felt whether after all there may not remain some deviation from flatness due to irregularities of temperature.

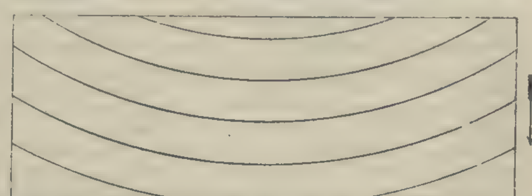


FIG. 3.

With the aid of the levelling screws the bands may be made as broad as the nature of the surface admits; but it is usually better so to adjust the level that the field is traversed by five or six approximately parallel bands. Fig. 3 represents bands actually observed from the face of a prism. That these are not straight, parallel, and equi-distant is a proof that the surface deviates from flatness. The question next arising is to determine the direction of the deviation. This may be effected by observing the displacement of the bands due to a known motion of the levelling screws; but a simpler process is open to us. It is evident that if the surface under test were to be moved downwards parallel to itself, so as to increase the thickness of the layer of water, every band would move in a certain direction, viz. *towards* the side where the layer is thinnest. What amounts to the same, the retardation may be increased, without touching the apparatus, by so moving the eye as to *diminish* the obliquity of the reflection. Suppose, for example, in Fig. 3, that the movement in question causes the bands to travel downwards, as indicated by the arrow. The inference is that the surface is concave. More glass must be removed at the ends of the bands than in the middle in order to straighten them. If the object be to correct the errors by local polishing operations

[1] The theory is given in a paper upon "Achromatic Interference Bands," *Phil. Mag.*, August 1889.

[1] The diameter would need to be 4 feet in order that the depression at the circumference, due to the general curvature of the earth, should amount to $\frac{1}{20}\lambda$.

upon the surface, the rule is that *the bands, or any parts of them, may be rubbed in the direction of the arrow.*

A good many surfaces have thus been operated upon; and although a fair amount of success has been attained, further experiment is required in order to determine the best procedure. There is a tendency to leave the marginal parts behind; so that the bands, though straight over the greater part of their length, remain curved at their extremities. In some cases hydrofluoric acid has been resorted to, but it appears to be rather difficult to control.

The delicacy of the test is sufficient for every optical purpose. A deviation from straightness amounting to $\frac{1}{10}$ of a band interval could hardly escape the eye, even on simple inspection. This corresponds to a departure from flatness of $\frac{1}{20}$ of a wave-length in water, or about $\frac{1}{30}$ of the wave-length in air. Probably a deviation of $\frac{1}{100}\lambda$ could be made apparent.

For practical purposes a layer of moderate thickness, adjusted so that the two systems of bands corresponding to the duplicity of the soda line do not interfere, is the most suitable. But if we wish to observe bands of high interference, not only must the thickness be increased, but certain precautions become necessary. For instance, the influence of obliquity must be considered. If this element were absolutely constant, it would entail no ill effect. But in consequence of the finite diameter of the pupil of the eye, various obliquities are mixed up together, even if attention be confined to one part of the field. When the thickness of the layer is increased, it becomes necessary to reduce the obliquity to a minimum, and further to diminish the aperture of the eye by the interposition of a suitable slit. The effect of obliquity is shown by the formula

$$2t(1 - \cos\theta) = n\lambda.$$

The necessary parallelism of the operative surfaces may be obtained, as in the above-described apparatus, by the aid of levelling. But a much simpler device may be employed, by which the experimental difficulties are greatly reduced. If we superpose a layer of water upon a surface of mercury, the flatness and parallelism of the surfaces take care of themselves. The objection that the two surfaces would reflect very unequally may be obviated by the addition of so much dissolved colouring matter, *e.g.* soluble aniline blue, to the water as shall equalise the intensities of the two reflected lights. If the adjustments are properly made, the whole field, with the exception of a margin near the sides of the containing vessel, may be brought to one degree of brightness, being, in fact, all included within a fraction of a band. The width of the margin, within which rings appear, is about one inch, in agreement with calculation founded upon the known values of the capillary constants. During the establishment of equilibrium after a disturbance, bands are seen due to variable thickness, and when the layer is thin, persist for a considerable time.

When the thickness of the layer is increased beyond a certain point, the difficulty above discussed, depending upon obliquity, becomes excessive, and it is advisable to change the manner of observation to that adopted by Michelson. In this case the eye is focused, not, as before, upon the operative surfaces, but upon the flame, or rather upon its image at E (Fig. 2). For this purpose it is only necessary to introduce an eye-piece of low power, which with the lens C (in its second operation) may be regarded as a telescope. The bands now seen depend entirely upon obliquity according to the formula above written, and therefore take the form of circular arcs. Since the thickness of the layer is absolutely constant, there is nothing to interfere with the perfection of the bands except want of homogeneity in the light.

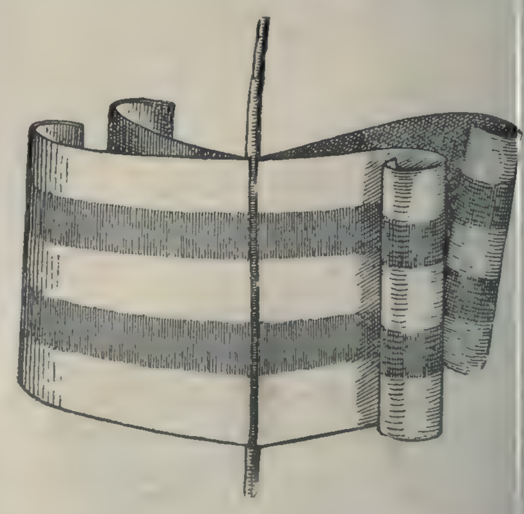
But, as Fizeau found many years ago, the latter difficulty soon becomes serious. At a very moderate thickness it becomes necessary to reduce the supply of soda, and even with a very feeble flame a limit is soon reached. When the thickness was pushed as far as possible, the retardation, calculated from the volume of liquid and the diameter of the vessel, was found to be 50,000 wave lengths, almost exactly the limit fixed by Fizeau.

To carry the experiment further requires still more homogeneous sources of light. It is well known that Michelson has recently observed interference with retardations previously unheard of, and with the aid of an instrument of ingenious construction has obtained most interesting information with respect to the structure of various spectral lines.

A curious observation respecting the action of hydrofluoric acid upon polished glass surfaces was mentioned in conclusion. After the operation of the acid the surfaces appear to be covered with fine scratches, in a manner which at first suggested the idea that the glass had been left in a specially tender condition, and had become scratched during the subsequent wiping. But it soon appeared that the effect was a *development* of scratches previously existent in a latent state. Thus parallel lines ruled with a knife edge, at first invisible even in a favourable light, became conspicuous after treatment with acid. Perhaps the simplest way of regarding the matter is to consider the case of a furrow with perpendicular sides and a flat bottom. If the acid may be supposed to eat in equally in all directions, the effect will be to *broaden* the furrow, while the depth remains unaltered. It is possible that this method might be employed with advantage to *intensify* (if a photographic term may be permitted) gratings ruled upon glass for the formation of spectra.

FROST FREAKS.

MR. LESTER F. WARD describes some remarkable frost figures in the current number of *The Botanical Gazette*. He says that on a bright frosty morning in December, 1892, Mr. Victor Mason and himself observed some white objects looking like icicles close to the ground, along the border of a pine wood. A closer examination showed that they were in truth nothing but ice, but that instead of icicles they were veritable freaks of frost. Every one was firmly attached to the stem of a small herbaceous plant which had succumbed to the season but still stood erect. The attachment was always close to the base, often at the very ground, sometimes an inch above. At a distance, the frost-works had the appearance of cylindrical masses, but one need not come very near to see that such was not the case. In fact, they really consisted of several thin foils or wings from one to three inches in width, firmly attached by one edge to the stem of the plant, thus standing in a vertical position.



From this attachment each of these little ice sheets projected out horizontally or with a slight upward tendency, not straight and stiff, but gently and gracefully curving or coiling into a beautiful conch-like roll at the distal margin. There were always several of these, usually three, four, or five, all attached to the same vertical portion of the stem but at regular intervals around it like the paddles of a flutter-wheel, but all curving in the same direction after the manner of a turbine-wheel. Thus, where there were four they stood with each pair opposite, as in the figure, which represents a side view. The amount of curving varied considerably, and the coil filled up most of the interval between the plates giving the object a compact appearance. The ice was white, opaque, and singularly light, as if consisting of congealed froth, but in all cases the scrolls bore horizontal stripes like those of a flag, resulting from degrees in the whiteness, varying from alabaster to nearly transparent. These stripes added greatly to the beauty of these singular objects. In some cases the inner margin, instead of being straight, was sinuous, giving a fluted character to the base of the wing. Many other peculiarities were noted in these evanescent toys, but they soon vanished.

But here is the chief wonder. There grew in the same situation some dozen or twenty small herbaceous plants of about the same general character which would all seem equally liable to exhibit such a phenomenon. There were species of Aster, Solidago, Chrysopsis, Pycnanthemum, Polygonum, Ludwigia, Sericocarpus, &c., and with these in considerable but not specially marked abundance, *Cunila Mariana.* The first frost-works seen were attached to this plant, which was supposed for a while to be an accident; but soon it was perceived that such was not the case, and an examination of hundreds of cases revealed the fact that they were exclusively confined to this species. No sign or semblance of them could be found on any other plant. They were, therefore, so far as observation went, a specific character, and it is this alone which prompted Mr. Ward to give the above account in the hope that others might be able to confirm or invalidate this induction by a wider one.

This plant persists after frost with all its branches, sere leaves, and empty seed vessels intact, so that its identity was as complete as in midsummer. The bark, which remained firm everywhere else, was seen to be longitudinally split into strips at the zone occupied by the frost-work, but as it could be seen between the several ice sheets, these rifts must have been covered by their bases. In other words, it cannot be doubted that the liquid matter out of which they were formed had passed through these longitudinal openings and been deposited by molecular accretions in the symmetrical forms observed. It was inferred from this that they might consist entirely of the juices of the plant, but on placing them on the tongue nothing distinguishable from pure distilled water could be detected. As the upper part of the stems was dead and dry and the roots perennial, the conclusion was that the water had by some agency been pressed or drawn up through the cambium layer of the roots from the soil and forced out through these apertures in the bark. The action of frost in the ground might account for the required pressure, and the whole would be thus explainable on physical principles. But it explains too much, since no reason can be assigned why the phenomenon should not be universal and not confined to a single species.

Since making these observations Mr. Ward has been to some pains to ascertain whether the phenomenon has been witnessed by others, but so far the inquiry has proved futile. It seems possible, therefore, that this is the first time that *Cunila Mariana* has been discovered to be a frost-weed. *Helianthemum Canadense*, however, behaves in a similar way. That plant is not common in the dittany and there has not been an opportunity to observe it at the proper season. The statement in the first edition of Gray's Manual, 1848, where the name "frost weed" is given to this species, that "late in autumn crystals of ice shoot from the cracked bark at the root, whence the popular name," repeated in all subsequent editions and copied into many other books, is doubtless founded on earlier recorded observations, but is not found in Nuttall or Pursh. A frost-figure also appears in Mr. Wm. Hamilton Gibson's recent book entitled "Sharp Eyes."[1] This figure is somewhat fanciful, being a vignette constituting the first letter of this chapter of his book and aiming to show all the parts of the plant in addition to the frost work. Although it is, according to this representation, a much less definite and less beautiful object than the dittany "frost-flowers," there can be no doubt that the principle on which it was formed is the same. The author's description of it as "fashioned into all sorts of whimsical feathery curls and flanges and ridges" indicates at once the inadequacy of his figure to do it justice, and the close analogy between it and the "frost flower" of Cunila.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

PROF. JEBB, M.P., in presenting the prizes and certificates on Tuesday to the students who successfully passed the last Cambridge local examination at Eastbourne centre, observed that thirty years ago examinations were believed to be a panacea for every educational defect. Now a reaction had set in, and some went so far as to hold that success in examinations afforded no trustworthy criterion of merit. The truth, of course, lay between these two extremes. An examination was not an infallible test, and was more favourable to some temperaments than to others; but, when well managed, was a sound test. An examiner must have at least three qualifications: he must know a great deal more than the subject in which he examined, or he would not have a proper sense of intellectual proportion and perspective; he must have a certain measure of acuteness to enable him to penetrate disguise or simulated knowledge; and, above all, he must have common sense in order to take proper account of particular circumstances of each case. The two older Universities, in the early part of the century, were said to be no longer in touch with the nation, and were regarded rather as great schools reserved for the education and, equally perhaps, the amusement of a select few; but now they had spread a network of examination, and were diffusing their influence over the country, becoming what they were in the Middle Ages, really national, but national in the higher sense, in the desire that every one who sought it should have the means of a liberal education, and that the best things which literature or science had to show should be placed within reach of all.

MR. ROBERT HOLT, late Assistant Lecturer in Engineering at University College, Liverpool, has been appointed Professor of Engineering at the People's Palace, London. Mr. Holt has held both Whitworth and National Scholarships, as well as one of the research scholarships founded by the Commissioners of the Exhibition of 1851.

AT a council meeting of the University College of Wales, Bangor, on June 21, a scheme for the supervision and residence of women students of the college next session was carried by a large majority.

LORD HERSCHEL has been appointed to succeed the late Earl of Derby as Chancellor of the University of London.

OXFORD has conferred the degree of D.C.L. upon Sir John B. Lawes, Bart., F.R.S.

SCIENTIFIC SERIAL.

Meteorologische Zeitschrift, May.—Rainfall probability and cloud in the United States, by W. Köppen. The author has submitted the rainfall charts published by the United States Government to a thorough investigation. The following are the generalised results as regards the distribution of rainfall:—(1) There is a district of continental summer rains, enclosed on both sides by littoral winter rains, which, corresponding to the contrast of the yearly oscillation of temperature, are much more marked in the west than in the east. (2) A district of isobaric summer rains, in the south-east, with equatorial sea-winds in summer, and with anticyclonic weather in winter. (3) Transition districts, in which both rainfall maxima occur near each other, while the minima occur in spring and autumn. Maxima after the equinoxes are nowhere very well marked, but the April and May rains of Colorado and Kansas and the autumn rains on Lake Superior are indications of them. With regard to the seasonal distribution in the tropical zone, the differences of temperature play only a small part compared to that of extra-tropical regions; this result naturally follows from the small variation of temperature in the tropics.—On the dynamics of the atmosphere, by M. Möller. This first part deals chiefly with the causes of the inversion of temperature with height, and with the cold experienced in the centres of areas of high barometric pressure. He deals especially with three causes of inversion:—The cooling of the lower strata by radiation, the effects on the higher strata by dynamic heating or cooling analogous to those caused by the action of Föhn winds, and the transference of warm air to the higher regions by horizontal winds coming from warmer parts. Various cases are separately considered from data afforded by mountain stations, such as Ben Nevis, and from discussions by Dr. Hann and others. Particular attention is also given to the formation and motions of clouds, as furnishing visible evidence of the processes in action in the higher strata of the atmosphere.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 8.—"Preliminary Report of the Joint Solar Eclipse Committee of the Royal Society, the Royal Astronomical Society, and the Solar Physics Committee on the

[1] New York, 1892. Article "The Frost Flower," pp. 210, 211.

Observations of the Solar Eclipse of April 16, 1893." Communicated by Dr. Common, F.R.S.

This report merely states the work undertaken by the British observers during the recent total solar eclipse, and the number and kind of photographs that were obtained. This information has appeared, from time to time, in these columns. A more detailed report, giving the results of the discussion of the pictures will shortly be published.

PARIS.

Academy of Sciences, June 12.—M. Lœwy in the chair.—Experimental verifications of the theory of weirs without lateral contraction, the sheet being free below, by M. J. Boussinesq.—On a simplification introduced into certain formulæ depending upon the resisting power of solids by introducing the greatest linear extension Δ which can be supported by the material, in the place of the corresponding elastic force R_0, by M. J. Boussinesq. In formulæ relating to the strength of elastic solids in motion, mechanicians as a rule introduce a quantity R_0 denoting the greatest tension which a fibre can sustain upon unit sectional area without breaking, instead of the maximum elongation Δ which does not endanger the texture. M. Boussinesq shows that many formulæ may be considerably simplified by introducing Δ. Thus the maximum velocity V which can be safely impressed upon an element of a solid under concussion is related to the velocity of sound in the solid and to Δ in a manner given by the formula $V = k\omega\Delta$, where k is a constant depending on the figure and mass of the solid, and ω is the velocity of sound in it. If V be the peripheral velocity of a flywheel in the form of a narrow ring with a large radius, the maximum safe velocity is given by the formula $V = \omega\sqrt{\Delta}$.—On various methods of observing the so-called anomalous focal properties of diffraction gratings, by M. A. Cornu.—On the extraction of zirconia and thorina, by M. L. Troost.—Study of some new phenomena of fusion and volatilisation produced by means of the heat of the electric arc, by M. Henri Moissan.—On Liouville's linear element surfaces, and surfaces with constant curvature, by M. Émile Waelsch.—On a general property of electric and magnetic fields, by M. Vaschy.—Study of the filtration of liquids, by M. R. Lezé. A porous vessel containing the liquid to be studied was placed in a test-tube and subjected to very rapid rotation. By a comparison of the weights of the porous vessel and its contents before and after rotation, the velocity of outflow through the porous walls due to centrifugal force was ascertained. Taking that of distilled water as unity, the figure for a five per cent. solution of sodium chloride was 1·023, for the nitrate 1·051, for ammonium sulphate 0·993. The velocity of efflux for alcohol solution showed a minimum at 40°, where it was 0·50. The numbers are those for a pressure of eight or ten atmospheres applied during ten minutes, during which the tubes travelled from 40 to 50 km.—On the combinations of molybdates and sulphurous acid, by M. E. Péchard.—On bromine-boracites; bromine compounds of iron and zinc, by MM. G. Rousseau and H. Allaire.—On fluorides of copper, by M. Poulenc.—Action of electricity upon the carburisation of iron by cementation, by M. Jules Garnier.—On the rotatory power of bodies belonging to an homologous series, by M. Ph. A. Guye. It is shown theoretically that if the schematic tetrahedron is slightly deformed, the rotatory powers of a homologous series of bodies must pass through a maximum.—On the rotatory powers of the ethers of valeric and glyceric acids, by MM. Ph. A. Guye and L. Chavanne. This paper contains experimental evidence supporting the conclusions of the previous paper.—Heat of formation of some derivatives of indigo, by M. R. d'Aladern.—On right-handed licareol, by M. Ph. Barbier.—A new apparatus for measuring the intensity of perfumes, by M. Eugène Mesnard. The instrument is based upon the property of essence of terebenthine of extinguishing the phosphorescence of phosphorus when mixed with the surrounding air in a certain minimum proportion. The phosphorescent body is a small piece of starch dipped into a concentrated solution of phosphorus in carbon bisulphide. After once determining the quantity of essence necessary to extinguish phosphorescence, the quantity of essence contained in air may be ascertained by passing sufficient of the air through the apparatus to produce extinction. This air is mixed with other air containing a known quantity of the essential oil or other perfume to be examined, and the odoriferous power of the latter is given by the quantity required to produce a "neutral" scent.—On the fertilisation of the Puccinicei, by M. Paul Vuillemin.—Magnesian chalk of the environs of Guise (Aisne), by M. H. Boursault.—On the cavern of Boundoulaou (Aveyron), by MM. E. A. Martel and Émile Rivière.—On the utilisation of the waste products of the vineyard, by M. A. Muntz.—Mode of action of the substances produced by microbes upon the circulatory apparatus, by MM. Charrin and Gley.—On a soluble derivative of β-naphthol, by MM. Dujardin-Beaumetz and Stackler.—On morbid intercurrencies in sulphate of quinine fevers, by M. Alcide Treille.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Primitive Music: R. Wallaschek (Longmans).—Life with Trans-Siberian Savages: B. D. Howard (Longmans).—Nineteen Charts of the Isle of Wight and Solent Tides from Portland Bill to the Owers: T. B. C. West and F. H. Collins (Potter).—Photography Annual, 1893 (Iliffe).—Lehrbuch der Zoologie, new edition: Dr. R. Hertwig (Jena, Fischer).—Das Kleine Botanische Practicum für Anfänger, new edition: Dr. E. Strasburger (Jena, Fischer).—Die Pilzgärten einiger Sudamerikanischer Ameisen: A. Möller (Jena, Fischer).—Smithsonian Meteorological Tables (Washington).—On the Chemistry of the Blood: L. C. Wooldridge (K. Paul).—Walks in the Ardennes, new edition: edited by P. Lindley (London).—On English Lagoons: P. H. Emerson (Nutt).

PAMPHLETS.—The Condition of the Western Farmer: A. F. Bentley (Baltimore).—Report of the Trustees of the South African Museum, 1892 (Cape Town).—Il Terremoto a Roma del 22 Gennaio, 1892: Dr. G. Agamennone (Roma).—The Brighton Life Table: Dr. A. Newsholme (Brighton).—Die Medicinische Electrotechnik und ihre Physikalischen Grundlagen: Dr. J. L. Hoorweg (Leipzig, Engelmann).—Ueber das Norian oder Ober-Laurentian von Canada: F. D. Adams (Stuttgart, Koch).—Geometrical Constructions for Cutting from a Cone of Revolution: E. A. Engler (St. Louis).

SERIALS.—Proceedings of the Bath Natural History and Antiquarian Field Club, Vol. vii. No. 4 (Bath).—Journal of the Polynesian Society, Vol. 2, No. 1 (Wellington).—Bulletin of the New York Mathematical Society, Vol. 2, No. 9 (New York, Macmillan).—Journal de Physique, June (Paris). Séances de la Société Française de Physique, November-December, 1892 (Paris).—Proceedings of the American Philosophical Society, Vol. xxxi. No. 140 (Philadelphia).—Proceedings of the Academy of Natural Sciences of Philadelphia, 1893, Part 1, January-March (Philadelphia).—Bulletins de la Société d'Anthropologie, No. 5, June 15 (Paris, Masson).—Reale Instituto Lombardo di Scienze e Letture, Rendiconti, Serie 2, Vol. 26, fasc. xi.-xii. (Milano, Hoepli).—Phycological Memoirs: edited by G. Murray, Part 2 (Dulau).—Zeitschrift für Physikalische Chemie, xi. Band, 6 Heft (Leipzig, Engelmann).—The American Naturalist, June (Philadelphia).—Bulletin de la Société d'Encouragement pour l'Industrie Nationale, Avril (Paris).

CONTENTS.

THURSDAY, JULY 6, 1893.

THE GREAT BARRIER REEF OF AUSTRALIA.

The Great Barrier Reef of Australia; its Products and Potentialities. By W. Saville-Kent, F.L.S., F.Z.S., F.I.Inst. 387 pp., 64 pls. (London: W. H. Allen and Co., Limited.)

THE first thought that strikes one in glancing through this magnificently illustrated volume is the diligence and skill of the author in photography and the enterprise of the publisher. Never before has a semi-scientific work been illustrated with such a wealth of plates. The illustrations will go far towards giving a realistic impression of some of the beauties of coral seas to the untravelled, and will awaken many recollections of happy hours of exciting shore collecting in those who have waded on coral reefs and peered over a boat-side at the edge of a reef.

The objects of the author in writing this book are set down in the Preface as being manifold—primarily to place before the reading public generally, and the scientific world in particular, more extensive and accurate information about coral-reefs as represented by the largest existing coral structure. Another prominent purpose is to lead to the industrial development of the "marvellous resources" of the Great Barrier Reef.

The book commences with a detailed description of over forty photographs of reefs and corals. These will well repay careful study, and to some naturalists they will be the most valuable portion of the work. The illustrations are unique for beauty, truthfulness, and number, and the descriptions are short and to the point. Two photographic plates and three sketches illustrate some groups of corals on the reef at Vivien Point, Thursday Island, of which measurements are given to furnish some data concerning the average rate of growth of the more important reef-forming species. The numerous plates of reef-scapes may possibly give the impression that coral reefs always present such scenes of interest and beauty, but the reader must be warned that it is only at low spring tides that he will see reefs as here photographed. At ordinary low tide the exposed surface of a reef is ugly and comparatively uninteresting. The amount of exposure to the fierce rays of a tropical sun which some corals can withstand will be surprising to many zoologists. In a few cases a future zoologist will be able to compare the *ad interim* growth or modification of a reef by the landmarks which appear in certain of Mr. Saville-Kent's photographs; but, unfortunately, little information of this kind is given, and it is still more to be regretted that the aspect of the area photographed is not recorded, there being no indication whether it is on the side of the steady south-east trade-wind or subject to the calms and storms of the north-west monsoon. It would further be of great interest if one knew why one reef or portion of a reef consisted almost solely of the genus Madrepora, while Porites characterises another area, or mixed corals a third.

The general reader is provided with the indispensable account of coral reefs, their general structure and theories of origin. This consists largely of appropriate quotations from other writers.

The third chapter is devoted "to a consideration of the general structure and most probable mode of origin of the Great Barrier Reef of Australia," the more notable features of the reef being described in order, beginning with the most southerly end. The view is enunciated "that coral-reefs are produced in the tropics, not with relation so much to the intrinsic reef-constructing properties of the specific coral polyps, but with relation to the rule that reef consolidation (or the amalgamation of coral *débris* into a more or less solid, coarse or fine, concrete, or into a finer-grained, compact limestone) is associated only with the rapid evaporation of the lime-saturated sea-water on inter-tropical, tidally exposed, coral banks or beaches." The presence of dead specimens of reef corals in Moreton Bay suggests two questions. Why did they not form reefs or reef-rock when they were abundant? and why have they now all but become extinct? Mr. Saville-Kent answers the first question by suggesting that the temperature of Moreton Bay is insufficient to produce the requisite rapid evaporation, and the second by pointing out that the increasing size of the three large islands which hem in the bay has latterly tended to freshen the bay in flood time, and this has led to the destruction of the corals. In his description of the Great Barrier Reef Mr. Saville-Kent has quoted largely from Jukes' "Voyage of the *Fly*" and thus endorses the accuracy of the observations of that distinguished naturalist. With regard to the question of subsidence and elevation, Mr. Saville-Kent found at many stations throughout the Barrier region (notably at Albany Pass, Cape York) large expanses of dead brittle coral *in situ* between high-water mark and the living banks. These beds of dead coral are now exposed to atmospheric influences which are antagonistic to coral growth with every ordinary springtide, and hence he concludes the general upheaval of the area on which it grew; additional evidence is given from the shallowing of a bay in Magnetic Island, near Townsville.

"It is difficult," Mr. Saville-Kent adds, "to associate the phenomena described in the foregoing record with any other than a movement of upheaval; but, accepting this as proven, and premising for the nonce that the whole length and breadth of the Barrier region exhibited a similar testimony of emergence, the amount raised, a foot or two only, would be as nothing compared with the latitude of movement in one direction or the other that is required to account for the construction of the Barrier's mass. Had the Great Barrier been fashioned during a prolonged epoch of upheaval, substantial evidence of such movement would be yielded by the strata of the seaboard which it skirts; but of this there is virtually none." Thus Mr. Saville-Kent supports the conclusion arrived at by Prof. Jukes and by the Reviewer that this is not an area of recent elevation. Mr. Saville-Kent refers to the well-known fact that all of the few big breaches in the Barrier's outer rampart are opposite large estuaries, though at the present time too remote from them to be influenced by their streams. These are to be expected on the subsidence hypothesis. Mr. Saville-Kent further elaborates an argument for this theory on the fauna of Tasmania and New Guinea being essentially similar to that of the respective neighbouring coasts of Australia and a more remote connection between New Zealand and Queensland through "Wallace's Bank." Mr. C. W. De Vis has recently identified some fossil bird bones from the Darling Downs (Queensland) as belonging to a true Moa (*Dinornis Queenslandiæ* n.sp.) to an allied genus (*Dromornis* n.g.) and to a near ally of the Kiwi (*Metapteryx bifrons* g.sp. nn.). This discovery is of such importance that it requires corroboration before it can be finally accepted by zoologists. It is unfortunate that on p. 137 occurs a foot-note in which the native name of an island in Torres Straits, "Moa," is associated with that of the extinct New Zealand bird. On the preceding page Dr. Wallace is quoted as saying that the complete disseverance of Australia and New Zealand was probably in the earlier portion of the tertiary period at least, and previous to this Mr. Saville-Kent himself says that "the very conspicuous racial distinctions between the human inhabitants of New Guinea, the Torres Strait Islands, and the Australian Continent, indicate that the separation of the districts must have been accomplished in prehistoric times, probably in a middle tertiary epoch."

While this statement of Mr. Saville-Kent's disproves his own suggestion, it cannot pass unchallenged. The Torres Straits Islanders are Papuans with probably, in some cases, an admixture of North Queensland blood, but anyhow, migration across Torres Straits is easy enough and does not require a land connection.

"Corals and Coral Animals" have a chapter to themselves. The classification adopted is not to be commended, and the term Zoantharia is restricted to the Zoantheæ, contrary to universal usage. Several new species of Actiniaria are described in general terms, and one new genus, *Physobrachia*, is erected for a polyp having "bladder-like apices of the tentacles." There is no evidence to show that this is a sea-anemone at all. The most remarkable form collected by Mr. Saville-Kent is a zoanthean which grows on an erect zigzag tube, about which there is a division of opinion; some zoologists regard it as an example of commensalism between an unknown annelid and a zoanthus, but Mr. Saville-Kent believes that the tube is secreted by the zoanthean, which he names *Acrozoanthus Australiæ*. The Reviewer finds that anatomically and histologically the polyp agrees precisely with other species of the genus Zoanthus. A rough sketch is given of *Platyzoanthus mussoides* Nov. gen. n.sp. which is insufficient for accurate determination; this is almost certainly a Hexactinian and not a Zoanthean, and probably it is *Rhodactis bryoides* H. and S., or an allied species. The section on the Madreporaria, or stony corals, is excellent, and the photographic illustrations of expanded corals are very valuable. The colours of the different species are described, and attention is drawn to the fact that not only may the same species, but in one case even the same individual varies in colour. The description of the Alcyonaria is valuable when confined to observations on the reef.

The chapter on "Pearl and Pearl-shell Fisheries" is chiefly intended for those interested in the commercial aspects of this important fishery, the average annual value of which is stated to be £69,000. The profits of the fishery are made out of the pearl-shell only, for though pearls, and often very valuable ones too, are frequent, they largely form the illegal perquisites of the nati crews. Mr. Saville-Kent distinguishes two species, t large white shell *Meleagrina margaritifera* and a small black-edged form which he names *M. nigro-marginat* Mr. Saville-Kent has proved that it is possible to tran plant living pearl-shell, and his experiments open up prospect of the "shellers," as they are locally terme forming nursery beds to which undersized shell can transferred to be again taken up when they are bett grown. The shells from these beds could be open under the superintendence of the owners, who would th secure the pearls. The author is inclined to think th under favourable conditions a period not exceeding thr years suffices for the shell to attain to the marketab size of eight or nine inches in diameter, and that hea shells of 5lb. or 6lb. weight per pair may be the produ of five years' growth.

The account of the "Bêche-de-Mer Fisheries" is o of the most workmanlike sections of the book. For t first time we can associate such terms as "prickly re or "teat fish" with their appropriate scientific name Twenty species of Holothurians are popularly diagnose of which six are described as being new species. only the fully-grown forms are found on the surface the reefs there is little fear of extermination throu over-fishing.

A long chapter is devoted to "Oysters and Oyst Fisheries of Queensland," which is of more local a commercial than of general interest. Several speci and numerous varieties of Ostrea are described a figured.

Two coloured plates and six photographic plates illu trate the chapter on "Food and Fancy Fishes," whic will be of considerable value to local naturalists. A fe new species are recorded.

The concluding chapter is entitled "Potentialities and summarises in an able manner the vast store of foo and wealth which is furnished by the Great Barrier Re and is still unappropriated.

There can be but little doubt if a serious fishery of t dugong is undertaken that interesting sirenian will soo become exterminated. It is not very evident why t "Great Barrier Reef sea-serpent" (*Chelosauria Lovell* n. gen. and sp.) should be placed among the potentialiti of the Great Reef. A detailed description and sketch are given of a supposed enormous Chelonian, with snak like head and fish-like tail. Dr. Günther, it appears, h offered "£100 for the entire animal, £50 for part, and fair price for the head and neck sun-dried." An exte sive fishery at these prices—for doubtless other curato would be willing to purchase—may perhaps be regarde as a possible, if improbable, source of wealth.

The author puts in a plea for a federal Australia marine biological station at Thursday Island in Torr Straits, which should "look for the main means of i foundation and maintenance to Australian corpora support and Australian private liberality." The Review would like to add his testimony to the suitability Thursday Island for this purpose. It is convenient fro every point of view, being easy of access, with a regul mail and a telegraph, a safe anchorage, extensive an prolific reefs almost entirely surrounding the island, an inexhaustible reefs in the vicinity. Mr. Saville-Kent's boo hows, as do also the series of papers by various experts, :hich are now being published by the Royal Dublin ociety, that the fauna is one of extreme interest. A iarine biological laboratory is one of those institutions ı which, beyond all question, the interests of pure :ience and its applications to industry and commerce re so interwoven that there need not be any hesitation ı endowing and supporting it by the most "practical" ıinded individual or Government.

There is evidence in the shape of numerous misprints that ıe author produced the book under stress of time. The ystematic zoologist has a right to complain of Mr. Saville-{ent's practice of naming imperfectly diagnosed genera nd species. In hardly a single case is there an adequate escription of a new species. Being himself a zoologist, e should have been more considerate to his colleagues.

It is difficult to criticise the sixteen coloured plates 'hich conclude the volume. They contain over two undred colour sketches, selected out of a much larger umber from the author's note books. This being so, e may regard them as colour memoranda, taken on the pot and grouped as plates. Very few of them can be garded as drawings of the animals, since, as a rule, ıe critical points of form are omitted. The reviewer as checked the colours of some of the animals depicted y sketches made by himself of the same species, and e finds that Mr. Saville-Kent's colouration, or rather ıe lithographer's rendering of it, is accurate enough, ut there is no doubt that the plates are very crude. nartistic as they are, they serve to emphasise the glorious auna of the coral seas.

ALFRED C. HADDON.

BACTERIOLOGY FOR THE PUBLIC.

l Manual of Bacteriology. By A. B. Griffiths, Ph.D., F.R.S.E., F.C.S. (Heinemann's Scientific Handbook Series). Small crown 8vo. Illustrated. (London: Heinemann, 1893.)

THE number of bacteriological text-books is still comparatively so small, that each successive endeavour › expound the principles of this new science attracts more eneral attention than is occasioned by the appearance of milar treatises in sciences which have already an abunance of such works in circulation. It might be supposed ıat because bacteriology is a science of such recent growth would be more easy to prepare a text-book of bacterilogy, than one dealing with a science the literature of 'hich extends over a much longer period of time. As a ıatter of fact, however, this is by no means the case, ›r probably in no other experimental science has so ıuch to be taken on trust, owing to the impossibility of epeating investigations under precisely similar conditions, s can be done in the case of physics and chemistry; 'hilst again from the very juvenility of the science of acteriology, there has not yet been sufficient time and pportunity for many of even the most important points › be firmly established through repeated observation by ifferent investigators. On this account there is the ıore scope for the exercise of the judgment and critical ıculty by the author of a work on bacteriology, and we re of opinion that a heavy load of responsibility rests pon the shoulders of a writer who undertakes to present › the public a worthy treatise on this important subject.

It is doubtless an appreciation of this grave responsibility which has deterred many well-qualified persons both in this country and on the Continent from publishing works dealing with more than comparatively small portions of this elastic and comprehensive science. The writer of the work before us plunges confidently into the task before him without even a moment's misgiving or hesitation; his preface does not contain a word which might betray any fear that the pages which are to follow may fail to do justice to "the important and far-reaching subject of bacteriology." The table of contents indicates that the information to be imparted in this little book of 348 small crown octavo pages, which are well printed in clear large type, is to be of a most comprehensive character. We find first, an introductory chapter, upon which follow the "bacteriological laboratory and its fittings," "methods of cultivating, staining, and mounting microbes," "origin, classification, and identification of microbes," "biology of microbes," "infectious diseases and microbes," "microbes of the air," "microbes of the soil," "microbes of water," "ptomaïnes and soluble ferments,' and lastly "germicides and antiseptics." To deal with this extensive material in such a small compass obviously requires that a very careful selection should be made of the matter which is to hand, in connection with each of the above divisions of the subject. The method of selection to be adopted in such a case must of course depend upon the kind of reader for which the book is intended, but this is a point on which we are not informed in the text nor on which have we been able to arrive at any conclusion from a perusal of the pages. The idea that the book is designed for the general reader is negatived by the fact that there occur long catalogues of bacterial species and of bacterial products, together with technical details which can only serve to increase the chaotic bewilderment in which the minds of most persons find themselves with regard to the subject of micro-organisms in general. On the other hand, for the serious student of bacteriology the information is as inadequate when detail is essential as it is discursive and wandering when terseness and precision are required. The entire work bears the impress of the hasty and premature compilation of undigested reading. We come to this conclusion, as it is almost impossible to believe that the author is so ignorant as some of his statements would indicate. Thus it would be uncharitable to believe that the author had written the following passage except by oversight: "Microbes may be simply divided into aërobic and anaërobic forms. *Bacillus spinosus* and *Bacillus œdematis maligni* are examples of the former; while *Micrococcus candicans* and *Bacillus subtilis* are examples of the latter kind." We feel sure that Dr. Griffiths is as well aware as the most elementary student of bacteriology that the *Bacillus subtilis* is a type of the aërobic and the *Bacillus œdematis maligni* a type of the anaërobic microbe. In the special description of *Bacillus subtilis* which follows in a later chapter we should be interested to learn on what authority this organism is described as "the hay-fever microbe." The same paragraph furnishes another excellent illustration of the kind of loose illogical writing in which this book abounds; thus, it is stated that "the action of ozone on both the spores and bacilli is that they are completely destroyed; this fact explains the absence of this and other microbes in the air at sea—the latter containing an appreciable amount of ozone." Innumerable experiments have surely proved that the absence of microbes in sea-air would be anticipated on mechanical grounds quite irrespectively of the possible subsidiary effect of ozone.

We believe that Dr. Griffiths is primarily a chemist, and a number of pages in this work are devoted to the chemical products elaborated by micro-organisms; in this connection we are informed that yeasts secrete a soluble enzyme which converts maltose into dextrose and levulose (*sic*), nor is it easy to believe that this is a *lapsus plumæ*, for the equation is given with the explanatory names beneath the formulæ, thus

$$\underset{\text{[maltose]}}{C_{12}H_{22}O_{11}} + H_2O = \underset{\text{[dextrose]}}{C_6H_{12}O_6} + \underset{\text{[levulose]}}{C_6H_{12}O_6}.$$

Dr. Griffiths devotes a number of pages to the subject of hydrophobia, but in connection with the hitherto undiscovered vital cause of this malady we hardly think that either the public or the scientific world will feel much interest in the author's statement that he has "observed a micrococcus in the saliva of a woman suffering from hydrophobia," notwithstanding the categorical assurance which follows that "this microbe does not occur in healthy human saliva."

In dealing with the much-vexed subject of the etiology of pneumonia, the author refers only to the pneumococcus of Friedländer which has long been regarded as an ineligible candidate for the distinction of being the specific cause of this disease, whilst of the far more probable diplococcus of Fränkel there is no mention whatever, nor indeed of the uncertainty which surrounds the entire question.

Similarly, in connection with the bacillus of typhoid fever we find no mention of the closely-allied *Bacillus coli communis*, nor does the author appear to be acquainted with any of the modern methods which have been resorted to for its diagnosis, but contents himself with copying a long passage from Gaffky's original paper of 1886 in which the statement is made that the well-known potato-test serves to distinguish this microbe from all others. Indeed, the transcription of long passages from the works of other authors is a striking feature in this book, and inasmuch as such extracts are not printed in different type, the reader must be ever on the alert for the small inverted comma, in order to know whether he has before him the words of Dr. Griffiths or those of some more or less distinguished authority.

We do not think that any useful purpose would be served in pursuing this criticism further, nor should we have referred to as many points as we have done but that we have such strong reason to believe that the circulation of works of this kind among some sections of the public is fraught with no little danger. It is by no means uncommon for persons without any special qualification whatever, but with plenty of cheap assurance and a smattering of information gleaned from semi-popular works like the one before us, to perambulate the country under the auspices of county councils and other equally competent bodies, and to deliver discourses or even write books on sanitary and hygienic subjects; so that if the sources from which these retailers of third-hand knowledge draw are g vously inaccurate, it requires but little imagination realise how serious may be the consequences.

THERMODYNAMICS.

Die Thermodynamik in der Chemie. Von J. J. v Laar. Mit einem Vorwort von Prof. Dr. J. H. van Hoff. Pp. xvi., and 196. (Amsterdam and Leip 1893.)

TWENTY years ago the first application of second law of thermodynamics to the study chemical phenomena was published by Horstmann, a shortly afterwards the whole subject was investigat by Willard Gibbs, but in a manner so general that work failed to gain the recognition of physical chemi for many years. Within the last decade, however, p gress in this direction has been very rapid, and spec branches or special aspects of chemical thermodynam have received exhaustive treatment at the hands van 't Hoff, Le Chatelier, Duhem, Planck, and othe But if we except the novel and brilliant exposition in t new edition of Ostwald's "Lehrbuch der allgemein Chemie," a general survey of the modern applicatio of thermodynamics to chemistry has hitherto been wan ing, and it is to supply this want that Dr. van Laar h written the present volume.

The first half of the book is concerned with gene thermodynamical principles and their application to t behaviour of gases and saturated vapours. The devi tions from the laws of perfect gases are considered ve fully—indeed, at inordinate length. As Prof. van 't H says in his preface, the work is alternately text-book a memoir. Now, while this method of treatment m have its advantages, it entails an utter absence of balan between the various parts of the work. It appears, f instance, out of all proportion to devote a fifteenth pa of the whole book to the discussion of the formula f the vapour pressure of a liquid. After making his wa through thirteen pages of infinite series, differenti equations, and determinants, the student finds tha when judiciously modified, van der Waals's equation ca be made to express exactly the relationship between th temperature and pressure of a vapour in contact with i liquid—a result (to the chemist, at least) quite incom mensurate with the trouble involved in arriving at it.

It is the second half of the work which is of speci interest to students of physical chemistry. Beginnin with the fundamental entropy principle of Gibbs, th author develops the various equilibrium equation and gives a general proof of the important relatio $d \log K/dT = Q/RT^2$. Then come applications to concre cases of dissociation and balanced action. The "tempe rature of transformation" of phases of constant com position and the "triple point" are next fully discusse and the last portion of the book is occupied with th behaviour of dilute solutions. Here the new theories o osmotic pressure and electrolytic dissociation are viewe from the thermodynamical standpoint, many importan constants being calculated afresh. The depression of th freezing point and of the vapour pressure in solutions, a well as the question of affinity constants, all receive ad quate treatment. In discussing neutralisation, however, the author has fallen into a serious error. On page 178 we find in italics the statement that "when a base and an acid are mixed in equivalent proportions in aqueous solution they are transformed entirely, no matter how weak they may be, into a salt and water." This is undoubtedly erroneous. A solution of potassium cyanide, for example, is never neutral, but always contains free potash and free prussic acid. The author has been led into this error by assuming in the construction of his equations that water is a perfect non-electrolyte, *i.e.* is not at all dissociated into ions.

The chief defects of the book are the want of proportion already alluded to, and the too bare formal mode of treatment. Fewer formulæ and more text would better suit the requirements of the average student. The typography and clear arrangement of the mathematical sections of the work are admirable. It is to be regretted, however, that the text has not had the advantage of revision by a German proof-reader. The Dutch compositor is presumably responsible for some quaint specimens of German, and oscillates in his spelling between antiquated forms like "dasz," "nähmlich," and painfully phonetic renderings such as "grafisch" and "Kwadratwurzel."

The book may be confidently recommended to those who already know the elements of thermodynamics and are desirous to learn the applications of that science to the problems of general chemistry.

J. W.

OUR BOOK SHELF.

Discussion of the Precision of Measurements. By Silas W. Holman. (London: Kegan Paul, Trench, Trübner, and Co., Ltd., 1892.)

THIS book deals with a subject that becomes more important every year, and its applications in nearly every science are both numerous and necessary. That our means of accurate measurement have reached a very fine stage, which is difficult to exceed, at any rate to a great extent, is well known, but results can be made of far greater value when subjected to a thorough discussion. In astronomy one may, perhaps, say that such discussions are carried through to their fullest extent and solving problems by the methods of least squares—a means of obtaining the most accurate values for the quantities sought after—is the rule and not the exception. To be able to find out the precision with which measurements have been made, whether by means of a yard-measure, the circle of a meridian instrument, or any other means, is at all times of great interest to the student of science, and the present work is intended especially as a course of study to engineers and for students of pure sciences, to present in a clear manner the principles on which such questions as, What accuracy is desired in the result? With what accuracy must each individual measure be obtained? and How trustworthy is the final result when obtained? &c., can be answered. The material here used is, as the author informs us, the outcome of several years' teaching of the subject, and a study of the volume itself indicates that he has presented it in a form that will commend itself to its readers. The book is divided mainly into three parts. The first deals with the treatment of direct measurements, the second with indirect, and the third with the determination of the best magnitudes of components. In the beginning the various sources of error, in different kinds of measurement, are pointed out, and the reader is made familiar with determinate and indeterminate errors, deviations, general laws of deviations, &c., terminating with two fully-worked out examples relating to the balance and voltmeter calibration. Part ii. gives in a clear way the methods of procedure with regard to indirect measurements, several examples being interpolated illustrative of the rules described. The third and last part is devoted to the solution of a certain class of problems, which deal more with the use of the instruments with which the observations are ma e, than with the observations themselves. Thus, for instance, in using a tangent galvanometer to find the best angle of the needle which will give the least errors of reading. This and several other problems, taking the cases when there are one, two, three, or more components, are thoroughly worked out. The book concludes with a series of illustrative examples.

Traité Pratique d'Analyse Chimique et de Recherches Toxicologiques. Par G. Guérin. (Paris: Georges Carré, 1893.)

THIS book differs in several important respects from ordinary works on analytical chemistry.

The first three parts are concerned with the ordinary processes of qualitative analysis—wet and dry reactions. the separation of group precipitates, &c. As special features of these sections it may be noted that coloured representations of borax beads and of beads of microcosmic salt are supplied, and that the reactions of the rare metals and of acids such as bromic, selenic, butyric, malic, meconic, &c., which are but seldom introduced into text-books, are fully discussed.

After a short section dealing with the qualitative analysis of gaseous substances, the author deals with spectroscopic methods of analysis. In this part are described the various forms of spectroscope, and the modes of obtaining and observing both emission and absorption spectra. A table is given of the characteristic rays in the emission spectra of the different elements arranged in order of their wave-lengths. In connection with absorption spectra, chlorophyll, salts of didymium and erbium, potassium permanganate, and blood, including the treatment of blood-stains, are considered. Both emission and absorption spectra are illustrated by means of coloured charts.

Part vi., which is by far the most extensive, is devoted to toxicology. The conduct of chemico-legal inquiries in cases of suspected poisoning by arsenic, phosphorus, hydrocyanic acid, chloroform, and chloral are first given in detail. Then are considered the general reactions and, where devised, the modes of separation of the vegetable alkaloids and the alkaloids of animal origin, the ptomaines and leucomaines. This section is completed by a full and historical account of the characteristic chemical properties and physiological action of the principal alkaloids.

Quantitative methods only find a place in the last part of the book, where the author introduces the examination of potable and mineral waters, and the estimation of clays, irons, and steels. In this part the apparatus and methods used in the bacteriological study of water are also included. An appendix relating to the preparation and concentration of reagents and a full index are supplied.

The prominence given to the reactions of the rare metals, the introduction of spectroscopic methods, and in particular the chapters on toxicology, make the work a valuable addition to the literature on analysis. It may be noted, however, that when dealing with the constitution of substances like the alkaloids, the author occasionally uses formulæ which are as yet far from being definitely established.

LETTERS TO THE EDITOR.

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

Identification.

PERMIT me to make in your columns a few remarks on the following topic:—

It is now well known that the Council of the British Association have lately memorialised the Secretaries of State for the Home Department, Army, Navy, India, and the Colonies, expressing an opinion that the Anthropometric methods for Identification in use in France and elsewhere, deserve serious inquiry, as to their efficiency, the cost of their maintenance, their general utility, and the propriety of introducing them, or any modification of them, into the Criminal Department of the Home Office, into the Recruiting Departments of the Army and Navy, or in the Indian and Colonial Administration.

In connection with this suggested inquiry I have some very recent information to give as regards the inclusion of finger prints among the records that admit of being usefully employed in *bertillonage.* This convenient term has been coined to express the principle of the French system, invented and directed by Alphonse Bertillon, of so classifying anthropometric records that each can be sorted into its own natural group, just as each surname falls into its alphabetical place in a common directory. There may be many Smiths, but every Smith will be found among the Smiths and not among the Browns. There may be doubt about the exact spelling, and the Smythes will have also to be searched, but the range of uncertainty as to where to look for the required name will always be narrowly limited. So it is with the ordinary anthropometric records; so also it is with finger prints, which are as yet unused in the French system. Those who have read my book on the subject will recollect that the index letters for finger prints are limited to *a*, *u*, *r*, or *w*, as the case may be, for the two forefingers, and *a*, *l*, *w*, for the remaining eight digits. These produce such combinations of ten letters as *ral*, *ull*; *wl*, *ll*, which are arranged alphabetically. The test of the efficiency of this system lies, *first* in the sureness with which different (instructed) persons assign the same index letters to the same indifferently printed set, and *secondly* in the degree to which the sets are differentiated by their classification. Now I possess and have examined some thousands of well printed sets of students and others at my laboratory; but until very recently I had no large collection of *ill*-printed sets of *prisoners.* This want has been at length supplied in the following manner, by which I am able to confirm previous conclusions. Lieut.-Col. Surgeon Hendley, whose energetic furtherance of science and art at Jeypore is well known, was in charge last year of the Maharajah's magnificent contribution to the Imperial Institute, and, having visited my laboratory, became much interested in finger prints, and promised to send me a collection taken from the gaols of Jeypore. It arrived not very many days ago, too late to be alluded to in my recently issued supplementary chapter on the Decipherment of Blurred Finger Prints. It contains nearly a thousand cards, each card bearing the impressions of all the ten digits of a different person. They were printed by pressing the finger first on the pad used for inking the office stamp and then on the card. This method, as I have recently had occasion to point out, gives far inferior results to that of printers' ink. So far as the Jeypore collection shows favourable results, a similar collection printed in the way always used in my laboratory would give still better ones.

Consequently, the Jeypore collection is particularly serviceable for arriving at moderate conclusions; moreover, their number is sufficiently large to justify them. My assistant marked the appropriate index letters on each card, and I compared them with my own independent determinations. The result was very favourable; our readings practically agreed, and although most of the prints were faint, or blurred, or otherwise imperfect, it was possible to classify nearly all of them. This affords a strong confirmation to my formerly expressed belief that the method of finger prints must, in time, come into use as an important and supplementary aid to *bertillonage.* The process of taking the impressions is extremely simple after it has been learnt and the small but necessary equipment is at hand. At the same time, there is no undressing necessary, and nothing else of a humiliating charac to be undergone during the brief act of making the prints.

I shall not here enter upon the unique and extraordina power of finger prints in enabling us to determine, irrespective of age and growth, whether two clear impressions, taken at d ferent dates, were or were not made by the same finger. does not depend on that general pattern of the print which the basis of classification, but upon the numerous forks a other details in the ridges that compose the patterns. T has been fully discussed and proved in my two books, and I ha nothing new to say, except that in my laboratory I have n upwards of 300 complete duplicate sets to work upon, the t members of each of which were taken at times separat by various intervals ranging between one and three yea These intervals are too short to be of much value, but the c lection will increase in importance as the years go by, a further repetitions of prints from the same fingers shall ha been made.

My letter is already long, so perhaps you will permit me another occasion to recur to the action of the Council of t British Association, and to indicate the character of the inform tion regarding the efficiency, cost, and utility of *bertillona* that might be gained with little trouble officially, but which almost beyond the reach of any private person to obtain.

FRANCIS GALTON.

The Publication of Physical Papers.

MR. SWINBURNE in his letter on this subject has omitt to recognise the existence of a society which is older and qui as important as the Physical Society, I mean the "Lond Mathematical Society."

For reasons which it is unnecessary to enter into, I fear th an impression has unfortunately got abroad that the Lond Mathematical Society is an institution which exists solely f the advancement of *pure* mathematics. No greater error cou be made; for whatever may have been the case in the earli days of the society, the council for some years past have be fully alive to the importance of doing everything they can encourage mathematical physics, and to induce physicist whether members of the society or not, to communicate pape on mathematical physics. In short, the policy of the counc at the present time is to endeavour to hold the balance even between the two branches of mathematics, and not to favo the one more than the other.

The policy of the society is still further exemplified by th fact that on the last two occasions the De Morgan medal h been awarded alternately to a mathematical physicist and to pure mathematician; and during the discussion which too place in connection with the last award to Prof. Klein, sever members of the council expressed a hope that this practic would be followed in future years.

A scientific newspaper like NATURE is scarcely suitable for th publication *in extenso* of papers relating to mathematic physics; but it may be well to point out that the Londo Mathematical Society presents contributors of papers wi twenty-five *gratuitous* copies, whereas the proprietors of th *Philosophical Magazine* refuse to present gratuitous copies or remunerate contributors in any way whatever. Moreover, th Proceedings of the Society can be purchased by the publi whilst (according to Mr. Swinburne) those of the Physica Society cannot. Also abstracts of papers read at the meeting of the London Mathematical Society can always, if the auth wishes it, be published in NATURE, and can thus be at onc brought before the notice of the scientific public.

It will thus be seen that the London Mathematical Societ offers greater advantages to contributors than the Physica Society or the *Philosophical Magazine;* and when this fact i once recognised I venture to hope that physicists will not stan aloof from the Society in the way that many of them hav hitherto done.

A. B. BASSET.

A Simple Rule for finding the Day of the Week corre sponding to any given Day of the Month and Year.

MR. H. W. W., in NATURE, vol. xlvii. p. 509, gives simple rule for finding the day of the week corresponding t any given date. It seems that this rule could be made stil more simple. Thus, let

A = number of the given year.
B = number of the day in the year.
C = number of leap years from A.D. 1 to the beginning o

the given year—viz. $(A-1) \div 4$, neglecting the remainder. Add these numbers together, and from the total subtract D = the number of secular years, which were ordinary years (100, 200, 300, 500, &c.). The sum is then divided by 7, and the remainder is the day of the week.

Example: June 18, 1815. $1815 + 169 + 453 - 14 = 2423 \div 7$. The remainder = 1. Therefore the day is Sunday.

This method holds good for any century according to the Gregorian Calendar. For the Julian reckoning, the rule is the same, only we must omit the number D, and write -2 in its place. The rule is then good without any change for any century.

Example: Oct. 14, 1066. $1066 + 287 + 266 - 2 = 1617 \div 7$. The remainder = 0 = 7th day, Saturday. C. BRAUN.

Mariaschein, Bohemia, June 15.

The Fundamental Axioms of Dynamics.

PROF. LODGE (NATURE, p. 174) maintains, in opposition to my correction, that your report of his recent paper on dynamical axioms was accurate in making the following statement:—"Dr. MacGregor objects to the author's definition of energy as the name given to 'work done,' and contends that this definition assumes conservation." He cites in proof the first two pages of my paper in the February number of the *Phil. Mag.* These pages, however, contain no reference to this definition, but a discussion of his definition of energy as *the effect of work done*. The definition of energy as a name given to work done is discussed on the fourth page, where the following will be found:—"In a second version of the above argument Newton's third law and contact action *are the only assumptions made . . .* The definition of energy in this argument is quite different from that of the earlier paper:—'Energy is that which a body loses when it does work; and it is to be measured as numerically equal to the work done.' There is here no reference to working-power. Loss of energy is simply a synonym for work done by, and gain of energy for work done on."

J. G. MACGREGOR.

Royal Society, Edinburgh, June 23.

Artistic Rows of Elms.

IN your Notes, p. 182, June 22, you say that "a correspondent desires to know where to find any celebrated and artistic hedgerows of elms within about thirty or forty miles of London."

If he will travel down to Sittingbourne, which is about forty-five miles by rail, and five miles less by road, from London, he can see some fine elms on the south and west bounds of the Murston Rectory Pastures, locally known as the Park.

The southern toll of elms is a triple row about 130 paces in length, the western toll of elms is on Gaze Hill, and is a double row about 212 paces in length. These elms must have been planted before this century. Being on elevated land they are well seen from considerable distances in the neighbourhood. Singularly enough they do not belong to the glebe. The southern toll, however, belongs to the patrons of the living, and the western toll to my predecessor, the Rev. J. S. Hoare, who purchased them, with the land they stand on, from the late Mr. Twopenny, of Woodstock, Tunstall. I have not yet been able to persuade the patrons of the living to purchase them from the present owner. ALEX. FREEMAN.

Murston Rectory, Sittingbourne, June 27.

Soaring of Hawk.

THE rest-house in which I now am stands close to the edge of a precipitous descent. There is a covered verandah in front, and we are nearly 9000 feet above the sea. I have just seen a hawk, or vulture hawk, circle round three times over the precipice. The whole time its wings were motionless (to the sight). Its first circle was on a level with me, the second was higher, the third was unquestionably higher still. As I sat I could see both the complete first and second circles. To see the last I should have had to go to the edge of the verandah. This appears to be a clear case of rising circles without (apparent) motion of the wings. I have seen the same thing from the plains, but have not been so sure of the fact observed. There is a light wind blowing, scarcely moving the trees.

The part of the circle near me was, in the first and second cases, within a few feet of where I sat, the third was *over* the roof of the verandah, and out of my line of sight.

Changla Gali, May 25. F. C. CONSTABLE.

Carrier Pigeons.

PROF. MAREY states in his "Animal Mechanism," p. 214, "that a bird which has traversed in a single flight a distance of fifty leagues (which it seems to do without taking any food) weighs only a few grammes less than at its departure." I shall be grateful to any of your readers who will inform me where evidence of this is to be found. The enormous amount of food consumed by birds would seem to show that the processes of loss and repair go on in their bodies with great rapidity.

F. W. HEADLEY.

Haileybury College, Hertford, June 27.

A Method of obtaining Glochidia.

THE Glochidia of Anodon are not always easy to obtain. They appear to be retained, and shed only when fish are swimming near.

Tadpoles have the same influence as fish, and a good supply of Glochida may be obtained by examining the tails of tadpoles swimming in a dish in which a few Anodons have been placed.

G. P. DARNELL-SMITH.

60, St. Michael's Hill, Bristol, June 26.

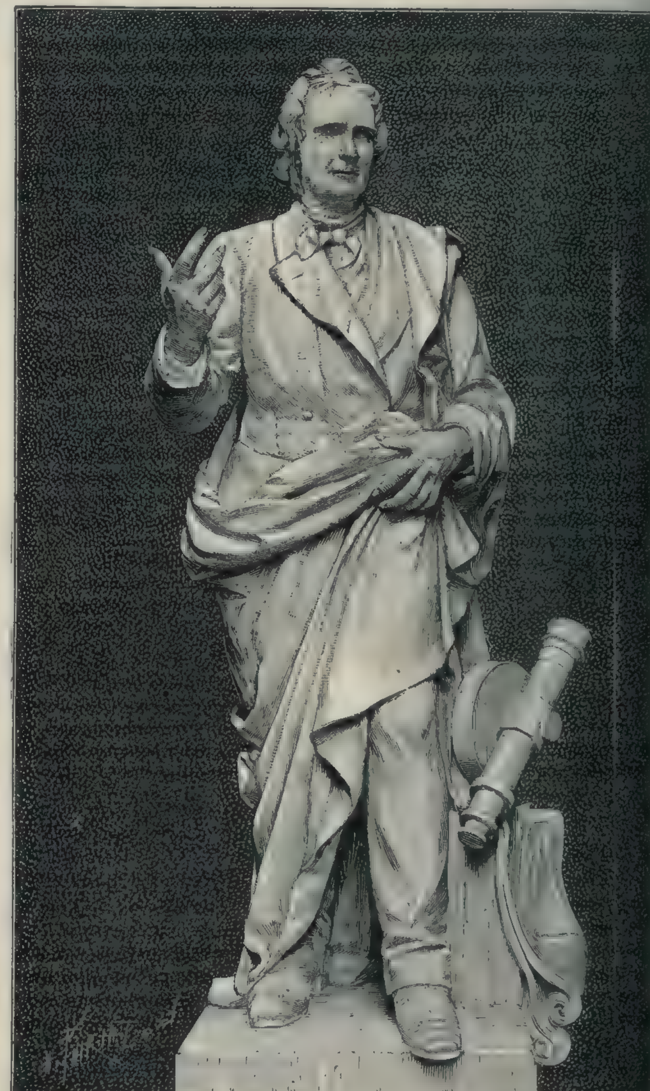
A NEW STATUE OF ARAGO.

IN this country the prevailing opinion is that the works of a man of science furnish the best monument to his memory. Though something can be said in favour of that principle, the restriction of its application to students and interpreters of nature is by no means justifiable. But a "look around" at the statues, and tablets, and other marks of public appreciation, shows that a man's greatness is, in general, not measured by his scientific labours. They do these things better in France. Those who honour a man and his works desire to proclaim his fame in the market-place, so that all may know that he was a giant among men. Passers-by are thus brought to a knowledge of deeds that they wot not of, and they see that a life devoted to science is one to be emulated. Thoughts of this kind forced themselves upon us when it was announced a few weeks ago that a statue to Arago had been unveiled in Paris.

Fourteen years ago a statue to Arago was erected at Perpignan, near his birthplace, and in 1886 it was decided to commemorate the centenary of his birth by raising the funds for erecting a statue at Paris. A committee, having the late Admiral Mouchez for its president, was then formed, and an appeal for subscriptions was made. Thanks to the contributions from the State and the Municipal Council of Paris, the necessary money was soon raised, and M. Oliva was commissioned as the sculptor. The statue has been completed for some time, and it would have been unveiled last summer but for the death of the artist, and later, of Admiral Mouchez, who was the prime mover in the matter.

The inauguration of the statue at the back of the Paris Observatory took place under M. Poincaré, Minister of Public Instruction, on June 11. Among those present were M. E. Arago, French Ambassador at Berne, and son of the renowned astronomer; M. Tisserand, the director of the Paris Observatory; M. Cornu, M. Huet, representing the Prefect of the Seine; and M. Muzet, vice-president of the Municipal Council of Paris. Each of these gentlemen dwelt in eulogistic terms on the career of Arago as a public man as well as a man of science. "Arago introduced physics into astronomy," said M. Tisserand, "and gave it a permanent place. Before him, astronomers concerned themselves chiefly with the movements of stars and members of our planetary system, seeking to explain them in their minutest details by the law of gravitation. Arago studied the nature of heavenly bodies, and the character of the phenomena continually exhibited by them. The polariscope showed him that the glaring surface of the sun is gaseous, and gave him important information as to the light of comets. Another application of physical methods furnished him with a precise means for measuring the diameters of planets or determining their magnitude. Nothing is more ingenious than his explanation of the scintillation of stars, founded upon the remarkable properties Fresnel found to be possessed by rays of light. Arago ought truly to be considered as the founder of a branch of astronomy—physical astronomy—that has since been remarkably extended, for it was he who pointed out the importance that would accrue from the application of photography to the study of celestial bodies. He was not able to foresee the day, however, when chemistry would enter into the domain of astronomy, and we should be able to discover their constitution; spectrum analysis has only been discovered, in fact, since the death of Arago."

"An example will give an idea of the perspicacity of Arago. It is generally known that about the end of last century France took the initiative of the metrical system and made it an international thing by connecting the metre with the size of the earth. But our globe is cooling and contracts, little by little, in the course of centuries, so that the unit of length is rendered liable to slight changes. Arago thought that a minute study of the light-rays that come to us from the sun and stars might furnish a rigorously constant unit of length, connected not with the earth, but with the stars—a sidereal metre of some kind. Well, this beautiful idea was realised a few months ago by Mr. Michelson, at the American Bureau of Weights and Measures." M. Tisserand also dwelt upon the influence that Arago exercised upon his pupils and the comprehensive character of his literary works. M. Cornu followed with an account of Arago's investigations in experimental physics, and after stating his work in connection with the *experimentum crucis* of the emission and wave theories of light, said, "If we come to terrestrial physics, meteorology, or industrial applications of steam and electricity, we always find Arago in the front rank with new ideas. Of an indefatigable activity, in science as in government, he was present with all the resources of his powerful spirit, with the ardour of his generous heart, especially where there was a great work to direct, a just cause to defend, a social evil to fight, and, at the call of duty, a peril to face."



The character of the statue, which is in bronze, is shown in the accompanying illustration from *La Nature.* Arago has his face turned towards the observatory. The pedestal on which the figure stands is also in bronze, and bears the simple inscription "FRANÇOIS ARAGO, 1786–1853. SOUSCRIPTION NATIONALE." Men of science throughout the world respect the name, and their French *confrères* revere it. Those who have done homage to the man by thus assisting to perpetuate his memory are themselves honoured in the act.

MODERN MYCOLOGY.[1]

It is not often that a great and industrious investigator lives to see his chief work so far completed as Prof. Brefeld has done; and still more rarely to find an enthusiastic exponent of all his views so willing and so capable of putting them before the public as Dr. von Tavel here proves himself to be.

It is hardly thirty years ago since the late Prof. de Bary of Strasburg showed that the study of the fungi, up to that time a chaos of statements in which the student usually lost himself hopelessly, was capable of being made not only a very scientific and important branch of Botany, but also a very interesting one, and that there were already workers in the field—especially the Tulasnes—who were showing how to do this, by patient and thorough investigations of each species that could be properly studied.

De Bary himself founded a school of exact inquirers,

[1] "Vergleichende Morphologie der Pilze." By Dr. F. Von Tavel (Jena: Fischer, 1892.)

whose brilliant discoveries on the nature of parasitism and the development of the fungi, and above all, the propounding and testing of intelligent theories to explain the facts observed, will never be forgotten.

Brefeld was driven, at an early period of his investigations, to differ entirely from De Bary regarding a fundamental point in the morphology of the fungi. Certain organs discovered by De Bary in the simpler ascomycetes were regarded by him as morphologically sexual organs, and in later years the doctrine of the sexuality of the fungi became a central pivot around which the whole question of the morphology and evolution of these remarkable cryptogams turned.

As is well known, De Bary showed that if his interpretation of the facts was right, we have the principal groups of the fungi ascending along one main path of development. Starting with the *Phycomycetes*, which include the mucors and the fungi of the potato-disease and vine-disease (and which are so obviously allied to certain green algæ that it was impossible to doubt that these lower fungi are derived from green algæ), the main path of evolution was traced through the lower ascomycetes, such as the fungi of the hop-disease, and the higher members of the same series—*e.g.* ergot of rye, the larch-disease, &c., and found to end in the Uredineæ or "rusts," and basidiomycetes—the mushrooms, toadstools, and puff-balls, &c.

From this main series, branches were regarded as given out at various points, as the *Chytridiaceæ*, *Ustilagineæ*—the "smuts" and "bunts" of our cereals, &c.—and so on.

De Bary pointed out very clearly that the most astonishing morphological phenomenon observable in the fungi is the gradual loss of first functional sexuality, and then of even the last traces of sexual organs, as we ascend from the lower to the higher fungi.

Brefeld—and it should be stated that the book before us is almost entirely an admirable short edition of Brefeld's ten large volumes—maintains that De Bary and his pupils were wrong in interpreting the organs of the ascomycetes in question as sexual, and that the loss of sexuality among fungi occurs much sooner than was supposed. The sexual organs, in fact, disappear within the limits of the *Phycomycetes* themselves, and De Bary's ascocarp and pollinodium lose all the significance his hypothesis assigned to them.

But De Bary's chief mistake—into which he was led by the above interpretation of his own observations—was in deriving his ascomycetous series from *the wrong branch of the Phycomycetes*. Instead of their origin being from the Peronosporeæ (*Oomycetes*) the ascomycetes are derived from the *Zygomycetes*, their line of descent passing through a group containing *Protomyces* and *Thelebolus*, and which group Brefeld terms the Hemiasci.

The oomycetes, indeed, are regarded as leading nowhere, except to the richly branched genera which compose it.

While the ascomycetes represent an enormously branched and successful series of forms which have specialized the type of the *sporangium* more and more, the basidiomycetes (in which the author includes uredineæ) have come off from another group of zygomycetes, and have specialized the *conidium* as their type of reproductive organ. The half-way group along this line is the Ustilagineæ, and Brefeld terms them Hemibasidii, accordingly.

The grounds for these revolutionary views cannot of course be explained in a review. They depend upon the numerous new facts brought to light by the untiring devotion and industry displayed in the Münster laboratory, and which are very clearly described and illustrated in the book before us.

A number of new forms have been discovered, of which the simple *Ascoidea rubescens* is an interesting example. Very instructive types, as yet unknown in text-books, are *Thelebolus*, *Pilacre*, *Tomentella*, *Tylostoma*, and some others; owing partly to the new facts brought out regarding them, and partly to the suggestiveness of the new views as to their morphology, such forms bid fair to become as well known in future hand-books as *Mucor*, *Podosphæra*, and *Agaricus*, are in those of to-day.

The generalizations regarding the comparative morphology of the reproductive organs of fungi as a whole are distinctly an advance, and show a delightful gleam of light leading to freedom from the chaos of terms the subject has laboured under: "pycnidia" and "spermogonia" disappear as such—they are merely chambers in which conidia are developed (*conidien-früchte*), the germination of numerous spermatia by Brefeld and others having established the conidial character of those mysterious particles, the spermatia.

The author's views regarding *Chlamydospores* will probably cause surprise to many who have not followed the progress of Brefeld's work during the last few years. If these views are accepted, the principal "spores" of *Protomyces*, the *Ustilagineæ*, and the *Uredineæ* are all to be interpreted as *Chlamydospores*, homologous with the resting spores of Mücor; even more startling is the discovery of such Chlamydospores (including "oidia" and "gemmæ") among the higher ascomycetes and basidiomycetes, novelties which are only equalled perhaps by the rich series of true conidial spores found in the latter group.

Zopf's work on fungi had already prepared us, in 1890, for some of the changes which these discoveries entail, but Zopf was not prepared for anything like the revolution which Von Tavel has accepted—and, indeed, so great a change of front was impossible before the publication of Brefeld's ninth and tenth volumes.

The new "comparative morphology of the fungi" certainly offers many advantages in the simplification of our views as to the nature of the spore, and promises to remove the bone of contention which this item has always offered to mycologists. We are asked now to accept the following view. There are four types of sporogenous organs in fungi:—(1) The *sexual spore*, only met with in the lower fungi (*Phycomycetes*), as the zygospore and the oospore, and gradually losing the sexual character within the group. (2) The *endospore*, formed asexually in a sporangium, and occurring as zoospores (Peronosporeæ, &c.), sporangiospores (*Mucor*, *Thelebolus*, &c.), or ascospores (all ascomycetes), the ascus being merely a sporangium of *definite* shape and size, and containing a *definite* number of endospores. (3) The *conidium*, which starts as a one-spored sporangium where *the sporangial wall and that of the contained spore fuse*, illustrated by the "yeasts" of Ustilagineæ and many ascomycetes, the "sporida" of Uredineæ, and the "conidia," "stylospores," "spermatia," &c., of Uredineæ and ascomycetes. The "*Basidium*" is merely a specialised conidiophore where *the position and number of the conidia* ("basidiospores") *are constant*, and true conidia occur in the group in addition—*e.g. Heterobasidion*, *Tomentella*, &c. Indeed, it is the play on this type leading to gradual specialisation which characterises the whole Basidiomycetous series. (4) The *Chlamydospore*, which, in the form of the type or of so-called "oidia," "gemmæ" occurs generally in all the series, and becomes specialised into "fructifications" in the *Uredineæ*.

This is perhaps a fair sketch of the central ideas of the new school, though it by no means summarizes or even mentions dozens of other interesting points brought out in the book under review, such as the remarkable evolutions of the germination—*e.g.* in *Nectria*—of the conidiophore—*e.g.* in *Peziza*—of the conidium, the basidium, the ascus, &c.

In conclusion, it may be pointed out that although Von

Tavel writes more fairly with regard to the work done by other schools, and has wisely avoided the bitter methods adopted by Brefeld towards De Bary's pupils in some of his volumes, there still seems to persist a tone of under-valuation of the work of the Strasburg school. After all, it should never be forgotten that unless De Bary and his pupils had followed up the clue—however false it may prove—of the "sexuality" of the ascomycetes, the matter would have had to be investigated, and the fact that the Münster school is enabled to explain the phenomena seen in a new sense proves how valuable De Bary's careful observations were. Moreover, however probable Brefeld's view of the origin of the ascomycetous series is—and it is now the clearest story yet put forward—many of his own facts show that the *impossibility* of De Bary's view of a sexual origin, now lost, of the ascocarp, is by no means proved. Brefeld insists that the simplest ascocarp (*e.g. Thelebolus*) may be derived by suppressing the stalk and withdrawing the sporangium of a form like *Mortierella* into the investing barren hyphæ at its base; but the *zygote* of *Mortierella* also has investing hyphæ, and it would not be going much further to suppose the sporangium of the germinated zygospore of such a form to be similarly withdrawn into the invested capsule. This "wild hypothesis" would not alter Brefeld's view as to the homology of the ascus, or the derivation of the ascomycetes from the zygomycetes, but it would, and very materially, alter the attitude adopted towards the sexual hypothesis. We have termed the suggestion "wild," but it is possibly not more so than Brefeld's own hypothesis as to the nature and evolution of the chlamydospore, and we imagine that the last word has not yet been said on either matter. However that may be, Brefeld's laurels of results are such as are won by very few investigators and Von Tavel is to be congratulated not only for his own discoveries, but also on his book, which is by far the best exposition of the subject in existence.

H. MARSHALL WARD.

DAUBRÉE ON THE GEOLOGICAL WORK OF HIGH-PRESSURE GAS.

A SERIES of experimental researches which promise to lead to important results, and which have already been applied by their author to the explanation of some difficult geological problems, have during the last few years been carried on by M. Daubrée. These experiments are concerned with the action of rapidly moving and high-pressure gas on rock masses, and lead to the conclusion that such high-pressure gas is a geological agent of no small importance. To carry out such experiments is no easy matter, but M. Daubrée has been fortunate enough to obtain the use of the apparatus used in the testing of explosives in the *Laboratoire Centrale des Poudres et Saltpêtres.* The high-pressure gas has been obtained by the explosion of gun-cotton and dynamite, the explosions being made in a steel cylinder with very thick walls, and closed at both ends with steel plugs. One of these plugs is fitted with a platinum wire, by the heating of which the charge can be exploded. The other, which under ordinary circumstances contains the manometer for measuring the force of an explosion, is modified so as to contain a block of the rock to be experimented on. A circular hole, moreover, is made at one end so that the gas, after traversing the rock, is allowed to escape. The rock, cut in the form of a cylinder, is supported between a steel stopper and the head of a piston. The charge of gun-cotton or dynamite usually filled a tenth part of the interior, and the pressures obtained were from 1100 to 1700 atmospheres. In one experiment the pressure was increased to 2300, and in another the still greater pressure of 2400 atmospheres was obtained. Many different kinds of rock were used, such as limestone, gypsum, slate, and granite, and each cylindrical block experimented on was cut through by a diametrical plane. In some of the experiments an additional very fine perforation was made along this plane.

As a result of the sudden shock of the explosions most of the rocks were fractured. In the case of the slate this resulted in faulting. The limestone and granite were broken up and crushed, but under the influence of the pressure the small fragments were quickly consolidated so as to resemble the original rock. This property of reconsolidating under pressure, thus shown to be possessed by rocks, seems analogous to the plasticity of ice observed by Tyndall.

All the rocks experimented upon, even the most tenacious, have undergone more or less erosion. The gases have disintegrated and pulverised them, and carried out the fragments. When their action was concentrated along certain lines, true perforations—that is to say, rounded channels more or less regular—were eroded through the blocks. In the case of a granite block the original perforation of 1·2 mm. was increased to a channel of 11 mm. The walls of these perforations after the explosions were found to be striated and polished. Sometimes the striations are parallel, like those produced by ice. At other times they spread in fan-form, and sometimes they are slightly curved.

The products of erosion are thrown out into the atmosphere, and an examination of the powder thus produced shows that a portion of the same possesses an interesting resemblance to the dust usually held to be of cosmic origin.

M. Daubrée applies the results of his experiments to explain the remarkable "diamond pipes" of South Africa. These diamond deposits are described by M. Mouelle in the *Annales des Mines* (tome vii. p. 193, 1885) as filling in cylindrical cavities of unknown depths in the rocks. These cavities appear to be cut out of the subjacent sedimentary or eruptive rocks, their upper parts are filled with a soft yellow decomposed rock matter, while below they contain hard volcanic conglomerate. They vary in size from a diameter of 30 to one of 450 m., and are originally surmounted by slight eminences, known as *kopyes* (little heads).

An interesting point about the general arrangement of the "pipes" is their occurrence along a straight line of 200 kilometres in length. Their walls, again, are smoothed and finely striated. These striations are often parallel, and indicate a powerful thrust from below upwards. No alteration is observable in the beds of shale forming the walls, except a slight elevation of their edges.

Thus in their general form, as long, narrow, cylindrical perforations in the earth's crust, they resemble the artificially produced perforations in the rocks experimented on. Their arrangement along a straight line suggests that they may have been opened along a line of fracture as were the perforations in the experiments. In the latter, the line of the eroded channel was determined by a very narrow perforation, and M. Daubrée suggests that in the former the positions of the "pipes" may have been determined in some cases by cross-fractures. The polishing and striation of the walls of the diamond pipes, again, is reproduced in the polishing and striation of the perforations in the experiments.

Another application of his experimental results made by M. Daubrée is to explain the opening out of the channels by which volcanic products reach the surface. Here, again, the linear arrangement of volcanoes, which has been so frequently pointed out, is noted as connecting volcanic vents with the experimental results. These are supposed to lie along lines of fracture, and each volcano is supposed to have been determined by a cross fracture, or some other cause, facilitating the passage of gas at that particular point. That there are reservoirs of gaseous pressure of great power below the surface is evident from volcanic phenomena generally, and given a line of fracture, with cross fractures, or other predisposing causes, the experiments prove that high pressure gas is capable of opening out cylindrical passages by which molten rock matter and fragments may reach the surface. In this connection, M. Daubrée points out the occurrence of volcanic craters, of which the cones are formed entirely of rock fragments, and known as "craters of explosion." Thus, near Confolens, in Velay, there is a crater excavated in the granite, and of which the cone is formed entirely of granitic fragments.

M. Daubrée further applies his experiments to explain, (1) the fracturing and crushing of rocks; (2) the transport of their debris; and (3) their apparent plasticity.

Some further results show that the high pressures of some of the earlier experiments are not essential, but that complete perforations can be obtained with pressures of 1100 atmospheres. A cylinder of granite, cut in two by a diametrical plane, and bound together with a ligature of copper, was thus excavated along its whole length by an irregular channel which opened on the surface by two branches. In the case of a cylinder of rock of which the height greatly exceeded the diameter the perforation tended to the form of two cones united by their summits. The action of the gases is not confined to the drilling of the perforations, they have likewise grooved and striated the surfaces of the divisional planes of the cylinders. These striations and groovings are not produced, as might be supposed, and as M. Daubrée himself at first believed, by solid particles of rock carried by the gas, and use as graving tools. It appears, in fact, that the gases themselves are able to striate and groove the rock on their first contact with it.

As an interesting corollary to his experiments, M. Daubrée points out, that leakage from steam pipes may in a similar way cut through metal plates. An example is quoted in which metal exposed to the escaping vapour from a steam pipe (pressure, seven atmospheres) was channelled and striated: the resulting marks were similar to those of a saw or file. A valve on a steam pipe, again, has been attacked in a similar way.

All these groovings in the metal have received a similar polish to that given by emery.

In the experiments the gases have in general caused the fusion of the surfaces which they have attacked. Thus, on the surfaces of the divisional plane of a granite cylinder the felspar is melted into white globules forming small projections. The plates of mica have also been softened. Even the quartz has not escaped, but appears pitted in a manner which recalls the erosion produced by hydrofluoric acid.

Scales of the rock are detached by the very unequal expansion as by a sort of shock.

A black crust exactly similar to the crust of meteorites has been produced with certain stones.

The transport of the debris produced in the perforation of the cylinders of rock is applied by M. Daubrée to the history of certain cosmic dusts, and the sediments existing in some of the deeper parts of the ocean. In making the perforations the gases carry out a quantity of debris. A part of this was collected on sheets of cardboard covered with vaseline. The particles arrange themselves in concentric circles on the sheet according to their size. Some of the large particles pierce the cardboard, and even its supporting plate; the very fine particles are carried to a distance by the gases, which they render opaque. In the powder retained on the cardboard, two sorts of grains can be distinguished under the microscope. The first are indistinguishable from those produced by simple mechanical pulverisation; the second have a special character intimately connected with the particular conditions of the experiment.

Thus, in the case of granite, fragments of all three constituents, quartz, felspar, and mica, are found in the powder produced. But besides this, minute, perfect or nearly perfect, spheres are found. These are opaque and black, or slightly translucent and brownish, with a glistening surface, and sometimes furnished with a very characteristic neck. They are doubtless the products of fusion.

This latter part of the powder of erosion seems identical with certain parts of the atmospheric dust, and that found in the deeper ocean, as well as in geological formations of various ages, and which have generally been looked upon as of extra-terrestrial origin. Thus the conclusion is arrived at that, while part of the so-called cosmic dust is undoubtedly of extra-terrestrial origin, the opening of volcanic and other channels in the earth's crust by high-pressure gas has also played an important part in its production.

Eruptive breccias may also have been produced by the force of high-pressure gas, as shown by the fracturing, breaking up, and reconsolidating of the rocks experimented upon.

A more remarkable fact is the passing back of the pounded and broken-up rock to its original solid state under the influence of the same gaseous pressure. Thus the fragments of the rock in the experiments were found to have moulded themselves so exactly on the containing steel apparatus as to have acquired a specular polish. The rock had, moreover, taken the impress of striations upon the steel. Limestone thus regenerated showed a schistosity concentric with the cylinder. It seems obvious, then, that the rocks of the earth's crust, having so frequently been subjected to enormous pressure, and so often folded and contorted, must in a similar way have been broken up and regenerated.

Another experiment showing the apparent plasticity of rocks is as follows:—

A cylinder of Carrara marble without a preliminary fissure, but with furrows on one of the ends and on the side, was placed in the apparatus and subjected to a pressure of 2400 atmospheres. It was afterwards found to be perforated with a channel, and moreover to be accurately moulded on the containing apparatus so as to take the impress of the concentric striations as in former experiments. The furrows were completely effaced, while the diameter of the cylinder was increased and its height diminished.

The ejection of rocky matter through the channels perforated by high-pressure gas occupies another paper. In such high-pressure gas M. Daubrée contends we have an agent capable of accounting for the facts in conformity with his experimental results. Special reference is made to certain trachytic domes—as, for example, those of the high plateau of Quito—of which the form seems to indicate that the rock matter forming them was ejected in an almost solid state. These domes, M. Daubrée supposes, crown the summits of orifices (diatremes) opened by the passage of high-pressure gas, and were themselves afterwards forced out by the same pressure. Attention is called to the remarkable uniformity in height observable in groups of volcanoes. This is explained as the result of origin from one common reservoir of pressure. The height of the volcanic cone gives a measure of this pressure. On the other hand, the hypothesis likewise explains the difference in height in different regions. Thus, in certain cases, reduction of pressure would be effected by lateral escape of gas, as happened in certain experiments in spite of the utmost care. A similar reduction of pressure may have occurred through the blocking of the channels of egress of the gas. This, too, occurred in certain of the experiments, notably when gypsum was the rock experimented on. With this rock the channel opened by the gas was quickly closed again by the rapidity with which the triturated rock resolidified. The paper concludes with a suggested application of the hypothesis to the cones and craters of the moon.

In another paper M. Daubrée returns to the subject of the flow of rocks under high pressure. With respect to this point he remarks that, in certain previous experiments, the rock not only accurately moulded itself to the apparatus, but also formed thimble-shaped protuberances outside it. Further experiments were conducted with round plates placed one upon another, instead of the former cylinders. Lead plates were first experimented on, and then these along with plates of rock. One of the most interesting results obtained was the production of little "eruptive cones" of lead or rock outside the apparatus. In one case the protuberance reached the height of 36 mm. After the experiments, some of the plates were found outside the apparatus in the form of circular capsules, so closely fitted into one another as to appear soldered. Some of the lead plates remaining in the apparatus were cut through in their central parts as with a punch. The thickness of these perforated plates was found to be diminished on their borders, and increased in their central portions. This effect may be compared to what occurs in many cases with contorted rocks. At the same time spaces were here and there formed between the plates thus united. Daubrée draws attention to the analogy between these spaces and those occurring between separate strata among contorted rocks, and which are often filled with metallic substances. Lamination was also produced in the plates of rock.

As a general designation for the accumulations of rocky matter crowning the summits of all perforations in the earth's crust opened by gaseous pressure, whether trachytic domes, lava flows, scoriæ cones, or the kopyes of South Africa, M Daubrée proposes the term "ecphysema" (French, *ecphysème*," Gr., ἐκφυσημα).

To sum up M. Daubrée's results:—

(1) High pressure gases from below are able to open out channels in the earth's crust, by means of which the same pressure can bring to the surface various products.

(2) In forming such channels the gases may striate and polish the walls of the perforations in a manner recalling that of glacial action.

(3) The products of such erosions are partly of the nature of fine dust, which may be carried to immense distances, and a part of which resembles exactly the so-called cosmic dust.

(4) That the same high-pressure gas can fracture, break up, and pound a rock, and afterwards resolidify the same. That in thus resolidifying, the broken-up rock may mould itself accurately on the bounding walls of its enclosure, so as to take their polish and the impress of the striations upon them. And, further, that portions may be thrust outside the apparatus in the form of protuberances of the nature of "eruptive cones." And thus it may be conceived that, by the force of high-pressure gas from below, rocks may be broken up and reconsolidated *in situ* to form breccias of diverse natures.

Some further applications of the experiments may be suggested.

Thus they may perhaps explain the origin of those remarkable natural pits of Hainaut, which have given rise to much discussion. In their general structure these pits are analogous to the diamond pipes of South Africa. Like them they are more or less circular perforations in the rocks, of unknown depth, and filled with rock debris. Since none of the explanations hitherto applied to them seem satisfactory, perforation by high pressure gas may be tried.

Again, in certain of the experiments the faces of the fissures in the cylinders of rock were found to be polished and striated. The polishing and striation of rock surfaces in connection with faults is known as slickensides, and ascribed to the movement of one surface over the other. M. Daubrée's results indicate the possibility that certain slickensided surfaces may rather be due to the energetic action of high pressure gas. In any case it is perhaps a little difficult to understand how a *single* movement of one rock surface over another—if we suppose a fault produced by a continued movement in one direction—could produce anything like a perfect polish. And it cannot be denied that the above experimental result shows the possibility of another cause.

And further, if we accept M. Daubrée's interpretation of his results, we arrive at the remarkable conclusion that gaseous bodies, given sufficiently high pressure and rapid motion, can polish and striate in a way generally supposed to be confined to solid bodies. This, indeed, is in conformity with the general results of advanced physical research which tends to show that, under sufficient pressure, hard and solid bodies can be made to act as liquids, while soft and even gaseous bodies, if endowed with sufficient force and speed, act like solids.

If, then, a gaseous body, under certain conditions of speed and pressure, can polish and striate a rock without the intervention of solid particles, is it not possible that ice, given certain conditions of speed and pressure, may likewise striate and polish without the graving tools usually considered necessary? The conception of an ice-sheet, or glacier, moving over the rock surface of the country with a series of pebbles and boulders firmly frozen into its lower surface is difficult to reconcile with the physics of ice masses in motion. Hence it seems worth while to make a trial application of the experimental results in this direction likewise. Even if we do not accept M. Daubrée's view that the striation of the rock surface was accomplished by the gas alone, and hold that the intervention of solid particles was required, there is still a possible application to glacial action. For if solid particles simply carried along by a rapidly-moving gas can produce parallel striations, may not particles simply carried along by the ice do likewise without being held firmly frozen into its mass? On either view, in fact, a difficulty in the conception of how a glacier striates and polishes is removed.

NOTES.

The professors of the University of Melbourne have interviewed the Premier on the subject of the decrease in the grant to that institution. They said that there was no possibility of reducing the present staff, as it was not overmanned. Many of their number had come to the colony under special contract with the authorities of the university, and it would be a serious matter if faith were broken with them by insisting on a reduction in their salaries. Mr. Patterson replied that these were times of retrenchment, and it was right that everybody should contribute something to pull the country out of its difficulty. It appeared, however, that the University had been cut down £5000 last year, and it was further proposed to reduce the expenditure on the institution by £3000. He reiterated generally the statement made by the Minister of Education on the subject of retrenchment, but he promised to hold a consultation with Mr. Campbell, with the view of ascertaining if anything could be done in the matter. He thought it possible that Mr. Campbell, on taking a review of the special circumstances of their case, might see his way to some abatement of the rigorous course which had been proposed.

A meeting of the Executive Committee of the Rothamsted Jubilee Fund was held on Monday, the Earl of Clarendon in the chair. On the motion of the Chairman, the Duke of Devonshire, as the incoming President of the Royal Agricultural Society of England, was added to the Committee. Sir John

Evans (hon. treasurer) reported that the fund now amounted to £572 13*s.*, that the granite memorial proposed to be set up in front of the Laboratory at Rothamsted was nearly ready, and that the portrait of Sir John Lawes, by Mr. Hubert Herkomer, was in progress. It was decided to request the Minister for Agriculture to preside at the dedication of the memorial and the presentation of addresses to Sir John Lawes and Dr. Gilbert by various learned societies, on Saturday, the 29th inst., at 3 p.m. It was also decided that the fund should not be closed until after the presentation, and subscriptions (not exceeding two guineas) will be received until further notice by Mr. Ernest Clarke, hon. secretary, at 12, Hanover Square.

THE next meeting of the Australasian Association for the Advancement of Science will commence in Adelaide, South Australia, on September 25, 1893, under the presidency of Prof. Ralph Tate, of the University of Adelaide. The Association has been in existence since 1888, and now numbers over 900 members. The four previous meetings, held at Sydney, Melbourne, Christchurch, and Hobart, under the presidencies respectively of Mr. Russell, Baron von Mueller, Sir James Hector, and Sir Robert Hamilton, K.C.B., have been very successful. It is hoped that some visitors from the old country may be induced to attend the coming meeting, where they may count upon a cordial welcome. The time fixed is eminently suitable for visitors; and in previous years the Colonial Governments and the local steamship companies have granted substantial reductions of fares to members of the Association, and it is anticipated that the same privileges will be continued on the present occasion. We may add that at the request of the local secretaries, two former members of the Adelaide University, Prof. T. Hudson Beare, of University College, London, and Prof. Horace Lamb, of the Owens College, Manchester, have underaken to answer inquiries, and to give all information in their power to intending visitors.

DR. ARCHIBALD SANDEMANN, who at one time was Professor of Mathematics at Owens College, Manchester, died at Perth a few days ago. He was seventy-one years of age.

AT a special general meeting of the Geological Society, on June 21, it was decided to have an index prepared to the first fifty volumes of the Quarterly Journal, at an expenditure not exceeding £450. If possible, the index will be issued early in 1895, in two numbers in paper covers, uniform with the Quarterly Journal, and as a supplement to volume fifty.

AT the first meeting of the recently elected Council of the Institution of Civil Engineers the following reappointments were made:—Mr. Hugh Lindsay Antrobus as Treasurer, Dr. William Pole, F.R.S., as Honorary Secretary, and Mr. James Forrest as the Secretary. The Council consists of Mr. Giles, President; Sir Robert Rawlinson, K.C.B., Sir B. Baker, K.C.M.G., F.R.S., Sir Jas. N. Douglass, F.R.S., and Mr. J. Wolfe Barry, Vice-Presidents; Dr. William Anderson, F.R.S., Mr. Alex. R. Binnie, Sir Douglas Fox, Sir Charles Hartley, K.C.M.G., Mr. J. C. Hawkshaw, Mr. Charles Hawksley, Prof. Alex. B. W. Kennedy, F.R.S., Sir Bradford Leslie, K.C.I.E., Mr. James Mansergh, Sir Guilford L. Molesworth, K.C.I.E., Mr. W. H. Preece, F.R.S., Sir Edward James Reed, K.C.B., F.R.S., M.P., Mr. William Shelford, Mr. F. W. Webb, and Mr. W. H. White, C.B., F.R.S.

A MEETING of the Yorkshire Naturalists' Union will be held at Kirkwood, Moorside, on Monday, July 10, for the investigation of the neighbourhood of Donthwaite Dale, Sleightholme Dale, and Kirkdale.

THE curator of the Maidstone Museum has printed and is circulating an Exchange List of duplicate lepidopterous insects contained in the museum. It embraces the Rhopalocera only, and upwards of 5000 specimens are available for distribution. Copies of the Exchange List can be had on application. The housing and proper supervision of duplicate natural history specimens has become in many museums a serious tax upon the ingenuity and time of the curators, and it would seem very desirable that exchange lists should become more general than is the case at present. Their value would be greatly increased, moreover, if for this purpose a uniform system of nomenclature were adopted.

TWO prizes of $150 and $75 respectively will be awarded by the Anthropological Society of Washington at the end of this year for the best essays on the elements that go to make up the most useful citizen of the United States, regardless of occupation. The prizes are open to competitors of all nationalities. While it is not proposed by the Society to limit the scope of the discussion, and while each essay will be considered on its merits by the Commissioners of Award, it is suggested, in view of the character of the Society and the wishes of the donor of the prize fund, that the treatment be scientific, and that the potential citizen be considered (1) from the point of view of anthropology in general, including heredity, anthropometry, viability, physiological psychology, &c.; (2) from the point of view of personal characteristics and habits, such as care of the body, mental traits, manual skill, sense training and specialisation, and all-round manhood; and (3) from the ethical point of view, including self-control, humanity, domesticity, charity, prudence, energy, *esprit de corps*, patriotism, &c. Essays submitted in competition for the prizes should be delivered not later than November 1, 1893, to the Secretary of the Board of Managers of the Society, Mr. Weston Flint, No. 1101 K Street, N.W., Washington, D.C., to whom all correspondence relating to the prizes should be addressed.

WE are requested by the Imperial and Royal Austro-Hungarian Consulate-General to call attention to the charitable foundation instituted by the Sisters Froehlich at Vienna, for making pecuniary grants to persons who have distinguished themselves in art, science, or literature. The grants are made irrespective of nationality, provided that the applicants are resident in Austria. Further information can be obtained at the Imperial and Royal Austro-Hungarian Embassy, 18 Belgrave Square, S.W.

A CORRESPONDENT, writing to the *Pioneer Mail*, says that Murree was visited by a terrific hailstorm on May 28. The hailstones are described as being fully the size of racket balls, and they bounded from the ground to a height of four or five feet. They did a large amount of damage to trees and flowers, and strewed the neighbourhood with small branches and leaves. Numerous panes of glass were broken, and the ground was covered with hail to a depth of between two and three inches.

IN the *Repertorium für Meteorologie* (vol. xvi.) A. Schoenrock describes a remarkable oscillation of temperature at St. Petersburg and neighbourhood on February 11 last. On the 10th the thermometer rose all day, the readings being $-12^\circ{\cdot}1$ F. at 7 a.m., $-0^\circ{\cdot}4$ at 1 p.m., $23^\circ{\cdot}4$ at 9 p.m., and at about 3.45 a.m. of the 11th, $28^\circ{\cdot}4$. At this time the thermometer began to fall very rapidly, the decrease being no less than 23° in the course of a quarter of an hour, and by 7 a.m. it had fallen to $2^\circ{\cdot}6$. The wind, which had been southerly on the morning of the 10th, suddenly changed to east-north-east on the morning of the 11th, the force being light on both days. The phenomenon was to a less extent observed at other stations around St. Petersburg; to the eastward it did not reach beyond Ssermaxa, but the westerly limit could not be determined for want of stations.

A USEFUL discussion of the normal distribution of the rainfall in the Madras Presidency, based on the records of twenty years (1870-89), has been published by C. Benson, Deputy Director of the Department of Land Records and Agriculture. The year has been divided into four periods:—(1) the hot weather, April and May; (2) the south-west monsoon, June to September; (3) the north-east monsoon, October to December; and (4) the dry weather, January to March. And the Presidency has been divided into sixty-four tracts, or groups of stations, lying in physico-geographical areas which showed, on inspection of the records, the greatest similarities. The results of the annual distribution of rainfall, from which we take a few extracts, shows that this selection of areas is correct in principle, and that any general average for the whole Presidency would be, as the author states, misleading in the extreme. Over the greater part of the Presidency the heaviest rainfall is brought by the south-west monsoon; the north-east monsoon only brings any considerable amount along the Coromandel coast. Over the whole of south Canara and in the northern part of the Wynaad the annual fall exceeds 125 inches, and in a portion of the former it amounts to nearly 180 inches. On the coast of Malabar it amounts to from 108 to 117 inches, while further inland, in the same district, it is only about 75 inches. Besides the above localities, it is only on the western slopes of the Nilgiris, where the annual fall amounts to rather over 90 inches, that it anywhere exceeds 70 inches. In a few other localities the rainfall exceeds 50 inches, while it is only over a comparatively small portion of the Presidency that the annual fall amounts to 40 inches, and over a very large section of it it does not reach 30 inches. The dryest section of the Presidency lies in the Bellary and Anantapur districts to the north of Mysore, where the average rainfall does not reach 21 inches.

THERE is perhaps no micro-organism which has been so exhaustively studied as regards its behaviour in water as the *Bacillus anthracis*. The list of memoirs on this subject has moreover been lately increased by the elaborate report just issued to the Water Research Committee of the Royal Society, entitled, "The Vitality and Virulence of *B. anthracis* in Potable Waters," by Percy Frankland and M. Ward. Additional interest and importance must however now be attached to these researches, inasmuch as quite recently this organism has been actually discovered in the mud at the bottom of a well ("Bactéries charbonneuses dans la vase du fond d'un puits," by Diatroptoff, *Annales de l'Institut Pasteur*, March, 1893). An epidemic of splenic fever broke out amongst some sheep on a farm in the South of Russia. Thinking that the disease might be connected with the use of a particular well water, the latter was bacteriologically examined. Diatroptoff was unable to discover the anthrax bacillus in the water, but an investigation of the *mud* at the bottom of the suspected well revealed the presence of an organism, which on inoculation into animals was proved beyond doubt to be the *B. anthracis*. On the well being closed no further cases of anthrax occurred. That the germs of anthrax had in some manner gained access to the well is certain, and opens up the possibility of the communication of this disease by means of drinking water. Moreover the likelihood of such contamination taking place through the drainage from soil, points to the desirability of destroying the carcases of infected animals by cremation rather than by burial.

ACCORDING to Faraday's electrolytic law we ought to obtain the same amount of metal deposited on the anode, for a given current, whatever the composition of the electrodes. However, Dr. Oettel (*Chemiker Zeitung*) finds that with platinum electrodes the deposit of copper is only from 74 to 89 per cent. of that obtained with copper electrodes, the density of the current being 0·13 ampères per square decimetre, and no free hydrogen being liberated. The cause of this divergence is the formation at the anode of persulphuric acid and of hydrogen dioxide, which diffuse in the liquid, and reaching the cathode become reduced, causing a diminution in the quantity of metal deposited. The addition of an easily oxydised body, such as formic acid, annuls the action of these secondary products, and increases the quantity of copper deposited to 98·7–99·6 per cent. of the theoretical quantity. Alcohol is still more efficacious, 99·9 per cent. being obtained.

DR. OETTEL has also investigated the divergences observed in the weight of the deposit in the copper voltameter when an acid solution is employed. The divergences are of such a magnitude that it has been generally recommended to use a perfectly neutral solution, although the resistance is in this case much higher. The author, however, finds that, with a current density less than 0·3 ampères per square decimetre, the neutral solution gives too heavy a deposit. When an acid solution to which alcohol has been added is used, the results agree with those obtained with the silver voltameter. The best results are obtained with a solution consisting of 15 grms. of copper sulphate, 5 grms. of sulphuric acid, and 5 grms. of alcohol mixed with 100 grms. of water, the current density being between 0·06 and 1·5 ampères per square decimetre.

A LETTER from Sir David Salomons appears in the *Electrician* in which he says that when trying some of the experiments shown at the Royal Society *soirée* by Mr. Pike and himself he found that the attraction between two vacuum tubes far exceeded what theory would expect, if due only to static effects, or to the mutual action of one current upon another. Further experiments (though not yet completed) have shown that:—(1) Two vacuum tubes attract one another strongly. (2) The attraction is almost, if not quite, the same, whether they touch one another along the whole length or only at their ends, one of the tubes being dumb-bell shaped. (3) A spiral vacuum tube sucks in a "core" tube like a solenoid does an iron core, and the more the "core" is drawn in the less luminous the "core" tube appears. The core tube in this experiment was not connected to the circuit. (4) When the tubes are placed end on they attract one another and stick together; no repulsion takes place, which would occur if the effect were of a static nature.

MM. SORET AND GUYE have made an investigation to determine the rotatory power of quartz at low temperatures (*Archives des Sciences Physiques et Naturelles*, Geneva, March 15). During the observations, the specimen of quartz was immersed in alcohol, and the temperature of the liquid was determined by noticing the variation in the resistance of a platinum wire, the readings being compared with those given by an air thermometer. The instruments of research were arranged along an optical bench and the order was first a light source, then one of Cornu's polarising prisms. After the collimator came the bath containing the quartz. A Foucault's analyser followed, and last of all was a direct vision spectroscope minus the collimator. The source of light was a vertical sparking-tube having platinum electrodes arranged at the surface of a solution of bromide of sodium. From the experiments it appears that Joubert's formula (*Jour. de Phys.* 1879, viii. 1) represents approximately the rotatory power of quartz for sodium light down to a temperature of about − 70°.

CONSIDERABLE importance can at present be attached to a study of the properties of solutions of salts in different solvents, for such solutions appear to be the most likely to afford evidence as to the validity of the hypothesis of electrolytic dissociation. From measurements on the magnetic rotatory polarisation of solutions of salts in water, alcohol, pyridine, amyl alcohol, and acetone, Herr Schönrock (*Zeitschrift für physikalische Chemie*, xi. 6, 753) concludes that the specific rotation of a salt is independent of the concentration, and of the nature of the solvent, and that there is therefore no evidence of effects which might be attributed to electrolytic dissociation. Dr. Perkin pointed out in 1889 that the molecular rotation of chlorhydric acid calculated from the behaviour of a solution in water was twice as great as the value deduced from a solution in amyl oxide. This result has been employed by the upholders of the "new" theory of solutions as clearly indicating the effect of electrolytic dissociation. Herr Schönrock finds, however, that chlorhydric acid reacts chemically with amyl oxide, and that if allowance be made for this reaction, chlorhydric acid exerts the same effect on polarised light when dissolved in amyl oxide as when dissolved in water. In the same communication values are given for the specific and molecular rotations of some fatty and aromatic hydrocarbons, fatty alcohols, &c., and relations are established between the magnitudes of these constants which are similar to those discovered by Dr. Perkin. The rotations of solutions of double salts are also treated in the paper.

AT a recent meeting of the Berlin Society of Naturalists, Herr Ascherson spoke on the metallic-looking deposit often found on the teeth of ruminating animals in Southern Europe and the East. Hertwig described a silver-like crust on the back teeth of a goat in Xante, as composed of fine lamellæ, and of calcium-carbonate with some iron. In most cases, however, the coating is rather of a gold, bronze, or brass colour, and the yellow pigment is probably of organic origin. It is more common to meet with the deposit on the molars of wild ruminants (especially antelopes) than on those of domesticated animals. Natives of the Mediterranean region say the gold colour is due to eating a mysterious, light-giving plant, very difficult to find, but much desired, as it changes all that it touches to gold, or indicates gold in the ground, or can be used for gold-making. Various plants have been specified as the source of the deposit, one being the Lebanon poppy, the ground leaves of which have a remarkable golden look, very similar to that of goats' teeth, so that a causal relation between the two has seemed natural. Dried remains of the plant, too, have a bright metallic lustre. An examination by Herr Graebner shows the gold colour to have its seat in the moderately thickened cell membranes of the tissues concerned; but the shining look apparently comes from a thick deposit of wax on the epidermis. The teeth of certain fossil ruminants have been found with similar incrustations, *e.g.* molars of Samotherium from the miocene of Mitylene in Samos.

AT the bottom of the valley of St. Martin, near Millau (Aveyron), the Boundoulaou grotto pierces the calcareous rocks of a promontory of the Larzac. There are four entrances on the face of the cliff; the most practicable lies on the western flank at a height of 535 m., and may be reached with the help of a ladder 14 m. long. It was explored last autumn by M. E. A. Martel, who, in conjunction with M. Émile Rivière, describes his finds in the *Comptes Rendus*. It was found to consist of three galleries, one above the other, the lowest of which contained a lake which fed two perennial springs emerging at a point lower down. This lake was explored with great difficulty in a canvas boat under a vault hardly 1 m. high. In the middle of the cave was found a kind of dome 25 m. high and wide, evidently hollowed out by water. In the upper gallery, 15 m. above the level of the lake, the explorers encountered a neolithic bone deposit containing a large fragment of pottery, a well-made cylinder of bone, and seven human skeletons. Three of these were arranged side by side under a sort of shed of rocks, with their heads touching each other. It seemed as if these persons had been surprised and drowned by a sudden flood of the lake below. One of the skulls is that of a young male adult remarkable for the thickness of the cranial bones and for the want of complexity in the sutures. The second complete skull belongs to a subject not completely grown up, and probably of the female sex. Besides these skulls many other human remains were found, including six mandibles, seven humeri and one cubitus, three femurs and five tibias, and one left ilium, amounting in all to traces of seven skeletons. Speaking generally, the type resembles that of the Caverne de l'Homme Mort (Aveyron). An interesting relic also found was a bone cylinder made of the diaphysis of a human femur, and probably representing an amulet or a trophy of war.

A BIOLOGICAL station has been recently started on Heligoland. According to the recent report of the director, Herr Heinke, it contains, with other rooms, six workrooms with excellent light, one for the director, two for the assistants, a fourth for Dr. Kuckuck (who is engaged on the marine flora of the island), while the two others are for "ambulant" naturalists. The conditions of occupation of these will soon be published. The cellar space is being arranged for aquaria. Several boats with dredging and fishing apparatus are at the disposal of the inmates. One of these is a launch with petroleum motor; it has a small cabin, with cooking-stove, &c., so that the whole day can be spent comfortably on the sea. In the summer months arrangements will be made for excursions of several days. A few months' researches on the fauna and flora round Heligoland have revealed a greater richness in these than had been supposed. New forms, not before observed in the German North Sea, have come to light almost daily. The ichthyologist finds Heligoland a rich field; and interesting studies can be prosecuted on the larval forms of crustacea, on mimicry and protective colours in marine animals, and their relations to marine plants, &c.

MR. THOMAS E. BEAN contributes to the *Entomologist* for July the results of a fairly extensive breeding of *Colias christina* and *C. elis*, undertaken with a view of determining whether more male or female butterflies are produced. From seventeen separate broods of *C. christina*, 116 males and 143 females were raised, and nine broods of *C. elis* gave 32 males and 69 females. All the families were subjected to uniform treatment and condition, hence the results show that some cause or causes control the development of sex entirely apart from the influence of variations in nutrition. The sex proportions do not seem to be determined by the seasonal stage at which the eggs are laid, and Mr. Bean thinks that in some cases at least sex is dependent upon antecedent causes, the influence of external conditions not applying.

A NUMBER of special articles contributed to the *Hampshire Observer*, by the Rev. R. H. Clutterbuck, on the Whites of Selborne, Fyfield, and Abbots Ann, will shortly be published at the office of the journal, Winchester.

MESSRS. DULAU AND CO. have just issued parts xxiii. to xxvii. of their catalogue of zoological and palæontological works. They include works on general Entomology, Coleoptera, Diptera, Hemiptera, and Hymenoptera.

MR. JAMES BRITTEN and Prof. G. S. Boulger have reprinted from the *Journal of Botany* their "Biographical Index of British and Irish Botanists." It is largely rewritten, and completed down to the end of 1892, giving the names and other information respecting all British (and Irish *sic*) botanists known to the editors who had died before that time. It contains 1825 names.

THE Ealing Microscopical and Natural History Society has issued its sixteenth annual report. In it are given abstracts of lectures delivered at meetings of the Society during 1892, and some notes on the local forms of *Helix memoralis* and *hortensis*, prepared by Mr. A. Belt. There are few societies in the environs of London that are able to publish such satisfactory reports of their proceedings.

IT is only in a very narrow and restricted sense that statistical information gained by the ordinary census can be accepted as an indication of the educational status of a country. However, an attempt was made to obtain some figures under this head during the census of the colony of Tasmania in 1891. The standards taken was the ability to read and write, to read only, and to be able to do neither. The tabulation of the results of the inquisition shows that the percentage of persons who said they could read and write reached a maximum of 95·04 between the ages of fifteen and twenty, and then decreased gradually to 55·68 for persons of eighty-five years of age and over. Of all the persons whose respective ages were not less than fourteen, 88·77 per cent. could read and write, 3·50 per cent. could read, and 7·73 per cent. avowedly lacked the qualifications for either of those classes.

MR. S. COTTERELL has compiled a little handbook to various publications, documents, and charts connected with the rise and development of the railway system of Great Britain and Ireland. The book is published by Mr. Edward Baker, John Bright Street, Birmingham. It is a compact little bibliography of railway matters, and deserves to be issued in a much better form than it is at present.

Two papers are contributed to the current journals upon the hitherto unisolated tetrachloride of lead. The earlier of the two, by Prof. Classen and Herr Zahorsky of the Aachen laboratory, is communicated to the *Zeitschrift für Anorganische Chemie*. During the course of an interesting series of experiments with liquid chlorine, it was observed that the liquid was entirely without action upon pure lead dichloride, $PbCl_2$, but that in presence of concentrated hydrochloric acid a solution of tetrachloride of lead was produced. Twenty-five grams of lead chloride were placed in two hundred cubic centimetres of fuming hydrochloric acid, and the mixture cooled by means of ice and salt. Liquid chlorine was then added and the vessel closed. After two days the lead dichloride had all disappeared and a homogeneous yellow liquid remained, consisting of a solution of lead tetrachloride in hydrochloric acid. All attempts to isolate the tetrachloride were unavailing, but upon adding ammonium chloride a double salt of the composition $2PbCl_4.5NH_4Cl$ crystallised out. This salt, containing tetrachloride of lead, forms yellow crystals which are quite permanent in closed vessels and withstand a temperature of 100° without change. The crystals are decomposed by water. If only a small quantity of water is added the dichloride separates and a solution of hypochlorous acid is formed. If much water is added a clear brown solution is produced which probably contains plumbic acid, $Pb(OH)_4$; this solution rapidly decomposes with separation of lead dioxide, PbO_2.

THE second paper, by Prof. Friedrich, of Graz, is contributed to the *Berichte*. Prof. Friedrich has succeeded in isolating the pure tetrachloride itself, $PbCl_4$. A solution in hydrochloric acid was first obtained by the action of chlorine gas on lead dichloride suspended in hydrochloric acid. From this the double salt with ammonium chloride was prepared by the addition of sal-ammonia to the liquid product. According to Prof. Friedrich, the composition of this salt is represented by the formula $PbCl_4.2NH_4Cl$. It was obtained in well-defined combinations of the octahedron and cube, and would appear to be isomorphous with the corresponding tin salt, $(NH_4)_2SnCl_6$, the well-known *pink salt* which was formerly so largely used as a mordant for madder dyes. When this double salt containing tetrachloride of lead is placed in strongly cooled oil of vitriol a somewhat energetic reaction occurs, the chloride of ammonium being decomposed with evolution of hydrochloric acid gas. But, strange to say, the tetrachloride of lead is not attacked by concentrated sulphuric acid, and it separates in yellow drops, which finally coalesce to form a heavy yellow liquid, which sinks to the bottom of the vessel. This may be purified by repeated agitation with oil of vitriol, and is eventually obtained after separation as a clear, yellow, very highly refractive, heavy but mobile liquid, which yields numbers upon analysis agreeing with the formula $PbCl_4$, fumes in contact with moist air, and decomposes slowly with separation of lead dichloride and escape of chlorine gas. Upon warming it suddenly decomposes with explosion, the dichloride of lead being produced in the form of a cloud tinted somewhat yellow by the free chlorine. Its specific gravity at 0° is 3·18. At − 15° it solidifies to a mass of yellow crystals. With a little cold water it forms a hydrate, probably $Pb(OH)_4$, which readily decomposes, and with excess of water it yields a precipitate of peroxide of lead PbO_2. When added to a little very cold concentrated hydrochloric acid a crystalline compound, probably of the composition $PbCl_4.2HCl$, is formed. When mixed with oil of vitriol and warmed in a current of hydrochloric acid gas the liquid may be partially distilled. As soon, however, as temperature reaches about 105° explosion occurs, as described above. In this respect, also, lead tetrachloride resembles tetrachloride of tin, which may be distilled without decomposition from a mixture with sulphuric acid.

NOTES from the Marine Biological Station, Plymouth.—Recent captures include large swarms of Salps, the nurses and young chains of *Thalia democratica-mucronata*. From the 15th to the 25th they were very common and in good condition; after the 25th they became reduced in number, and were much injured by the storm which occurred last week. In addition to the above there were observed numbers of *Obelia* and *Thaumantias* medusæ; and from time to time Echinoderm, Annelid, and Müller's larvæ, as well as *Cyphonautes* and the *Eudoxia* larva of *Muggiæa*. The Mollusc *Nassa incrassata* is now breeding.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*, ♂) from India, presented by Mr. W. Henegan; a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mr. J. H. Brown; three Common Marmosets (*Hapale jacchus*) from Brazil, presented by Mr. Hope Gibson; a Brown Bear (*Ursus arctos*, ♀) European, presented by Mr. F. Collier, F.Z.S.; two Wild Swine (*Sus scrofa*, ♂ ♀) from North Africa, presented by Mr. Jasper A. Mathews; a Purple Heron (*Ardea purpurea*) British, presented by Mr. R. Heywood; a Leadbeater's Cockatoo (*Cacatua leadbeateri*) from Australia, presented by Mrs. Anna Margaret Hills; a Guilding's Amazon (*Chrysotis guildingi*) from St. Vincent, W.I., two Tree Boas (*Corallus hortulanus*) from Grenada, W.I., presented by the Hon. Sir Walter Hely-Hutchinson, K.C.M.G.; a Brazilian Cariama (*Cariama cristata*), a Barn Owl (*Strix flammea*), a King Vulture (*Gypagus papa*), a —— Buzzard (*Buteo* sp. inc.) from Brazil, presented by Mr. Howard C. Wolfe; an Illiger's Macaw (*Ara maracana*), two yellow-headed Conures (*Conurus jendaya*) from Brazil, two Rufescent Teguexins (*Tupinambis rufescens*) from Mendoza, deposited; six European Beavers (*Castor* ——) from the river Rhone, France, eight Garganey Teal (*Querquedula circia*), six Common Teal (*Querquedula crecea*) European, purchased; a Thar (*Capra jemlaica*, ♂), two Black-headed Gulls (*Larus ridibundus*) bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET FINLAY (1886 VII.).—M. Schulhof, in the current number of the *Astr. Nach.* (3171) gives the new elements and ephemeris of Comet Finlay. They are as follows :—

$$
\begin{array}{rcl}
M & = & 6^\circ\ 58'\ 5''{\cdot}33 \\
\pi & = & 7\ 41\ 34{\cdot}1 \\
\Omega & = & 52\ 27\ 42{\cdot}7 \\
i & = & 3\ \ 2\ \ 2{\cdot}1 \\
\phi & = & 46\ \ 0\ 49{\cdot}4 \\
\mu & = & 535{\cdot}8046 \\
\log.\ a & = & 0{\cdot}5473335
\end{array}
\left.\begin{array}{l} \\ \\ \\ \end{array}\right\} 1893{\cdot}0 \ (\pi, \Omega, i)
$$

12h. M.T. Paris.

1893		R.A. app.		Decl. app.
		h. m. s.		° ' "
July 6	...	3 26 58·9	...	+16 49 2·9
7	...	31 39·4	...	17 8 33·7
8	...	36 19·1	...	17 27 33·1
9	...	40 57·9	...	17 46 1·0
10	...	45 35·9	...	18 3 57·1
11	...	50 12·9	...	18 21 21·3
12	...	54 48·9	...	18 38 13·1
13	...	3 59 23·8	...	18 54 32·8

A BRIGHT COMET?—In a note under this heading which appeared in these columns on June 22, we gave an interpretation of a telegram from Kiel to one of the German Observatories. The message ran: "From Boston probably bright comet photograph, Lewis, 5 June, 09571 ; Boston 26423, 07558, 43552 ; 12 June, 10043 ; Boston 27119, 06904, 44066. Verbatim ventilate unpliable."

Unfortunately, after having translated the code on a separate sheet of paper, we set down the Boston times as the right ascensions, an error often liable to occur when one is used to reading right ascensions in hours, minutes, and seconds, and not in degrees of arc.

This telegram was distributed only to a few observatories in order to substantiate the discovery, or otherwise, before the announcement was openly made, and it was in the endeavour to present our readers with this piece of news as early as possible that this clerical error was made.

STARS WITH REMARKABLE SPECTRA.—In *Astronomische Nachrichten*, No. 3171, Mr. T. E. Espin continues his list of stars with remarkable spectra (*Astr. Nach.* 3090), the number amounting now to 736. The places are all brought up approximately to 1900.

THE PERIOD OF ROTATION OF VENUS.—It was hoped that the pure telescopic observations of the surface of Venus would settle the question of the period of rotation, but the results show that we are not yet in possession of the absolute value as can be gathered from a comparison of Schiaparelli's work with Trouvelot's, and Löschardt's and Wislicenus determinations. A method, apparently not yet tried, is that suggested by Egon von Oppolzer (*Astr. Nach.* 3170), which involves the use of the spectroscope for the determination of the motion in the line of sight. By comparing the spectra of opposite points on the equator, he says it might probably be possible to determine the time of rotation. Cassini de Vico's assumption involves a velocity for an equatorial point of somewhere about 473 metres per second, so that we should expect to get a motion, indicated in the spectrum by the displacement of the lines, of about 946 metres, or roughly, one kilometre. This motion, he thinks, can with our present means of measuring be made apparent, and we should thus decide between Cassini de Vico's assumption and Schiaparelli's 225-day period.

THE NEWALL TELESCOPE.—The report of the work done with the Newall refractor (*Camb. Univ. Reporter*, June 20) shows that during the past year the work was severely handicapped by the fact that the driving clock was undergoing repair. Last summer the objective prisms were adjusted, and about eighty stellar spectra were obtained, sixteen of which are of use for measurement ; but later the driving worm had to be dismounted and sent to Dublin. Using a single prism, the spectrum beween F and H is 2 inches long. In a photograph of Vega with an exposure of nine minutes the hydrogen lines up to ζ (Huggins's notation) were obtained, the spectrum between F and ζ being 3 inches in length. With both prisms the dispersion is very great, the spectrum more than covering the length of the photographic plate used (length between Hγ and H is 1·75 inches). The necessity of having to send the driving worm of the new clock away to be re-cut, in addition to making several instrumental tests, seems to have taken up much of the time that might have been used in observing. The fifth satellite of Jupiter is within the reach of this instrument, and has been seen on two occasions, January 24 and February 4, Mr. Newall remarking that "it has been most justly described as a very difficult object."

JOHNSTON'S NOTES ON ASTRONOMY.—Under this title we have before us a small book, by Swift P. Johnston, edited by James Lowe, consisting of about eighty pages, dealing with the more purely elementary mathematical portion of astronomy. The book is a compromise between a popular work and a textbook for students, and links the one to the other. Coming out originally in the form of notes, the present edition has been widely expanded, and may now be said to form an excellent course of astronomy for beginners. It is simple-worded and concise, and presents the reader with a general sketch of the more important problems which is the part of the science of astronomy to solve. The diagrammatical figures supplement and render more clear various parts of the text, and the 150 excellent questions, if fully answered by the reader, would prove a very serviceable addition to his astronomical education.

THE HODGKINS FUND PRIZES.—The following prizes are announced by the Smithsonian Institution with the intention of furthering the wishes of Mr. Thomas Hodgkins, who we have previously referred to as having presented a large donation to the institution for the "increase and diffusion of more exact knowledge in regard to the nature and properties of atmospheric air in connection with the welfare of man" :—

(1) \$10,000 for a treatise embodying some new and important discovery in regard to the nature and properties of atmospheric air. These properties may be considered as bearing upon all or any of the sciences, *e.g.* not only in regard to meteorology, but in connection with hygiene, or with any department whatever of biological or physical science.

(2) \$2000 for a satisfactory essay on : (*a*) The known properties of atmospheric air considered in their relationship to research in every department of natural science, and the importance of a study of the atmosphere considered in view of these relationships. (*b*) The proper direction of future research in connection with the imperfections of our knowledge of atmospheric air, and of the connections of that knowledge with other sciences. The essay as a whole should tend to indicate the path best calculated to lead to worthy results in connection with the future administration of the Hodgkins foundation.

(3) \$1000 for the best popular treatise upon atmospheric air, its properties and relationships (including those to hygiene, physical and mental). This essay need not exceed 20,000 words in length.

All these treatises may be written in English, French, German, or Italian, and sent to the secretary of the Smithsonian Institute, Washington, before July 1, 1894, with the exception of those in competition for the first prize, which will be delayed until December 31, 1894. Further information on the above and other points, such as the giving of medals, &c., may be obtained from the secretary's report, and also from *Astronomy and Astrophysics*, No. 116, p. 560.

GEOGRAPHICAL NOTES.

AT the meeting of the Royal Geographical Society, held on June 26, Captain F. R. Maunsell gave an account of his journeys in Kurdistan during the summer of 1892. Kurdistan is not an accurately-defined province, but may be described as the extensive district inhabited by the Kurds, embracing the region of Lake Van and the Upper Euphrates, as well as the country between the Tigris and the Persian frontier south of Lake Van. Captain Maunsell entered Kurdistan from the north, passing Erzingan and Erzerum, and skirted the eastern shore of Lake Van. The watershed between the lake and the Tigris Valley is very low, but it is not easy to discover any place at which there might at some former time have been an outlet. It seems not unlikely that a lava overflow from the volcano Mount Nimrud, on the western shore of the lake, cut off the plain of Van from the Tigris, and thus formed the lake. Captain

Maunsell descended to the Tigris, and followed that river to its mouth, making excursions into the mountainous country to the east. Only in southern Kurdistan is the population exclusively Kurdish. North of Mosul there is a considerable Christian element. Not many years ago Kurdistan was a separate province, ruled over by Kurdish beys, whose strongholds were Amadia, Rawanduz, Sulaimanie, and other places. But all this is changed, and the country is now under the direct control of Turkish officials. The original Kurdish organisation was tribal, and the prevailing habits of the tribes are still nomadic and pastoral, but have been modified by local conditions. Thus, the Kurds of the mountainous district north of Lake Van remain in villages all through the severe winter, the great distance being a bar to migration into a warmer plain country. In the summer, however, they leave their village dwellings for their tents, which they often pitch close to their winter home. In the rugged Dersim country the Kurds are perforce sedentary. In central and southern Kurdistan the tribes have easy access to the Mesopotamian plain, and a large number of them live in tents all the year round.

AT a special meeting of the Royal Geographical Society held on Monday at London University, Burlington House, it was decided, by 172 to 158 votes, that it was inexpedient to admit ladies as ordinary Fellows of the Society.

A DALZIEL'S telegram says that Lieutenant Peary, with Mrs. Peary and twelve companions, left New York on July 2 in the whaling barque *Falcon*, on his second expedition to the Arctic regions.

MUSEUMS ASSOCIATION.[1]

I.

THE Museums Association is one of the youngest of the numerous social organisations which it is thought expedient at the present day to constitute in order to give facilities for the interchange of ideas on subjects interesting to a special group of men. It is, indeed, only in the fourth year of its existence, and this is the first time that a meeting has been held in London, the centre in which are gathered the great national collections, and in which reside so considerable a number of persons engaged in their custody. The association claims York as its birthplace, and Liverpool, Cambridge, and Manchester have in succession afforded it hospitality and enjoyed the advantage of its presence.

We all meet with one object in view. We are all impressed with the value—with the necessity, I should say—of the Museum (using the word in its widest sense, as a collection of works of art and of nature) in the intellectual advance of mankind.

How could art make any progress, how could it even exist, if its productions were destroyed as soon as they were created; if there were no museums, private or public, in which they could be preserved and made available to mankind then and thereafter? How could science be studied without ready access to the materials upon which knowledge is built up? In many branches of science the progress is mainly commensurate with the abundance and accessibility of such materials.

Though the first duty of museums is, without question, to preserve the materials upon which the history of mankind and the knowledge of science is based, any one acquainted with the numerous succession of essays, addresses, lectures, and papers which constitute the museum literature of the last thirty years must recognise the gradual development of the conception that the museum of the future is to have for its complete ideal, not only the simple preservation of the objects contained in it, but also their arrangement in such a manner as to provide for the instruction of those who visit it. The value of a museum will be tested not only by its contents, but by the treatment of those contents as a means of the advancement of knowledge. Though this is the general consensus of opinion, as expressed in the literature just referred to, there is naturally still much divergence as to the best methods by which this ideal may be carried out, and there are still many practical difficulties to be overcome before the views so ably advocated on paper can be reduced to the test of actual performance. It is with a hope of assisting in the solution of these difficulties that this Association has been founded.

If in the few words with which I am expected to preface the real work of the Association I shall be found to dwell too exclusively upon the subject of natural history museums, I must apologise to many friends and members of the Association who are present. It must be distinctly understood that under the word museum we include collections of all kinds formed for the advancement of any branch of knowledge, except those specially devoted to books, which already are cared for by the "Libraries Association"—on the model of which ours was formed. I hope that in our papers at this meeting and in future presidential addresses we shall have all branches of museum work fairly represented.

It is my fate to have been born what is commonly called a "naturalist." I hardly remember the time when I was not a possessor of a museum, but it always took a distinctly biological direction. Hence, although by no means unappreciative of other branches of museum work, I shall confine myself chiefly to that part of the subject upon which I can speak from personal experience. Even in this branch time will compel me to limit myself to observations upon some of the larger questions connected with our subject, leaving details for discussion in our subsequent meetings.

One great difference between the work of the curator of an art museum and that of one devoted to what are called natural history subjects, is that in the case of the former the specimens he has to preserve and exhibit come into his hands very nearly in the condition in which they will have to remain. A picture, a vase, a piece of old armour, or a statue, beyond a certain amount of tender care in cleaning and repairing, which is more or less mechanical in its nature, is ready for its place upon the museum shelves. But this is far from being the case with the greater number of natural objects. Not only do they require special methods of preservation, but very often their value as museum specimens depends entirely upon the skill, labour, patience, and knowledge expended upon them. In specimens illustrating biological subjects the highest powers of the museum curator are called forth. A properly mounted animal or a carefully-displayed anatomical preparation is in itself a work of art, based upon a natural substratum. In few branches of museum work has there been greater progress in late years than in this, and few offer still further scope for development.

Partly from this cause, and partly from the fact that art has for a longer period and to a greater degree engaged the attention of civilised man than nature, the method of preservation, arrangement, and exhibition of works of art are on the whole further advanced than are those of natural objects. But no one can deny that there is still in many galleries devoted to the exhibition of works of art of various kinds great room for improvement. There is generally far too great crowding; too many objects so placed that the tallest man cannot see them properly, even when standing on tiptoe; too many others placed so low that they can only be examined by lying down on the floor; too many completely spoiled by the juxtaposition of other incongruous objects, or by unsuitable settings. It is only in a very few public museums (I may instance as a conspicuous example the splendid museum of antiquities at Naples) that the immense advantage to be gained by ample space and appropriate surroundings in aiding the formation of a just idea of the beauty and interest of each specimen contained in it can be properly appreciated. Correct classification, good labelling, isolation of each object from its neighbours, the provision of a suitable background, and above all of a position in which it can be readily and distinctly seen, are absolute requisites in art museums as well as in those of natural history. Nothing detracts so much from the enjoyment and advantage derived from a visit to a museum as the overcrowding of the specimens exhibited. The development of the new museum idea to be spoken of later on will be one way by which this can be remedied in the public galleries; but if museums are what they ought to be, and what I venture to believe they will be in the future, the question of space on a considerably larger scale than has hitherto been thought of will have to be faced. This is of course mainly a matter of expense, and after all but a small matter compared with expenditure now considered necessary in other directions. There are persons who think the country made a tremendous effort in building so much as is yet finished of the new Natural History Museum in the Cromwell Road, and shake their heads at the expenditure

[1] Address of the President, Sir William H. Flower, K.C.B., F.R.S., &c. London Meeting, July 3, 1893.

asked for either to complete that establishment by the erection of the wings at the sides, or to finish the neighbouring South Kensington Museum in such a manner as worthily to hold its collections, both of art and science; or who would deprecate the further expansion of the magnificent series of treasures of ancient and mediæval art in the British Museum at Bloomsbury, of which the country has such just reason to be proud. Let such persons consider that the largest museum yet erected, with all its internal fittings, has not cost so much as a single fully-equipped line-of-battle ship which in a few years may be either at the bottom of the sea, or so obsolete in construction as to be worth no more than the materials of which it is made. Not that I am deprecating the building of ships necessary for our protection, but rather wishing to show that the cost of such museums as are still required for the proper education of the nation is not such as would produce any sensible impression upon its financial position.

I may make a still more apposite comparison, and point to the vast sums of money spent by this nation upon the whole subject of education now and a few years ago. The total estimate for what is called "Class IV., Education, Science and Art," for the financial year 1883-84, amounted to £4,748,556. In ten years it has grown to nearly double that amount, the estimate for 1893-94 being £9,172,216, the increase being mainly due to what is termed "Public Education." The amount spent upon the development of museums is comparatively insignificant. The British Museum vote (including the library and the natural history branch) has only increased from £146,019 to £157,500. The cost of the various museums maintained by the Science and Art Department shows little appreciable augmentation, except in the case of that at Dublin, where I am glad to see £19,035 is now put down instead of the £13,602 of the former period. Compared with the whole amount expended upon other methods of education, national expenditure upon museums and art galleries is at present very small.

In reference to this subject one cannot help considering how much might have been done if only a moderate portion of that large sum of money obtained a few years ago by the tax on brewers, and handed over to the County Councils to spend in promoting technical education, had been used for erecting museums, which might have taken a permanent place in the education of the country. Every subject taught, in order to make the teaching real and practical, should have its collection, and these various collections might all have been associated in the county museum under the same general management. The staff of teachers would assist in the curatorial work, and thus a well-equipped central college for technical education might have been formed in every county, sending out ramifications into the various districts in which the need of special instruction was most felt, and being also the parent of smaller branch museums of the same kind wherever they seem required.

But it is not only in the buildings that the expense of the museums of the future will have to be met. Another great advance will have to be made before they can be placed upon a satisfactory footing, and perform the functions that can be legitimately expected of them. This is in the elevation of the position and acquirements of those who have the care of them. As I have said on a previous occasion, "What a museum really depends upon for its success and usefulness is not its building, not its cases, not even its specimens, but its curator."

Speaking in the presence of a number of gentlemen who are curators of museums, do not let me be misunderstood. I do not mean that you are not zealous in the cause and make great sacrifices for it, and do all you can under the often difficult circumstances in which you are placed; but what I mean is—and I am sure you will one and all agree with me when I say it—you are not properly appreciated by the public, and the importance and difficulties of your position are by no means sufficiently understood. In a civilised community the necessities of life, to say nothing of luxuries (which we do not ask for), but the bare necessities of a man of education and refinement, who has to associate with his equals, and bring up his children to the life of educated and refined people, involve a certain annual expenditure, and the means afforded by any occupation for this necessary expenditure gives a rough and ready test of the appreciation in which such occupation is held.

Now, a curator of a museum, if he is fit for his duties, must be a man of very considerable education as well as natural ability. If he is not himself an expert in all the branches of human knowledge his museum illustrates, he must be able to understand and appreciate them sufficiently to know where and how he can supplement his own deficiencies, so as to be able to keep every department up to the proper level. His education, in fact, must be not dissimilar to that required for most of the learned professions. Still, manual dexterity and good taste are also most valuable. He must, in addition, if he is to be a success in his vocation, possess various moral qualifications not found in every professional man—punctuality, habits of business, conciliatory manners, and, above all, indomitable and conscientious industry in the discharge of the small and somewhat monotonous routine duties, which constitute so large a part of a curator's life. Such being the requirements of the profession, let us see what are the inducements offered to men to take it up as a means of livelihood. I really am sorry to have to speak of such a sordid subject, but I know it is one you naturally shrink from talking of yourselves. You would be the last people in the world to take the remedy, so often now resorted to by other classes, into your own hands. A strike of curators is hardly to be contemplated. Remember, now, that I am not speaking of this subject in your interests, or the interests of any individuals. Whether any of you personally should have your emoluments, your social position, your opportunities for good, improved, is not now with me an object of concern, it is in the interest of that great question, the advance of the museum as a means of educating, cultivating, and elevating mankind, that I am speaking, an advance that can only be effectively made when the curatorship of a museum is looked upon as an honourable and desirable profession for men of high intellectual acquirements.

Let me take a few examples of the inducements to enter this profession at the present time. I have before me some recent advertisements. The curator of the Museum of the Philosophical and Literary Society of one of the largest and most flourishing of our manufacturing cities is offered £125 a year for his services. In another town, smaller and less wealthy, it is true, "a resident curator, meteorological observer, and caretaker, is wanted for the museum and library buildings at a salary of £50 per annum, with rooms, coal, and gas. Applicants are to state age and scientific qualifications."

In a recent newspaper discussion upon the establishment of a museum in one of the midland counties, after it had been pointed out that one of the prime necessities of such an institution was a provision for the maintenance of a curator, a leading gentleman of the district, a zealous and sympathetic advocate of the cause, perfectly acquiescing in this view, suggested that £100 a year should by all means be set aside for this purpose.

It is frequently my lot to be consulted by anxious parents of sons who develop a taste for museum work as to what such a taste will lead to if cultivated. I need hardly say that, however much I may wish our ranks to be recruited by such enthusiastic aspirants, boys often of great ability and promise, I cannot conscientiously offer much encouragement. The best I can say is that I hope things will be better in the future than they are at present. As far as the Metropolis is concerned there has been some improvement, and I think that indications are not wanting that this improvement will continue and extend.

I have referred at the beginning of this address to the great amount of recent literature upon the museum question, consisting chiefly in depreciation of the old ways of arranging museums, of suggestions for the improvements for the future, and mainly in the development of what may be called the new museum idea. What this idea is was tersely expressed nearly thirty years ago by the late Dr. John Edward Gray, in his address to the British Association at Bath (1864) as President of Section D, when near the close of his long career as administrator of a collection which by his exertions he had made the largest of the kind in the world, he laid down the axiom that the purposes for which a museum was established were two—"first, the diffusion of instruction and rational amusement among the mass of the people, and, secondly, to afford the scientific student every possible means of examining and studying the specimens of which the museum consists." He then continued—"Now, it appears to me that in the desire to combine these two objects, which are essentially distinct, the first object—namely, the general instruction of the people—has been to a great extent lost sight of and sacrificed to the second without any corresponding advantage to the latter, because the system itself has been thoroughly erroneous."

This was a remarkable admission, coming from a man who had been brought up in, and had acted throughout the whole of his life upon, the old idea; but it clearly expressed what was then beginning to be felt by many who turned their unbiassed attention to the subject, and it is the keynote of nearly all the museum reforms of recent date. During the long discussion which followed, the new idea found powerful advocates in Huxley, Hooker, Sclater, Wallace, and others; but Owen, whose official position made him the chief scientific adviser in the construction of the new National Museum of Natural History, never became reconciled to it, and, unfortunately, threw all the weight of his great authority into the opposite scale.

The method of application of this principle depends entirely upon the general nature of the museum, whether that of a nation, a town, a school, or a society or institution established to cultivate some definite branch of knowledge. It is mainly of national museums that I am speaking at present, and it is only in national museums that the fulfilment of both functions in fairly equal proportions can be expected. In almost all other museums the diffusion of knowledge or popular education will be the primary function, and if the true principles of arrangement of such museums be once grasped, this is a function which can be carried out upon the largest or the smallest, or any intermediate scale, according to the means of the institution and requirements of the locality.

The collections for the advancement of science, on the other hand, are of value mainly in proportion to their size, and no museum at present existing has come anywhere near what is required for the exhaustive study of natural history. If any one were now to endeavour to write a complete monograph of any family in the animal kingdom, he would search in vain for materials for doing so, not only in any one museum, but in all the museums in the world put together.

Soon after the arrival in our Natural History Museum of the great and carefully selected and labelled collection of Indian birds, presented by Mr. A. O. Hume, containing upwards of 60,000 specimens, a well known ornithologist commenced the volumes devoted to birds in the excellent series of manuals on the fauna of British India, edited by Mr. Blanford. I am told that when he began the work he was seen sitting at his table rubbing his hands with delight at the prospect of success in his labours guaranteed by such an unprecedented mass of material. But after a few weeks the scene had changed. He was pacing up and down the room, wringing the same hands in despair at the hopelessness of solving the tangled problems of the variation according to age, sex, season, and locality, the geographical distribution, and the limits and relationship of any single species, owing to the absolutely insufficient number of properly authenticated specimens at his command. Every zoologist will recognise this as a scarcely exaggerated description of what he meets with at every step of his work. Except, perhaps, for some special and limited groups, which may be taken up in private collections, a national museum alone can possibly attempt to bring together the materials required for such exhaustive work, but it is undoubtedly the duty of all national museums to endeavour to do this. There should be in every great nation one establishment at least where problems may be attacked with some prospect of success, and the only conditions upon which collections for this purpose can be maintained are that they should be so arranged as to occupy the smallest possible space compatible with their proper preservation and convenience of access; and that they should be removed from all the deteriorating influences of light and dust, and at the same time be perfectly available for the closest examination by all those whose knowledge is sufficient to enable them to extract any information from them. This means that they cannot be *exhibited* in the ordinary sense of the word; although it must not be supposed that they are on that account in less need of orderly and methodical arrangement. There is certainly a danger of collections which are not generally exhibited becoming neglected, and degenerating into the condition of mere accumulations of rubbish. Anything of the kind is absolutely incompatible with the true requirements of specimens kept for research. They specially need to be arranged in an orderly and methodical manner, and to be thoroughly well catalogued and labelled, so that each may be found directly it is wanted, and to be frequently inspected to see that they are free from moth or other deleterious influence. The object of keeping them in this condition is, indeed, that they should be preserved and not destroyed, as many exhibited specimens ultimately are. Much curatorial ingenuity may be exercised in the methods of stowing and arranging such specimens to the best advantage. The conditions of access to them will be precisely those now accorded to books or manuscripts in a library, prints and drawings in an art museum, the records and public documents in the Rolls Office or Somerset House.

As the actual comparison of specimen with specimen is the basis of zoological and botanical research, and as work done with imperfect materials is necessarily imperfect in itself, it is far the wisest policy to concentrate in a few great central institutions the number and situation of which must be determined by the population and resources of the country, all the collections (especially those containing author's types or the actual specimens upon which species have been established, and which must be appealed to through all time to settle vexed questions of nomenclature) which are required for the prosecution of original research. It is far more advantageous to the investigator to go to such a collection, and take up his temporary abode there while his research is being carried out, with all the material required at his hand at once, than to travel from place to place and pick up piecemeal the information he requires, without opportunity of direct comparison of specimens.

On the other hand, in local museums, such collections are not only not required, but add greatly to the trouble and expense of the maintenance of the institution, without any compensating advantage. Here it will be the duty of the curator to develop the side of the museum which is educational and attractive to the general visitor, and to all who wish to obtain that knowledge, which is the ambition of many cultivated persons to acquire without becoming a specialist or expert. The study of the methods by which such museums may be made instructive and interesting offers an endless field for experiment and discussion, and the various problems connected with it are treated of not only in the literature I have referred to, but in a more practical manner in many museums in various parts of the world.

Without pursuing this question further at the present time, I should like to repeat from a previous address on the same subject[1] certain propositions which are fundamental in the arrangement of collections of the class of which I am now speaking.

The number of the specimens must be strictly limited, according to the nature of the subject to be illustrated, and the space available. None must be placed either too high or too low for ready examination. There must be no crowding of specimens one behind the other, every one being perfectly and distinctly seen, and with a clear space around it. If an object is worth putting into a gallery at all, it is worth such a position as will enable it to be seen. Every specimen exhibited should be good of its kind, and all available skill and care should be spent upon its preservation, and rendering it capable of teaching the lesson it is intended to convey. Every specimen should have its definite purpose, and no absolute duplicate should on any account be admitted. Above all, the purpose for which each specimen is exhibited, and the main lesson to be derived from it, must be distinctly indicated by the labels affixed, both as headings of the various divisions of the series and to the individual specimens.

(*To be continued.*)

MARINE BIOLOGICAL ASSOCIATION.

THE report of the Marine Biological Association of Great Britain was read at the annual meeting of the Association held in the rooms of the Royal Society on June 28. From it we learn that the buildings, fittings, and machinery of the Plymouth laboratory are in a satisfactory condition, and have not necessitated any special outlay.

The question of the boats has occupied the council very seriously during the past year. The old steam-launch *Firefly* is still at work, although it was decided to replace her a year ago. A new steam-launch, of about the same size as the *Firefly*, was recently purchased, but has proved to be unsuitable for rough work. The little sailing-boat, *Anton Dohrn*, is in excellent repair, and continues to be very useful.

The need of a deep-sea-going boat has become most pressing, but there are no funds in hand sufficient for its purchase and maintenance. This need has been particularly felt of late in the fishery inquiries in which the Association has been engaged in the North Sea as well as at Plymouth.

The type-collection is increasing satisfactorily under Mr. Garstang's care. In addition to the specimens at Plymouth, a

1 British Association for the Advancement of Science. Report of Newcastle Meeting, 1889.

series of selected specimens has been arranged and exhibited at various *soirées*. This exhibition series is being enlarged.

Owing to the generosity of Mr. J. P. Thomasson, who has made a second donation of £250 for this purpose, it has been possible for the council to retain the services of Mr. Holt for fishing inquiries in the North Sea for a second year.

Mr. Garstang has been appointed for a second year to superintend the collection, preservation, and supply of material. The character of the specimens supplied by the laboratory has improved very greatly under his care.

Mr. Cunningham has continued his observations on the rate of growth and probable ages of young fish, a paper on which was published in the November number of the Association's journal. He has also continued his experiments on the colouration of the under-side of flat-fishes. Since Christmas he has been occupied in an inquiry into the question of the destruction of immature fish, the first results of which appear in the May number of the journal.

Mr. Cunningham has also succeeded in artificially fertilising the eggs of the flounders which he has reared in the laboratory tanks during the last three years from a length of half an inch; the eggs developed, and the larvæ were artificially fed for ten days after the absorption of the yolk-sac. This result is of great importance and interest.

Mr. Holt has been at work now for eighteen months upon an investigation of the fisheries of the North Sea, and his papers in the journals for November and May supply a large amount of important information. The Council contribute to the expenses of the Cleethorpes Aquarium of the Marine Fisheries Society (Grimsby) in return for Mr. Holt's use of their laboratory and tanks.

Mr. Garstang has captured a large number of rare forms during the past year, and he has added five new species to the list of the British fauna. As a result of his work during the past year, an intimate knowledge of the localities of the fauna has been acquired, so that specimens can be obtained without delay.

The receipts for the past year include the annual grants from H.M. Treasury (£1000) and the Worshipful Company of Fishmongers (£400); annual subscriptions have produced £160, composition fees £16, the rent of tables at the laboratories, £34, the sale of specimens £205, and the admission to the tank-room £70, the total amounting, with lesser sums, to £2199.

The Vice-Presidents, Officers, and Council proposed by the Council for 1893–94 are:—President: Prof. E. Ray Lankester, F.R.S.; Vice-Presidents: The Duke of Argyll, K.G., K.T., F.R.S., the Duke of Abercorn, K.G., C.B., the Earl of St. Germans, the Earl of Morley, the Earl of Ducie, F.R.S., Lord Walsingham, F.R.S., Lord Revelstoke, the Right Hon. A. J. Balfour, M.P., F.R.S., the Right Hon. Joseph Chamberlain, M.P., Prof. G. J. Allman, F.R.S., Sir Edward Birkbeck, Bart., M.P., Sir Wm. Flower, K.C.B., F.R.S., the Right Hon. Sir John Lubbock, Bart., M.P., F.R.S., Prof. Alfred Newton, F.R.S., Sir Henry Thompson, Rev. Canon Norman, F.R.S., Captain Wharton, R.N., F.R.S.; Council—elected Members: F. E. Beddard, F.R.S., Prof. F. Jeffrey Bell, Prof. W. A. Herdman, F.R.S., Sir John Evans K.C.B., F.R.S., A. C. L. G. Günther, F.R.S., Prof. A. C. Haddon, Dr. Sydney J. Hickson, Prof. W. C. McIntosh, F.R.S., Right Hon. E. Majoribanks, M.P., E. B. Poulton, F.R.S., P. L. Sclater, F.R.S., Adam Sedgwick, F.R.S., Prof. Charles Stewart, Prof. W. F. R. Weldon, F.R.S., Hon. Treasurer: E.L. Beckwith; Hon. Secretary: G. Herbert Fowler.

THE CONDITIONS DETERMINATIVE OF CHEMICAL CHANGE.[1]

NOTWITHSTANDING the large amount of evidence now placed on record that substances commonly supposed to be capable of directly interacting do so only in the presence of at least one other substance, chemists do not appear to have arrived at any clear and consistent understanding of the conditions determinative of chemical change: as each fresh case is recorded, we continue to express surprise, overlooking the fact that Faraday, in his early "Experimental Researches in Electricity," clearly foresaw what the conditions were, and that but a slight extension of his generalisations is needed to frame a comprehensive theory. The subject is of such importance that it appears to me desirable to discuss the bearing of recent observations, especially as they to some extent necessitate the modification of views that I have expressed elsewhere, and in order to attract the attention of physicists, to whom we must now look for guidance in these matters.

Eight years ago, in the course of the discussion on Mr. H. B. Baker's communication on combustion in dried gases (Proc. Chem. Soc., 1885, 40), I defined chemical action as *reversed electrolysis*: in other words, in order that chemical action may take place, it is essential that the system operated on comprise an electrolyte. I then pointed out that as neither hydrogen nor oxygen was an electrolyte, a mixture of only these two gases should not be explosive; and, moreover, as water was not an electrolyte, and it was scarcely probable that water and oxygen or hydrogen would form an electrolyte, it was difficult to understand how the presence of water pure and simple should be of influence in the case of a mixture of hydrogen and oxygen. This forecast has since been verified, the remarkable series of experiments carried out by V. Meyer in conjunction with Krause and Askenasy having clearly demonstrated that the formation of water from hydrogen and oxygen takes place at an irregular rate, and is, therefore, dependent on the presence of a something other than water—I imagine an acid impurity. But this is a consideration which has not yet received the proper attention, and it is, therefore, desirable to emphasise its importance by reference to other cases. Mr. Baker's recent preliminary note on the influence of moisture in promoting chemical action (*ante*, p. 229) affords several interesting examples:—Thus, he states that neither does hydrogen chloride combine with ammonia, nor is nitric oxide oxidised by oxygen if moisture be excluded. In the former case, the addition of water should suffice to determine the combination, as water and hydrogen chloride together form a "composite electrolyte" (*cf.* Roy. Soc. Proc., 1886, No. 243, p. 268); as neither nitric oxide nor oxygen, however, forms a composite electrolyte with water, in this case water alone should not determine the occurrence of change; but if, by the introduction of a trace of "impurity" in addition to water the presence of a composite electrolyte were secured (however high its resistance, owing to the smallness of the amount of "impurity"), action would set in, and when once commenced would proceed at an increasing rate, as nitric acid would be formed and the resistance of the electrolyte would consequently diminish. On this account it will be a task of exceeding difficulty to experimentally demonstrate that nitric oxide and oxygen are inactive in presence of water alone; but there can be no doubt that such must eventually be admitted to be the case, provided always that it is permissible to extrapolate Kohlrausch's observations, and to conclude from them that *pure* water is a dielectric. The gradual increase in the rate of change here contemplated corresponds to the period of induction observed by Bunsen and Roscoe in their observations on the interaction of chlorine and hydrogen; the statement recently made by Bodenstein and V. Meyer (*Berichte*, 1893, 1146) that a mixture of chlorine and hydrogen behaves irregularly on exposure to light is a valuable confirmation of Pringsheim's observations, and there is now no room for doubt that *pure* chlorine and hydrogen would be incapable of interacting. That no such irregularity is observed on heating iodine with hydrogen is not surprising, as hydrogen iodide would be formed from the very outset, and the electrolyte present would exert a minimum resistance almost at once. There is, however, a significant difference in the behaviour of the two mixtures, as hydrogen chloride should behave as hydrogen iodide, so that the problem is but incompletely solved: it may be that the one mixture was more nearly pure than the other, or it may be that the formation of hydrogen chloride from hydrogen and chlorine, under the influence of light, is dependent on the presence of some particular substance, together with water, and does not take place under the influence of any substance capable of forming a composite electrolyte with water; probably, however, the difference observed is chiefly due to the fact that only one of the actions is reversible under the conditions prevailing in the experiments.

Lastly, attention may be directed to the formation of sulphuric oxide from sulphurous oxide and oxygen, which is readily effected in presence of a catalyst, such as finely divided platinum; it cannot be supposed that the mere presence of platinum would condition the occurrence of change, and doubtless moisture is also necessary, the platinum or other catalys

[1] Reprinted from the Proceedings of the Chemical Society, No. 125.

but serving to promote the oxidation of the sulphurous oxide at a temperature considerably below that at which sulphuric oxide decomposes when heated. The action of surfaces generally may well be of this character, and the converse influence they so frequently exercise is probably an effect of the same order.

I have elsewhere raised the question whether there may not be a difference between actions taking place under the influence of low and of high electromotive forces—whether water, *per se*, may not be an electrolyte towards high, although not towards low, forces, in the case of high temperature changes, or those brought about under the influence of the electric spark, for example. More attentive consideration of the subject has led me to think that this is not the case, and that we must treat high temperature changes such as occur and are involved in gaseous explosions in the same way as those occurring under ordinary conditions and at low temperatures. From this point of view, Mr. Baker's statement that ammonia and hydrogen chloride do not combine is of extreme importance; the formation of ammonium chloride from these two compounds apparently involves no interchange, but a mere combination of two substances each endowed with considerable "residual affinity," and there is no reason why a distinction should be drawn between such a case and that afforded by, say, *atoms of hydrogen and oxygen*, the difference being, it would seem, one of degree only; in fact, I am no longer inclined to believe that atoms are capable of directly uniting. In all cases at least one function of the (composite) electrolyte would appear to be that of providing the necessary "mechanism" whereby the degradation or discharge of the energy is effected. If this argument be sound, its logical extension involves the conclusion that *pure* gases should be dielectrics, *i.e.* that the passage of an electric discharge through a gas like that of an explosive wave through, say, a mixture of hydrogen and oxygen, can only take place if an electrolyte be present. Hitherto but little attention has been paid to the electric discharge in gases which have been highly purified. The peculiar behaviour of Tesla tubes referred to by Mr. Crookes in the discussion on Mr. Shenstone's paper on the formation of ozone is, perhaps, explicable from this point of view—it may be that the atmosphere within the tube does not become conducting until sufficient moisture and "impurity" have been projected from its sides. It is conceivable that a similar explanation may hold good in the case of Prof. Schuster's observation, that it is possible to urge a current of low electromotive force across a gas subjected to a high electromotive force in itself insufficient to cause a discharge in the gas; the atomic dissociation hypothesis put forward in explanation of the phenomenon does not appear to me to be sufficient.

Finally, the question arises, Can no line be drawn; are no two pure substances capable of combining or interacting:—For example, water and sulphuric anhydride? There is little to guide us here, but it seems not unlikely that water has special properties which enable it to act directly; moreover—perhaps because—in such cases composite electrolytes would result. Ammonium chloride, so long as it remains solid, is clearly a compound of a different order, and it may well be that compounds of this type are in no case directly obtainable from their constituents, because, under the conditions under which they are formed, they cannot behave as electrolytes.

Apparently, in all cases in which molecular aggregates are formed—as in the case of solutions—we are dealing with dissociable and dissociating systems, and it is not improbable that we may ultimately find an explanation of the mechanism of such changes in this fact.

At present there is no information forthcoming whether simple electrolytes, such as fused silver chloride, for example, will condition chemical change in the way that water does—whether, for instance, silver chloride will condition the formation of hydrogen chloride from chlorine and hydrogen, so that a gas battery might be constructed of these three substances.

HENRY E. ARMSTRONG.

THE SUCCESSION OF TEETH IN MAMMALS.

PROF. H. F. OSBORN, in the *American Naturalist* for June, gives an account of recent researches upon the succession of the teeth in mammals. He says:—

"The recent studies of Kükenthal, Röse, and Taeker in the discovery of the complete double or milk dentition in the Marsupials, and in the discussion of its relation to that of the reptiles, also in the ontogenesis of the crowns of the teeth among the Cetaceans, Edentates, Primates, and Ungulates are of the greatest interest and importance. They involve a complete revolution in our ideas as to the interpretation of the dentition in the three orders first mentioned above."

After giving an account of the work done by the European observers, Prof. Osborn shows, by means of a table, the phylogenetic order as observed by Cope and Osborn, and the ontogenetic order as observed by Röse and Taeker. His researches indicate that the earliest forms of mammals were homodont, and had two or more series of successional teeth. Then within the mammalian stem the teeth were differentiated, and there arose a great heterodont group with teeth at least of three kinds—incisors, premolars, and molars, all successional. From the most anterior premolar arose the canine. Then came the division between the Marsupials and the Placentals, the former tending to suppress the development of the second series of teeth, the latter retaining the second series as far back as the first molar. There is an obvious advantage in the line of succession being drawn at the first molar,[1] for upon the molars rested the necessity of complex development, and such development was best effected in permanent crowns.

1. All the so-called "milk molars" plus the so-called "true molars" constitute the *first series*. Beneath one or more of the "true molars" in lower mammals are rudiments of a second series. The *second series* consists therefore of these submolar rudiments plus the successional or permanent premolars, incisors and canines.

2. In the stem Marsupials the entire first series persisted and became mainly permanent (non-deciduous); the second series became rudimentary and non-successional with the exception of the fourth upper and lower premolars, and possibly one or two other teeth which either replaced or were intercalated between members of the first series. One or more premolars were suppressed, and one more molar retained than typical in the Placentals. Thus is explained the apparently atypical dental formula of Marsupials.

3. In the stem heterodont Placentals (excepting the Cetacea and Edentata) the entire first series persisted, and all the incisors, canines, and premolars remained deciduous. The successional second series persisted as far back as the first molar.

4. In the stem Cetacea the entire first series persisted, and the second series became rudimentary and non-successional. The tooth form changed from a heterodont to a homodont type.

5. In the stem Edentates, which also transformed from the heterodont to the homodont type, the first series became rudimentary, and the second series persisted in the succession even behind the region of the first molar.

Finally, there is evidence that a primitive succession in the region of the molar teeth, lost in the Marsupials and in the Placentals, was more or less fully retained in the Cetacea and Edentates.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Governors of the Glasgow and West of Scotland Technical College have appointed Mr. W. H. Watkinson, lecturerer on engineering, Central Higher Grade School, Sheffield, to the Chair of steam, steam engines, and other prime movers, recently instituted in the college. By several important changes, the engineering department has been recently re-organised, Prof. Jamieson devoting his attention entirely to electrical engineering, Prof. Rowden to mechanics (theoretical and applied), Prof. MacSay to machine drawing, and Prof. Watkinson to the subjects stated above. With this addition and rearrangement the college now possesses an engineering staff worthy of one of the greatest engineering centres in the kingdom. Many additions are wanted, however, to bring the laboratories and general equipment to a position of equality with those even in many provincial towns.

[1] The law of molar evolution is that complication is most rapid in teeth which are longest in use. Thus the first molar is the most progressive tooth of the true molar series, and the last premolar is the most progressive of the premolar series. The apparent exception that the third milk premolar is always an advance type of the third permanent premolar is explained by the fact that the milk premolars are formed to assume the molar function

We have received from the Cambridge University Extension authorities the detailed programme of their summer meeting. Courses of study extending over a month (from July 29 to August 26 inclusive) have been arranged, intended primarily for those connected in some way with the University Extension Movement, though all members of the teaching profession and other students are also admitted. Though the full course extends over a month it has been arranged that those who can only spare a fortnight shall have a fairly complete course of work to go through. The subjects on which instruction is offered are extremely varied, including history, literature, and language, art, economics, and natural science. On the scientific side several courses of laboratory work are provided and in addition there are to be a set of lectures illustrating, from the history of several sciences, the progress and methods of natural science. The services of Sir Robert Ball, Sir Henry Roscoe, and a number of other well-known lecturers have been secured. Many intending visitors will be glad also to see that the authorities have not forgotten that August is a time for recreation as well as study and have made special arrangements for boating, for admission to college gardens, as well as for several excursions to places of historic, artistic, or scientific interest. Three colleges have agreed to board students at extremely moderate rates, and there is an abundance of lodgings. The total expense of the month for a student living economically need not exceed £6 or £7. There are probably not many other ways in which such a pleasant and profitable holiday can be spent for so small a sum.

THE following elections to natural science scholarships at Oxford have been announced:—Mr. H. C. H. Carpenter, of Eastbourne College, to a Natural Science Postmastership at Merton College. Mr. T. J. Garstang, of Manchester Grammar School, to a Natural Science Scholarship at Corpus Christi College. Mr. Richard Warren, of the Charterhouse, to an Open Natural Science Scholarship at New College. In each case the value gained is £80 per annum.

SUMMER courses seem to be the order of rhe day. The Marine Biological Laboratory at Woods Holl, Massachusetts, was opened on June 1, and will remain open until August 30. The Laboratory has aquaria supplied with running sea-water, boats, a steam launch, collecting apparatus, and dredges. There are thirty-three private laboratories for investigators, and five general laboratories. Short courses has also been arranged in zoology and botany, the laboratory work in each case being accompanied by lectures. Every facility is given for the obtain- of general knowledge, while those who are prepared to begin original work, under the guidance of instructors, are provided for as well as the practised investigator. This classification of workers into three grades is an excellent one and well worthy of imitation.

COL. SIR CHARLES W. WILSON, F.R.S., has been appointed Honorary Master of Engineering of the University of Dublin.

SCIENTIFIC SERIAL.

American Meteorological Journal, June.—The principal articles are: Note on the relation of solar spots to terrestrial anticyclones, by A. Searle. The relation considered is not one of cause and effect, but simply an analogy recently suggested in the *Astronomische Nachrichten*, by E. von Oppolzer, whose idea is to substitute the anticyclone instead of the cyclone as is usually done, as the terrestrial term of the comparison. The author considers the comparison to be both striking and plausible, but Prof. Davis thinks it should be limited to terrestrial anticyclones during winter nights.—A new series of isanomalous temperature charts, based on Buchan's isothermal charts, by S. F. Batchelder. The author has constructed a new set of isabnormal charts, based on the observations of the *Challenger* expedition, which are said to show more plainly than those of Humboldt and Dove the departures from the average temperature of a parallel of latitude. The cold area on the west coast of South America is found to be 10° too cool, instead of 6°·7; that on the west coast of Africa to be 6° instead of 4°·5. The excess of heat of Southern Alaska is given as 10° instead of 6°·7, and the south coast of Norway (under the influence of the Gulf Stream) is found to be 23° over the average for the latitude, instead of 20°·3, while the cold areas in the interior of North America and Asia, given as 11°·3 by Dove, are now shown to be 14° below the mean temperature of their latitude.—Proposed subjects for correlated study by State Weather Services, by W. M. Davis. The non-telegraphic records are almost entirely reduced in an arithmetical manner, suitable for the determination of climate, but not for the determination of unperiodic factors of the kind with which weather changes are concerned. The author suggests that all observers should make hourly records of the ordinary weather elements on certain days, that these observations should be charted for every hour, and afterwards consolidated on a single map for the whole country, by which means some extremely interesting illustrations of weather phenomena would be gained, and give a better knowledge of processes now imperfectly understood.—Meteorology as the physics of the atmosphere, by W. von Bezold. This concluding part deals more especially with observations made in balloons, and with thermometer exposure. The author thinks it probable that Dr. Assmann's aspirator will show that the temperatures hitherto made in balloons are affected by radiation to the extent of 10° at least. He also gives some valuable advice as to the observation of clouds, and draws especial attention to the importance of observing not only their outward appearance, but more particularly their formation and dissolution, so as to establish their classification and nomenclature upon a natural basis.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 8.—"The Experimental Proof that the Colours of certain Lepidopterous Larvæ are largely due to modified Plant Pigments, derived from Food." By E. B. Poulton, F.R.S.

The object of this investigation was to afford a conclusive test as to the theory, previously submitted by the author, that some of the colours of certain Lepidopterous larvæ are made up of modified chlorophyll derived from the food-plant.

Larvæ from one batch of eggs laid by a female *Tryphæna pronuba* were divided into three lots fed (in darkness) respectively throughout their whole life upon (1) green leaves, (2) yellow etiolated leaves, and (3) white mid-ribs of cabbage. The larvæ fed upon (1) and (2) became green or brown as in nature, thus proving that etiolin, no less than chlorophyll, can form the basis of the larval ground-colour. Those fed upon (3), in which neither chlorophyll nor etiolin was accessible, were entirely unable to form the green or brown ground-colour. The production of dark superficial cuticular pigment was, however, unchecked. One of the larvæ fed in this way was perfectly healthy, and had become nearly mature when it was accidentally killed. Many others died early, but resembled that last described in the inability to form a ground-colour.

The experiment seems to leave no doubt as to the validity of the conclusions previously reached. Interesting questions as to the changes passed through by the derived pigments are suggested by this inquiry.

"The Menstruation of *Semnopithecus entellus*." By Walter Heape, Balfour Student at the University of Cambridge. Communicated by Prof. M. Foster, Sec. R.S.

"Researches on the Structure, Organisation, and Classification of the Fossil Reptilia. Part viii. On further Evidences of *Deuterosaurus* and *Rhopalodon* from the Permian Rocks of Russia." By H. G. Seeley, F.R.S.

Royal Meteorological Society, June 21.—Dr. C. Theodore Williams, President, in the chair.—Mr. R. H. Scott, F.R.S., read a paper on fifteen years' fogs in the British Islands, 1876–1890, which was a discussion of the fog observations made at the stations which appear in the *Daily Weather Report*. From the observations it appears that there is no trace of a regular increase either in the monthly or in the annual curve. All that can be said is that taking the three lustral periods of five years each, the last of these, 1886–90, comes out markedly the worst, the successive totals being 262, 250, 322.—A paper on upper currents of air over the Arabian Sea, by Mr. W. L. Dallas, of the Indian Meteorological Office, was also read, in which it is shown that there exists a regular arrangement in the vertical succession of the upper currents, and that the Doldrum region, and not the geographical equator, is really the dividing line between the currents of the northern and southern hemispheres.

PARIS.

Academy of Sciences, June 26.—M. Lœwy in the chair.—On the employment of Lagrange's equations in the theory of impact and percussions, by M. Paul Appell.—Theoretical calculation of the inferior contraction in weirs with thin walls and sheets free below, when this contraction attains its greatest values; with experimental verifications, by M. J. Boussinesq.—Formation of natural phosphates of aluminium and iron; phenomena of fossilisation, by M. Armand Gautier. Aluminium phosphate was formed in the Minerva grotto by the action of ammonium phosphate, resulting from the destruction of a bank of guano, upon a subjacent layer of hydrargilite. This action is easily reproduced experimentally. It is even possible to form a small quantity of aluminium phosphate by the prolonged action of ammonium phosphate upon kaolin. Iron phosphates are produced by the action of ammonium phosphate upon spathic iron ore. This is probably the usual origin of vivianite. It is shown that the simultaneous formation of ammonia, sulphuretted hydrogen, and other products of slow bacterian fermentation, with the action of the air dissolved in water, gives rise, in strata at the same time calcareous and ferruginous, to the simultaneous production of lime phosphates and of pyrites.—Note by M. Daubrée accompanying the presentation, in the name of its authors, of the geological map of European Russia.—Observations of the planet Charlois (1893 Z) made with the 14-inch equatorial of the Bordeaux Observatory by M. L. Picart.—On the maximum modulus which a determinant can attain, by M. Hadamard.—Experimental determination of the constant of universal attraction, and of the mass and density of the earth, by M. Alphonse Berget.—On the third principle of energetics, by M. H. Le Chatelier. The laws of the conservation of mass, of momentum, of quantity of electricity, of the centre of gravity, &c., can be embodied in a single law as follows: The individual "energy capacities" of an isolated system are constant, except that of heat (entropy) which increases in irreversible transformations. This "energy capacity," so termed by Ostwald, is made up of several factors of the type of those enumerated above.—On the employment of mercury in potential equalisers by flow, by M. G. Gouré de Villemontée.—Research on the dielectric constants of some biaxial crystals, by M. Ch. Borel. The principal constants of five rhombic and ten clinorhombic substances were determined by finding their axes of polarisation and measuring their periods of oscillation in a uniform electric field, and also measuring the attraction along each axis of polarisation. The crystals were cut in the shape of spheres. The attraction method was like that used by Boltzmann, except that his bifilar balance was replaced by a unifilar quartz fibre balance. Most of the substances examined were double sulphates. A redetermination of the constants for rhombic sulphur showed a closer agreement with Maxwell's law than Boltzmann's results.—On a new method of directly transforming alternating into direct currents, by M. Charles Pollak.—On the combinations of oxalic acid with titanic and stannic acids, by M. E. Pechard.—Researches on the chlorosulphides of arsenic and antimony, by M. L. Ouvrard.—Action of carbonic oxide upon sodammonium and potassammonium, by M. A. Joannis.—On the combinations of boron bromide with the bromides of phosphorus, by M. Tarible.—On the action of zinc and magnesium on metallic solutions and on the estimation of potash, by MM. A. Villiers and Fr. Borg.—Observations on a marine miocene randannite of the Limagne d'Auvergne, by M. Paul Gautier.—The duration of excitability of the nerves and muscles after death is much greater than is generally believed, by M. A. d'Arsonval. This may be shown by means of the myophone, a kind of microphone arranged so as to indicate small muscular contractions. The instrument gives indications of muscular excitability in a rabbit even ten hours after death.—Remarks on M. d'Arsonval's paper, by M. Brown-Séquard. The fact that a muscle under the influence of complete cadaveric rigidity, remaining perfectly inert under the influence of the strongest impulses provoking contraction, is capable of rhythmic motor actions when its nerve is excited, is one of the most interesting discoveries in the physiology of nerves and muscles.—Sketch of the principal anatomo-pathological types of adult chronic gastritis, by M. Georges Hayem.—Observations on ice, made during the cruise of *La Manche*, by M. G. Pouchet.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Elements of Psychology: Prof. J. M. Baldwin (Macmillan).—Everybody's Guide to Music: J. Booth (Saxon).—A Handbook on the Steam-Engine: H. Haeder, translated by H. H. P. Powles (C. Lockwood).—Murray's Handbook—Switzerland, Savoy, Piedmont, 18th edition (Murray).—University Correspondence College Calendar, 1892–93 (London).—Worked Examples in Co-ordinate Geometry (Clive).—A Biographical Index of British and Irish Botanists: J. Britten and G. S. Boulger (West, Newman).—Foundations of the Atomic Theory (Alembic Club Reprints, No. 2): Dalton, Wollaston, and Thomson (Edinburgh, Clay).—Im Reiche des Lichtes, Sonnen, Zodiakallichte, Kometen: H. Gruson (Asher).—Hourly Meteorological Observations made at the Madras Observatory, January, 1856, to February, 1861 (Madras).

PAMPHLETS.—Sir J. B. Lawes and the Rothamsted Experiments: C. M. Aikman (Glasgow).—U.S. Department of Agriculture: Reports of Observations and Experiments in the Practical Work of the Division (Washington).—Traces of Glacial Man in Ohio: W. H. Holmes (Chicago).—Are there Traces of Man in the Trenton Gravels: W. H. Holmes (Chicago).—Distribution of Stone Implements in the Tide-Water Country: W. H. Holmes (Chicago).—Report and Proceedings of the Ealing Microscopical and Natural History Society for 1892 (Ealing).—Yorkshire Carboniferous Flora: R. Kidston (Leeds).

SERIALS.—Proceedings of the Royal Society of Victoria, Vol. v. new series (Williams and Norgate).—Journal of the Royal Microscopical Society, June (Williams and Norgate).—Journal of the Asiatic Society of Bengal, Vol. lxi. Part 2, No. 3. 1892 (Calcutta).—Journal of the Royal Agricultural Society of England, third series, Vol. 4, Part 2, No. 14 (Murray).—The Botanical Gazette, June (Bloomington, Ind.).—Nyt Magazin for Naturvidenskaberne, 33te Binds, 4de og, 5te Hefte (Christiania).—L'Astronomie, July (Paris).—Himmel und Erde, July (Berlin).—Journal of Botany, July (West, Newman).

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THURSDAY, JULY 13, 1893.

ORDER OR CHAOS?

THE question as to how the vast mass of scientific work which is now annually produced can be most readily sifted and utilised is a matter of pressing importance. There are two opposite types of scientific men who fail in achieving all of which they are capable, because they respectively pay too much and too little regard to the work of their predecessors and contemporaries. The one class are pre-eminently students. Masters of the past history of their subject, they are familiar also with its latest developments, but in the effort to know what others have done, they not unfrequently exhaust energies which might have been better spent in adding to knowledge. To such men a well-ordered scheme for bringing the results of research into a small compass would be a most valuable boon. Of the other type are those who declare, "I never read; if I want to know a thing it is easier to find out all about it in the laboratory than in the library." Whether this is so or not is largely a question of temperament, but there is no doubt that as matters now stand the task of repeating work which has already been done is often less distasteful and scarcely more wasteful of time and energy than the effort to discover if the question has been previously attacked, and if so, by whom and with what results.

In providing for the future it must be remembered that the art of scientific investigation is now taught at many educational centres. Students are turned out by the score who are not only capable of using ordinary laboratory instruments to good effect, but who have taken part in original research. Within a year or two they settle down as masters in schools, mechanics' institutes, or "Polytechnics," or are absorbed in some branch of technology. Whether or no they are to spend their lives in a dull routine of teaching or testing, falling gradually further and further behind the times, or whether they are to aid or even to follow the advance of knowledge depends largely upon the facilities for acquiring information which are afforded to them. They leave the University, or the University College, with its well-stocked library, and forthwith their touch or want of touch with the outer world depends almost entirely on the periodic literature of the science to which they have devoted themselves.

Such persons constitute a class which has only lately come into existence, which will increase largely in the future. Their wants must be considered if any improvement in the organisation of our scientific publications is taken in hand. It follows naturally from the spread of scientific education that the results of scientific study must be made more accessible than heretofore. It is not only the leisured amateur or the distinguished Professor who "knows the ropes" who are to be provided with ready access to knowledge. If a man who does not believe that his student days are over when he leaves college has the right of *entrée* to some first-rate library, and is free from the calls of business at the hours when it is open, he may study modern science there. If he remembers or can easily find out in what volume of the "Phil. Trans." or *Wiedemann's Annalen* the paper he requires was published, if he or his bookseller knows who to write to for a separate copy, and lastly, if he can afford the money to buy it, it is no doubt possible even when far from libraries to bring together the literature of any given subject. It is, however, contended that in all this there is an unnecessary waste of time and trouble, that there ought to be a recognised index, in which references to all that was known on any particular point at some given date are collected, and that each science should be served by some single journal or group of journals with clearly defined functions, in which all that is required in the description and publication of the results of later inquiry may be found.

The letter from Mr. Swinburne, which we published recently, thus raises a larger issue than that with which he chiefly dealt. The Royal Society has for some decades published an admirable name index to scientific literature. The task is rapidly growing beyond the powers of a single society, or indeed of a single country. It is only by the munificence of a wealthy and public-spirited Fellow that it can be carried on at all. Has not the time come when there should be an International Bureau, engaged on a full subject-catalogue, divided into separate parts devoted to different sciences so that the student of any one of them might obtain at a moderate cost an index to past research on his subject?

As regards the question chiefly discussed by Mr. Swinburne, viz. the publication of papers on Physics, it may perhaps be laid down that there are three classes of papers which require different treatment. First are those which should be published in full. They are at present found in the Philosophical Transactions and Proceedings of the Royal Society, in the *Philosophical Magazine*, in the Proceedings of the Physical Society, in the Reports of the British Association, and in the Transactions of the Cambridge and the Manchester Philosophical Societies. To these may be added the journals of the principal Scotch and Irish societies, with which for the present we do not deal. The same author not unfrequently publishes the same facts several times over in several of these periodicals, or publishes fragments of what is practically one series of researches in different journals. No greater state of chaos can be imagined.

Where a man publishes depends not upon the convenience of his readers, but upon whether his paper is ready in March for the Royal Society, or in September for the British Association, upon whether he cares more for a discussion at the "Physical" than for the honours of large type and quarto pages in the Transactions; upon whether he dreads anticipation, or is content to make the leisurely announcements which prove that he has the field to himself.

The second class of papers are those which are only worth publication in abstract. The Royal Society occasionally adopts this form of publication, but other societies for the most part either accept or reject a paper *in toto*.

The third class of paper is that which is a criticism or discussion of what is known rather than a description of an original research. At present these appear chiefly in the *Philosophical Magazine* and in our own columns. It is, however, with regard to the first two classes that the need for organisation is most keenly felt, and as Mr. Swinburne points out, the attitude of the Royal Society is of prime importance. Many would regret if the Society to which the "Principia" was communicated ceased to publish physical work, and indeed if we know anything of the feelings of English Physicists, we do not think that such a catastrophe is probable. On the other hand, it is impossible not to recognise the fact that the Royal Society is an obstacle to the realisation of a satisfactory scheme for the publication of English physical papers.

The Physical Society was founded because at that time the Royal Society offered no facilities for the experimental illustration of communications made to it. The meetings of both the elder and the younger society are fully occupied with the work now undertaken, in spite of the fact that the discussions at the meetings of the Royal Society are short.

If to-morrow all English physicists were to agree to send all their work to the Royal Society there would not be time to discuss it, and many of the papers thus offered, though worthy of publication, would be regarded as not of the type which the Society affects. Yet if there is to be organisation, if order is to succeed chaos, it can only be either by a friendly struggle between the Royal and the Physical Societies, which would not be likely to lead to any definite result at present, or by still more friendly co-operation between them, by which all that is desired might be attained in a few months. That going forward or standing still are alike difficult is undeniable. It is obvious that the conditions which apply to physics apply to other branches of natural knowledge. We shall be glad if those most closely interested will try to smooth the way by discussion in our columns.

THE CAUSES OF GLACIAL PHENOMENA.

The Glacial Nightmare and the Flood: a Second Appeal to Common Sense from the Extravagance of some Recent Geology. By Sir Henry H. Howorth, K.C.I.E., M.P., F.R.S., F.G.S., &c., &c. (London: Sampson Low, Marston and Co., 1893.)

IT is not uncommon to find that men who have devoted much time and careful research to the elucidation of complex phenomena have experienced all the phases of thought through which a succession of previous observers have passed in bringing the subject to its then present stage. This is more usual in certain classes of inquiry than in others, and in such it is clearly helpful to dwell upon the history of the development of opinion upon the question. It is giving, as it were, the embryology of an idea in order to enable the reader to understand better the adult form. In the volumes before us Sir Henry Howorth has rendered this good service to students of glacial phenomena.

The title of the book is unfortunate and may prejudice many against what is really a scientific work of great value.

Sir Henry first gives a sketch of the views of the earlier writers who referred all the phenomena in question to the action of water; then he explains how by degrees the agency of icebergs was called in; how it was next considered that larger glaciers would account for most of the facts; and how, after that, it was supposed that they were to be explained only on the hypothesis of great ice-sheets extending south from either pole, even to the tropics, according to some.

These ice-sheets must, of course, be accounted for by exceptional agencies, such as secularly-recurring astronomical combinations, in connection with which the author discusses the obvious inference that there must have been similar combinations and similar results in previous ages. He then devotes almost the whole of another volume to the various incidental theories which have grown up round the theory of circumpolar glaciation, or are necessary to it, and, finally, admitting a moderate extension of glaciers, he sums up in favour of stronger and more widely extended marine action than has of late been generally admitted.

As we read we cannot but learn to admire the shrewd observation of the older geologists, though the true explanation of the phenomena had not yet been put forward. We see how the obvious suggestion that great rushes of water would account for it all, set Von Buch and Hopkins to calculate what depth and velocity of water would be required to obtain force necessary to transport the blocks perched on the hills; and if there were difficult cases which made some of the "Champions of Water," such as Mierotto, De Luc, and Hall call in the aid of icebergs, still there was the fact that a great deal of the drift appeared to be sorted by water, and that, in great floods, boulders several feet in diameter have been hurried along the rocky bed of a stream with a noise like thunder; that large stones are often tossed by the storm waves to the top of precipices on our western rock-bound coast, as may be seen on a smaller scale where single stones are thrown on to a pier or promenade, though the sea-wall may be almost vertical. The gravel carried by a spate over the meadows is just like that found in the Esgairs, and is thrown up on either side of the torrent in long ridges. There is no doubt that a great deal of what is included in the drift, especially in Germany, is just like what is carried by flood water. It would not be comfortable to feel that the great old heroes of geology advocated views impossible in physics and unsupported by observation. Whether better explanations may in many cases now be offered is another question.

When it was once admitted that the glaciers were formerly much more extensive, and the drift round mountain regions was referred to their agency, it is easy to see how the impossibility of accounting for the occurrence of glaciers in North Germany, where what was thought to be similar drift was widely spread, led to speculation as to the possible extension of ice-sheets from high latitudes all over north-western Europe and north-eastern America, and the views of Bernhardi and Schimper, which involved an ice-sheet coextensive with the distribution of the drift began to be received with favour.

After this was given up as the *direct* cause, it was still held that its *indirect* effects would be very potent in producing extremes of climate alternately in the north and south hemispheres. The question now naturally arose whether there were any recurring glacial conditions in past times, and evidence of such action was seen in rounded surfaces and striated stones from various ancient rocks.

But most of the examples were from localities where the included fragments had been crushed against one another by earth movements, the grooves running alike across the included pebbles and the matrix in which they were imbedded. Or they were from the neighbourhood of what had been mountain ranges repeatedly through long ages. Even if we admit that some ancient conglomerates appear to have derived their boulders from glacial debris, that does not make the conglomerates glacial, but only requires glaciers in the adjacent mountains then as now. On the hypothesis of the geographical origin of glacial conditions, seeing that there must have been elevations and submergences over and over again, glacial phenomena should recur near the areas of upheaval, only without that periodicity which is required by the astronomical theory. There is, moreover, in the fossil flora and fauna no evidence of the recurrence of widespread glaciation such as would justify our referring it to a glacial epoch.

The astronomical glacialists further hold that not only were there secularly alternating periods of cold and heat in either hemisphere throughout the ages, but that within each period there were shorter periods of greater and less intensity of cold, of which we find evidence in the so-called interglacial beds of Britain, and in such deposits as those of Dürnten, where glacially striated pebbles underlie lignite which is covered also by morainic debris. But all advocates of the geographical explanation suppose that the earth movements on which it depends were discontinuous and subject to considerable oscillation, while the advance and retreat of glaciers, as a mere weather result, is so marked that we may safely admit that, as a climatic result of oscillations of level, it might be quite as great as required by any of the cases referred to.

Croll says that by far the most important of all the agencies, and the one which mainly brought about the glacial epoch, was the deflection of ocean currents, but he does not show that it is not possible to account for this deflection by earth movements.

There is one very important fact which does not seem to be generally recognised, namely, that the last glacial conditions extended only over a limited area on either side of the North Atlantic, and that this limitation must be referred to geographical causes, so that, if these were sufficiently powerful to determine the area, they may account for the glaciation itself. "What is wanted, however," our author remarks, "is not testimony to sporadic glaciers or local ice action, but to widespread glacial phenomena such as would witness an ice age."

The absurdity of the answer that percolating water must have removed ice markings from the surface of the stones is sufficiently obvious to any one who has had his attention called to the much finer markings on fossils, &c., which have been preserved.

The grooved stones of Devonian Age in Victoria are worth about as much as the facetted stones from Gorplitz by Barna, which are supposed to prove the great southerly extension of glacial action in Germany, but which more probably owe their form and condition to blown sand.

Several ingenious explanations have been offered of the occurrence of marine shells in stratified drift on the high ground of southern Sweden and northern England and Wales. The more obvious explanation is, of course, that they were left there as the shingly shore of the receding post-glacial sea. But this would have involved earth movements in comparatively recent times to so great an extent as would lend probability to the theory of such elevations as would account for glaciers in temperate regions, and of such submergences as would explain the widespread post-glacial sands and gravels. Some therefore suggested that these masses had been scraped up from the sea bottom and been pushed up the mountains to their present position; that they were, in fact, part of a great terminal moraine of the polar ice-sheet. Some got over the difficulty of explaining the even stratification and the ripple marks on the beds, as well as the non-Arctic character of the shells, by supposing that the sand and shells were pushed up in the ice from the sea bed in temperate regions, but that the deposit in which they are now seen was washed from the ice-foot at these several elevations by the fresh water due to the melting of the ice, and bearing away with it the mud, sand, and stones transported so far in the ice.

Too much stress must not be laid upon stratification and lines of boulders in the drift, as this may be produced by iceberg loads being thrown down in deep water; just as when a handful of mixed sand and grit of various form and different coarseness is dropped into a long glass of water, the larger grains will, *cæteris paribus*, reach the bottom first, and a rough stratification will be produced. The contortion of clays and sands can often be explained by the loads of debris carried by icebergs and dropped upon them, squeezing the underlying plastic mass away, and rolling up the surrounding layers in every variety of fold and crumple.

Our author lays great stress on the fact that there is now no polar ice-cap at all, and that all the evidence shows that the pole is not, and never has been, the centre of greatest cold or of greatest glaciation. The ice radiated from Scandinavia, not from the pole, and the pillars and prominent unglaciated rocks of Northern Asia show that there has been no ice sheet there in recent ages.

In his advocacy of a considerable submergence in comparatively recent times our author has the support of Prof. Prestwich, who, in the last number of the Proceedings of the Royal Society, has expressed the opinion that the masses of unstratified rubble commonly found resting on the slopes and terraces along the English Channel seem to be due to a force of propulsion for which the hitherto generally-suggested causes are manifestly inadequate. He extends his generalisation over Western Europe and the coasts of the Mediterranean, and arrives at the conclusion that the loess was a sediment deposited from the turbid sea-waters during the submergence, while the superficial deposits called "head" he refers to the surface debris swept off by divergent currents during the subsequent upheaval. Both of these movements he refers to periods of such short duration that large numbers of animals were simultaneously drowned and the waters were rendered so turbid as to be unsuited for marine life.

Our author explains many of the phenomena of the later drift by reference to a great submergence, but, wishing apparently to imply that it was of a still more transient nature, speaks of it as a great flood. His flood deposits are not, however, the same as those referred to by Prof. Prestwich.

Sir Robert Ball has pointed out that if the heat received in winter is distributed over thirty-three more days, instead of only over seven more, the result would be glacial conditions in the northern hemisphere, a result which has been somewhat modified by Mr. Hobson, who pointed out that the heat received over the regions within the Arctic circle should be omitted from the calculation.

But the opponents of the astronomical theory are prepared to admit that when we are dealing with operations in which the effects are so obviously cumulative and the reaction of one on the other so important, we may expect in climate, as there are in what we call weather, times of such unstable equilibrium that, for instance, a slight prolongation of the period of cold, which may be small in itself, may yet cause a local change, the effects of which may eventually become very far-reaching—as, in the case of weather, rain may be produced by the explosion of a small quantity of dynamite in the upper regions of the atmosphere. It is useless to deny the existence of such causes as those on which the advocates of the astronomical theory chiefly rely any more than we should deny the possibility of the detection of tidal action in one of the American lakes, because we are convinced that the real cause of the rise of six feet or so of water on one side is due to the gale which we observe blowing across the lake. Nor are we justified in rejecting the possibility of more or less rapid submergences resulting in a rearrangement of surface debris or even in more cataclysmic action of the same kind, as was seen in the earthquake wave that rolled in on Lisbon.

We do seem to require some simpler theory than that of the extreme glacialists to explain the phenomena of the Pleistocene Age.

If the north-eastern portion of America and the north western part of Europe were raised so as to get a snowy mountain range on either side of the Atlantic, sending ice-sheets down to the sea in the intervening depressed trough, and by the convergence of the axes of elevation deflecting the ocean currents and causing glaciers to creep down east and west from the mountain ranges—all the phenomena of the glacial epoch could be explained.

Reverse the process; send up Greenland and lower the North American and Scandinavian chains even to below where they now stand, bringing in again the warm currents from the South, and the post-glacial submergence takes its place. Let the Icelandic volcanic system play its part, and let there be earthquakes and jerks and oscillations, all part of the regular course of operations accompanying such movements, and we have the marine drifts all explained. The forms of life which have been driven away from the centres of ice dispersal will follow the receding glaciers back again. Observers will find in their own district evidence of land ice, or of icebergs, or of sea currents, or of glacier water, but in this less cumbrous theory there will be room for all.

The conflict of views recorded in Sir Henry Howorth's exhaustive work prepares one to believe that the matter may not be finally settled for some time, and, before public opinion comes to rest, we may expect many swings of the pendulum now far on this, now far on that side of the truth. But we welcome this protest against the extravagant views of the extreme glacialists and this valuable encyclopædia of the facts and arguments bearing on glacial phenomena which must be in the hands of every student of the subject. Our author is well known for his scientific treatment of literary subjects and for the literary skill with which he presents his scientific facts. Though he is an uncompromising advocate of what commends itself to him as the right view, he has indulged in no criticism which can be regarded as discourteous to the living or unfair to the dead.

T. MCKENNY HUGHES.

DYNAMO-ELECTRIC MACHINERY.

Original Papers on Dynamo Machinery and Allied Subjects. By J. Hopkinson, M.A., D.Sc., F.R.S. (New York: The W. J. Johnston Company, Limited. London: Whittaker and Co., 1892.)

The Dynamo. By C. C. Hawkins, M.A., A.I.E.E., and F. Wallis, A.I.E.E. (London: Whittaker and Co., 1893.)

THERE is hardly any greater authority on the subject of dynamo-electric machinery than Dr. Hopkinson. It was he who, turning his attention to the Edison machine, first showed how the iron in the magnets should be distributed, how the magnetising coils should be wound, and the machine built up so as to ensure its possessing the highest possible efficiency in every sense of the word.

This he did not attempt to do by mere theoretical speculation, though himself a great theorist, but by instituting a very complete and exhaustive set of experiments on dynamo machines under practical conditions, and graphically representing their results. No device in the whole history of the evolution of the dynamo has been of more general service than his plan of exhibiting the results of experiments in the well-named characteristic curve of the machine. This did for the dynamo what the indicator diagram had long been doing for the steam engine, though not, of course, in the same way.

With the most admirable simplicity this curve of electromotive forces as ordinates, and currents as abscissæ, gave just the information required regarding the action of the machine. Thus, when the ordinates represented the potential differences between the terminals, the inclination to the axis of abscissæ of the line joining the origin to any point gave the working resistance in the external circuit, corresponding to the current and potential difference defining the point to which the line was drawn, or, this resistance being known, gave the current and potential difference which the machine might be expected to develop with this as the working part of the circuit.

Then again, Dr. Hopkinson showed how the characteristic curve could be used to give the conditions under which an arc lamp can be made to work. It is well known that if the generating machine working on an arc lamp be run so as to give an electromotive force below a certain limiting value, the machine cannot be made to "keep" an arc. An explanation had been previously given by Dr. Siemens; but Dr. Hopkinson showed that all that was necessary was to lay down in the characteristic curve of the dynamo as already explained the line representing the *metallic* resistance R in circuit, then draw the tangent parallel to this line, and observe whether the ordinate corresponding to the normal working current of the lamp falls on the right or on the left of the point of contact. If E denote the length of the ordinate in question, and C denote the current, we have in the former case

$$dE < RdC$$

and in the latter

$$dE > RdC$$

Thus in the former case the value of dE is smaller than the increment of electromotive force required to drive the corresponding increase of current through the metallic resistance, in the latter case it is larger than this. Consequently, in the latter case, there will be an excess of electromotive force which will go to increase the length of arc. Thus the arc will continually lengthen until the current suddenly fails and the light goes out.

Hence the mere inspection of the curve settles the question as to whether the machine is running fast enough, or whether there is a sufficient margin of speed to ensure stability.

In the paper on Some Points in Electric Lighting, a large number of facts, now so well known as to have become common places of practical science, are discussed. But ten years ago, when the paper was read, many electricians engaged in supplying electric light were themselves working very much in the dark; and Dr. Hopkinson's paper was to many of them exceedingly useful as supplying facts, and especially hints as to graphical processes of investigating the behaviour of dynamos, whether used as a generator or a motor.

The next paper is that by the author and his brother, Dr. E. Hopkinson, on Dynamo-Electric Machinery, which has become justly famous as that in which the enormously useful idea of the magnetic circuit was first applied in a complete and consistent manner to the discussion of the results of experiment on different types of dynamo. In this a comparison between the characteristic curve of the machine, and the curve of magnetising force and magnetic induction, is made to give important information as to the proper disposition of the magnetic circuit, and the failure of the total induction to pass through the armature. Further, the effect of the lead of the brushes and of the current in the armature is fully discussed and graphically illustrated; and the paper closes with what were most valuable at the time, a description of the author's method of testing the efficiency of dynamos, and numerous results of experiments on machines with armatures wound according to the Hefner Alteneck plan, and the unsymmetrical horseshoe arrangement of magnets, and on others with Gramme armatures and the Siemens rectangular symmetrical arrangement of magnets. In these efficiency experiments the ingenious plan of using two similar machines in the same circuit and having their shafts coupled, one acting as generator, the other as motor, was first adopted. The motor in great measure drives the generator which feeds it, and it is only necessary to supply by means of a belt the balance of driving power required. Thus, uncertainty in dynamometric measurement of power transmitted has effect only on the estimation of this balance. The power developed by the motor can be found electrically, as likewise the electrical energy developed by the generator, and thus all the data are obtained for estimating the efficiency of the machine.

This idea has borne important fruit in the extremely valuable methods which have been invented by others for more conveniently carrying out similar dynamo experiments, and for testing transformers.

Next comes the very valuable continuation of this paper published only last year, which completes the discussion of direct current machines. In this sequel the effect on the electromotive force of the machine of the current in the armature for a given lead of the brushes is experimentally investigated, and compared with its theoretical value as given in the earlier part of the paper.

The remaining portion of the book consists mainly of papers relating to the theory of alternating currents, and the testing of alternate-current machines and transformers, and concludes with an account of the author's arrangements for applying the electric light to the lighthouses of Macquarie and Tino. The first paper on alternating currents is the one which has been so much referred to in recent discussions on the action of alternators, and the possibility of running more than one in the same circuit.

Though the increased use of alternating currents has added much to our knowledge of the behaviour and capabilities of alternators, Dr. Hopkinson's paper is, and will remain, one of the classics of the subject. But the last word of theoretical and practical explanation has not yet been said, and will probably not be said for a long time. In the meantime there is a possibility, now that the behaviour of iron in rapid magnetic cycles can be studied completely in various ways, of our obtaining further information which may clear up some of the outstanding difficulties of the subject.

Some results of a very interesting character as to rapid cycles are given in the paper on the Tests of Westinghouse Transformers. The curves showing the electromotive force and the current at different instants during a half period are plotted and come out very considerably different from the ordinarily assumed curve of series. The harmonic analysis, or the new analysing machine of Henrici and Sharpe, might with advantage be applied to them to reveal their components. From these curves the dissipation loops are plotted and made to give the loss of energy due to local currents and hysteresis in the curves.

Further description of these papers is unnecessary. They have already passed to a considerable extent into electrical literature; but a great service to practical electricians has nevertheless been done by their publication in a collected form.

In Messrs. Hawkins and Wallis's book we have little of originality; but what seems a straightforward, accurate, and fairly full account of dynamo-electric machinery. Beginning with chapters on the Magnetic Field, the Magnetic Circuit, the Production of an E. M. F., and Self-Induction, the authors enter on their main subject with a chapter on the Classification of Dynamos. The principal types of machine are described and well illustrated, so far as the number and general nature of the cuts are concerned. But while the authors have been liberal with carefully made drawings and well considered diagrams, the execution and printing of the illustrations in the text are here and there rather poor, and a higher general standard in this respect might easily have been attained.

After a general analysis, so to speak, of dynamos, in which armatures, magnets, &c., are discussed, we come to matters relating to the action of dynamos, such as series, shunt, and compound winding, and sparking and angle of lead of brushes. Then follow descriptions of typical machines, illustrated by folding sheets, and the book closes with chapters on Dynamo-Designing, and the Working and the Management of Dynamos.

We should have liked to have seen dynamo-testing worked out more fully, and a separate chapter on this important subject might easily have been given without burdening the book with matter properly belonging to works on general electrical measurements.

Considering the compass of the book—520 small 8vo pages—the authors have succeeded in placing before their readers a very great amount of valuable information, well arranged and clearly expressed, and their work will no doubt be appreciated by students and workers in practical electricity.

A. GRAY.

OUR BOOK SHELF.

Modern Microscopy: a Hand-book for Beginners. In two parts. 1. "The Microscope, and Instructions for its Use." By M. J. Cross. 2. "Microscopic Objects: how Prepared and Mounted." By Martin J. Cole. (London: Baillière, Tindall, and Cox, 1893.)

THIS book, although only extending to 104 pages, is what it professes to be, and will prove thoroughly useful to beginners. The authors understand practically their respective subjects, and this has given the capacity, never otherwise possessed, to tell the beginner accurately and efficiently what it is needful for him at the outset to know.

It is highly to be commended that they have not rendered their pages incompetent by any pretence at an introduction to the optics of the instrument, or concerned themselves with any attempt at exposition of modern optical theory. They have done what affords a more genuine evidence of their appreciation of the importance of these subjects, having presented the results of the study of them in a practical form to the beginner, so that although his earlier efforts are not complicated with mathematical demonstrations and theory, he is nevertheless taught to work, on the highest results reached through these, so far at least as they apply to his initial endeavours.

The danger of extremely elementary books on microscopy is shallowness. They have often been a mere catalogue of two or three chosen instruments, with brief accounts of the apparatus affected by the author, and descriptions of pretty or pleasing objects. The former part of this book is much more than this; it gives the results of a practical knowledge of how to employ the instrument in such a way as to attain the finest results; always remembering that it is beginners that are receiving the instruction.

There are some thoroughly sensible things said on the microscope-stand. We may differ slightly from some of these, but they are written with a knowledge of the subject, and those who follow them will not greatly err.

We can commend also the chapter on "Optical Construction." It is brief, but puts to the beginner exactly what he requires to know. The pages on "Illuminating Apparatus" are specially commendable because thoroughly experimental. In fact, the fifty-five pages devoted to modern microscopy will be a boon to every one of the many who are every year "beginning" with the use of the microscope.

But the practical character of the book is seen even more clearly in the second part of it, by Mr. Martin Cole. He at once introduces the tyro to the art of preparing and mounting his own objects. Here again it is not a mere repetition of what has been obtained from other sources that is presented, but Mr. Cole's long experience as a mounter is given to the reader unostentatiously and with pleasant and useful brevity.

There are some who, glancing at this little treatise, will at once conclude that the thirty-six pages devoted to the subject must leave it inefficiently treated even for beginners. We advise such to read the pages; and after some years of practice in most of the departments of mounting referred to and explained, we can only say that they present in a brief but a very efficient manner the facts required to enable the earliest efforts of an earnest amateur to become so successful as almost certainly to secure his interest in the subject, and cause him to intelligently pursue his pleasure and instruction, if not to aim at scientific work directed by more exhaustive treatises.

W. H. DALLINGER.

Lectures on Sanitary Law. By A. Wynter Blyth, M.R.C.S., L.S.A. (Macmillan and Co. 1893.)

THIS work presents a general view of the powers and duties of Local Authorities in relation to public health, and since the material has been compiled by one who, while he is a prominent sanitarian is also a barrister-at-law, the fact that the work is good and trustworthy, and leaves but little to be desired, goes without saying. The only point upon which there is any scope for adverse criticism is that the review of sanitary legislation appears to be, in places, a little too cursory, and in consequence some important material is a trifle too hurriedly passed over. To indicate one such instance:—There is some important material contained in the Dairies, Cowsheds, and Milkshops Orders of 1885 and 1886 which is not given, and with which the health-officer is directly concerned. Sections 10, 11, and 12 of the 1885 Order are omitted; and no one will question their right to be fully included within any serviceable abstract of the Order, since they deal specifically with certain well recognised sources of contamination, against which it is necessary to guard the milk in those places where it is stored or kept for sale.

Nothing need be more inclusive or better expressed than the majority of the work, and when in one or two places the information is a little more extended, and the statutes specially dealing with the inspection and examination of food (which are now given *in extenso* in the appendix) are incorporated in, say, another two chapters, the book will be rendered even more acceptable than it is at present to those desirous of obtaining in a readable and concise form a good knowledge of sanitary legislation.

The scope of the book embraces the entire range of public health legislation, and the volume is largely an embodiment of a series of lectures which have frequently been given by the author. The first chapter treats of the constitution of Sanitary Districts and Authorities, and includes the definitions of certain terms employed in the Sanitary Acts. Lecture ii. deals with the statutory provisions regarding nuisances; and the next three lectures are concerned with the legal aspect of sewerage and drainage, water-supply and sanitary appliances; regulations and bye-laws; port sanitary law, canal boats. Metropolitan sanitary law, the Housing of the Working Classes Act, 1890, are all dealt with in subsequent chapters; and the statutory provisions which deal with the prevention of disease are particularly well and clearly mapped out in Lectures vi. and vii. The book comprises nearly 300 well-printed pages, and it is neatly and serviceably bound.

The author must be congratulated upon having presented a rather heavy and unattractive subject in the most concise and readable form—consistent with general usefulness—of any in which it has hitherto appeared.

LETTERS TO THE EDITOR.

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

The Royal Society.

THE article on the Royal Society, published in NATURE of June 8 by my friend Mr. Thiselton-Dyer, contains very little statement of fact to which I, or any one acquainted with the history and traditions of the Society, could wish to take exception.

It does, however, seem to me to be important to point out (a thing Mr. Thiselton Dyer has omitted to do) that the tendency of the development of the Society has been to restrict its ordinary membership to those who have done valuable work in "the improvement of natural knowledge" either by the exercise of their own mental gifts, or by assisting in some marked way—by the wise application of money or other direct influence—the efforts of others to that end. When, some thirty-five years ago, the annual number of elections of ordinary Fellows was practically restricted to fifteen by the limitation to that number of the list recommended by the Council, the chance of admission to the Society for "a member of the legislature with the keenest sympathy for science" (to quote Mr. Thiselton-Dyer's words) became small; and as the years rolled on, and the number of serious workers in science increased in unexpected proportion, it became less and less. Accordingly, not many years ago, it was determined by the Society, in order to meet this undesirable state of things, that members of the Privy Council should be eligible at any time as Fellows of the Society without reference to the annual list of fifteen prepared by the Council. Apparently the intention of this measure was to relieve the ordinary annual list of fifteen candidates for Fellowship from the presence of a certain number of members of the legislature with keen sympathy for science, and other such aspirants, and to reserve it for those for whom it could be claimed that they had done something tangible for "the improvement of natural knowledge." It seems to me that the selections made by the Council since that date confirm this view. Mr. Thiselton-Dyer makes a mistake in confounding the real services to natural knowledge rendered by Sir John Kirk, Sir George Nares, and Sir Charles Warren, with the "sympathy for science" of amiable members of Parliament.

There is another aspect of the question recently discussed which seems to me to be important. Does the Royal Society propose, or does it not, to include in its annual elections persons eminent in historical study? If it does, surely Freeman, Stubbs and Gardiner would have been Fellows of the Society. The examination and exposition of documents when they relate to an Asiatic race cannot be regarded as more akin to the investigations of the improvers of natural knowledge than is the study of the inscriptions, camps, and pottery of European peoples. Does the Royal Society explicitly or implicitly recognise claims which would give their possessor a first place in an Academy of Inscriptions or of Historical Science? I should venture to reply to this question: "Certainly not; by most definitely expressed intention such studies as those of the historian were excluded by the founders of the Society from their scope. And further, were such studies to be embraced by the Society as a new departure, it would be necessary to make special provision for them by increasing the annual number of elections, and by securing seats on the Council for one or two persons acquainted with those studies and the merits of those who pursue them."

I believe that the Royal Society is honoured and trusted by the British public as being the leading society "for the improvement of natural knowledge." Its original and deliberately chosen motto, "Nullius in verba" is a distinct profession of its purpose to appeal to experiment and the observation of phenomena, rather than to encourage the disquisitions of the bookman and compiler of history.

Though it may well be urged that such a body as "the Royal Society for the Improvement of Natural Knowledge" is wise in offering a kind of honorary membership on special terms to those who are a power in the State, there seems to be no ground for maintaining that the Fellows (as Mr. Thiselton-Dyer declares) "display themselves as reasonable, if hard-headed, men of the world" when they sacrifice one of their fifteen ordinary annual fellowships for the purpose of enrolling among their number an isolated example of the numerous body of historians and essayists who have attained some distinction in subjects and methods remote from those professedly pursued by the Society.[1]

Were the Royal Academy of Arts to assign one of its Associateships to, let us say, a distinguished botanist who is known to have a keen sympathy for Art, the world would, I venture to maintain, consider that the Academicians had not "brought themselves into touch with another field of national life," nor "displayed themselves as reasonable or hard-headed men of the world," but had simply stultified themselves whilst conferring no real honour upon their nominee. The Royal Academy includes a small number of laymen as honorary members, but it is recognised that the Academicians shall only confer their regular membership upon those of whose work they are *competent judges*, and consequently upon those who are really honoured by the selection, namely, artists.

It seems to me that *mutatis mutandis* much the same is true of the Royal Society. The Society has gained in the past, and will retain in the future, public esteem, and increasing opportunities for usefulness by aiming with singleness of purpose at "*the improvement of natural knowledge.*" To confer honour on those who have improved natural knowledge is its privilege and its duty. The appreciation of historians and of "sympathetic legislators" is a function which the Society is incapable of performing, and moreover one which few, if any, persons desire it to attempt, since it must lose dignity by assuming to adjudicate in matters in which it is incompetent.

Oxford, June 26. E. RAY LANKESTER.

ALTHOUGH my friend Prof. Lankester finds that the "tendency of the development" of the Royal Society has been to restrict the area from which its members are selected—a conclusion in which I am not disposed to agree—I do not find that he seriously impugns the account which I attempted to give of what appeared to me to be the traditional practice of the Society in the matter.

In fact in one respect he goes much further than I should myself be inclined to do in admitting as a qualification for membership "the wise application of money." I must confess that I should be disposed to regard this, for obvious reasons, with very close scrutiny.

Apart, however, from this it is evident that Prof. Lankester and those who agree with him would like to make the Royal Society much more professionally scientific (for there are very few scientific men nowadays who are not in some sort or other professional). If they succeed I am disposed to think that it would be a very much less influential body than it is at present. And I find that no inconsiderable body of the existing Fellows are of the same opinion. W. T. THISELTON-DYER.

Kew, July 1.

Ice as an Excavator of Lakes and a Transporter of Boulders.

I HAVE devoted a considerable space in a work I have recently published in which I have criticised the extreme glacial views of some writers to an issue which underlies a great deal of their reasoning, and which, it seems to me, it is absolutely necessary we should determine before we are entitled to make the deductions habitually made by them.

Before a geologist is justified in making gigantic demands upon the capacity and the power of ice as an excavator or as a distributor of erratics and other debris over level plains it is essential that he should first ascertain whether it is capable of the postulated work or not. It is not science, it is a reversion to scholasticism to invoke ice as the cause of certain phenomena unless and until we have justified the appeal by showing that it is competent to do the work demanded from it. This preliminary step is not a geological one at all. It is a question of physics, and must be determined by the same methods and the same processes as other physical questions. So far as we know the mechanical work done by ice is limited to one process. The ice of which glaciers are formed is shod with boulders and with pieces of rock which have fallen down their crevasses. These

[1] I have addressed my remarks mainly to the contentions of Mr. Dyer's article. I should wish to avoid discussing the merits of a particular election which in my opinion cannot now and never could legitimately be a subject for public comment. I wish, however, to state that I am not unacquainted with the interesting essays on the history of geological theory which we owe to the hero of that election.

pieces of rock abrade and polish and scratch the rocky bed in which they lie when they are dragged over it by the moving ice. Without this motion they can of course effect nothing either as burnishers or as excavators.

This motion has been shown by recent experiments to be very largely if not entirely a differential motion due to the viscous nature of ice, as Forbes long ago argued on *à priori* and other grounds that it was. The viscosity of ice is different at different temperatures. It differs also greatly when it is in the form of granulated ice, such as a glacier is composed of, from ice formed in a laboratory or directly frozen from water in a pond, but in any case it is slight, and it needs a considerable and a long-applied force to make it shear. The consequence is that when it rests on a level or nearly level surface, where gravity does not work, it ceases to move at all. In order that it should acquire motion sufficient to drag stones, &c., along, it is necessary that there should be some *vis a tergo*. Either the ice must rest on a slope sufficiently inclined to generate a gravitating movement in it, as a whole, or the slope of its upper surface must be sufficiently great to cause the movement of its surface layers to be continued down to and to remain effective in its nethermost parts. Every attempt made by Croll and others to invent for, and assign to, ice molecular movements capable of causing lateral motion in the stones beneath it other than those induced by gravity, seems to me to have utterly failed. The cause—the only cause which is competent to make it move is gravity acting either in one or the other way above specified.

This seems to be the inevitable conclusion whenever the problem is tested as it ought to be tested, by empirical tests. If so, it seems to put out of court the continual appeals made to ice as the distributor of debris over hundreds of miles of level plains, and as the excavator of basins and lakes at a considerable distance from mountain slopes.

In the first place, the modulus of cohesion of ice being what it is, it has been shown by Mallet, Oldham, and Irving that thrust cannot be conveyed through it for more than a short distance, since it must yield and eventually crush.

This *à priori* view is supported by the actual observation of glaciers in which we find that the rate of motion is very largely a function of the slope of the bed, and when a glacier leaves the slope on which it rests and gets on to level ground it very soon ceases to move altogether.

It has been argued that in the Ice Age the ice was piled up in dome-shaped ice sheets, and that the distribution of the boulders and the excavation of mountain lakes was due to the results of the efforts of the viscous mass to reach a state of equilibrium by hydrostatic movement, or by rolling over itself. But this ignores the very slight viscosity of ice which would require a very high slope in its upper layers to induce movement in its lower ones at all. It is impossible to see how this high slope could be secured, since the effort to restore equilibrium would be continuous, and the potential movement involved in every fresh fall of snow would at once be dissipated instead of being accumulated.

I cannot see, therefore, how under any circumstances it is possible for ice either to travel over long distances of level ground, or to excavate hollows such as the great majority of mountain lakes are.

I have not in this letter referred to the geological difficulties of such an hypothesis, which are manifold. I have limited myself to the physical difficulties alone. They seem to me to underlie the whole problem, and it is useless to discuss it until they have been solved, yet they are persistently ignored by the ardent champions of ice. That ice can do a good deal when allied with gravity is true enough, but the problem, as presented by Mr. Wallace, Prof. James Geikie and others requires that it should continue to do portentous work when no longer allied with gravity. Is it too much to ask that some justification should be offered (and nowhere better than in your catholic pages) for such an enormous unverified postulate?

Athenæum Club, July 1. HENRY H. HOWORTH.

Abnormal Weather in the Himalayas.

ON May 26 I walked from Changla Gali (about 9000 feet) to Dungar Gali (under 9000 feet) by the "pipe" road. On the way we passed (the road is cut along the side of the steep mountains) a narrow valley filled with snow to about a height of 100 feet. The width of the hard snow on the road was 20 feet. On the 28th I walked back to Changla Gali by the main road. Here we saw a great deal of snow. A bridge spanned a narrow valley, a mass of flat snow, perhaps 15 feet thick, filled the valley to the bridge. No snow ran up the valley. Then we came on two valleys converging into one at the point where the road passed. Both valleys above and the valley below were filled with snow, and the road for 150 feet was cut on the face of the snow.

In the first week of May terrific storms burst over Murree; we had constant storms at Dungar on the night of the 26th up to 12 a.m. on the day of our leaving, the 28th. On the 28th the last two miles of the road into Changla were simply carpeted with leaves and twigs broken off by a violent hailstorm. The sides of the road, sometimes the road itself (four hours after the storm), were covered with drift and massed hailstones of the size of big marbles (ice with the usual whitish centre).

This continuance of snow and this stormy weather is stated to be altogether abnormal. F. C. CONSTABLE

Changla Gali, May 29.

Peculiar Hailstones.

A FRIEND of mine writes me from Peshawar about a very curious phenomenon which I think is worth notice in your columns. The monsoon has set in this season earlier than for some years past. A few days ago in a village named Daduzai (a tehsil in the Peshawar district) rain fell, preceded by a wind storm, and with the rain came a shower of hailstones which lasted for a few minutes. The most curious part of this occurrence is that the hailstones when touched *were not at all cold*, and when put in the mouth (as is the custom in this hot country) tasted like sugar. I am further told that these hailstones were extremely fragile, and as soon as they reached the ground they broke in pieces. These pieces when examined looked like broken sticks of crystallised nitre. My informant tasted them, and was struck with their purity and sweetness. A few pieces were also sent to the Deputy Commissioner of the district. The phenomenon has been duly reported in the leading newspapers of the province, and the *Akhbar-i-Am* has noted it in its leading columns. KANHAIYALAL.

Lahore, June 20.

Crocodile's Egg with Solid Shell.

DURING the year 1885 I was stationed at Trincomalee, when it was my luck to find a large crocodile's egg near Kantalay tank. On showing the specimen to several friends who knew more about natural history than I did, they expressed their astonishment at seeing a hard-shelled egg, as the concensus of opinion was that such eggs were invariably surrounded with a soft parchment-like covering.

I made a hole in the top and bottom of the egg and blew out the contents. The shell is still in my possession, and resembles more the hard enamelled-like egg of the ostrich than anything else I have seen.

The above facts may interest those who take a pleasure in objects of natural history. J. BATTERSBY.

Murree Hills, June 7.

UNIVERSITY AND EDUCATIONAL ENDOWMENT IN AMERICA.

THE statements in the following extract are so remarkable that I think they deserve a wider publicity than they will probably receive in the pages of a Parliamentary paper.

One may hope that the reconstructed University of London will make provision for post-graduate study and the advancement of knowledge in the greatest city of the world. It must be admitted that this cannot be done without the expenditure of a good deal of money. May one hope further that the cause of the higher education will find friends amongst us in London as munificent as university and technological studies have found in one of the newest of the world's cities?

Kew, June 30.

W. T. THISELTON-DYER.

Extract from "Report for the year 1892 *on the Trade of the Consular District of Chicago." (F.O. Annual Series,* 1893, *Diplomatic and Consular Reports, No.* 1233.)

FIVE years ago the University of Chicago was not thought of, and now there are twelve fine buildings of English Gothic architecture, either finished and occupied or in course of construction, on twenty-five acres of land owned by the University in the neighbourhood of Jackson Park, near the Exhibition grounds, where three years ago was a marsh. The University has now a large staff of professors, selected from other institutions in the country and Europe, and about 1000 students. Its origin and rapid growth are greatly owing to the generosity of Mr. Rockefeller, who in 1889 offered an endowment of £120,000 if a committee could raise the sum of £80,000; this sum was quickly raised, and about the same time a merchant of Chicago presented the University with twelve acres of the ground on which the buildings now stand. Further gifts came in, and up to the present time the total donations amount to £1,284,000, of which Mr. Rockefeller alone has contributed £754,000. The sums given in 1892 amounted to £711,500, and among the gifts was the offer of a telescope, to be the largest and most powerful in the world, which, with the observatory in which it will be placed, will cost more than £150,000. The University was opened last October with a faculty of 115 professors, men and women. One of the features of its regular work will be university extension and a system for the education of the masses.

A magnificent gift was last year presented to the city, and entitled the Armour Institute, after the patriotic and public benefactor of that name. It consists of a large and handsome building already completed, and fitted interiorly with marble wainscoting on every floor, marble arches and marble bath rooms, and the gift was accompanied with an endowment of £289,000. It is to be used as a manual training school and an institute for every branch of science and art; it is fitted with laboratories, forges, gymnasium, and library, and contains electrical, lecture, and other rooms for domestic sciences. It is intended as a benefit to young men and women of every class to be within the range of the poorest, and is taking the form of a school of technology.

ANTIPODEAN RETRENCHMENT.

LAST week a brief reference was made in these columns to the decrease in the grant to the University of Melbourne—a curtailment only justifiable under very special circumstances, and one that may bring reproach on the Colony that adopts it. Since then we have seen a letter in the *Journal of Education* for July by Dr. E. A. Abbott, late Headmaster of the City of London School. The letter is as follows:—

I venture to ask space for the following extract from a letter I received to-day from the Professor of Mathematics in Auckland College, New Zealand. Prof. W. S. Aldis was Senior Wrangler and First Smith's Prizeman in 1861, and subsequently, for several years, Principal of the College of Physical Science in Newcastle-on-Tyne. The failure of his wife's health induced him, about ten years ago, to accept the Auckland Professorship, at some sacrifice of income, on the understanding, of course, that he was irremovable as long as he could do the work. After nearly ten years of service, here is the result, as stated in the extract, which bears date May 19. I give it with the mere suppression of the name of the chief mover in this business.

> "Last Monday —— succeeded in getting a majority of the Council to give me six months' notice of the termination of my engagement, on the ground that the amount of work I did could be perfectly well performed by plenty of men who could be got for a much lower salary. . . . No charge of incompetence or neglect of duty has been made against me, unless by slander behind my back. I have never been asked to meet the Council; the debates were held with closed doors; and, before I even knew what was being proposed, I was allowed to read the result of their discussion in the *New Zealand Herald*."

Those who know my old schoolfellow, Prof. Aldis, as a man incapable of dereliction of duty or exaggeration of fact, will think that the only way of meeting the necessities of the case is to rescind the resolution. Others may reasonably defer their final judgment till they hear what is to be said on the other side; but meantime I would appeal to all University men to defer applying for the professorship. For the present, to succeed a professor thus arbitrarily dismissed by the Council involves not only the possibility of being similarly treated, but also the certainty of contributing to what Sir Robert Stout has justly described as "a grievous injury to higher education." Many teachers, and many University men who are not teachers, will, perhaps go with me still further, and agree that, if Prof. Aldis's statements cannot be denied, no one can take the post without some forfeiture of self-respect.

Dr. Abbott puts the case plainly and fairly enough, and, lacking an explanation from the Council concerned, we conclude that this is another example of the reactionary policy of retrenchment which now fills the minds and dictates the deeds of Colonial officials. Let them retrench by all means, but in the right direction. There could hardly be a more short-sighted and mistaken policy than that of curtailing educational grants in order to redeem a position lost by extravagant expenditure. Wealth-producing power and facilities for obtaining knowledge go hand in hand. In the past many of the Colonies have proved that they recognised the prime importance of their Universities and similar establishments. Indeed, they have often shown the way to the authorities at home. Apparently, however, this wisdom is departing from Colonial Councils, for healthy branches are being lopped off indiscriminately, while obtrusive suckers at the roots of the constitution are left untouched. However, it is not too late to rescind the measures that have been taken—measures that are derogatory both to the good sense and dignity of Colonial Governments. We trust that the next mail will bring us news of the reinstatement of Prof. Aldis and the restoration of University grants.

SCIENCE IN THE MAGAZINES.

THE July magazines contain a few papers of scientific interest. In the *New Review* Mr. E. R. Spearman writes on "Criminals and their Detection." This article is a vigorous protest against the crude methods of identification employed at Scotland Yard. In spite of the thousands of blunders that have been made, our police authorities are stolidly indifferent to their imperfections, and look upon the Bertillon system as a "scientific fad." But this is the way in which the official mind usually views matters of scientific importance. To show the absurdity of the position taken up, Mr. Spearman gives a full description of the Bertillon process o measurement, with the results obtained since the method was adopted in France, and compares it with the haphazard system of identification used in our prisons. But for the fact that officialism never acknowledges itself to be in the wrong, *bertillonage* would have been established in England long ago.

The Bertillon system, says Mr. Spearman, is fast circling the globe. Our great Indian Empire has taken it up, the whole province of Bengal being recently put under its protection, and still more recently the island of Ceylon. Even in still more Eastern Asia, Japan has borrowed M. Bertillon's scheme. In Eastern Europe, Russia (St. Petersburg and Moscow) and Roumania are using the system, which is also practised in Norway and Switzerland. In North America the United States Government has successfully applied anthropometry to deal with deserters in the army and navy; while Chicago not only uses the system for its own purposes, but is the centre of a large field of operations in the States and in the adjoining portions of the Dominion of Canada. Beside this, on the Pacific coast it was successfully used to enforce the Chinese immigration law, the Celestials being able to use each other's permits with impunity, all being alike as two peas to the casual Caucasian glance, but not to the Bertillon compasses. In South America the Bertillon system has also penetrated, the Argentine Confederation making use of it.

The anthropometric system could be established in England at the present time, for Mr. Spearman points out that in the Penal Servitude Act, 1891, it is enacted that

The Secretary of State shall make regulations as to the measuring and photographing of all prisoners who may for the time being be confined in any prison, and all the provisions of section six of the Prevention of Crimes Act, 1871, with respect to the photographing of prisoners, shall apply to any regulations as to measuring made in pursuance of the section.

Dr. S. S. Sprigge has an article on "The Poisoning of the Future." He says:—

There are two directions which the poisoner of the future may take in an intelligent attempt to use superior knowledge in the accomplishment of undetected crime. One of them is the bringing of the older methods of poisoning to perfection by the exhibition of subtler drugs. The other, and by far the more terrifying, is the employment by the poisoner of the results of recent biological research.

Neither of these methods is likely to be very successful, for those who understand the power of such deadly essences as strychnine, atropine, digitalin, and aconitine, or know how to isolate, cultivate, preserve, and inoculate the germs of a malignant disease, will be comparatively marked men, inasmuch as they will belong to a limited class.

The *Humanitarian* appears this month for the first time as a magazine. In it M. A. Bertillon gives a description of the anthropometrical measurements made in France under his direction. The measures taken are (1) height, (2) length of head, (3) maximum breadth of head, (4) length of middle finger of left hand, (5) maximum length of left foot, (6) maximum length of arms extended, (7) colour of the eyes. M. Bertillon describes in detail all the operations, and shows how the measures are classified so that the question as to whether a prisoner has been arrested before or not can be irrevocably settled in a few minutes.

In the *Contemporary Review* Mr. G. J. Romanes, F.R.S., furnishes a postscript to his article in the April number in support of Weismannism against Mr. Herbert Spencer. The points touched upon are (1) the principle of Panmixia, or cessation of selection; and (2) the influence of a previous sire on the progeny of a subsequent one by the same dam. Mr. Spencer briefly replies to Prof. Romanes, and Prof. Marcus Hartog follows with a short description of the works of Weismann, from the publication of the essay on "Heredity" in 1883 to the last conception of the germ-plasm and the theory of variation at present held by the great zoologist of Freiburg.

Prof. Thorpe, F.R.S., contributes to the *Fortnightly Review* a descriptive account of the recent solar eclipse in the form of a reprint of a discourse delivered at the Royal Institution. As the article contains no information of scientific moment that has not been chronicled in these columns, further comment upon it is unnecessary.

The *Century Magazine* contains an article by Dr. Allan McLane Hamilton on "Mental Medicine," or the treatment of disease by suggestion. Though a vast amount of quackery is carried on in connection with hypnotism and mesmerism, there is no doubt that many cases have been successfully treated.

It is only within the past few years that scientific men have really adopted suggestion in a rational way, and the advances in phychology and psychopathology have paved the way for the use of a most potent agent. Our knowledge of disorders of motility and the disturbance of the governing coordinating faculties permits us to determine the pathology of certain convulsive and spasmodic conditions, which until recently were simply looked upon as vague symptomatic states. Writer's cramp, which is a diseased automatism, has been repeatedly cured by suggestion made during the hypnotic state. I have seen forms of persistent tremor, chorea, speech defects, and other motor disturbances very much ameliorated, if not always cured, by the methods of Luys and Bernheim. In England and elsewhere suggestion has been used for the correction of certain mental states manifested in moral perversion, among which dipsomania and certain varieties of infantile viciousness figure; and my own experience has convinced me that in some insanities it is certainly a most valuable means for combating the development of delusions, and in restoring the equilibrium of an unbalanced nervous system.

"The Galaxy" (seen through a telescope) forms the subject of a short poem by Mr. Charles J. O'Malley. He finely describes the Milky Way in the lines—

"Luminous archipelago of heaven!
Islands of splendour sown in depths of night."

In *McClure's Magazine* Dr. H. R. Mill describes the Arctic Expeditions of Nansen and Jackson under the title "The Race to the North Pole." The former expedition started from Christiania a few days ago, but Mr. Jackson will not leave England with his companions until about the middle of July, or perhaps the beginning of August. He intends to approach Franz-Josef Land, which will be a comparatively easy task, and then to advance over the ice in sledges, trusting that the land-ice stretches northwards to the immediate neighbourhood of the Pole. If, however, Franz Josef Land proves not to have a great northerly extent, an advance may be made on the sea-ice, carrying boats for crossing open water. Mr. C. Moffett summarises the programme of Lieut. Peary's expedition, pointing out several important considerations which make it probable that the expedition will attain a considerable measure of success. It remains to be seen whether any or all the explorers will reach the goal. The race is a long one, and will tax to the utmost the energies and pertinacity of those who have elected to run.

"An Expedition to the North Magnetic Pole" is the theme of an article by Colonel W. H. Gilder. About three years ago Prof. Mendenhall wrote to the Secretary of the United States Treasury as follows:—

"The importance of a redetermination of the geographical position of the North Magnetic Pole has long been recognised by all interested in the theory of the earth's magnetism or its application. The point as determined by Ross in the early part of this century was not located with that degree of accuracy which modern science demands and permits, and, besides, it is altogether likely that its position is not a fixed one. Our knowledge of the secular variation of the magnetic needle would be better increased by better information concerning the Magnetic Pole, and, in my judgment, it would be the duty of the Government to offer all possible encouragement to any suitably organised exploring expedition which might undertake to seek for this information."

Acting upon a further recommendation, the Secretary of the Treasury requested the President of the National Academy of Sciences to appoint a committee of its members "to formulate a plan or scheme for the carrying out of a systematic search for the North Magnetic Pole and kindred work," and such a committee was subsequently appointed, with Prof. S. P. Langley, Secretary of the Smithsonian Institution, as Chairman.

The observers will be selected from among the officers of the United States Navy attached to the Coast Survey, who have had special training in magnetic field work, and a scheme of the observations to be made has been drawn up by Prof. C. A. Schott.

It is proposed to charter a steam whaler to take the party from St. John's, Newfoundland, to the northern part of Repulse Bay, which, being directly connected with Hudson's Bay, is the nearest point to the Pole, containing area that is accessible any year. There a permanent station is to be erected, where regular observations will be continued all the time, and from which each spring a field party (perhaps two) will start to locate the geographical position of the Pole.

NOTES.

THE annual meeting of the Institution of Naval Architects commenced at Cardiff on Tuesday, when an important paper upon "Fast Ocean Steamships" was read by Dr. Elgar. Owing to the rough weather, Lord Brassey, the president, was unable to be present, his yacht being prevented from reaching the fort.

THE forty-second meeting of the American Association for the Advancement of Science will be held during August at Madison, Wisconsin. The local secretary is Prof. C. R. Barnes, of the State University.

THE second annual meeting of the International Union of Photography will be held in Geneva from August 21 to 26. The headquarters of the Union are at 33, Rue Rembrandt, Antwerp.

ARRANGEMENTS have been made for a visit of the Geologists' Association to Ireland from July 24 to 29. The directors of the excursion are Profs. W. J. Sollas, F.R.S., and Grenville A. J. Cole, and a very attractive programme has been provided. In addition to the serious work, more than one social gathering is promised, so the trip will doubtless be enjoyed by all who undertake it. A geological map of the district to be visited, prepared by Prof. Cole, is printed in the special circular issued for the excursion by the Association, and Prof. Sollas's paper on the geology of Dublin and its neighbourhood, read before the Association on the 7th inst., is now in the press, and will be published the day before the party leaves London. As it is important to obtain an early estimate of the probable number of the party, all members who propose joining the excursion should apply at once to the Secretary, Mr. Thos. Leighton, Lindisfarne, St. Julian's Farm Road, West Norwood, S.E.

A COPY of the report of the Zoological Society that has just been printed has been received. Its contents will be summarised next week.

THE fifth Congress of Archæological Societies in union with the Society of Antiquaries was held on Tuesday at Burlington House, Sir John Evans, K.C.B., F.R.S., being in the chair. About forty delegates were present, including Lord Hawkesbury, Mr. Stanley Leighton, M.P., Profs. Flinders Petrie, and E. C. Clark, &c. It was announced that progress had been made with the archæological maps of Essex, Derbyshire, Sussex, and Surrey. Several papers were read, one on "A Photographic Record of Archæological Objects" exciting an interesting discussion.

THE Laboratory of the Marine Biological Association at Plymouth has still a few tables unoccupied for the summer vacation. Applications for permission to work there should be sent in without delay to the Director.

WRITING from Murree, on June 7, Mr. F. C. Constable says that, during a recent hailstorm, corrugated iron roofs were in many cases perforated by the hail. He measured one hailstone four hours after the storm, and found it to be 4½ inches round.

A VIOLENT thunderstorm occurred on Ben Nevis last week from 11 p.m. of Friday to 2 a.m. of Saturday, St. Elmo's fire appearing there at the same time. During another thunderstorm on Saturday afternoon flashes came off from the telegraph wire connections inside the observatory; and about the same time a fire-ball was seen to strike the ground near the foot of the hill. The hygrometric fluctuations at the time were remarkable.

DURING the past week sharp thunderstorms have occurred in many parts of the British Islands, accompanied by hail and very heavy rain. Between the 7th and 9th the fall within twenty-four hours exceeded an inch at several places in the north of England and in parts of Scotland, and in the north of Ireland on Sunday it amounted to 2·81 inches, a fall more than double the total for the month of June this year. The temperature was also exceptionally high in the southern parts of England during the first part of the period, the maximum reading being 89°·9 at Greenwich on Friday and Saturday, a temperature which was not equalled in any part of the summer during the five years 1888–92, and at Cambridge the shade reading on Saturday registered 92°.

SINCE February, 1892, a Richard thermograph has been installed on the summit of the Obir, at a height of 2140m., or about 1000m. below the level of the Sonnblick Observatory. The records of temperature up to February, 1893, as shown by this thermograph, were communicated and discussed by Director J. Hann at a recent meeting of the Vienna Academy (June 12). They afford a valuable contribution to the knowledge of the daily changes of temperature in the higher regions of the atmosphere. A comparison with the corresponding temperatures registered on the Sonnblick shows an almost identical course of changes, except that in summer the range on the Obir was perceptibly larger. During eight months, from October to May, hardly any daily variation is recorded in the decrease of temperature with height between the Obir and Sonnblick. In the summer months, the most rapid decrease was found to occur at 1 p.m., being 0°·74 per 100m., the least rapid at 11 p.m., being 0°·61 per 100m. The mean decrease per 100m. for the summer months was 0°·67, for winter 0°·54, and for spring and autumn 0°·56.

A NEW determination of the mass and the density of the earth has been made by M. Alphonse Berget, who describes his method in the current number of the *Comptes Rendus*. It consisted in altering the level of a lake by 1 m., and noticing the effect produced upon a hydrogen gravimeter such as was used by Boussingault and Mascart to determine the diurnal variation of gravity. The lake was that of Habaz-la-Neuve, in Luxemburg, of 79 acres area, belonging to M. François de Curel. The level could be raised or lowered in a few hours. The variation of the column of mercury was minutely observed by means of Fizeau's interference fringes, produced *in vacuo* between the surface of the mercury and a piece of plane-polished glass at the bottom of the observing tube. Two series of readings were taken, the one on lowering the level of the lake by 50 cm. and 1 m., the other on raising it by the two corresponding amounts. The displacement of the column for a change of level of 1 m. was $1·26 \times 10^{-8}$ cm. The value for K, [the constant of gravitation, *i.e.* the attraction in dynes produced by a mass of 1 gr. upon another placed 1 cm. from it in air, was found to be $6·80 \times 10^{-8}$. The mass of the earth was found to be $5·85 \times 10^{27}$ grammes, and its density 5·41, which is in fair agreement with results hitherto obtained.

DURING the cruise of the *Manche* in the neighbourhood of Jan Mayen and Spitzbergen, M. G. Pouchet made some interesting observations of the various kinds of ice to be found on those barren Arctic islands. In the northern lagoon of Jan Mayen, which was partly covered with ice on July 27, the ice, according to a description in the *Comptes Rendus*, was formed of irregular vertical prisms about 10 mm. thick separated by spaces of about 1 mm. and joined at the upper surface by a uniform layer of semi-transparent ice 1 to 2 mm. thick. At

Research Bay, Spitzbergen, the gigantic front of the two glaciers which flow into the sea presented three different tints. At the base some parts were quite dark, suggesting deep caves, but really consisting of pure homogeneous, compact ice. The middle region was greenish-blue, and the upper, consisting of snow-ice, was white. The ice-floes were either white or greenish-blue, or of an extremely intense emerald green. On taking one of the latter out of the water it was found to consist of homogeneous limpid ice, absolutely colourless to the thickness of 1 m. or so. The deep green colour was due to its illumination by the green water of the bay, which, like that of the Isfjord, is of an intensely green colour.

AN important paper by Messrs. Sarasin and De la Rive is published in the *Archives des Sciences Physique et Naturelles* and contains an account of a series of experiments on the interference of electrical waves after reflection from a metallic screen. The authors being of opinion that the results obtained by Hertz and themselves in a former investigation were vitiated on account of the reflecting surface being too small, undertook this series of experiments, using as a reflecting surface a sheet of zinc 16 metres long and 8 metres high. The arrangement employed was almost the same as that used by Hertz, the spark-gap of the oscillator, however, being surrounded by oil. The resonators were circular, and had been used in a previous series of experiments on the propagation of electrical waves along conducting wires, in which it had been found that each resonator responds to waves of a definite wave-length, and to these only. A series of observations, made with a view of ascertaining the minimum size of mirror, which gives consistent results with resonators of different sizes, showed that for a resonator of 75 cm. in diameter the reflecting surface must have a length of from 12 m. to 14 m. and a height of 8 m., while for a resonator of 35 cm. in diameter a mirror 5 m. long and 3 m. high is sufficient. The results obtained may be summed up as follows:—(1) A circular resonator has a constant wave-length to which it responds, whatever be the dimensions of the oscillator, the strength of the induced spark only varies, attaining a maximum value for a certain length of the oscillator, which gives waves in unison with the resonator. (2) The quarter wave length of a circular resonator is approximately equal to twice its diameter. (3) In the case of normal reflection from a metallic mirror the first node coincides exactly with the surface of the mirror. (4) The velocity of propagation of the electrical waves is the same in air as along conducting wires.

WE have received a copy of a calibration curve of one of Prof. Perry's new electric current meters, which are now being constructed for practical work by Messrs. Johnson and Phillips. This meter, as some of our readers may know, consists of a copper bell (with open neck) which rotates about its axis in a radial magnetic field formed between an inner cylinder and an outer surrounding cylinder, both of iron, and magnetised by a coil surrounding the inner. As the surfaces of these cylinders are furnished with teeth projecting towards one another, leaving just sufficient clearance space for the bell, there are, alternating with one another round the bell, places of maximum and minimum field intensity. The bell is immersed in mercury, and being covered with varnish, except at the lip and at the neck, where it receives and gives out current, is the seat of a current sheet running from the lip to the neck. Thus the bell rotates about its axis with a speed depending on the current flowing and the intensity of the magnetic field. By the ingenious device of rendering the field non-uniform, the resisting couple due to solid and fluid friction is made small in comparison with that due to Foucault currents; and as the latter is proportional to the square of the maximum field intensity multiplied by the speed of rotation, and the driving couple to the product of the field intensity and the current, a working formula is obtained in which the current is proportional to speed and to field intensity. By making the field sufficiently intense, the speed can be made as slow as may be desired, and error from neglect of friction proportionately diminished. The meter is thus very simple, and unlikely to get out of order, or to be inconstant or untrustworthy in action. It is claimed, further, that the temperature errors balance one another, and this is borne out by the fact that the calibration curve is a straight line from the first current marked, 2·5 ampères, to the highest, 60 ampères. The instrument must therefore, within the range of currents for which it is designed, work with great accuracy.

THE *Philosophical Magazine* for July contains a note by Messrs. Harvey and Hird on some differences they have observed in the behaviour of positive and negative electricity in high frequency discharges. They find that, when a brush discharge takes place in air between a point and a plate, the plate is always positively charged, although the discharge is oscillatory. In the case of hydrogen, however, the plate becomes negatively electrified. Thus in the case of a brush discharge in air or oxygen the positive electricity passes more readily than negative from a point into any neighbouring conductor, while in hydrogen the reverse takes place, negative electricity passing more readily.

WEBER showed some years ago that the eggs of the common pike could be caused to produce double monstrosities if the recently fertilised ova were violently shaken. Mr. John A. Ryder has recently communicated a paper to the Academy of Natural Sciences of Philadelphia, which leads to the belief that the Japanese produced their singular breeds of double-tailed goldfishes by taking the eggs of the normal species of goldfishes and shaking them, or disturbing them in some way, as Prof. Weber did with the eggs of the pike. They would thus obtain some complete double monsters, some with two heads and a single tail, and some with double tails. Those most likely to survive would be those with only a duplication of the tail. These being selected and bred would probably hand down the tendency to reproduce the double tail, a tendency which could become fixed and characteristic if judicious selection were maintained. Mr. Ryder thinks that his investigation warrants the conclusion that the regenerative power of organisms disappears as we rise in the scale of organisation, last of all in the peripheral extremital parts. He further observes that the power to produce monstrosities or cogenital aberrations of development due to external disturbances of segmentation, during growth, diminishes in the higher forms *pari passu* with the advance in development.

IN a number of papers communicated to the American Philosophical Society, the American Academy of Arts and Sciences, and the Boston Society of Natural History, Mr. A. S. Packard gives the results of studies on the life-history of some Bombycine moths. He has worked out the transformations of several of the lower Bombyces, and has arrived at some valuable results. He has treated the larvæ as though they were adult, independent animals, and has worked out their specific and generic as well as family characters. The origin of mimetic and protective characters has been traced, and the time of larval life when they are assumed ascertained. This involves a study of the development of the more specialised setae, spines, tubercles, lines, spots, and other markings. Facts have also been obtained with regard to the ontogeny of American species and genera, which, when compared with the life-histories of European, Asiatic, and South American Bombyces, may lead to a partial comprehension of the phylogeny of the higher Lepidoptera.

THE *Essex Naturalist*, No. 4, contains an address on periodicity in organic life, delivered by Mr. Henry Laver as retiring President of the Essex Field Club. Reasons are given for the belief that plant and animal life periodically fluctuate in richness and scarcity.

AT Trenton, and the Delaware Valley, and Ohio, flints have been found in ice-age drift and described as implements of palæolithic man. In three papers received from Mr. W. H. Holmes this interpretation is disputed, and the "finds" are said to be of Indian manufacture—a view which, if accepted, tells against the existence of glacial man in America.

PROFS. L. CICCONE and F. CAMPANILE have prepared a set of tables showing the intensity of gravity, in C.G.S. units, for every ten minutes of latitude (*Rivista Scientifico-Industriale*). They also give the value of *g* at all the principal observing stations in the world.

OWING to the delay in the publication, by the U.S. National Museum, of a "Monograph of the North American Bats," by Dr. Harrison Allen, the introduction to the Bulletin has been issued in advance. Judging from it, the coming memoir will be of an important character.

MESSRS. FRIEDLANDER AND SON, Berlin, have issued their *Natural History News*, No. 10.

THE "Transactions of the Leicester Literary and Philosophical Society," vol. ii., part 12, contains a paper on stings and poison fangs, by Mr. G. T. Mott, and a number of notes on some East Anglian birds, by Mr. L. Creaghe-Haward.

A VOLUME has just been published containing the results of rain, river, and evaporation observations made in New South Wales during 1891, under the direction of Mr. H. C. Russell, C.M.G., F.R.S., the Government Astronomer of the colony.

IN *Das Wetter* for May G. Falkenhorst gives an account of the various plants which are affected by weather, including the paternoster-pea (*Abrus precatorius*), or "weather plant," the claims of which as a prognosticator of coming weather were shown to be groundless in the *Kew Bulletin* of January 1890. He points out that the indications of these hygroscopic plants, however worthy of study from a botanical point of view, only refer to simultaneous changes of weather.

THE Royal University of Ireland has issued its calendar for the year 1892. The papers set at the examination held during the year are published in a separate volume as a supplement to the calendar.

THE "Matriculation Directory" has been published by the University Correspondence College Press. It contains solutions to the questions set at the matriculation examination of London University last month, and articles on the special subjects for January and June next year.

"DIE MEDICINISCHE ELECTROTECKNIK," by Dr. J. L. Hoorweg, is a little book, dealing chiefly with elementary facts and principles more or less connected with medical electricity. Magnetism, statical electricity, voltaic electricity, and electrical measurements are the subjects of four separate chapters, and the remaining three chapters are devoted to a study of the action of electricity upon the human body, electro-medical apparatus, and various methods of electrification. The text is illustrated by seventy-seven figures and diagrams.

THE second number of Alembic Club Reprints can now be obtained from Messrs. Simpkin, Marshall and Co. It is entitled "Foundations of the Atomic Theory," and contains reprints of papers by Dalton and Wollaston, and an extract from Dr. Thomas Thomson's "System of Chemistry," in which book the earliest printed account of Dalton's views was given.

A NEW acid containing chromium and sulphuric acid, possessing somewhat remarkable properties, is described by M. Recoura in the current number of the *Comptes Rendus*. It is related to pyrosulphuric acid, $H_2S_2O_7$, in a manner somewhat similar to that in which the chromosulphuric acid, $(SO_4)_2Cr_2(SO_4H)_2$, previously prepared by M. Recoura, is related to ordinary sulphuric acid. Its constitution is represented by the formula $(S_2O_7H)_4Cr_2(OH)_2$. Its most remarkable property is that the two atoms of hydroxylic hydrogen are readily replaceable by metals to form salts, the whole of which, even those yielded by the introduction of the metals of the alkalies and of ammonium, are completely insoluble in water, although the acid itself is readily soluble. It has been termed chromopyrosulphuric acid. In order to prepare it a solution containing one molecular equivalent of chromic sulphate, $Cr_2(SO_4)_3$, and five molecular equivalents of sulphuric acid is evaporated over a water-bath, when a syrupy liquid of a deep green colour is eventually obtained. This liquid is then further heated to a temperature of 110–115° for a couple of days, which treatment induces a complete change of character and transparent tabular crystals of the new acid, possessing a vitreous lustre and a bottle-green colour, are deposited. Its formation is represented by the following equation:—

$$Cr_2(SO_4)_3 + 5H_2SO_4 = (S_2O_7H)_4Cr_2(OH)_2 + 2H_2O.$$

THE properties of chromopyrosulphuric acid differ widely from those of chromosulphuric acid. It is readily soluble in water, forming an opaline yellowish-green solution. This solution yields precipitates with the solutions of all commonly occurring salts, those of the alkalies not excepted. It may be generally stated that upon the addition of the solution of any metallic salt whatever to a solution of chromopyrosulphuric acid, a flocculent precipitate, more or less green in colour, is obtained. The precipitate, however, is not chromopyrosulphuric acid in which merely the hydroxylic hydrogen is replaced by the metal of the salt employed. One half of the pyrosulphuric acid is detached, and in contact with the water present produces four molecules of free ordinary sulphuric acid. The salt precipitated is thus derived from the acid $(S_2O_7)_2Cr_2(OH)_2$. For instance, when a solution of potassium chloride is added to a solution of chromopyrosulphuric acid the following change occurs:—

$$(S_2O_7H)_4Cr_2(OH)_2 + 2KCl + 2H_2O = (S_2O_7)_2Cr_2(OK)_2 + 2HCl + 4H_2SO_4.$$

Similarly copper sulphate solution produces a pale green precipitate of the salt $(S_2O_7)_2Cr_2{<}^{O}_{O}{>}Cu$.

Solutions of caustic alkalies act like salts. Thus, when a solution of caustic soda of known strength is slowly added a precipitate of the sodium salt $(S_2O_7)_2Cr_2(ONa)_2$ is thrown down, and the solution attains its neutral point when ten molecular equivalents of soda have been added, the amount required to form the above salt and to neutralise the four molecules of sulphuric acid liberated. M. Recoura has also isolated the acid itself from which these salts are derived, and promises a description of its properties in a subsequent memoir.

NOTES from the Marine Biological Station, Plymouth.—Last week's captures include the Nemertines *Prosorhochmus Claparedii* and *Carinella linearis*, numbers of the Polychæte *Myzostomum* on *Antedon rosacea*, various species of the Pantopod genera *Phoxichilus*, *Nymphon* and *Ammothea*, the Isopod *Apseudes talpa*, the Schizopod *Heteromysis formosa*, the Brachyuran *Achæus Cranchii*, and the Nudibranchiate Mollusca *Æolidiella glauca* and *Galvina cingulata*. The chains of the

Salp *Thalia democratica-mucronata* have now for the most part broken up, and the detached sexual forms, each with a contained embryo, have been taken in considerable numbers. The floating fauna has also included Cirripede and Copepod Nauplii, Polychæte trochospheres and Molluscan veligers. Among Leptomedusæ *Clytia Johnstoni* and small *Obeliæ* have been abundant; and among Anthomedusæ *Sarsia eximia* has been observed, together with numbers of an apparently undescribed species of *Dysmorphosa*, resembling *Rathkea octopunctata* in its power of budding from the manubrium. The Mollusc *Galvina cingulata* and the Tunicate *Thalia democratica-mucronata* are now breeding.

THE additions to the Zoological Society's Gardens during the past week include an American Black Bear (*Ursus americanus*) from Canada, presented by Mr. Joseph Politzer; a Hawk's-billed Turtle (*Chelone imbricata*) from the West Indies, presented by Mr. C. Melhado; two Common Buzzards (*Buteo vulgaris*) European, deposited; two Australian Crows (*Corvus australis*) from Australia, purchased; a Thar (*Capra jemlaica*, ♀), a Triangular-spotted Pigeon (*Columba guinea*), a Cardinal Grosbeak (*Cardinalis virginianus*), two Hybrid Pied Wagtails (between *Motacilla lugubris*, ♂, and *M. melanope*, ♀) bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

A NEW COMET.—A telegram received from Prof. Krueger announces that a comet with a bright tail was discovered by M. Quenisset at M. Flammarion's observatory, Juvisy, on July 9, its approximate place being R.A. 7h. 50m., N. Decl. 48° 10′. The comet is therefore in the constellation Lynx.

In *Edinburgh Circular* No. 38, Mr. Heath says that a second telegram from the same source states that the comet was again seen on the 10th, at 12h. 59·3m. M.T. at Kiel, its place being then R.A. 8h. 29m. 45·7s., N. Decl. 46° 59′ 29″; daily motion, + 34m. 48s. and − 1° 24′.

COMET FINLAY (1886 VII.).—A continuation of M. Schulhof's ephemeris for the ensuing week is as follows:—

12h. M.T. Paris.

1893		R.A. app.		Decl. app.
		h. m. s.		° ′ ″
July 13	...	3 59 23·84	...	+18 54 32·8
14	...	4 3 57·65	...	19 10 20·2
15	...	8 30·28	...	19 25 35·4
16	...	13 1·69	...	19 40 18·4
17	...	17 31·83	...	19 54 29·3
18	...	22 0·65	...	20 8 8·3
19	...	26 28·11	...	20 21 15·4
20	...	4 30 54·16	...	20 33 51·0

In the above ephemeris we have corrected the error made in the *Astronomische Nachrichten* (No. 3171), where the 16th is inadvertently printed 14th.

METEOR SHOWERS THIS MONTH.—In the list of the radiants of the principal meteor showers which Mr. Denning gives in the companion to the *Observatory* the following are visible this month, that occurring on the 28th being defined as "most brilliant":—

Date.		Radiant. α	δ		Meteors.
		°	°		
July 19	...	314	+48	...	Short, swift.
20	...	269	+49	...	Swift.
22	...	16	+31	...	Swift, streaks.
25	...	48	+43	...	Swift, streaks.
28	...	**339**	**−12**	...	Slow, long.
30	...	6	+35	...	Swift, streaks.

L'ASTRONOMIE FOR JULY.—The current number of this journal commences with an article by M. Tisserand on the inauguration of the statue of Arago, which was referred to in these pages last week. M. Deslandres briefly refers to some of his results as shown by the photographs taken by him at the late total solar eclipse, to which are added the observations of several other observers, and several illustrations of the instruments employed. M. Denning contributes three drawings of comet Holmes (made on November 9, 16, and 19 last), showing its change of shape from the circular to the pear-shaped form. Other articles of interest refer to meteorological statistics, atmospheric phenomena, earth tremblings, &c. In the notes some recent measures are given of the diameter of Mars, and of the snow caps, the former made by M. W. W. Campbell at the Lick Observatory, and the latter by M. Asaph Hall at the Washington Observatory.

HIMMEL UND ERDE FOR JULY.—In this number Dr. W. Luzi concludes his interesting article on the diamond, having covered the ground between the first observations made at Florence in 1694, and M. Moissan's recent researches. Dr. Wilhelm Meyer continues his chapters on the physical condition of the planet Mars after the evidence of eminent observers, while Herr Gingel gives us his fourth chapter on the mechanics of the heavens, dealing with the new researches by G. H. Darwin on the influence of tides on the movements and form-proportions of the heavenly bodies, embracing particularly the earth-moon system. Among the notes that on variable stars calls for attention.

MUSEUMS ASSOCIATION.[1]

II.

THESE are the principles of what may be called the New Museum idea as applied to national museums of natural history. It is a remarkable coincidence that since they were first enunciated, and during the time of their discussion, but before they had met with anything like universal acceptance, the four first nations of Europe almost simultaneously erected in their respective capitals—London, Paris, Vienna, and Berlin—entirely new buildings on a costly, even palatial scale, to receive the natural history collections, which in each case had quite outgrown their previous insufficient accommodation. In the construction of neither of these four edifices can the guardians of the public purse be accused of want of liberality. Each building is a monument in itself of the appreciation of the government of the country of the value and interest of the natural history sciences. So far this is most satisfactory. Now that each is more or less completed, at all events for the present, and its contents in a fair way towards a permanent arrangement, it may not be without interest on the present occasion to give some comparative account of their salient features, especially with a view to ascertain whether and to what extent their construction and arrangement have complied with the requirements of the modern idea of such institutions.

It may seem ungrateful to those who have so liberally responded to the urgent representations of men of science by providing the means of erecting these splendid buildings, to suggest that if they had all been delayed for a few years the result might have been more satisfactory. The effects of having been erected in what may be called a transitional period of museum ideas is more or less evident in all, and all show traces of compromise, or rather adaptation to new ideas of structures avowedly designed for old ones. In none, perhaps, is this more strikingly shown than in our own, built, unfortunately, before any of the others, and so without the advantages of the experience that might have been gained from their successes or their shortcomings. Though a building of acknowledged architectural beauty, and with some excellent features, it cannot be taken structurally as a model museum, when the test of adaptation to the purpose to which it is devoted is rigidly applied. But to speak of its defects is an ungracious and uncongenial task for me. If it were not taking me too far away from my present subject I would rather speak of the admirable manner in which the staff are endeavouring to carry out the new idea under somewhat disadvantageous circumstances.

The new zoological museum in the Jardin des Plantes at Paris is a glorification of the old idea pure and simple. It consists of one huge hall, with galleries and some annexes, in which every specimen is intended to be exhibited, more or less imperfectly, on alternate periods to students and to the general public. The building and cases are very handsome in style, and there are endless rows of specimens of all kinds neatly mounted in a uniform manner. There are no storerooms, no laboratories, no workrooms connected with the building. These are all in

[1] Continued from p. 236.

other more or less distant parts of the establishment, separated from it in most cases by the whole breadth of the garden. Of course this can only be looked upon as a temporary condition of affairs. Fortunately there is still room on the site of the old museum behind the new building, and if this is utilised by erecting upon it a commodious set of workrooms, laboratories, rooms for reserve collections and administrative offices directly in connection with each other and with the main building, which might then be emptied of a considerable portion of its contents, an extremely good working museum may be evolved. But if this space, as I believe was the original design, is used for the further extension of the already over large public galleries, the opportunity will be lost.

The new museums at Vienna, the one for natural history, the other for art, placed one on each side of a handsome public garden in one of the most important quarters of the city, exactly alike in size and architectural features, are elegant buildings, and present many excellent features of construction. The natural history museum, which was alone finished when I visited Vienna three years ago, is a quadrilateral structure with a central court, and consists of three stories and a basement. Each story is divided into a number of moderately-sized rooms, opening one into another, so that by passing along in the same direction, the visitor can make an inspection in systematic order of all the collections arranged in each story, returning to the point from whence he started; or, if need be, breaking off at the middle where a passage of communication runs across the central court. An admirable feature in the design of this museum, is that the public galleries of each story, lighted by windows from the outside of the building, have on their inner side other rooms communicating with them, and lighted from the court within, which are devoted to the private studies of the curators and to the reserve collections belonging to the same series as the exhibited collections in the public galleries with which they are in connection. Thus the public collections, the reserve collections, and the officers in charge are are in each section of the museum brought into close relation—a most advantageous arrangement—and one greatly facilitating the new museum idea. The only drawback is that these rooms, occupying the inner side of the quadrangular range of galleries, are necessarily small, and as the collections grow, will be found insufficient for the purpose. This has, in fact, already proved to be the case in several departments, and a remedy has been found by devoting the whole upper story of the building to the reserve collections of insects, shells, and plants, and the working library of the institution, an arrangement which gives excellent accommodation for these important departments, at all events for the present. Another great future difficulty will arise, owing to the building being externally architecturally complete and visible on all four sides from the public grounds in which it stands; it therefore admits of no extension, and the public galleries already contain as many specimens as can possibly be placed in them with any advantage. These are in most sections, especially the invertebrata, displayed in an extremely tasteful and instructive manner, but the series is by no means over large for a national museum. The limitation of space is partly due to the somewhat singular division which has been made between the art and the natural history collections. Instead of taking the dividing line adopted at the British Museum between specimens in a state of nature, and those fashioned by man's hand, the pictures, the splendid collection of European mediæval armour, the classical and Egyptian antiquities are treated as works of art; but the so-called ethnological collection, containing the specimens of Mexican, Peruvian, Japanese, Chinese, Polynesian, African, and prehistoric European art, are placed in the Natural History Museum, taking up a large portion of the space, which the curators of the zoological, mineralogical, and geological departments hoped to have had at their disposal for the display of their specimens. Whether room could be found for them in the Art Museum or not I cannot say; but certainly their actual position is incongruous, and it is difficult to understand why a Peruvian mummy should find its place in a building professedly devoted to natural history, while the preserved remains of an ancient Egyptian are treated as works of art.

Before leaving Vienna I should like to refer to the splendid specimens of taxidermy by the artist Hodek, the choicest examples of whose work are contained in a special collection, occupying a small separate room, consisting of sporting trophies of the late Crown Prince Rudolph. Otherwise the general level of the specimens in the galleries is in no wise remarkable. The birds have the advantage of being mounted, not upon turned wooden stands of uniform pattern as in Paris, but upon pieces of natural tree branches, fixed in square or oblong oak stands. The exhibited specimens of vertebrate zoology include skeletons, but no other anatomical preparations, of which there is a distinct collection in the University Museum. The exhibited fishes and reptiles are exceedingly well preserved and mounted in spirit. In the Mollusca, Articulata, Echinoderms and Corals great care has been taken in setting the specimens off to advantage by selecting appropriate colours for backgrounds. Specimens in spirit are interspersed in their proper places. All have printed labels. The cases in which they are displayed are of oak, and of very handsome and even ornamental construction.

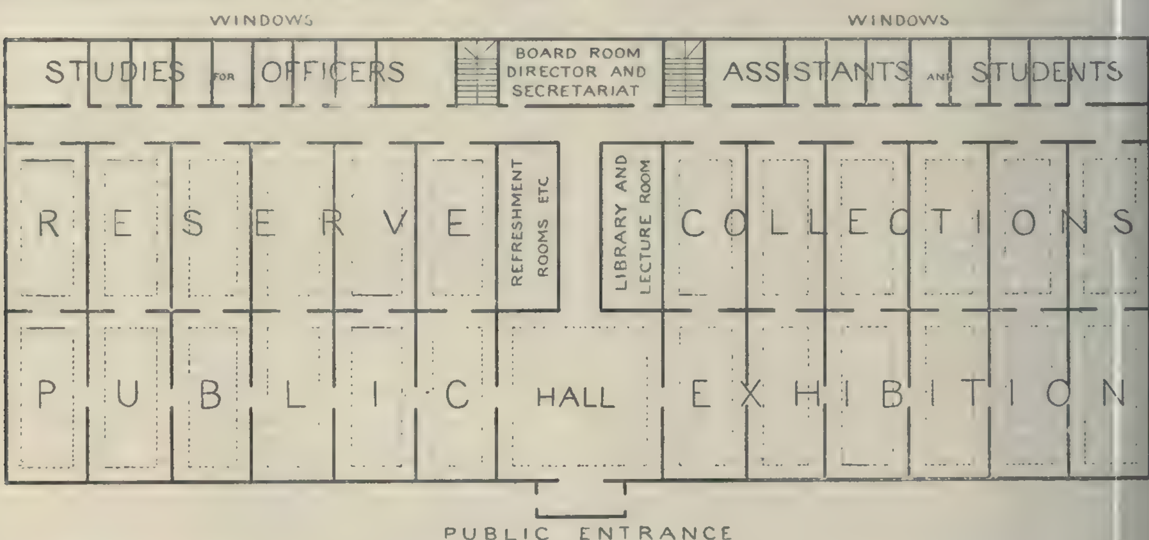
The arrangement of all these collections displays a most intelligent appreciation of the needs of the ordinary visitor. Thus in the room appropriated for the exhibition of insects there are three distinct series, a general systematic series, a morphological series, and a very fine special collection of the insects of the neighbourhood of Vienna. The other rooms are arranged more or less on similar principles The main collection of insects, is, as I have mentioned before, entirely apart in rooms very well adapted to the purpose in the upper floor of the building, and kept as usual in drawers in cabinets.

The zoological portion of the new museum for "Naturkunde," in Berlin, situated in the Invaliden Strasse, is a remarkable illustration of the complete revolution of ideas on museum arrangement, which took place between its commencement and its completion. The building, entirely designed upon the old system, came empty into the hands of the present director, who has arranged the contents absolutely upon the new method. It consists of a fine glass covered hall, and three stories of galleries, all originally intended for a uniform exhibition of all the various groups of specimens which had accumulated in the crowded rooms of the old museum in the University. When Dr. Möbius succeeded to the directorate he conceived the bold plan of limiting the public exhibition to the ground floor, and devoting the two upper stories entirely to the reserve or working collections. This was a step which required some courage to take, especially as the two great staircases, which are the principal ornamental architectural features of the building, have by it become practically useless. Except, of course, for certain inconveniences always resulting from adaptation of a building to purposes not originally contemplated, especially local disjunction of different series of the same groups, the result has been eminently satisfactory, and if the arrangement is completed upon the lines laid down by the Director, as explained to me on my last visit, this will be the most practical and conveniently arranged museum of natural history at present existing. As much attention appears to be bestowed upon making the exhibited portion attractive and instructive, as on making the reserve collections complete and accessible to workers. In the former, the characteristics of the native fauna were being specially developed. For instance, the fish collection (of which the individual specimens are beautifully displayed, fastened on to glass plates in flat-sided bottles) consists of a general representative systematic series, and three special faunistic collections, one of the German fresh-water fishes, one of the north and east sea fishes, and one of the Mediterranean fishes. One room is devoted to German mammals and birds, and the recently added specimens show indications of an improvement in taxidermy which would have been impossible in the old days of wholesale bird-stuffing. Excellently prepared anatomical specimens, diagrams, explanatory labels, and maps showing geographical distribution, are abundantly introduced among the dried specimens of which such collections are usually composed, and a commencement has been made of illustrations of habits and natural surroundings. On the other hand, in marked contrast to Vienna, everything in the way of architecture and furniture and fittings is severely plain and practical, and a uniform drab colour is the pervading background of all kinds of specimens. All danger from fire seems to have been most carefully guarded against. The floors are of artificial stone, the cases, and even the shelving, are constructed of glass and iron. Wood is almost entirely excluded, both in the structure and fittings. The ground floor, as I have said, is entirely devoted to the public exhibition, the first story to the reserve collection of vertebrates, and the upper story to the invertebrates; and the basement contains commodious rooms for unpacking, mounting, preparing skeletons, &c. The construction of the building allows of considerable extension backwards, whenever more space will be needed, at small cost and with little interference with existing arrangements. I should also mention that the zoological department of the University, with its admirably appointed laboratories and lecture-rooms, and excellent working collection for teaching purposes, is in immediate contact with the museum, and the two institutions, though under different direction, are thus brought into harmonious cooperation.

Any one who wishes to compare and contrast the two systems upon which a national zoological museum may be arranged cannot do better than visit Paris and Berlin at the present time. He will see excellent illustrations of the best of both.

Of the museums of the United States of America much may be expected. They are starting up in all directions untrammelled by the restrictions and traditions which envelope so many of our old institutions at home, and many admirable essays on museum work have reached us from the other side of the Atlantic, from which it appears that the new idea has taken firm root there. In Mr. Brown Goode's lecture on "The Museums of the Future" (Report of the National Museum, 1888–89) it is said "In the National Museum in Washington the collections are divided into two great classes. The exhibition series, which constitutes the educational portion of the museum and is exposed to public view with all possible accessions for public entertainment and instruction, and the study series, which is kept in scientific laboratories and is scarcely examined except

In the first place, I have endeavoured to work out in detail, in its application to natural history, that most original and theoretically perfect plan for a museum of exhibited objects in which there are two main lines of interest running in different directions and intersecting each other, which we owe to the ingenuity of General Pitt-Rivers. This was explained in his address as President of the Anthropological Section of the British Association at Bath in 1888, and again in a lecture given about two years ago before the Society of Arts. Upon this plan the museum building would consist of a series of galleries in the form of circles, one within the other, and communicating at frequent intervals. Each circle would represent an epoch in the world's history, commencing in the centre and finishing at the outermost, which would be that in which we are now living. The history of each natural group would be traced in radiating lines, and so by passing from the centre to the circumference, its condition of development in each period of the world's history could be studied. If, on the other hand, the subject for investigation should be the general fauna or flora of any particular epoch, it would be found in natural association by confining the attention to the circle representing that period. By such an arrangement that most desirable object, the union of palæontology with the zoology and botany of existing forms in one natural scheme, could be perfectly carried out, as both the structural and the geological relations of each would be preserved, as indicated by its position in the museum. Such a



by professional investigators. In every properly constructed museum the collections must from the very beginning divide themselves into these two classes, and in planning for its administration, provision should be made not only for the exhibition of objects in glass cases, but for the preservation of large collections not available for exhibition to be used for the studies of a very limited number of specialists."

The museum of comparative zoology at Harvard, founded by the late Louis Agassiz and now ably administered and extended by his son, Alexander Agassiz, is a conspicuous example of the same method of construction and arrangement. But as I can say nothing of these from personal knowledge, I am obliged to leave out any further reference to them on the present occasion.

From what has just been said it will be gathered that in Europe at least an ideal natural history museum, perfect in original design, as well as in execution, does not exist at present. We have indeed hardly yet come to an agreement as to the principles upon which such a building should be constructed. But as there are countries which have still their national museums in the future, and as those already built are susceptible of modifications, when the right direction has been determined on I should be glad to take this opportunity of putting on record what appears to me, after long reflection on the subject, the main considerations which should not be lost sight of in such an undertaking.

building would undoubtedly offer difficulties in practical construction, but even if these could be got over, our extremely imperfect knowledge of the past history of animal and plant life would make its arrangement with all the gaps and irregularities that would become evident, so unsatisfactory, that I can scarcely hope to see it adopted in the near future.

I have therefore brought before you a humbler plan, but one which, I think, will be found to embody the practical principles necessary in a working museum of almost any description, large or small.

The fundamental idea of this plan is that the whole of the building should be divided by lines intersecting at right angles, like the warp and the woof of a piece of canvas.

The lines running in one direction divide the different natural sections of which the collection is composed, and which it is convenient to keep apart; the lines crossing these separate the portions of the collection according to the method of treatment or conservation. Thus, the exhibited part of the whole collection will come together in a series of rooms, occupying naturally the front of the building. The reserve collections will occupy another, or the middle, section, and beyond these will be the working rooms, studies, and administrative offices, all in relation to each other, as well as to the particular part of the collection to which they belong. A glance at the plan will show at once the great convenience of such a system, both for the public, and still more for those who work in the museum.

This plan, of course, contemplates a one-storied, top-lighted building as far as the main rooms are concerned, although the workrooms and studies will be in two or more stories. The main rooms should all have a good substantial gallery running round them, by means of which their wall space is doubled. There is no question whatever that an evenly-diffused top light is far the best for exhibition rooms. Windows not only occupy the valuable wall-space, but give all kinds of uncomfortable cross lights, interspersed with dark intervals. On the other hand, for doing any kind of delicate work, a good north light from a window, as provided in the plan, is the most suitable. The convenience of having all the studies in relation with each other, and with the central administrative offices, while each one is also in close contiguity with the section of the collection to which it belongs, will, I am sure, be appreciated by all who are acquainted with the capriciously scattered position of such rooms in most large museums, notably in our own. Among other advantages would be the very great one that when the daily hour of closing the main building arrives, the officers need no longer, as at present, be interrupted in whatever piece of work they may have at hand, and turned out of the building, but as arrangements could easily be made for a separate exit, they could continue their labours as long and as late as they find it convenient to do so, without any fear for the safety of the general collections.

It will be observed that provision is made for a central hall, which is always a good architectural feature at the entrance of a building, and which in a museum is certainly useful in providing for the exhibition of objects of general interest not strictly coming under any of the divisions of the subject in the galleries, or possibly for specimens too large to be conveniently exhibited elsewhere. There is also provision in the central part of the building for the refreshment-rooms, and also for the library and a lecture room; the first being an essential, and the latter a very useful adjunct to any collection intended for popular instruction, even if no strictly systematic teaching should be part of its programme.

I may point out, lastly, as a great advantage of this plan, that it can be, if space is reserved or obtainable, indefinitely extended on both sides on exactly the same system without in any way interfering with the existing arrangements, a new section, containing exhibition and reserve galleries and studies can be added as required at either end, either for the reception of new departments, or for the expansion of the old ones. With a view to the latter it is most important that the fittings should be as little as possible of the nature of fixtures, but should all be so constructed as to be readily removable and interchangeable. This is a point I would strongly impress upon all who are concerned in fitting up museums either large or small.

The modifications of this plan to adapt it to the requirements of a municipal, school, or even village museum will consist mainly in altering the relative proportion of the two sections of the collection. The majority of museums in country localities require little, if anything, beyond the exhibition series. In this the primary arrangement to be aimed at is first, absolutely to separate the archæological, historic, and art portions of the collection from the natural history, if, as will generally be the case, both are to be represented in the museum. If possible they should be in distinct rooms. The second point is to divide each branch into two sections: 1, a strictly limited general or type collection, arranged upon a purely educational plan; 2, a local collection, consisting only of objects found within a certain well-defined radius around the museum, which should be as exhaustive as possible. Nothing else should be attempted, and therefore reserve collections are unnecessary. Even the insects and dried plants can be exhibited on some such plans as those adopted for the Walsingham collection of Lepidoptera in the Zoological Department, or the collection of British plants in the Botanical Department in our Natural History Museum.

I have elsewhere indicated my views as to the objects most suitable for, and the best arrangement of them in, school museums,[1] so I need say nothing further on the subject now. Indeed I fear I have exhausted your patience, so I will conclude by expressing an earnest hope that this meeting may prove a stimulus to all of us to continue heartily and thoroughly at our work, which I need not say is the only way to ensure that general recognition of it which we all so much desire.

[1] NATURE, vol. xli. p. 177, December 26, 1889.

At the close of the address a vote of thanks was moved by Sir James Paget and seconded by Sir Henry H. Howorth. The meeting was largely attended by delegates from various provincial museums, as well as by representatives of a number of museums and scientific societies in the metropolis. Among those present were Sir Joseph Fayrer, Dr. Jonathan Hutchinson, General Festing, Lady Flower, Dr. Günther, Dr. Sclater, Dr. Henry Woodward, Mr. L. Fletcher, Mr. and Mrs. Cuthbert Peek, Mr. W. Topley, Mr. E. F. Newton, Prof. Jeffrey Bell, Mr. Osbert Salvin, Mr. F. W. Rudler, and others. The following museums were represented:—

Bootle, Bolton, Brighton, Cardiff, Chester, Dublin, Glasgow, Maidstone, Manchester, Nottingham, Parkes Museum, Saffron Walden, Sheffield, Southampton, Stockport, Sunderland, Warrington, and York.

At the conclusion of the proceedings Sir William and Lady Flower held a reception in the library of the Zoological Society.

July 4, 5, and 7 were occupied by the business of the Association. As on previous occasions, papers were read and discussed and general business transacted during the mornings; while the afternoons were devoted to the inspection of museums. The Association owes a debt of gratitude to several societies and individuals for courtesy and hospitality. The convenient rooms of the Zoological Society, at 3 Hanover Square, were kindly placed at the disposal of the Association by the Council of the Society, and the Anthropological Society kindly gave the use of its library. The Council of the Royal College of Surgeons invited the members of the Association to the conversazione held at the Museum on July 5. The Royal Society and the Geological Society allowed members of the Association the privilege of inspecting their collections, and the officers of the British Museum (both at Bloomsbury and at Cromwell Road), and of the Museum of Practical Geology, conducted the members over the departments under their charge. Dr. and Mrs. Woodward held a reception at 129, Beaufort Street on July 6, and Mr. Jonathan Hutchinson entertained a party at Haslemere on July 8, and exhibited his educational museum to his guests.

THE DISTRIBUTION OF MARINE FLORAS.

IN *Phycological Memoirs*, Part II., May 1893, Mr. George Murray gives a comparative table, showing the marine floras of the warm Atlantic, Indian Ocean, and the Cape of Good Hope.

Preceding the comparison, he says:—"In delimiting the above regions I have been guided by what may fairly be taken to be their natural boundaries. The warm Atlantic is the tropical Atlantic, with a slight northward extension, to include Florida, the Bahamas, and Bermuda in the track of the Gulf Stream, and also Madeira and the Canary Islands, washed by that branch of the same stream which trends off backward to the south, the north equatorial current. I have not included the Azores, since they are not sufficiently under this influence, and their marine flora, so far as we know it, appears to be more akin to that of the north temperate Atlantic. On its southern boundary on the African coast the Cape region is permitted to come slightly within the tropics, so far as Wallfisch Bay, on account of this coast being swept by a cold current from the south, bringing with it up to this point at all events such temperate forms as *Laminaria*, recently recorded from that place. The Indian Ocean similarly is the tropical Indian Ocean, but including the whole of the Red Sea, and extending to the south slightly outside the tropics down the coast of Africa, and including the whole of Madagascar. I am justified in this by the course of the warm Mozambique current. I do not include on the east Sumatra, which appears to belong to another region, though I have included a few forms from the Andaman Islands and Mergui. The Cape of Good Hope region has already been indirectly described, and, as has been said, extends for the reasons given, slightly into the tropics on the west coast, and recedes slightly from that boundary on the east coast."

The table shows that the warm Atlantic has the largest recorded flora, viz. 859 species in 162 genera. I may explain that, out of this total, no less than 788 species in 150 genera occur in the West India region, and that the rest of the warm Atlantic furnishes only 71 species in 12 genera not occurring in the West Indies out of a much smaller total flora. Allowing for the undoubted fact that a large number of West Indian species are bad species, there still remains a large balance in its favour. It has been better examined than any other part of the warm Atlantic, but still we may attribute this preponderance mostly to the favourable natural conditions, principally the coral formation of large portions of its island shores. On the coast of Africa there is not only no coral, but league after league of muddy shore, making a marine desert so far as Algæ are concerned. The Indian Ocean comes next, with 514 species in 139 genera. It possesses an enormous coast line, to a considerable extent favourable to the growth of Algæ (though including long desert stretches); but the bulk of the records are from Ceylon, Mauritius, and the Red Sea, while a very large proportion of the region is unexamined. As in the West Indies, there is also here a considerable proportion of bad species, principally *Sargassa*, from the Red Sea. From the Cape we have 429 species in 141 genera. This remarkable total, from so short a coast line, is obtained from Miss Barton's list in the *Journal of Botany*, 1893. The flora previously recorded in books amounted only to 242 species in 99 genera, and this addition to its flora has resulted from her examination of the British Museum Herbarium, and her naming of the admirable collection made by Mr. Boodle, and also those made by Mr. Scott Elliot and Mr. Tyson. The most noteworthy observation on these aggregates is the proportion of species to genera. In the warm Atlantic the genus averages well over 5 species; in the Indian Ocean the proportion is nearer 4 than 3 species to the genus; while at the Cape it is almost exactly 3. This is instructive when we remember, as I have elsewhere pointed out (Trans. Biol. Soc. Liverpool, vol. v. p. 177), that while the Arctic Algæ average slightly more than 2 species only to the genus, the West Indies and Australia average rather more than 5 and less than 5 respectively. I estimate that the north temperate Atlantic yields an average of about 4½ species to the genus, and the difference between this and 3 species per genus found at the Cape is to be attributed primarily to the short coast line of the Cape, and in a less degree to its Algæ being less known. The calculation of such averages and proportions appears to me to be justified only when applied to the whole flora, and becomes more dangerous and apt to mislead when applied to portions of it, since particular groups in all the floras have been subjected to unequal treatment by collectors and describers, and we may perhaps trust to these personal errors neutralising each other when the complete totals are compared.

The warm Atlantic and Cape have 85 genera and 114 species in common, while the Indian Ocean and Cape have 86 genera and 89 species in common. That the number of genera in common should be so nearly exactly similar is interesting, and to discover whether they are the same genera in many cases it is only necessary to turn to the last table, where the Algæ common to all three regions are given to find that 72 genera are common to all three. Some years ago I hazarded the speculation that, while the genera of the tropical Atlantic and those of the Indian Ocean were largely the same, the species were, in a high proportion, different ("Catalogue of Marine Algæ of the West Indian Region"). We can now see that they have no less than 103 genera in common out of a total of 139 occurring in the Indian Ocean and 162 in the warm Atlantic. They have certainly more species in common, viz. 173, but these must be considered relatively to the two totals of 514 in the Indian Ocean and 859 in the warm Atlantic, when my expectation will appear to be fairly borne out. Nevertheless, I confess to having anticipated an even greater diversity of species. That the absolute number of genera occurring at the Cape should be by two greater than those of the Indian Ocean completely puzzles me. I cannot fully account for it on any theory. While the number of species in common between any two of the floras is greater than the number of genera (though in one case only three more), the number of species, as might be expected, in common to all three—viz. 59—is less than the genera—viz. 72. Again I should have expected to find relatively fewer species in common.

When one comes to analyse these totals, the process must be carried on in a more guarded fashion. One expects, as shown above, to find fewer species to the genus at the Cape than in the tropical floras, but one hardly expects to find that the genera of *Florideæ* at the Cape are by five more numerous than in the warm Atlantic, and by 15 more than in the Indian Ocean. There are no less than 95 genera of *Florideæ* at the Cape, with 295 species, while the 90 of the warm Atlantic contain nearly 200 more species! Matters are much the same in the case of the *Phæophyceæ*, and we have come to the *Chlorophyceæ* to redress the balance in the case of the warm Atlantic. They just fail to bring it level in the case of the Indian Ocean. It has been remarked above that the genera which the two tropical floras have in common with the Cape are almost identical in number. The analysis shows that the figures are very steady, viz. 58 each of *Florideæ*, 14 and 15 of *Phæophyceæ*, 11 each of *Chlorophyceæ*, and two each of *Protophyceæ*. The table shows the tropical character of such a group as the *Siphoneæ* very markedly. There are 99 species in 23 genera in the warm Atlantic, 72 species in 16 genera in the Indian Ocean, and only 20 species in 7 genera at the Cape. It is interesting to observe that the whole of the 16 genera of *Siphoneæ* in the Indian Ocean are represented in the warm Atlantic. It has no peculiar generic type of its own in this tropical group. While the genera of this tropical order are thus practically identical, the species are in a very high proportion different. Only 29 are possessed in common out of the two totals of 99 and 72. In the comparison of the two tropical floras there is the coincidence that the genera and species of *Siphoneæ* agree exactly in numbers, viz. 16 and 29, with the total of all the *Phæophyceæ*—a thing without significance, however.

The interest that is attached to the above comparison is mainly this. We have here two tropical marine floras cut off from each other by a permanent continental area, and communicating only *viâ* the Cape. That these floras have been periodically mingled at the epochs of warmer climate at the Cape seems a reasonable conclusion with regard to a group of such antiquity as the Algæ, and the proportions of species in common and genera in common between the different regions, and among all three may have a significance in this respect to students of distribution (cf. the totals of *Siphoneæ*, a peculiarly tropical order). I have elsewhere (Trans. Biol. Soc. Liverpool, vol. v. p. 178) commented on the fact that, "while in the Arctic and Australian regions the *Phæophyceæ* far outnumber the *Chlorophyceæ*, in the tropical West Indian flora the proportion is very markedly reversed, and the green Algæ outnumber the olive-brown. One is tempted to put this down to the strong illumination of the tropical sea, but another reason is to be found in the fact that a number of the Antilles richest as regards Algæ are subject to irruptions of fresh and brackish water from the Orinoco floods—a condition that would operate in the same direction." We can now check this speculation by a comparison with the figures for the Indian Ocean, mainly derived from such localities as the Red Sea, Ceylon, Mauritius, &c., in no case affected by the question of fresh-water floods. The figures for the Indian Ocean are very nearly the same for both groups—24 genera and 117 species of *Phæophyceæ*, and 26 genera and 121 species of *Chlorophyceæ*—thus showing indirectly that the irruptions of fresh water are, in all probability, potent in the case of the West Indian Algæ. One is much struck by the strength of illumination of the bottom in a shallow coral sea, but the filtering action by sea water of the rays of light, and the interception first of those rays that are most efficient in the work of assimilation—conditions modifying the pigments of Algæ—are the same in all seas.[1] The practically tideless character of the Antilles would also make for a preponderance of green over olive-brown forms.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Bristol Medical School, which was established early in this century, has, since the establishment of University College, Bristol, about seventeen years ago, been affiliated to it, but remained under the direction of a separate governing body. Within the last few months the two institutions have been amalgamated and placed under one Council, and the Medical School now constitutes the faculty of medicine in the College.

THE Council of University College, Bristol, have raised to the status of Professor, in the Faculty of Arts and Science, Mr. F. R. Barrell, Lecturer in Mathematics, and Mr. A. P. Chattock, Lecturer in Physics, and have also appointed Dr. Edward Fawcett, late Senior Demonstrator of Anatomy in the Yorkshire College, Leeds, to the Professorship of Anatomy in the Faculty of Medicine.

[1] Recent research on other pigments by Prof. Marshall Ward makes it appear to me more probable that, in the case of the marine Algæ, the pigments are rather shields against the excess of blue rays than adaptations to heighten the susceptibility of chlorophyll to the diminished supply of the others.

HER Majesty's Commissioners for the exhibition of 1851 have made the following appointments to science research scholarships for the year 1893, on the recommendation of the authorities of the respective Universities and colleges. The scholarships are of the value of £150 a year, and are tenable for two years (subject to a satisfactory report at the end of the first year), in any University at home or abroad, or in some other institution to be approved of by the Commissioners. The scholars are to devote themselves exclusively to study and research in some branch of science, the extension of which is important to the industries of the country. The list of scholars and of the nominating institutions is as follows:—Herbert William Bolam, University of Edinburgh; George Edwin Allan, University of Glasgow; James Wallace Walker; University of St. Andrews; Arthur Lapworth, Mason College, Birmingham; John Ellis Myers, Yorkshire College, Leeds; Arthur Walsh Titherley, University College, Liverpool; Edward Chester Cyril Baley, University College, London; John Cannell Cain, Owens College, Manchester; Ella Mary Bryant, Durham College of Science, Newcastle-on-Tyne; James Darnell Granger, University College, Nottingham; Mary O'Brien, University College of Wales, Aberystwyth; Frederick George Donnan, Queen's College, Belfast; James Alexander M'Phail, M'Gill University, Montreal; Norman Ross Carmichael, Queen's University, Kingston, Canada; William Henry Ledger, University of Sydney.

MISS MARIA M. OGILVIE, daughter of Dr. Ogilvie, of Gordon's College, Aberdeen, has passed the final examination for the degree of Doctor of Sciences of London University. The subject of her thesis was the "Geology of the Wingen and St. Cassian Strata in Southern Tyrol," published in the *Quarterly Journal* of the Geological Society for February.

THE electors to the Savilian Professorship of Astronomy will proceed to the appointment of a successor to the late Prof. Pritchard, in the couse of the ensuing Michaelmas Term. The duties of the Professor are defined by the following provisions of the statutes:—The Savilian Professor of Astronomy shall lecture and give instruction on theoretical and practical Astronomy. "Ne alia quapiam professione eodem tempore fungatur professor; nec munus observatoris Radcliviani, nec officium prælectoris alicujus in quovis collegio publice legentis cum munere suo conjungat." The Professor shall reside within the University during six months, at least, in each academical year, between the first day of September and the ensuing first day of July. He shall lecture in two at least of the three University terms. His lectures shall extend over a period not less in any term than six weeks, and not less in the whole than fourteen weeks, and he shall lecture twice at least in each week. The University Observatory shall be open for eight weeks in each term, and at such other times and for such hours as the University may by statute determine. The Savilian Professor of Astronomy shall have the charge of the University Observatory, and shall undertake the personal and regular supervision of the same, and of the several demonstrators and other assistants employed therein, and shall be responsible for all the work carried on there. The emoluments of the Professorship as determined by statute are as follows:—He shall be entitled to the emoluments now assigned to the Professorship and derived from the benefaction of Sir Henry Savile, Knight, or from the University Chest; and shall receive in addition the emoluments appropriated to the Professorship by the statutes of New College. The total amount of all these emoluments is at present £850 a year. Applications, together with such papers as the candidate may desire to submit to the electors, must be sent to the Registrar of the University, Clarendon Building, Oxford, on or before October 31, 1893.

ARRANGEMENTS have been completed for the seventh session of the Edinburgh Summer Meeting, which begins on July 31, and lasts throughout August. Among the better known lecturers are:—M. Edmond Demolins, M. Paul Desjardins, Prof. Patrick Geddes (who will treat of contemporary social evolution), Prof. Lloyd Morgan (giving a course of comparative psychology—perhaps the first of its kind in Britain) and Mr. Arthur Thomson, discussing bionomics and evolution. A course on the history and principles of the sciences will be conducted by Prof. Cargill Knott, Dr. Charles Douglas, and others. A characteristic feature will be the series of studies entitled "A Regional Survey of Edinburgh and Neighbourhood." Among other subjects are Physiology, Modern History, Education and Elocution, and there will be practical classes in Botany, Zoology, and Geology. Work will be continued in the seminars and the studios, and a new departure is the course of Sloyd. While the student is obviously invited to serious work, a pleasant relief is promised in the shape of excursions.

THE New York *Nation* says that on June 14, at the University of Virginia, for the first time in its history, a certificate of attainment qualifying for graduation (in the School of Pure Mathematics) was given to a woman, Miss Caroline Preston Davis. Miss Davis, while excluded from the lectures, had taken successfully the same examinations on the same day with the male students, but "in a separate room"; and, at the request of the Chairman of the Faculty, the graduating class in a body handed the certificate to her.

SOME years ago (writes the Allahbad *Pioneer Mail*), the Senate, or the Syndicate, of the University of Madras promulgated a rule that any examiner who failed to send in his marks by a certain fixed date would be fined 20 rupees for each day's delay. The Syndicate, however, refrained from acting on this remarkable rule until this year, when its sense of humour was too strong for it, and it determined to carry its little joke to its conclusion. A number of examiners were accordingly fined. One gentleman earned a fee of 210 rupees, but he was fined 200 rupees, and received a pay bill for 10 rupees. Entering into the spirit of the thing, he returned this amount to the Registrar as a present to the University, and possibly it will be invested, and the proceeds devoted to the purchase of an infinitesimal medal, as the custom is. But, seriously, it is most regrettable that the Syndicate should deliberately degrade its examiners in this way. Surely it is possible to find a sufficient number of gentlemen who can be trusted to do their work with such promptness as is compatible with fairness to the candidate, and more than this the Senate cannot desire. If an examiner is guilty of great delay, the remedy is simple—do not appoint him again. But to treat an examiner like a careless domestic is as insulting to him as it is undignified on the part of the University.

MR. F. W. GAMBLE, B.Sc. (Victoria), formerly Bishop Berkeley Research Fellow in Zoology, has been appointed to the post of Assistant Lecturer and Demonstrator in Zoology in the Owens College, Manchester

BISHOP BERKELEY Research Fellowships has been awarded by the council as follows:—H. B. Pollard, M.A. (Oxon.), in Zoology; Albert Griffiths, M.Sc. (Vict.), in Physics; J. A. Harker, D.Sc. (Tübingen), in Physics; Bevan Lean, B.A., B.Sc. (Lond.), in Chemistry; and a Fellowship has been renewed to Stanley Dunkerley, M.Sc. (Vict.), in Engineering.

SCIENTIFIC SERIALS.

Bulletin of the New York Mathematical Society, Vol. ii. No. 9, June, 1893.—The mechanics of the earth's atmosphere is a collection of translations by Cleveland Abbe (published by the Smithsonian Institution, 1891, 324 pp. 8vo). An account of it is furnished by R. S. Woodward (pp. 199–203). The volume contains twenty papers, all but two of which were published originally in the German language. The opening paper is by Hagen (1874), then follows the classic memoir by Helmholtz (1858), with five others by the same author. Then comes the extension of one of the last cited papers by Kirchhoff (1869); we then have five memoirs by Oberbeck, a paper by Hertz (1884), three papers by Bezold (1888–1889), a paper by Lord Rayleigh (1890, on the vibration of the atmosphere), and papers by Margules (1890) and Ferrel (1890). It will be readily inferred from this outline that Mr. Abbe has performed a work of prime importance to mathematical meteorologists. Dr. T. S. Fiske (pp. 204–211) also gives an outline sketch of mathematical investigations in the theory of values and prices, by Dr. I. Fisher (reprinted from the Transactions of the Connecticut Academy, July, 1892). The number closes with a few brief notes and a list of recent publications.

Wiedemann's Annalen der Physik und Chemie, No. 6.—On the determination of electrical resistances by means of alternating currents, by F. Kohlrausch. This is a minute study of the errors involved in measuring liquid resistances with alternate currents and the telephone. For potassium chloride solution between clean platinum electrodes, the error by which the resistance of the liquid was found too great remained below 1 per cent. so long as the product of the resistance in ohms and the surface of the electrode in sq. cm. did not fall below 250. In cases of high resistance, say 100,000 ohms, where MM.

Bouty and Foussereau failed altogether to obtain consistent results, these may be secured by using certain precautions, such as placing the induction coil at a sufficient distance (1 m. at least) from the bridge, directing its axis perpendicular to that of the rheostat, and placing the telephone perpendicular to the lines of force of the induction coil. In the case of water and very dilute solutions the electrostatic capacity of the containing cell is a source of disturbance, which may, however, be obliterated by introducing a small condenser of adjustable capacity.—The temperature coefficient of the dielectric constant of pure water, by F. Heerwagen. This was investigated with a kind of differential electrometer, in which two needles were suspended by one wire in two electrometers arranged vertically one above the other. The needles, the vessel, and one pair each of the quadrants were joined to one point in a constant voltaic circuit, and the other pairs to two other points. The lower electrometer was alternately empty and filled with pure water. Under these circumstances the ratio of the sensibilities was inversely as the ratio of the squares of the differences of potential. The value obtained for K was $80{\cdot}878 - 0{\cdot}362\,(t - 17)$, where t is the temperature of the water in degrees centigrade.—Polarising effects of the refraction of light, by K. Exner. Glass gratings, necessary in order to obtain a sufficiently large angle of diffraction, have the disadvantage of producing polarisation effects due to change of medium in addition to those due to diffraction. This difficulty was overcome by attaching the cut surface to a semi-cylindrical lens by a drop of oil of the same refractive index. The polarisation effects show a fair agreement with Stokes's cosine law.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 8.—"The Process of Secretion in the Skin of the Common Eel," by E. Waymouth Reid, Professor of Physiology in University College, Dundee.

By special attention to the condition of the fish at the time of fixation of their skins for histological investigation, the author has succeeded in obtaining pictures of the various phases of secretory action. The *lowest* phase of activity was obtained by rendering hybernating fish suddenly motionless by a successful transfixion of the medulla, and then removing skin before recovery from "shock" admitted of reflex secretion. The *highest* phase of secretory action was produced by artificial stimulation of the intact animal by the vapour of chloroform, by faradisation, or by simply allowing a pithed summer eel to "slime" after recovery from the primary "shock." The following are the main conclusions:—

(1) The secreting elements of the epidermis of the common eel consist of goblet cells and club cells, both direct descendants of the cells of the palisade layer. The former supply a mucin, the latter threads and a material appearing as fine granules in the slime.

(2) The goblet cells contain mucin granules, and, after reaching the surface and discharging their load, are capable of undergoing regeneration by growth of the protoplasmic foot and re-formation of mucin.

(3) The threads of the slime resemble those of *Myxine glutinosa*, but are usually of finer texture. As in *Myxine*, they are developed from the club cells, but there are no special glandular involutions of the epidermis. The club cells of *Petromyzon fluviatilis* also supply slime threads.

(4) The granular material of the slime is the contents of vesicular spaces developed in the club cells in the immediate neighbourhood of their nuclei, and is set free enclosed in a lattice work developed by vacuolation of the surrounding material, and finally extruded, carrying with it the original nucleus of the club cell.

(5) The remainder of the club cell, after extrusion of its vesicle and nucleus, becomes a spirally coiled fibre, which finally breaks up into the fine fibrils of the slime.

(6) Severe stimulation, especially by the vapour of chloroform applied to the intact animal, causes so sudden a development of the coiled fibres from the club cells that the surface of the epidermis is thrown off and the secretory products set free *en masse*. This process is of reflex nature, for similar excitation applied to excised skin is without effect.

(7) A system of connective tissue cells, distinct from chromatophores, exists in the epidermis developed from cells which are direct descendants of leucocytes, and which can be traced from the blood vessels of the corium through the basement membrane into the epidermis. The number of these wandering cells in the epidermis is greatly increased by stimulation, probably with a view to providing subsequent support to the secretory elements during regeneration.

The paper was illustrated by photo-micrographic lantern slides.

June 15.—"On the Ratio of the Specific Heats of the Paraffins and their Monohalogen Derivatives." By J. W. Capstick, D.Sc. (Vict.), B.A. (Camb.), Scholar and Coutts-Trotter Student of Trinity College, Cambridge. Communicated by Prof. J. J. Thomson, F.R.S.

The object of the experiments was to throw light on an obscure point in the kinetic theory of gases, viz. the distribution of energy in the molecule.

From the ratio of the specific heats we can calculate the relative rates of increase of the internal energy and the energy of translation of the molecules per degree rise of temperature, by the well-known formula, $\beta + 1 = \dfrac{2}{3(\gamma - 1)}$, where γ is the ratio of the specific heats and β the ratio of the rate of increase of the internal to that of the translational energy.

In order to make the results comparable it was decided to keep the translational energy constant by working at a constant temperature—the temperature of the room.

The ratio of the specific heats was calculated from the velocity of sound in the gases. This was determined by Kundt's method, a double-ended form of apparatus similar to that described in *Pogg. Ann.* vol. cxxxv. being used.

The calculation requires the density of the gas to be known, a circumstance which makes the method very sensitive to small amounts of impurity. Regnault's value of the density was used for methane and the theoretical value for ethane, an analysis of the gas being made after each experiment to determine the correction for the air that was unavoidably present. All the other gases were freed from air by liquefaction immediately before being admitted into the apparatus, and the vapour density of the material in the state in which it was used was determined by a modified form of Hofmann's apparatus, which gave results concordant to one part in a thousand.

The formula used in calculating the ratio of the specific heats was

$$\gamma = 1{\cdot}408 \times \rho \times \left(\frac{l}{l'}\right)^2 \left(1 + \frac{1}{p}\frac{d}{dv}(pv)\right),$$

the last factor being added to the ordinary formula to correct for the divergence of the gas from Boyle's Law.

The correction is obtained at once by putting in the equation

$$u^2 = -\gamma v^2 \left(\frac{dp}{dv}\right)_t \text{ the value of } \left(\frac{dp}{dv}\right)_t \text{ given by the equation}$$

$$\left(\frac{dpv}{dv}\right)_t = p + v\left(\frac{dp}{dv}\right)_t.$$

From the vapour density determinations a curve is constructed giving pv in terms of v, and the slope of this curve at any point gives the value of $\frac{d}{dv}(pv)$ in arbitrary units. Dividing by the corresponding value of p in the same units, we obtain the amount of the correction.

The correction increases the ratio of the specific heats by from 1 to 2 per cent. in most cases.

Observations varying in number from three to nine were made on each gas, the extreme range of the values being 2 per cent. for marsh gas, 1½ per cent. for methyl iodide, and 1 per cent., or less, for the rest.

The mean values of the ratio of the specific heats are shown in the following table:—

Methane	CH_4	1·313
Methyl chloride	CH_3Cl	1·279
Methyl bromide	CH_3Br	1·274
Methyl iodide	CH_3I	1·286
Ethane	C_2H_6	1·182
Ethyl chloride	C_2H_5Cl	1·187
Ethyl bromide	C_2H_5Br	1·188
Propane	C_3H_8	1·130
Normal propyl chloride	nC_3H_7Cl	1·126
Isopropyl chloride	iC_3H_7Cl	1·127
Isopropyl bromide	iC_3H_7Br	1·131

From this table we have the result that the gases fall into four groups, the members of any one group having within the limits of experimental error the same ratio of the specific heats.

These groups are—

I. Methane.
II. The three methyl compounds.
III. Ethane and its derivatives.
IV. Propane and its derivatives.

If the members of a group have the same ratio of the specific heats, we know that the ratio of the internal energy absorbed by the molecule to the total energy absorbed, per degree rise of temperature, is the same for all. Hence we have the result that, with the single exception of marsh gas, the compounds with similar formulæ have the same energy-absorbing power, a result which supplies a link of a kind much needed to connect the graphic formula of a gas with the dynamical properties of its molecules.

From the conclusion we have reached, it follows with a high degree of probability that the atoms which can be interchanged without effect on the ratio of the specific heats have themselves the same energy-absorbing power, their mass and other special peculiarities being of no consequence. Further, the anomalous behaviour of methane confirms what was clear from previous determinations, namely, that the number of atoms in the molecule is not in itself sufficient to fix the distribution of energy, and suggests that perhaps the configuration is the sole determining cause.

If this is so, it follows that ethane and propane have the same configuration as their monohalogen derivatives, but that methane differs from the methyl compounds, a conclusion that in no way conflicts with the symmetry of the graphic formulæ of methane and its derivatives, for this is a symmetry of reactions, not of form.

"On Interference Phenomena in Electric Waves passing through different Thicknesses of Electrolyte." By G. Udny Yule. Communicated by Prof. G. Carey Foster, F.R.S.

In the spring of 1889 Prof. J. J. Thomson published [1] a description of some experiments made by him for comparing the resistances of electrolytes to the passage of very rapidly alternating currents, the method consisting in comparing the thicknesses of layers of different electrolytes which were equally opaque to Hertzian radiation. During last winter I made trial of an arrangement identical in principle but more completely analogous to Hughes' induction balance. The method seemed, however, to offer several difficulties and disadvantages, and finally I adopted another, also, one may say, analogous to Prof. Thomson's, inasmuch as it measures transparencies, but in outward appearance completely different from his.

The wires B, F, D, about 1 mm. diameter, were spanned 6 cm. apart. If these wires be made too short, a wave-train emitted from B, B′ may reach the electrolyte x_1, or the bridge D, be reflected, and return to B before the primary has practically done oscillating. If this occur, the state of the secondary may affect the primary as in an alternate current transformer. If, however, Bx_1 be made longer than half the effective length of the wave-train, the reflected waves will not reach B until the primary oscillations have practically come to rest, and under these circumstances the latter will know nothing about any alternations in the secondary at or beyond x_1. This reaction of the secondary on the primary had been first noticed, and to a serious extent, by Herr J. Ritter von Geitler [1] with an exciter of the type used by Blondlot.[2]

In the actual apparatus the wires were at F_1 run out through a window in a loop of about 50 m. circumference round the laboratory garden. They re-entered the room at F_2 and were then run vertically through the vessel for containing the electrolyte. The circuit was completed by another loop, F_3F_4, 50 m. long, round the garden, re-entering the room at F_4, connecting to the electrometer at E, and bridged at D, 2·25 m. = $\frac{1}{4}\lambda$ from the electrometer. According to the researches of Bjerknes (*loc. cit.*) these dimensions should be sufficient, with the present apparatus, to prevent any sensible reaction.

The electrometer was the same one as that used by Bjerknes in his researches in the same laboratory. It is a simple quadrant electrometer with only one pair of quadrants and an uncharged aluminium needle of the usual shape suspended by a quartz fibre. One quadrant is connected to each wire. The needle taking no account of sign, elongations are simply proportional to the time integral of the energy: first throws, not steady deflections, are read.

Various glass jars were used for holding the electrolyte. The wires were run vertically through holes drilled in the bottom of the jar, into which they were cemented.

Several trials were made of this apparatus with dilute solutions of copper sulphate. Readings were taken in pairs alternately, with no solution in the jar and with some given thickness; usually about ten readings at each point. The ratio of the transmitted intensities so obtained was determined for several points and plotted as a curve. Some 5 or 6 cm. of electrolyte was the maximum thickness that could be used in these first experiments. The curves so obtained for these badly-conducting solutions always differed sensibly from the log-arithmic, and the more so the more the solution was diluted. If the mean log. dec. over the whole thickness was taken, the corresponding value of the specific conductivity appeared extremely high.

It appeared likely that these irregularities might be due to interference effects analogous to Newton's rings (by transmission), or the phenomena of "thin plates," particularly in view of the

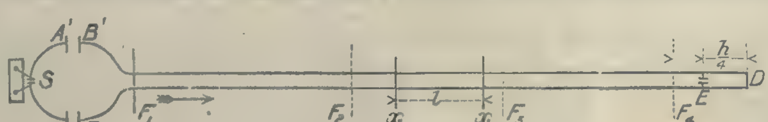


FIG. 1.

Let ASA′ be a Hertz exciter, and B, B′ secondary conductors similar to the primary from which a pair of long wires, stretched parallel to each other, are led off to a considerable distance. One may regard the wires simply as guides for the radiation, which then travels straight up the space between them. If we run these wires for a certain length, l, through an electrolyte, the radiation will have to traverse this and will be partly absorbed. If an electrometer be connected at E, a quarter wave-length from the bridge at the end of the wires, readings taken with various thicknesses of electrolyte should, according to my expectations, give a logarithmic curve, from which the specific resistance would be at once calculable.

The actual dimensions of the exciter, &c., erected were the same as those use by Bjerknes.[2]

A, A′, B, B′ circular zinc plates, diameter	40 cm.
Distance from A to B	30 „
Length of wire ASA (2 mm. diameter)	200 „
Wave length, λ	900 „

[1] "Roy. Soc. Proc.," vol. xlv. p. 269, 1889.
[2] *Wiedemann's Annalen*, vol. xliv. p. 513, 1891.

results obtained just previously by Mr. E. H. Barton in the same laboratory. I consequently desired to investigate for such interference phenomena over as great a thickness of electrolyte as the absorption would permit of using. Distilled water offered itself naturally as the best electrolyte for this purpose.

For the containing vessel a glass cylinder 114 cm. high was used; the internal diameter varied somewhat, but was about 12 cm. at the narrowest.

With this apparatus a series of observations were made for various thicknesses of distilled water. To cover, as far as possible, irregularities in sparking, readings were now taken in pairs alternately at the point to be determined and some other point taken for the time as the standard; it would have caused too great delay, and consequent irregularity in the effectiveness of the sparks, were all the water to be siphoned out between each pair of readings. As before, ten or twelve readings were usually taken at each point. The throw obtained with no liquid was also always taken as unity.

As a specimen of the usual spark variations, the following

[1] Doctor-Dissertation, Bonn, Jan. 1893, p. 22.
[2] *Compt. Rend.*, vol. cxiv., p. 283, Feb. 1892.

series of readings for the determination of the throw with 55 cm. water with reference to 40 cm. will serve. The series is taken quite at random from the others.

40 cm.	55 cm.
4·6	11·4
4·9	11 4
5·0	11·0
4·2	11·9
4·3	11·5
3 9	11·2
4·0	11·6
4·3	11·4
4 6	10·4
4·4	11·2
4·5	10·4
4·6	10·0

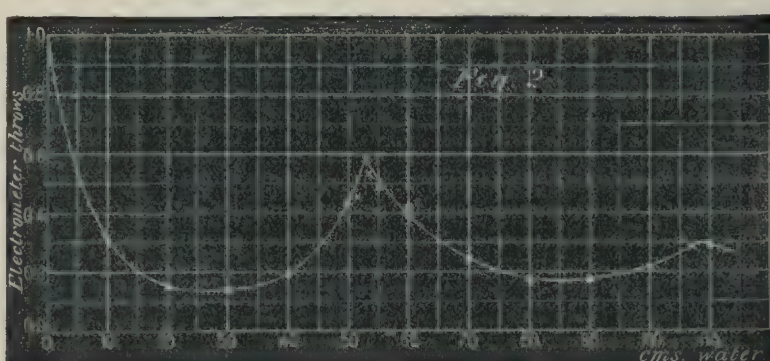
The readings are grouped separately, but it will be understood that they were taken in pairs alternately.

The complete results are given in the curve (Fig. 2). It is seen that for such a poor conductor as distilled water the interference completely masks the absorption effects. The intensity of the transmitted ray does *not* steadliy decrease; on the contrary, far more may be transmitted through a thick than through a thin layer of the absorbent medium. The transmission follows the same general law as for light with a thin plate; we are, in fact, dealing with a "thin" plate—a plate whose thickness is comparable with the wave-length. The intensity of the transmitted ray is a minimum for a plate $\frac{1}{4}\lambda$ thick, a maximum for $\frac{1}{2}\lambda$ thick, a minimum again for $\frac{3}{4}\lambda$, and so on.

The points on the curve round the maximum at $\frac{1}{2}\lambda$ are somewhat irregular, and the two maxima do not absolutely agree. Excluding the Russian physicist as a negligible majority, it will be seen that my value of κ is somewhat low. The cause may lie in the fact that not the whole of the field surrounding the wires lies in the water.

The uncertainty due to this stray field might be easily avoided in one way, namely, by making one wire into a tube surrounding the other, and using this tube also as the jar for the electrolyte. This was, in fact, the arrangement originally intended to be adopted. Several disadvantages attended it, however, and led to its final rejection in favour of the simple wires and glass jar. First, such a condenser reflects under all circumstances a considerable portion of the incident energy.[1] Secondly, the variation of the position of the top surface of the electrolyte relatively to the top of the jar would introduce fresh interference phenomena. This appeared directly from the work of Mr. Barton to which I have already had occasion to refer. Lastly, the large surface of metal in contact with the liquid would render distilled water rapidly impure.

This investigation was carried out in the Physical Institute of the University of Bonn. I desire particularly to express my thanks to Prof. Hertz for his most useful advice and suggestions.



Taking the mean, we may say the wave-lengths in air and water are respectively:—

$$\lambda_a = 900. \qquad \lambda_w = 108 \text{ cm.}$$

This gives us for the coefficient of refraction and the dielectric constant—

$$n = 8{\cdot}33. \qquad \kappa = 69{\cdot}5.$$

The following are the values of K found by previous investigators, all that are known to me:—

Method used.	Authority.	κ
Alternated currents	Heerwagen[1] ...	79·56
	Rosa[2]	75·70
	Rosa[3]	70·00
Ruhmkorff coil ...	Cohn and Arons[4]	76 00
	Tereschin[5]	83·80
Hertz oscillations...	Cohn[6]	73·50
	Ellinger[7]	81·00
	Itschegtiaeff[8] ...	1·75

1 *Wied. Ann.*, vol. xlviii. p. 35, 1893.
2 *Phil. Mag.*, vol. xxxi. p. 200, 1891.
3 *Ibid.*, vol. xxxiv. p. 344. 1892.
4 *Wied. Ann.*, vol. xxxiii. p. 13, 1888.
5 *Ibid.*, vol. xxxvi. p. 792, 1889.
6 *Ibid.*, vol. xlv. p. p. 370, 1892.
7 *Ibid.*, vol. xlvi. p. 513, 1892.
8 *Phil. Mag.*, vol. xxxiv. p. 388, 1892.

1 J. Ritter von Geitler, Doctor-Dissertation, Bonn, Jan., 1893.

Chemical Society, June 1.—Dr. Armstrong, President, in the chair. The following papers were read:—On azo-compounds of the ortho-series, by R. Meldola, E. M. Hawkins, and F. B. Burls. The constitution of the orthazo-compounds is still unsolved owing to the contradictory results obtained by different investigators using different methods. The azo-β-naphthols have been represented by the formulæ X . NH . N : $C_{10}H_6$: O and X . N_2 . $C_{10}H_6$. OH. The principal evidence in favour of the former hydrazone formula was furnished by Goldschmidt and Brubacher; it is, however, rendered invalid by the authors' experiments. On reducing an acetyl derivative of the form X . N_2 . $C_{10}H_6$. OC_2H_3O or X . $N(C_2H_3O)$. N : $C_{10}H_6$: O with zinc dust and acetic acid, four products result, viz.:—X . NH . C_2H_3O, $C_{10}H_6(NH . C_2H_3O)$. OHβ, X . NH_2 and $C_{10}H_6$. NH_2 . OHβ.—The production of a fluorescein from camphoric anhydride, by J. N. Collie. On heating camphoric anhydride with resorcinol and a small quantity of zinc chloride at 180°, a fluorescein is obtained having the composition $C_{22}H_{22}O_5$; it is a reddish powder with a greenish lustre and shows a beautiful green fluorescence in dilute aqueous solutions.—Researches on the terpenes, III. The action of phosphorous pentachloride on camphene, by J. E. Marsh and J. A. Gardner. Camphene and phosphorus pentachloride interact at ordinary temperatures, yielding a compound of the composition $C_{10}H_{15}PCl_4$; on treatment with water a product is obtained from which two crystalline isomeric camphenephosphonic acids, $C_{10}H_{15}PO_3H_2$, have been isolated. On heating camphene with phosphorus pentachloride, a crystalline substance, $C_{10}H_{14}PCl_3$ is obtained; on treating this with sodium carbonate, a salt of the composition $C_{10}H_{14}ClPO_2NaH$ results, whilst on oxidation it yields chlorocamphenephosphonic acid, $C_{10}H_{14}ClPO_3H_2$.—The composition of a specimen of jute fibre produced in England, by A. Pears, junr.—Note on the combination of dry gases, by W. Ramsay. In connection with the results recently obtained by Baker, the author states that in 1886 he recorded the fact that dry hydrogen chloride does not combine with dry ammonia, even in presence of solid ammonium chloride.—Ortho-, para-, and peri-disulphonic derivatives of naphthalene, by H. E. Armstrong and W. P. Wynne. By displacing the amido-group in a naphthylamine derivative by SH and oxidising the resulting thioderivative, a sulphonic group enters the position previously occupied by the amidogen. By means of this reaction the authors have prepared and characterised the 1 : 1′, 1 : 2 and 1 : 4 naphthalenedisulphonic acids; nine out of the theoretically possible ten of these isomerides are hence now known. The 2 : 2′ : 3′ naphthalenetrisulphonic acid has been prepared by a similar method. The corresponding sulphonic chlorides and other derivatives of the above acids are also described.—Supplementary notes on madder colouring matters, by E. Schunck and L. Marchlewski. In 1853 Schunck obtained from madder a yellow colouring matter which he termed rubiadin; it is now shown that madder contains a glucoside of rubiadin, having the composition $C_{21}H_{20}O_9$. It yields a pentacetyl derivative, and on hydrolysis, is converted into rubiadin and dextrose. $C_{21}H_{20}O_9 + H_2O = C_{15}H_{10}O_4 + C_6H_{12}O_6$.—The constitution of rubiadin glucoside and of rubiadin, by L. Marchlewski. The author proposes a formula for rubiadin glucoside, and notes that on heating a mixture of symmetrical metadihydroxybenzoic acid, paramethylbenzoic acid, and sulphuric acid, he has obtained a substance isomeric with and closely resembling rubiadin, but melting at a lower temperature.

Physical Society, June 23.—Prof. A. W. Rücker, F.R.S., President, in the chair.—Mr. F. H. Nalder exhibited a bridge and commutator for comparing resistances by Prof. Carey Foster's method, the chief features of which are simplicity, compactness, long range, and great accuracy. The commutation of the coils to be compared is effected by mercury cups, the eight holes necessary for this purpose being arranged in a circle. An ebonite disc carrying the four connectors is mounted on a spindle in the middle of the circle, and the positions of the coils are interchanged by rotating the disc through 180°. A large range is secured by providing a number of interchangeable bridge wires, and a fine adjustment for the galvanometer key enables great accuracy to be attained.—Mr. W. R. Pidgeon and Mr. J. Wimshurst each read a paper on an influence machine, and exhibited their machines in action. In designing his machine, Mr. Pidgeon has endeavoured—first, to make the capacity of each sector large when being charged, and small when being discharged; second, to prevent leakage from sector to sector as they enter or leave the different fields of induction; and third, to increase the capacity of the machine by making the sectors large and numerous. The first object is attained by arranging fixed inductors of opposite sign to the sectors near the charging points, and of the same sign near the places of discharge. Objects 2 and 3 are secured by embedding the sectors in wax, run in channels in the ebonite discs which form the plates of the machine, and carrying wires from each sector through the ebonite, each wire terminating in a knob. In this way the sectors can be placed much nearer together than otherwise without sparking back. By setting the sectors skew with the radius they are caused to enter the electric fields more gradually, consequently the potential difference between adjacent sectors is kept comparatively small. Experiment showed that the use of the stationary inductors at the charging points increased the output threefold, and as compared with an ordinary Wimshurst, the output for a given area of plate passing the conductors was as 5·6 : 1. The recovery of the machine after a spark had occurred was particularly rapid. Mr. Wimshurst's new machine consists of two glass discs 3 feet 5 inches diameter, mounted about ⅝″ apart on the same spindle. Both plates turn in the same direction. Between the discs are fixed four vertical glass slips over 4 feet long, two on each side, and each covering about ⅛th of a disc. Each slip carries a tinfoil inductor, which has a brush touching lightly on the inside of the adjacent disc on its leading edge. Collecting and neutralising brushes touch the outsides of the discs, and the few metallic sectors attached thereto. An account of some experiments made to determine the efficiency of the machine was given. The author also showed that when all the circuits of the machine were broken, it still continued to excite itself freely, and sparked from the discs to the hands when brought near. In a written communication, Prof. O. Lodge said his assistant, Mr. E. E. Robinson, constructed a machine on lines similar to Mr. Pidgeon's a few months ago, and had now a large one nearly completed. Mr. Robinson's fixed inductors are carried on a third plate fixed between the two movable ones. The sectors are quite small, and neither they nor the inductors are embedded. On close circuit the machine gives a large current ($\frac{1}{10000}$ ampère), and on open circuit exceedingly high potentials. In Dr. Lodge's opinion, Mr. Pidgeon attaches too much importance to his sectors and their shape. Mr. J. Gray wrote to say that stationary inductors enclosed in insulating material would probably give trouble at high voltages, because of the surface of the insulator becoming charged with electricity of opposite sign to that on the inductor. He suggested that this might explain why Mr. Pidgeon could not obtain very long sparks. Prof. C. V. Boys inquired as to how far the wax made insulating union with the ebonite, for if good, glass might possibly be used instead of ebonite. He greatly appreciated the design of Mr. Pidgeon's machine. After some remarks by the president on the great advances which had been made, Mr. Pidgeon replied, and Mr. Wimshurst tried some further experiments with a small experimental machine.—A paper on a new volumemometer, by Mr. J. E. Myers, describing the developed form of Prof. Stroud's instrument, was, in the absence of the author, taken as read.—Mr. R. W. Paul exhibited a compact form of sulphuric acid voltameter of small resistance. The voltameter is a modification of a pattern designed at the Central Institution, in which the rate of decomposition is determined from the time required to fill a bulb made in the stem of a thistle funnel. He also showed a handy form of Daniell cell devised by Prof. Barrett. When not in use, the porous pot containing the zinc is removed from the copper sulphate solution and placed in a vessel containing zinc sulphate or sulphuric acid. A paper on long-distance telephony, by Prof. J. Perry, F.R.S., assisted by H. A. Beeston, was read by Prof. Perry. The case of a line of infinite length, having resistance capacity, self-induction, and leakage, is taken up, and the state of a signal as it gets further and further away from the origin is considered. Taking the shrillest and gravest notes of the human voice to have frequencies of about 950 and 95 respectively, the distance from the origin at which the ratio of the amplitudes of these high and low frequency currents is lessened by $1/m$th of itself, has been determined when $m = 4$ for different values of leakage and self-induction; and under similar conditions the distances at which the relative phase of the two currents become altered by $1/n$th of the periodic time of the most rapid one, have been worked out for $n = 6$. The results are given in the form of tables, from which it appears that if there was no self-induction, increasing the leakage increases the distance to which we can telephone, whilst if there was no leakage increasing the self-induction increases the distance. When self-induction and leakage are not too great, increasing either increases the distance, and for particular values the distances become very large. At the end of the paper tables of general application are given, from which the limiting distances for any line can be readily found by multiplying the numbers by simple functions of the constants of the line. Mr. Blakesley said that some ten years ago he discussed the subject, when capacity and resistance were alone considered, and now pointed out that when self-induction and leakage were introduced the equations were still of the same form. He also suggested how terminal conditions on lines of finite length might be easily taken into consideration. Prof. Perry, in reply, said the introduction of self-induction and leakage rendered the calculations very laborious, and that the terminal conditions were much more complicated than Mr. Blakesley supposed.

Zoological Society, June 20.—Sir William H. Flower, K.C.B., F.R.S., President, in the Chair.—The Secretary exhibited and made remarks on two eggs of the Cape Coly (*Colius capensis*) laid in the Society's Gardens.—A head of a rhinoceros from Northern Somali-land was shown by Mr. Walter Rothschild; also a Caspian seal, believed to be the only specimen of this seal in England; and a series of skins of parrots of the genus *Cyanorhamphus* from New Zealand and other islands of the South Pacific. Mr. Rothschild proposed to refer the specimens of this group from the Auckland Islands to a new species to be called *C. forbesi*.—Other objects exhibited and remarked upon were a specimen of the foot of a calf, in which there were three toes springing from a single cannon-bone, by Mr. W. Bateson, some teeth of a ray (*Myliobatis*) from the Lower Tertiaries of Egypt, remarkable for their enormous size, by Mr. A. Smith-Woodward, and a fragmentary skull of a lemuroid mammal from south-east Madagascar with very remarkable characters, by Dr. Forsyth-Major.—A communication was read from Messrs. Hamilton H. Druce and G. T. Bethune-Baker, containing a monograph of the butterflies of the genus *Thysonotis*. This included a revision of the synonymy of the species, descriptions of several new species and varieties, a complete table showing the distribution of the genus, and descriptions of the genitalia.—Among other communications was one from the Rev. H. S. Gorham, containing a list of the Coleoptera of the family *Cleridæ* collected by Mr. Doherty in Burmah and Northern India, with descriptions of new species; and an account of some species of the same family from Borneo, Perak, and other localities, in the collection of Mr. Alexander Fry. Twenty-eight species were described as new.—Prof. G. B. Howes read a paper on the coracoid of the terrestrial vertebrates. Prof. Howes first spoke of the terminology of the bone commonly called "the coracoid," and then proceeded to the discussion of the mammalian coracoid in particular. He came to the conclusion that it would be best to call the whole ventral coracoidal bar the "coracoid," and to distinguish the doubly ossified type as "bicoracoidal" from the singly ossified or "unicoracoidal" type.—Lieut.-Col. H. H. Godwin-Austen, F.R.S., read the descriptions of some new species of land-shells of the genus *Alycæus* from the Khasi and Naga Hill countries, Assam, Munipur, and the Ruby Mine district, Upper Burmah.—This meeting closed the present session. The next session (1893-94) will commence in November.

PARIS.

Academy of Sciences, July 3.—M. Lœwy in the chair.—Tidal and atmospheric waves due to the action of the sun and of the moon, by M. Bouquet de la Grye. The results are given of a series of determinations of the tides, barometric pressures, and winds made by a French commission at Orange Bay, Cape Horn, ranging at half-hourly intervals from November 1, 1882, to August 31, 1883. A first study of these results confirms the facts, announced previously, relating to luni-solar influence upon the atmosphere. This action is very apparent at Cape Horn, since the water and air at lat. 56° south have a uniform temperature at any given date, and the annual range of temperature is very small.—On the successive deformations of the front of an isolated air wave, during the propagation of the wave along an indefinitely long empty water-pipe, by M. J. Boussinesq.—On birational transformations of algebraic curves, by M. H. Poincaré.—On the observation of the total eclipse of the sun of April 16, made at Joal (Senegal), by M. A. de la Baume Pluvinel.—On a self-registering hydrokinemometer, by M. Clerc. This consists of two vertical cylinders communicating with the water at the stem and the stern of the vessel respectively. The difference of level in the two cylinders is proportional to the square of the velocity with which the boat is travelling. The cylinders are provided with floats, each of which takes a share in actuating the recording pencil, with which they are connected by strings passing over pulleys, disposed in such a manner as to let the record be unaffecting by any heeling or plunging of the boat.—Experimental researches on shipbuilding material, by M. F. B. de Mas.—Radiation of different refractory bodies, heated in the electric furnace, by M. J. Violle.—Auto-conduction, or a new method of electrifying living beings; measurement of magnetic fields of high frequency, by M. A. d'Arsonval.—Additional remarks by M. Cornu.—On chromopyrosulphuric acid, by M. A. Recoura. After showing that the molecule of chromic sulphate can be combined with one, two, or three molecules of sulphuric acid, M. Recoura has succeeded in combining the sulphate with a larger quantity of acid, and has obtained new compounds presenting properties completely different from those of the three former acids, and characters not found in any other chromium compounds. One of these, "chromopyrosulphuric acid," contains five molecules of sulphuric acid.—Constitution of the colouring matters of the fuchsine group, by MM. Prud'homme and C. Rabaut.—On cinchonibine, by MM. E. Jungfleisch and E. Léger.—On mercuric salicylates, by MM. H. Layoux and Alexandre Grandval.—On metallic combinations of Gallanilide, by M. P. Cazeneuve.—On topinambour carbohydrates, by M. Ch. Tanret.—On essence of lavender (*Lavandula Spica*), by M. G. Bouchardat.—Heat of combustion of oil-gas and its relation to illuminating power, by M. Aguitton.—On the genus *Homalogyra*, a type of gasteropod prosobranch molluscs, by M. Vayssière.—On certain physiological effects of unipolar faradisation, by M. Ang. Charpentier.—Experiments on the transmission and evolution of certain epithelial tumours in the white mouse, by M. Henry Morau.—Observations on the preceding note, by M. Verneuil.—Laws of evolution of the digestive functions, by M. J. Winter.—On the histological structure of yeasts and their development, by M. P. A. Dangeard.—On a new process of *Champignon de couche* culture, by MM. J. Costantin and L. Matruchot.—On the glaciers of Spitzberg, by M. Charles Rabot.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Royal University of Ireland Calendar for 1893 (Dublin, Thom).—The Law of Cremation: A. Richardson (Reeves and Turner).—Ostwald's Klassiker der Exakten Wissenschaften, Nos. 41 and 42 (Leipzig, Engelmann).—The Points of the Horse: M. H. Hayes (Thacker).—The Life of a Butterfly: S. H. Scudder (New York, Holt).—Brief Guide to the Commoner Butterflies of the Northern United States and Canada: S. H. Scudder (New York, Holt).—Katechismus der Meteorologie: Dr. Bebber (Leipzig, Weber).—Results of Rain, &c., Observations made in New South Wales during 1891: H. C. Russell (Sydney, Potter).—Results of Meteorological Observations made in New South Wales, 1890: H. C. Russell (Sydney, Potter).—Prodromus Faunæ Mediterraneæ, Vol. 2, Pars 3—Vertebrata: J. V. Carus (Stuttgart, Koch).—Manual of Bacteriology: Dr. S. L. Schenck, translated by W. R. Dawson (Longmans).—Researches on the Zodiacal Light, &c.: Prof. Pickering (Cambridge, Wilson)

PAMPHLETS.—Erster Jahres-Bericht des Sonnblick-Vereines für das Jahr 1892 (Wien).—Transactions of the Astronomical and Physical Society of Toronto for the Year 1892 (Toronto).—Studies on the Life-History of some Bombycine Moths, &c.: A. S. Packard (New York).—Life-Histories of certain Moths of the Families Ceratocampidæ, Hemileucidæ, &c.: A. S. Packard (New York).—Life History of certain Moths of the Family Cochliopodidæ, &c.: A. S. Packard (New York).—Studies on the Transformations of Moths of the Family Saturniidæ: A. S. Packard (New York).—The Migrations and Habits of the Pilchard; M. Dunn (Falmouth, Lake).

SERIALS.—Engineering Magazine, July (New York).—Geographical Journal, July (Stanford).—Natural Science, July (Macmillan).—Gazzetta Chimica Italiana, Anno xxiii., 1893, Vol. 1, Fasc. vi. (Palermo).—The Observatory, July (Taylor and Francis).—Geological Magazine, July (K. Paul).—Journal of the Chemical Society, July (Gurney and Jackson).—Encyklopædie der Naturwissenschaften, Dritte Abthg. 14 und 15 Liefg (Williams and Norgate).—Goldthwaite's Geographical Magazine, May-June (New York).—Journal of the Anthropological Institute, May (K. Paul).—Mind, July (Williams and Norgate).—Essex Institute Historical Collections, October to December, 1891, January to September, 1892 (Salem, Mass.).—Records of the Geological Survey of India, Vol. xxvi., Part 2 (Calcutta).—Journal of the Royal Statistical Society, June (Stanford).—American Journal of Science, July (New Haven).—Quarterly Journal of Microscopical Science, July (Churchill).—Bulletin de la Société Impériale des Naturalistes de Moscou. 1893 No. 1 (Moscou).—Physical Review, No. 1 (Macmillan).—Bulletin of the American Museum of Natural History, Vol. 4, 1892 (New York).

CONTENTS.

THURSDAY, JULY 20, 1893.

VERTEBRATE EMBRYOLOGY.

Vertebrate Embryology. By A. Milnes Marshall. (London: Smith, Elder, 1893.)

THIS is an eminently practical treatise, designed to assist the senior university student in his laboratory work so as to enable him to gain a thorough knowledge of the successive appearances of the embryos of amphioxus, the frog, the chick, the rabbit, and man, during their course of development from the egg to the adult form. The student is supposed to pursue his studies by the aid of the most modern methods, and he has here placed before him by means of clear methodical description and clever original drawings exactly what he ought to see and identify in his series of microscopic sections. The book will be extremely useful, as are the author's other treatises, to all teachers and students of biology. It should be pointed out that very considerable pains has been taken by Prof. Milnes Marshall to give accuracy and reality to his statements. Especial care has been given to the account of the embryology of the frog, which is illustrated by admirable original drawings and may be regarded as a critical revision of the subject based upon original work carried out by the author and his pupils. Most of the novel features in the chapter on the chick are derived from the work of Duval, but in the later stages of the rabbit's development Prof. Marshall again relies on his own observations and drawings. The account of the human embryo is based upon that of Prof. His with some judicious additions.

I have said that the work is eminently practical, and by that I mean not only that the book is one for the laboratory, but that the author whilst giving the greatest care to accuracy of statement and presentation of fact, has dealt very little—I may even say has avoided dealing—with theoretical questions of wide interest. An introductory chapter in some thirty pages gives a brief and general sketch of the structure of the animal egg, its maturation, its fertilisation, the segmentation of the egg and the germ layers, theories of fertilisation and recapitulation and the origin of sex, and then we settle down to our "types."

I do not doubt that the plan of teaching by "types" has its merits, and has served a very useful purpose; also I cannot doubt that the plan of describing all the phases of an animal's growth (except the adult phase) in order, one after another, has advantages, and perhaps such descriptions constitute—if such a study can really be distinguished and recognised—what is known as "embryology." But it becomes daily more obvious that the histology, morphology, and physiology of the organism must also be considered and treated without regard to the arbitrary separation of adult and embryonic conditions, and without that exclusiveness which the selection of "types" involves. Morphology is essentially *comparative;* it involves the consideration alike of embryonic and adult structure, and must avail itself of the facts of structure exhibited in any and all forms, without being restricted to certain types. It is a consequence of the method of treatment adopted by Prof. Marshall that many interesting morphological problems are not discussed by him. It clearly was not his purpose to consider these problems, but rather to furnish the student with a sound basis of observed fact. At the same time it is a little disappointing—on looking up, in the successive chapters on frog, chick, and rabbit, the account of the development of the urinary and genital ducts—to find no discussion or decisive statement on the author's part as to the morphological relation of these structures, or any suggestion as to the explanation of the divergences in the developmental history of the Müllerian and Wolffian ducts in these "types" respectively, and in other vertebrates. In a work on vertebrate embryology one might reasonably expect such a comparative treatment. Similarly, the question of blastophore and primitive streak and "sickle" is but lightly touched, whilst the conflicting and bewildering accounts of the germinal layers of the mammalian blastoderm are left without further remark than that the account adopted from Rauber and Kölliker, as to what takes place in the rabbit, "is difficult to reconcile with the course of development in other mammals; and further investigation is much needed on these points." It could not be expected that Prof. Marshall should settle in the present treatise all the knotty points of vertebrate embryology, but would it not have been well had he pointed out in some detail the difficulties of reconciliation to which he briefly alludes, and given some indications of alternative solutions of the problems involved? These reflections are by no means to be regarded as depreciation; they are rather intended to illustrate the special lines within which the author has confined his treatise. These being given, it is not too much to say that he has produced a most valuable, clear, and masterly exposition of the known facts of the developmental history of leading types of vertebrata.

Before concluding I may venture to point out two matters which might be amended in a new edition of the book, as well as in the same author's "Practical Zoology." The word "stomatodæum" occurs in several places. There is no reason that I know of for altering the more elegant form "stomodæum" in this way: the one is as "correct" as the other. Being the father of the word "stomodæum" and its twin "proctodæum," I should prefer that those who use it would not delude themselves into the notion that I have inadvertently or ignorantly omitted a necessary syllable in its composition. The second matter is as to Prof. Marshall's figures of transverse sections of adult Amphioxus (Figs. 12 and 13). These require (and have for some time required) correction. The clear space below the black undulated line representing the plaited epithelium of the ventral surface of the atrium should be filled in with shading. It is *not* a space, as it was at one time thought to be, but is a solid mass of gelatinous connective tissue. Moreover, the dotted area marked S in both the figures is not, as the explanation of the figure has it, the cardiac aorta. The space so marked is the sub-endostylar cœlomic space, and the cardiac aorta, which is a relatively small vessel lying within it, is not represented in the figures at all.

E. RAY LANKESTER.

RURAL HYGIENE.

Essays on Rural Hygiene. By George Vivian Poore, M.D., F.R.C.P. (London: Longmans, Green, and Co, 1893.)

EIGHT of the chapters of this work have been, in whole or part, previously published; to these the author has added five others, and the result is a welcome volume, which appeals to all those who take an interest in problems of health.

To the lay reader the book will probably carry conviction upon every one of the many sanitary points which are raised and dealt with, for the writer has a style which is at once clear, incisive, and convincing; and he builds up his conclusions upon good, sound, scientific, and logical bases. Many professed sanitarians will, however, cull here and there from among much which they are unhesitatingly prepared to accept, a little which is not in entire accordance with their own tenets and experience, but which is none the less acceptable as affording much food for thought and speculation.

The keynote struck throughout the work has a genuine ring, for the dominant principles of *rus in urbe* and *urbs in rure* resound through every chapter.

The first chapter deals with the concentration of population in cities, and the author very justly finds great fault with the overcrowding on space that now obtains, and he indicates, upon sound sanitary lines, the conditions which should be imposed to obviate this evil. The advice, however, comes too late for many of our large towns, in which, alas, at the present day, hygiene must needs make way for measures of expediency. Later on, in a capital chapter on "Air," the author resumes his diatribe against overcrowding, and even goes to the extent of facing it in our conventional "at homes." He writes: "Perhaps the day will dawn when it will be considered 'bad form' to give your guests far less than one-twentieth of the fresh air which is allowed to criminals." One is not prepared to unreservedly accept the view that water under pressure and the laying down of sewers have been mainly instrumental in causing overcrowding on space. There can be no gainsaying that our towns, long before the era of the introduction of these two systems, were miserably overcrowded; and there is no reason to doubt that, apart from either of these innovations, the towns would have continued to spread with little or no improvement in this respect, and that, despite the absence of water under pressure, the value of land over certain favoured areas would have insured the appearance of the modern high buildings.

The following principles are powerfully advocated throughout the book: The shallow-earth burial of dead bodies; the payment of water by meter on a sliding scale of charges, giving the "water of necessity" at a low rate, and charging more for the "water of luxury"; that each individual should have at least two-thirds of an acre of land, so as to secure an adequate supply of fresh air, and to provide that all refuse of every kind might be returned to this land in order to maintain and increase its fertility.

The two chapters that deal with personal experiences in a country town are extremely interesting and instructive, as giving the author's experience of a small estate of his own, upon which about a hundred people are housed, and in which he endeavoured—with no small measure of success—to realise his Utopia, *i.e.* a place where there are no sewer pipes; where every cottage has around it an allotment sufficient to be fertilised by, and to purify, all the waste products furnished by the inmates; and in which the waste waters should run "clear as crystal in open channels without needing so-called ventilation."

Throughout the book many interesting agricultural points are raised and treated ably by one who is evidently able to bring considerable practical experience in harmony with theory.

To sum up:—The book is eminently interesting; it is instructive and furnishes much food for the reflective mind, and as such its perusal may be confidently recommended to one and all.

OUR BOOK SHELF.

Die Klimate der Geologischen Vergangenheit und ihre Beziehung zur Entwickelungsgeschichte der Sonne. Von Eug. Dubois. (Nijmegen: H. C. A. Thieme. Leipzig: Max Spohrr, 1893.)

THIS pamphlet is a translation, with additions, of a paper originally published in the Journal of the Dutch East India Company. It consists of two portions of somewhat unequal value and interest. In the first section of the book, extending to thirty-six pages, a short but clear summary is given of the evidence bearing on the question of the climate of former geological periods. The references and notes display complete familiarity with the very large literature which is now in existence in connection with this subject. The second and larger half of the pamphlet, extending to nearly fifty pages, is a well-reasoned development of the theme that the variations in the temperature of the earth's surface during successive geological periods were the result of changes in the heat of the sun, and that the sun is in fact a variable star. Anyone wishing to become acquainted with all the recent facts and arguments bearing on the question of the climate of former geological periods, and to find them carefully summarised, with abundant references to original sources of information, will in this little pamphlet recognise a work admirably adapted to his needs.

Polarization Rotatoire, Réflexion et Réfraction vitreuses, Réflexion métallique. Par G Foussereau. (Paris: Georges Carré, 1893.)

THIS volume consists of a series of lessons given at Sorbonne in 1891-92 to *candidats à l'agrégation.*

Under natural rotatory polarisation the author deals with the fundamental phenomena presented by quartz when traversed by polarised light parallel to the optic axes, and discusses the theories of Fresnel and others relative to rotatory polarisation. The relations between activity and crystalline form, the rotatory power of liquids, and the behaviour of quartz when traversed by light in a direction inclined to the optic axis, are also treated in this section.

Magnetic rotatory polarisation in singly- and doubly-refracting media is discussed in the second part. In both of these sections the effects of the various factors upon which the magnitude of the rotatory power depends—wave length of the light employed, temperature, length and chemical nature of the medium, &c.—are briefly stated.

In the last part is found a discussion of the various hypotheses advanced in connection with the phenomena of vitreous reflection and refraction and of reflection at metallic surfaces.

The book contains a clear account of the theoretical aspects of the above questions, the mathematical treatment being as elementary as is consistent with the nature of the subject.

LETTERS TO THE EDITOR.

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

The Non-Inheritance of Acquired Characters.

I WISH to call the attention and elicit the opinion of naturalists as to the interpretation of certain facts bearing upon this question.

In my article in the *Fortnightly Review* of May last, p. 664, I give what appears to be a new interpretation of facts which have been often quoted, as to the change in the external characters of a Texan species of Saturnia when the larvæ were fed upon *Juglans regia*, its native food-plant being *Juglans nigra*; and the somewhat analogous facts as to *Artemia salina* being changed into *A. Milhausenii* (the former living in brackish, the latter in salt water) when the water became gradually more salt; the change in this case being progressive, year by year, and proportionate to the change in the saltness of the water. The reverse change was also effected by gradually reducing the salinity of the water inhabited by *A. Milhausenii*.

As regards the former case I remarked in my article as follows:—

"Prof. Lloyd Morgan (in his 'Animal Life and Intelligence,' pp. 163–166) clearly sees that this and other cases do not prove more than a modification of the individual; but it seems to me to go further than this. For here we have a species the larvæ of which for thousands, perhaps millions, of generations have fed upon one species of plant, and the perfect insect has a definite set of characters. But when the larvæ are fed on a distinct but allied species of plant, the resulting perfect insect differs both in colouration and form. We may conclude from this fact that some portion of the characters of the species are dependent on the native food-plant, *Juglans nigra*, and that this portion changed under the influence of the new food-plant. Yet the influence of the native food-plant had been acting uninterruptedly for unknown ages. Why then had the resulting characters not become fixed and hereditary? The obvious conclusion is, that being a change produced in the body only by the environment, it is not hereditary, no matter for how many generations the agent continues at work; in Weismann's phraseology it is a somatic variation, not a germ variation."

I then referred to the marked difference between somatic and germ variations in plants, the former disappearing at once, the latter persisting, when cultivated under abnormal conditions; and also to the cases of many closely allied species of animals and of the races of mankind, which preserve their distinctive characteristics when living and breeding under very different conditions.

The above seems to me a perfectly valid and logical argument, and I was interested to see how it would be met by Lamarckians, who have frequently referred to the same facts as being obviously in their favour, though without any attempt to show how and why they are in their favour. I was therefore rather surprised to read, in the July issue of the *Contemporary Review*, a paper by Prof. Marcus Hartog, in which he characterises my argument as a very bad kind of special pleading, and adds that it amounts to this: "Any change in the offspring produced by altered conditions in the parent is limited to characters that are 'not fixed and inherited'; for fixed and inherited characters cannot be altered by changed conditions in the parent; therefore no experimental proof can be given of the transmission of acquired characters."

The above is of course simple reasoning in a circle, and I cannot recognise it as my reasoning. I have made no general proposition that "fixed and inherited characters cannot be altered by changed conditions in the parent," or that "no experimental proof can be given of the transmission of acquired characters." But I argue that when a decided character is immediately changed by changed conditions of the individual, as in Saturnia, it is not "fixed and inherited." The experiment itself shows that it is not a fixed character, and there can be no proof that it is inherited so long as it only appears under the very same changed conditions that produced it in the parent.

As to experimental proof I believe it to be quite possible. There is one case, which I do not remember having seen referred to, in which nature has tried an experiment for us. I was informed by the President of the Deaf-Mute College at Washington that the male and female students frequently marry after leaving the college, and that their children are rarely deaf-mutes. But the point to which I wish to call attention is the admitted fact that there is usually no disease or malformation of the vocal organs in a deaf-mute. Now, before deaf-mutes were taught to talk as they are now, they passed their whole lives without using the complex muscles and motor-nerves by the accurate coordination of which speech is effected. Here is a case of complete disuse, and there must have been some consequent atrophy. Yet it has, I believe, never been alleged that the children of deaf-mutes exhibited any unusual difficulty in learning to speak, as they should do if the effects of disuse of the organs of speech in their parents were inherited. Here is at all events the material of an experiment ready to our hands. An experiment to show whether the effects of use and disuse were inherited might also be tried by bringing up a number of dove-cot pigeons in a large area covered in with wire netting so low as to prevent flight, at the same time encouraging running by placing food always at the two extremities of the enclosure only, or in some other way ensuring the greatest amount of use of the legs. After two or three generations had been brought up in this way, the latest might be turned out among other dove-cot pigeons, at the age when they would normally begin to fly, and it would then be seen if the diminished wing-power and increased leg-power of the parents were inherited.

No doubt many better experiments might be suggested; but these are sufficient to indicate the character of such as do not require that the offspring be submitted to the same conditions as those which produced the change in the parents, and which thus enable us to discriminate between effects due to inheritance and those due to a direct effect of the conditions upon the individual. The cases of the Saturnia and the shrimps are of the latter kind, and in their very nature can afford no proof of heredity.

ALFRED R. WALLACE.

The Conditions Determinative of Chemical Change: Some Comments on Prof. Armstrong's Remarks.

IN a paper (NATURE, vol. xlviii. p. 237, Proc. Chem. Soc. 1893, 145) bearing the above title, Prof. Armstrong discusses the phenomena of contact action, particularly those of the kind described by Mr. H. B. Baker. The whole discussion appears to us to be based on erroneous conceptions and to call for some criticism, first, on the general position assumed by him and, second, of the details which he brings forward to support that position.

Eight years ago Prof. Armstrong defined chemical action as "reversed electrolysis." It is not clear from his remarks whether this is one of the views which recent observations have led him to modify; but, assuming that he still holds that belief, it may be pointed out that it by no means follows that because an electric current can effect a chemical change, every chemical change is due to or accompanied by electric action. It might as well be argued that because a stone let fall on a glass plate can shiver it, a shivered plate glass always implies a falling stone as its cause—it could be broken by irregular rise of temperature, or by loading it with a too heavy weight, phenomena which imply no expenditure of kinetic energy. Yet the statement contains a germ of truth, but only when so qualified as to amount to something very different. Electrical energy may be absorbed in effecting chemical decomposition; when chemical combination occurs *some form of energy* is made manifest. The facts, apart from theory, as we know them, appear to be these. A certain fraction of some definite amount of electrical energy may be absorbed in producing chemical decomposition, and that fraction will be quantitatively converted into chemical energy; the electrical energy disappears as such, and elements may be liberated from a compound, containing, as elements, the equivalent quantity of chemical energy. These elements may part with their chemical energy, which will then cease to exist as such, but will appear in various forms: some of it may be evolved as heat, some as volume energy, some as kinetic energy, and it is even possible by an appropriate contrivance to obtain a large portion of the chemical as electrical energy. But to state that the energy always passes through the electric stage on its way to other forms in which it manifests itself to us is something altogether different.

The question that Prof. Armstrong tries to answer by the supposition that the presence of an electrolyte is required in order to bring about chemical change admits of a very different reply. We conceive it to be this: In most exothermic combinations the heat evolved is sufficient, provided the change were to proceed adiabatically, to resolve the compound into its constituents. Why, then, should they react? To take a concrete instance:—Why should ammonia and hydrochloric acid combine at ordinary temperatures when the heat evolved by their union is sufficient (*provided none escape*) to raise the reacting molecules to the temperature at which they refuse to combine? For convenience sake the question is stated in terms of heat, since that is the usual form in which the loss of chemical energy manifests itself to us; but it is advisable to keep the statement of the question quite general. It appears to us that the answer is:—because the reaction is not adiabatic. Some substances must be present—the walls of the containing vessel, some compound capable of dissociation, some solid body, such as spongy platinum, which will absorb a portion, perhaps an exceedingly small portion, of energy, and so give the bodies present a chance of interacting without liberating so much energy by their interaction as would decompose the prospective compound. These views, it may be contended, are speculative. It is true: but we venture to think that they are legitimate speculations, involving a complete survey of the circumstances, and not one-sided and partial like those of the paper we are criticising.

Assuming the correctness of Prof. Armstrong's main idea, there are still one or two matters of detail where the assumption scarcely seems in harmony with known facts. He assumes that because hydrogen chloride when dissolved in water forms a composite electrolyte, a gaseous mixture of hydrogen chloride and water will also be an electrolyte. This by no means follows, and indeed experiments which have been made in this direction point to the contrary conclusion. The same holds good of his argument as to the combination of nitric oxide and oxygen—water *vapour* is not known to form a composite electrolyte with gaseous nitric acid.

With regard to the regularity displayed by iodine and hydrogen compared with the irregularity of the results obtained by Victor Meyer with chlorine and hydrogen, it is altogether impossible to understand Prof. Armstrong's attitude. In one sentence he assures us that "this is not surprising," and in the next that "there is a significant [of what?] difference in the behaviour of the two mixtures, as hydrogen iodide should behave as hydrogen chloride." He suggests that some special electrolyte may be active in the case of chlorine and hydrogen; but he is inclined to account for the difference observed from the fact that only one of the reactions is reversible under the conditions of experiment. We quite fail to understand the influence which the reversibility of the reaction would exert on its regularity.

In fine, still assuming for the sake of argument the notion of "reversed electrolysis," we would ask:—In a mixture of hydrogen and oxygen, are the ions there, or are they not there? If not there, will the presence of a *vapour* bring them into existence? If there, what is the need of a so-called impurity? Is it supposed that the impurity will discharge them? Why, then, does not the presence of one or of two conducting wires of the same metal in an electrolyte cause combination of the ions?

University College, London, July 8. W. RAMSAY.
JAMES WALKER.

The Corona Spectrum.

IN the preliminary account by M. Deslandres of the main results of the eclipse photographs obtained by the French astronomers at Fundium, as reported in this journal on May 25 (vol. xlviii. p. 81), it is stated that many new coronal lines have been photographed, and that a displacement of the lines in the light from opposite points of the corona in the solar equatorial plane proves a rotational movement nearly corresponding with that of the surface of the sun itself.

In the absence of fuller details it is perhaps a little difficult to accept without reserve these interesting statements, particularly when one considers the somewhat unfavourable conditions under which the photographs were obtained. In the first place, one would like to ask by what means have these new bright lines been identified as belonging to the corona, seeing that, owing to the hazy condition of the air at the above station, the brilliant chromospheric radiations were apparently reflected from a considerable area of the sky in the sun's neighbourhood, forming, as it were, a kind of false corona with a bright line spectrum. So obvious, indeed, is this atmospheric spreading of the chromosphere lines in the spectrum photographs obtained by the English astronomers at the same station, that many lines are shown as clearly on the moon's disk as in the coronal regions; the calcium lines "H" and "K," which are very brilliant chromosphere lines, are in these found to extend considerably above the limits of the true corona, as defined by its continuous spectrum, and are also found equally bright across the dark moon.

From the above considerations one is inclined almost to doubt whether, after all, any true corona lines have ever been proved to exist, excepting perhaps the line 1474 (K), which is not ordinarily a brilliant line in the chromosphere, and would therefore not be easily seen by atmospheric reflexion;[1] and it would seem possible, if not probable, that this beautiful solar appendage, with its dark rifts and curving streamers, shines simply by continuous light.

Definite information on this point would, however, be gladly welcomed by those who are endeavouring to photograph the corona without an eclipse. We would, in fact, clutch at any straw, in the shape of a bright line, in the hope of its yielding a true image of the coronal forms, and it was hoped that the recent eclipse would furnish evidence which would settle this question.

With regard to the second point, namely, the displacement of lines in the coronal spectrum. This is said to be equal to a velocity in the line of sight of 5 to 7 kilometres per second (I presume for the total difference of position of the line), say 3 kilometres for the speed of approach or recession at a distance from the solar limb equal to two-thirds of the diameter.

This is certainly a very striking result, and if confirmed by further study would in itself go far to prove the true coronal nature of the line measured. A displacement is conceivable, it is true, under certain conditions, on the assumption that the light is reflected chromospheric light, but this would not exceed a velocity of 1·87 kilometres, whilst the above result comes not far short of an angular rotation equal to that of the disk itself. A point at the distance named would, if rigidly connected with the sun, alternately approach and recede at a speed of about 4·35 kilometres per second.

It would be interesting to know, however, what are the limits of error in these measurements. I gather that a high dispersion was not employed, and it would seem, therefore, that a large uncertainty may be expected; supposing, for instance, that in the original negative the lines H and K are depicted 25 mm. apart, the total displacement corresponding to 7 kilometres per second will only amount to 09 mm.; an error, therefore, of $\frac{1}{30}$ mm., or $\frac{1}{1250}$ of an inch (corresponding to over $1\frac{1}{2}$ kilometres) would materially affect the result; and to come within this limit would require unusually fine definition in the line measured.

In view of the novelty and great importance of the conclusions arrived at by the leader of the French eclipse expedition to Senegal, students of solar physics will await with keen interest, not to say impatience, the publication of a full detailed discussion of the results obtained. J. EVERSHED.

Kenley, Surrey, July 2.

Lord Coleridge and Vivisection.

MY attention has been called to a letter which the Lord Chief Justice has written in support of an endeavour which is being made by a section of the Society for Promoting Christian Knowledge to withdraw from circulation my little work "Our Secret Friends and Foes," recently published in their "Romance of Science Series." Until the Publication Committee of the

[1] It seems pretty certain, however, from the clearly-defined coronal "rings" seen by Prof. Lockyer and others at former eclipses by means of an objective prism, that a more or less uniform gaseous extension must exist far above the chromosphere and prominences; but is this the corona proper?

Society, in which I have every confidence, takes any action in this matter, I have no wish to participate in the controversy, and have but little doubt that the simple publication in your columns of the enclosed correspondence, without any comment from me, will be quite sufficient to enable the readers of NATURE to form a correct opinion as to the manner in which my book has been made to serve the purposes of the Victoria Street Anti-Vivisection Society. PERCY F. FRANKLAND.

University College, Dundee, July 15.

The committee of the Victoria Street Anti-Vivisection Society have issued the following protest to the members of the Society for the Promotion of Christian Knowledge against a work recently published by that Society, and concerning which the Lord Chief Justice has written the letter appended :—

20, *Victoria Street, London, S.W., July* 1893.

Sir (or Madam),—The attention of the Committee of the above society has lately been drawn to a book issued by the Society for Promoting Christian Knowledge entitled "Our Secret Friends and Foes," the author of which, Dr. Percy Faraday Frankland, held a license last year as a practical vivisector.

My committee consider that the following extracts sufficiently show that the book is calculated to encourage the unjustifiable and demoralising practice of experimenting on living animals :—

"Nicolaier was the first to discover that certain bacilli, widely distributed in the superficial layers of soil, were capable when subcutaneously inoculated into mice, guinea-pigs, and rabbits, of setting up symptons typical of tetanus from which they subsequently died." (Page 123.)

"Rabbits and guinea-pigs inoculated with some (spider's) web . . . . died under particularly well-defined symptoms of tetanus." (Page 126).

Again, with regard to the Pasteur methods, which, from their nature, must involve great torture of animals, we read :—

"Numerous investigators have succeeded in calling forth many of the symptoms of a disease by injecting the products of these organisms" (Page 140.)

On page 148 there is the following passage referring to the establishment of Pasteur Institutes :—

"Such institutions have been established in Russia, Hungary, Italy, Sicily, Brazil, Mexico, Turkey, the United States, and Roumania, whilst in Great Britain, to our unutterable disgrace, we are in this respect behind the unspeakable Turk, and the semi-barbarous subjects of the Czar."

That a Pasteur Institute has not yet been established in England, in spite of repeated efforts on the part of the vivisecting school, is greatly to the credit of this country, for such an institution would result in an enormous increase in the number of painful experiments on God's innocent creatures.

My committee are of opinion that the teaching of this book is opposed to the objects of the Society for Promoting Christian Knowledge, and I am directed earnestly to urge you, if you consider the objections to the book are valid, to write the Secretary, Editorial Department, S.P.C.K., Northumberland Avenue, London, W.C., and protest against the continned publication of it.—I am, Sir (or Madam), your obedient servant,

BENJN. BRYAN, Secretary.

The following is the letter from the Lord Chief Justice of England :—

1, *Sussex Square, W., June* 27.

Madam,—I have signed this paper, not exactly with pleasure, for the whole subject is utterly odious to me, but with great willingness. I have never seen any reason to change or qualify the opinions I expressed many years ago in an article on vivisection which your society reprinted. Should the book in question not be withdrawn by the Society for Promoting Christian Knowledge, I shall at once withdraw myself from it, as it will, in my judgement, become a Society for the Promotion of Unchristian Knowledge. Very good men, I am quite aware, take a different view, and will continue to support the society ; but a man, however obscure, must act upon his convictions, especially when they have not been hastily taken up and are not quite ignorantly maintained.—I am, Madam, your obedient servant (Signed) COLERIDGE. Miss Monro.

Oyster-Culture and Temperature.

IT may interest some of your readers to know that there has been an unusually heavy deposit of oyster spat just now on the collectors (tiles) along this west coast of France. Some of the tiles I have seen during the last few days have been very densely crowded over with the little amber-coloured scales. The oyster breeders both at Arcachon and at Point de Chapus, men of long experience, attribute the special abundance of the spat this season to the continuous hot weather.

The calmness of the sea at the time when the embryos were set free may also have had something to do with an unusually large number passing safely through the critical larval stages.

The temperature of the sea on various parts of the oyster "parcs" at Arcachon last Monday was from 80° to 90° F., and out in the open to-day, half-way between the islands of Oleron and Ré, I find it is 72° F. However, it may be hoped that although temperatures like these may be favourable, they are not necessary for successful oyster breeding.

W. A. HERDMAN.

St. Pierre Ile d'Oleron, France, July 7.

The Diffusion Photometer.

IN the discussion before the Physical Society of June 9, a photometer made of paraffin blocks is mentioned as "The Jolly Photometer." I think, however, that this is the photometer described by me in the *Philosophical Magazine* some two or three years ago ; also in the proceedings of the Royal Dublin Society, and exhibited before the British Association on the occasion of their meeting at Bath. I cannot now give exact references, but I must be pardoned for calling attention to the mistake, as it has been made before by a high authority, and seems likely to be perpetuated in England.

It is correctly described in Wiedemann and Ebert's "Physikalisches Praktikum," recently published (p. 217).

Bonn, July 12. J. JOLY.

P.S.—I have no objection to the prefix if written with a small letter.

[We followed the spelling of the word contained in the official report of the Physical Society.—ED.]

ALPHONSE DE CANDOLLE.

THOUGH this notice is somewhat belated, the passing away of a figure so conspicuous as De Candolle in the European world of science cannot be permitted to receive no more sympathetic notice than a bare record of the fact.

Alphonse Louis Pierre Pyramus de Candolle, to give him his full name, died on April 4 at his house in the Cour de St. Pierre at Geneva, in the eighty-seventh year of his age. If his bodily vigour had of late somewhat failed, he preserved his scientific interests and mental activity up to the last. Only the week before his death I received a letter from him, in which there was no indication of failing vitality, and in which he wrote without anxiety of the work that he had in hand.

So many of us have grown up under the shadow of De Candolle, that it seems almost a kind of impiety to sit down and coldly measure his stature. To me it seems that in a manner his death closes an epoch. With him passes away the last great representative of the French School of Botanical Taxonomy—to which, through Bentham, the English was in a great measure affiliated—and which had its root in Lamarck, whom the world in general scarcely realises as a botanist.

Geneva has long been remarkable as the home of a number of families whose members have cultivated science with distinction. These are for the most part descendants of French Protestants who have emigrated from the south of France. Amongst these the De Candolles stand out in pre-eminence ; the third generation still sees them in the front rank of the scientific world.

Alphonse de Candolle's father, Augustin Pyramus, was a man who would have been remarkable in any age. Gifted with astonishing energy and enthusiasm, a singular power of grasping and co-ordinating large masses of detail, and indefatigable industry, his buoyant charm of manner inspired even the citizens of Geneva with interest and conviction in the supreme importance of taxonomic studies.

I know nothing in scientific literature more entertaining and instructive than his *Mémoires* and *Souvenirs*. They supply a striking instance of his irresistible influence. The return of an important collection of original drawings of Mexican plants was demanded by the lender. De Candolle roused the whole of Genevan society to his aid; the city was almost in a ferment till by united co-operation every one of the 1200 drawings had been copied.

The facts to be told of Alphonse de Candolle's life are simple. Born October 27, 1806, at Paris, he took the degree of Bachelor of Science at Geneva in 1825, and of Doctor of Laws with great distinction in 1829. The influence of his legal training probably gave an impress to his work and character all through life. In 1831 he began to assist his father in his duties as Professor of Botany, and he succeeded him in the chair in 1835. He held it till 1850, when he left it, owing to political events. The remainder of his life he passed as a private man of science. But during middle life he fulfilled with dignity, and not without influence, the duties of a citizen which his character and social position in some sort imposed upon him. After serving as a member of the Representative Council of Geneva, he was a member of the Grand Council from 1862 to 1866. He was the first to advocate the "referendum" in political affairs; he exerted himself to effect numerous reforms in economic and sanitary matters; and by obtaining the use of postage-stamps for his Canton he appears to have paved the way for their general introduction into Switzerland.

The earliest and perhaps the best of De Candolle's botanical works is his Monograph of the *Campanulaceæ*, published in 1831. It has stood its ground more solidly than is often the case with the taxonomic work of the time, and its conclusions have been in the main adopted in the later revision of the order by Bentham and Hooker.

In 1841 De Candolle's father died. He had commenced the publication of the *Prodromus* in 1824. The object of this vast undertaking was to give brief diagnostic descriptions of all known plants. Its publication finally settled the question which had long agitated the scientific world as to the supersession of the artificial Linnean system by a natural one. What is called the Candollean sequence is still in general use, though it is confessedly in some respects itself artificial, and only an approximation to a truly natural arrangement. The father had published seven volumes of this classical and indispensable work. The son carried it down to the completion of the Dicotyledons in the seventeenth volume, published in 1873. He saw that no one man could carry out the task single-handed. While formulating a uniform plan and method of procedure, he managed to summon to his aid the systematic botanists of all Europe. In 1847 he was able to claim that he had contributors from England to the Tyrol, and from Montpellier to the Baltic. He took himself no mean share of the work, and if this kind of research affords comparatively little opportunity for the display of genius, Alphonse de Candolle's work is always characterised by qualities of workmanlike accuracy and scholarly finish.

In early life the writings of Humboldt inspired De Candolle, as they have done many young men, with the impulse to travel. Family circumstances, however, forbad it. But the fascination of phyto-geographical problems had taken possession of him, and the vast assemblage of specific forms which continually passed through his hands must have supplied him with inexhaustible food for reflection.

In 1855 appeared his *Géographie botanique raisonnée*, which was the most important work of his life. It would be impossible in a short space to appreciate this justly. It has been complained that it led to no direct conclusion; and it is all but inexplicable that the author missed seeing that the immense mass of facts he had collected really pointed directly to evolution as the key to its explanation. But the character of the man is an element which must not be overlooked. Essentially in method a statistician, he believed these facts, properly marshalled, would evolve their own law. But scientific method, like other calculating machines, will not evolve more than is implicitly put into it. De Candolle, it must be admitted, neither possessed nor had much sympathy with that touch of imagination akin to inspiration, which by some unconscious cerebral integration sees an even wider principle underlying the facts which are contemplated than by any method of manipulation can be educed from them. But it may be doubted whether a study of the Distribution problem would ever have led to evolution directly. The essence of the Darwinian theory was the discovery of a possible, at any rate conceivable, *modus operandi*. This was the result of an attack from the biological side. The phenomena on a large scale which geographical distribution present are too remote from their ultimate cause to immediately suggest it; yet when the principle is grasped they are immediately susceptible of deductive explanation.

Nevertheless, I cannot but regard the *Géographie*, if not as an actual precursor, yet as one of the inevitable foundation-stones of the modern evolution-principle. In the first place, De Candolle dealt more than one heavy blow to Lamarckism. Botanists were impregnated with the idea that plant-distribution was a mere matter of temperature. Adanson had supposed that there was a simple numerical relation between it and growth. Boussingault had gone further and stated that the product of the period of growth multiplied into the mean temperature was a constant. That within limits there is truth in these statements, I myself believe, and for cultural staples the problem is still worth fresh investigation. But the facts will not bear generalisation, and in the field of nature De Candolle saw that they explained little. Other factors, such as light and moisture, must also be taken into account; if he had gone a little further he would have met the "Struggle for Existence."

But De Candolle's most fertile conclusion was the derivative nature of existing floras, and he cites with approval the classical speculations of Edward Forbes on the flora of Western Europe. De Candolle at any rate brought together a mine of accurate information, collected with vast labour without prepossession and marshalled with consummate judgment. He has furnished an armoury from which it will be long before successive students of the subject cease to draw their weapons. Had he taken narrow and pedantic views of specific limitations, he would have left the subject more confused than he found it. But by treating, for example, the aquatic Ranunculi as a group of variable forms of a single species, *Ranunculus aquatilis*, he supplies facts in a shape at once available for the Darwinian student.

De Candolle met Darwin in 1839, and though he maintained a correspondence with him, they did not meet again till 1880, when the former paid a visit to town. Of this he published a touching and in some degree pathetic account in 1882. He makes his submission to the inevitable. I will translate a few words:—

"The existing distribution of species, especially in islands, compelled me to admit, as early as 1855, four years before the appearance of the "Origin of Species," the creation, in certain cases, of new specific forms derived from older ones. I proved to demonstration that the majority of species ascend to periods far more remote than is generally supposed, and that they have passed through both geological and climatic changes. Lyell accustomed geologists to consider small causes, operating through long periods, as competent to produce large effects. The astronomical conception of indefinite time had penetrated natural science. Five or six thousand years counted for little in the history of organised beings. . . . Uncertainty was everywhere. The facts of classification, of palæontology, of geographical distribution, of organogeny ceased to be intelligible. It was necessary to tread through the barrier of a limited time, and of the belief in the permanence of specific forms. *Alors parut Darwin.*"

The influence of Darwin was conspicuously shown in the remarkable book which De Candolle published in 1873, under the title of "Histoire des Savants." He lays botany aside, and going back to the studies of his academic life, starts afresh under the inspiration of the new ideas. But he does this with the same reserve and almost sceptical spirit which characterises all his writings. The facts must evolve their own consequences. He is reported to have said that "he was a botanist by inheritance and a statistician by birth." But he applies to the treatment of his data a statistical method which is positively fascinating in the skill with which it is employed, and the interest of the results to which it leads. I must content myself with a single conclusion, the undoubted validity of which, it seems to me, is often overlooked.

"Heredity neither gives scientific men special nor extraordinary powers; but only that combination of moral and intellectual qualities which may be directed according to circumstances and the choice of the individual to scientific study or to any other serious or definite object." If we slightly enlarge this conclusion by regarding extraordinary aptitude for particular branches of scientific discovery (or any other field of intellectual or artistic activity), as a sort of exceptional sport from an already specialised race, it appears to me that we have the whole root of the matter. A very distinguished man of science has been known to hazard the opinion that if he had turned his attention to law, he would probably have become Lord Chancellor. I think that he only erred on the side of modesty, and that he would equally likely have been Prime Minister.

But I must pass on. In 1880 De Candolle published his *Phytographie.* This is a useful book, indispensable to the taxonomic workshop. It elaborates and enforces the admirable principles of plant descriptive work laid down by Linnæus, which make the study one of no small value as an educational discipline. The book will always have its value as keeping alive an admirable tradition. Would that its example and precepts were more taken to heart by many modern botanists who fail to see that a description is one thing, a luminous and logical diagnosis a totally different one!

Finally, in 1883, De Candolle published his "Origine des Plantes Cultivées." This sprang from his prefatory studies for the *Géographie.* It is an altogether admirable book: not perfect certainly, or complete, and faulty perhaps more especially in the difficult matter of handling the philological evidence. Yet I know of no one who could have put together the material in a more masterly way, or who could have presented the conclusions derivable from it in a form more likely to carry conviction.

Here I must close. As I began by saying, a great figure has passed away. Distinguished in appearance, his manners though reserved, were always exquisitely urbane. If he lacked enthusiasm of a demonstrative sort he made up for it by extreme sobriety of judgment and inexorable persistence. He was singularly kind to all who were disposed to engage in botanical work; and would spare no pains to help and even aid, with his own accumulated materials, those who were willing to undertake a research. He died beloved by his family, revered by his countrymen, and loaded with distinctions. He was a Foreign Member of the Royal Society, a Gold Medallist of the Linnean Society, a D.C.L. of Oxford, and an LL.D. of Cambridge; and the possessor of the order which perhaps confers the greatest distinction on a scientific man, the "pour le mérite" of Prussia. W. T. THISELTON-DYER.

CARL SEMPER.

A GREAT investigator has left us, and one more vacant tablet of the Hall of Fame has received its inscription.

Carl Semper, born July 6, 1832, at Altona, near Hamburg, a son of the celebrated architect, Gottfried Semper, at first destined for the Royal Navy, but afterwards student, graduate, Privat-Docent, and for twenty-five years Professor of the University of Würzburg, has merited eminence as a traveller, a zoologist, a teacher, and an investigator.

The range of his "Thun und Schaffen"—his doing and making—is so wide that but scant justice can be paid to his labours within the short space of this article. As that of a travelled naturalist and the writer of important works of travel his name is honourably known to the geographer, while his investigations in pure zoology are among the most brilliant and weighty of the past thirty years.

Even in this field of science there was a many-sidedness about the observer, impelling him to work for the increase of knowledge in systematic zoology, comparative anatomy, embryology, comparative histology, and physiology.

His travels in the Philippine and Palau or Pelew Islands, for which he expended nearly the half of the large fortune inherited from his father, resulted in many valuable memoirs on various groups of invertebrata, the joint work of himself and others. Semper's "Holothuria," and his special studies of mollusca—a group in which he was a leading authority—may only be mentioned. His book on the "Palau-Inseln im Stillen Ocean" is unfortunately less known—at least, in this country—but in the opinion of good authorities there are few more delightful works of travel, and fewer still in which the observational powers of the naturalist find as full play.

Of Semper's molluscan work only a specialist can speak as it merits. I know not if he completed all that he intended to do, but I have a lively remembrance of the immense stores of material and drawings which he possessed ten years ago.

To experimental physiology he made many contributions in the *Existenz-bedingungen der Tiere* and elsewhere.

But the works of all others which established his reputation as a university professor were undoubtedly those on comparative embryology.

Among these, "Das Uro-genitalsystem der Plagiostomen" is preeminent. In this and other priceless memoirs was laid the solid foundation on which the ten volumes of the *Arbeiten aus dem Zoologisch-zootomischen Institut zu Würzburg* were gradually built up. The intensity and ardour with which he devoted himself to the problems of embryology also laid the beginnings of the long years of ill-health which have just closed with his death.

Though his work cannot be described as having escaped unscathed from the fierce embryological battles of recent years, most of it still stands intact, and is destined to remain, associated with the name of Semper, as part of the classic literature of vertebrate morphology.

With recapitulation embryology he had no sort of sympathy, and his polemics against Haeckel clearly defined his position as an opponent of the so-called "Law of Ontogeny." He was of those whose embryological work is based rather on the idea that organs, not organisms, repeat parts of their ancestral history in their development.

Of the departed master—"Der Chef," as his students affectionately termed him—a pupil cannot write without feeling. Long before his death the great number of his pupils, who had become occupants of University chairs, testified to the success of his training. Profs. Ludwig (Bonn), Braun (Königsberg), Spengel (Giessen), Kennel (Dorpat), Kossmann (Heidelberg), Carrière (Strassburg), and Fraisse (Leipsic), and the Privat-Docenten Ludwig Will, Biehringer, Voigt, Schuberg, and others, still represent the old Würzburg Institute in more than half of the Universities of Germany. Pupils came to him from all parts of the world. Of his contemporaries only two, Albert von Kölliker and Rudolf Leuckart, can claim a longer array of scholars, and none have trained more successful investigators. Among those who pride themselves on their studies in the quaint old rooms overlooking the Neubaustrasse are R. S. Bergh, C. S. Minot, H. Jungersen, Sharp, Strubell, Goronowitch, Grassi, and the cousins Sarasin. From Great Britain came but two, the late Philip Carpenter and the writer.

The peculiarity of Semper's training consisted in this:—The budding zoologist was first thoroughly grounded in comparative anatomy and histology, and then only, after a preliminary trial on some well-worked theme, might he commence independent investigation. The work once begun, the student received abundant criticism but no help, and thus while Semper guided the worker, he never performed the task himself. In this way the memoirs of his pupils came to be not the work of a school in which the master alone was in evidence, but a series of papers dealing with widely divergent questions, and having only this in common that they were built on the same solid basis of elementary knowledge.

Semper was above all the close friend of his pupils, and with them he formed a small "Verein," in which he took considerable pride. The evenings—which usually became early mornings—spent in the little "Alt-deutsche Stube" of the "Zoological Garden" down the Main will not readily fade from recollection. Then it was that the conversation—French, German, and English—more frequently turned to zoological travel, and discussions on current zoology gave place to little lectures on the Philippines and Palau Islands, on Heligoland and the Riviera, on tropical animals and plants. The educational importance of travel to the young zoologist was an ever-recurring topic with Semper. The advice usually had good effect, for most of his pupils have at one time or another made zoological journeys to distant parts of the world—to Ceylon, to Trinidad, to Greenland, the Celebes, and other places.

One of Semper's ideals was a new laboratory with a tropical house for animals. After long treaty with the Government he was happy in obtaining the completion of his wishes—the new Zoological Institute, a building worthy of the architect-zoologist. Three short years ago we who were his old pupils rejoiced with him on the opening of the new abode. Now, as he would bid the fleeting moment stay, he is taken from us. The director's room is vacant, our chief and our "Studentenzeit" are alike memories, on both of which we can only dwell with fondness and affection.

J. BEARD.

NOTES.

WE regret to record that M. Marié Davy died on July 16, at Clamecy, Niévre, at the age of seventy-seven. M. Davy was at one time at the head of the physical-astronomy service of the Paris Observatory, and took a leading part in the protest against Le Verrier's administration in 1870. He published a large number of papers on electrical and astronomical subjects.

PROF. S. P. LANGLEY, Secretary of the Smithsonian Institution, announces that the Institution has secured a table at the Naples Zoological Station for the use of American investigators. The table will be known as the Smithsonian table. Publications resulting from its use will bear the name of the Smithsonian Institution, and such of them as are of sufficient importance will be printed in the "Smithsonian Contributions to Knowledge."

THE munificent gifts of the legatees of Sir Joseph Whitworth to Manchester are to be increased by a sum of £50,000. The amount previously given by them to carry out the scheme of the Whitworth Institute was £105,000. The legatees consider, however, that even their additional donation will need supplementing by the public if the institute is to attain its due importance.

THE International Maritime Congress commenced its second meeting on July 18 at the Institution of Civil Engineers, under the presidency of Lord Brassey. A large number of British and foreign representatives of maritime interests were present, and the outcome of the week's conference will doubtless be of considerable importance. Lord Brassey took for the text of his presidential address the construction and use of breakwaters, and the works that have been undertaken for the improvement of the entrances to ports. Mr. Mundella, M.P., followed with a description of the growth of the mercantile marine service of Great Britain. The Congress then divided into sections for the reading and discussion of papers. Lord Swansea presided over the section dealing with questions relating to the construction of harbours, breakwaters, and general sea-works; and Admiral Colomb is the president of the section devoted to signals, lights, and buoys. The papers read before these two sections were chiefly of a technical character.

AT the recent Congress of Archæological Societies a subject that elicited an interesting discussion was the "Continuation of the Archæological Survey of England." It was announced that the archæological maps of Essex, Lancashire, Cheshire, Surrey, Sussex, and Derbyshire had been considerably advanced since the meeting of last year. Maps are being prepared by societies in Herefordshire, Cumberland, and Westmoreland, on which all interesting antiquities are indicated. A series of symbols has been devised by the Standing Committee for the diagrammatic representation of antique objects and sites, and a resolution was passed expressing a hope that all societies participating in the survey will adopt these symbols and so ensure uniformity. Mr. H. S. Pearson, of the Birmingham and Midland Institute Archæological Society, gave a detailed description of a photographic survey of the county of Warwick. Each photographer who took part in the work was assigned a district of about six square miles, and their pictures were subjected to the criticism of a committee, in order to determine whether they were "worthy of acceptation." Up to now about 1,700 excellent photographs have been taken, and permanent prints of them have been well mounted and presented to the Birmingham Free Library, so that they could be referred to at any time. Mr. Pearson's paper was cordially received, Sir John Evans expressing his warm approval, and bidding all archæological societies throughout the country to "Go and do likewise." The Archæological Institute also held its annual meeting last week. There was a reception at the Guildhall, several excellent luncheons, with pleasurable and doubtless profitable excursions, and a *conversazione* at the Mansion House, so the meeting was a decided success, though no papers were read or discussion raised of scientific moment.

AT the annual meeting of the Wilts Archæological Society, to be held at Warminster on July 25 and two following days, the President, General Pitt-Rivers, F.R.S., will give an account of some excavations he has been recently making in an early camp in Cranborne Chase, near Rushmore, Salisbury, and adjacent to the group of tumuli of the Bronze Age, which were investigated by him in 1880 in conjunction with the late Prof.

Rolleston. The address will be illustrated by plans and sections, and two models will be exhibited showing the entrenchment before and after excavation.

A NUMBER of water-colour drawings, executed by the artists of the Archæological Survey of Egypt, are being exhibited at the residence of the Marquis of Bute, K.T., 83, Eccleston Square, S.W., and will remain on view until Saturday next. The collection of drawings comprise sketches by Mr. Percy Buckman of various sites of historical interest in the provinces of Minich and Assint, a large number of facsimile drawings of wall paintings in tombs of the ancient and middle kingdoms in the same province by Mr. Buckman, Mr. Blackven, and Mr. Howard Carter, as well as many architectural drawings from the tombs by Mr. John Newberry. Cards for admission to the exhibition may be had on application at the offices of the Egypt Exploration Fund, 37, Great Russell Street, W.C.

THE new laboratories at Guy's Hospital were opened on July 17 by Sir John Lubbock, Bart., M.P., F.R.S., a number of men of science being present. In the course of his remarks Sir John Lubbock said that great and brilliant as had been the discoveries in science during the last fifty years, that of the next would be grander still. He based his belief on three grounds. First, because while knowledge was finite science was infinite; secondly, because new processes and inventions were constantly being applied to research; thirdly, the number of investigators was greater and would go on increasing. He hoped that in the laboratories opened that day new steps would be taken in the triumphal progress of science. Sir John Lubbock subsequently presented the scholarships, medals, and prizes, to the successful students, and delivered an interesting address in which he pointed out the necessity of administering kindly advice and sympathy "to a mind diseased" as well as medicine to the body.

MR. R. LYDEKKER is about to visit the museums of Buenos Ayres and La Plata in order to examine the collections of fossil mammals and birds, a grant for that purpose having been made to him by the Royal Society.

THE Japanese section of the Cornwall Counties Fisheries Exhibition, shortly to be held at Truro, is being organised by a committee of the Council of the Japan Society, and promises to be attractive and interesting. Numerous exhibits, illustrating the fisheries of Japan, are now on their way to England, and many collectors of Japanese works of art have promised to lend objects representing fish and fishing.

THE British Consul at Porto Rico has reported to the Foreign Office that it is proposed to hold an exhibition in that city in November next to commemorate the four hundredth anniversary of the discovery of the island of Porto Rico. The exhibits will include agricultural and industrial implements and machinery, and other objects that are or may become articles of commerce. Space will be granted to exhibitors free of charge, and must be applied for by September 1. All exhibits will be admitted free of customs duty.

FROM September 3rd to 6th a meeting will be held at Lausanne in connection with the Société Helvétique des Sciences Naturelles. There will be a general assembly of the Swiss geological, botanical, and entomological societies, and also various geological and zoological excursions. A detailed programme of the excursions can be had on application to one of the Secretaries, Prof. E. Bugnion, or M. A. Nicati, Lausanne.

THE *Société de Topographie de France* intend to erect a statue of Cassini, the author of the first topographical map of France, in the town of Clermont-en-Beauvais (Oise), not far from Thury. It is a remarkable fact that the family of Cassini had, in a century and a half, five representatives as Members of the Academy of Sciences, of which four were directors of Paris Observatory, the third of them—César François Cassini, of Thury (1714–1784),—being the one whose memory will be honoured.

A REUTER'S telegram reports that the steamer *Falcon*, with Lieut. Peary and the members of the American Polar Expedition, sailed on July 15 from St. John's, Newfoundland, for Bowden Bay, the autumn quarters of the expedition.

THE arrangements are now completed for the celebration of the jubilee of the Rothamsted agricultural experiments at the Laboratory, Harpenden-common, on Saturday, the 29th inst., at 3 p.m., under the presidency of Mr. Herbert Gardner, M.P., President of the Board of Agriculture. The proceedings will commence with the dedication by Mr. Gardner of a granite memorial, erected in front of the Rothamsted Laboratory, to commemorate the occasion. Addresses of congratulation will then be presented to Sir John Lawes and Dr. Gilbert on behalf of the subscribers to the Rothamsted Jubilee Fund and various learned societies, including the Royal, Royal Agricultural, Chemical, Linnean, and other leading scientific institutions. Sir John Lawes will also be presented with his portrait, which has been painted by Mr. Hubert Herkomer, R.A., for the subscribers to the Jubilee Fund. Afterwards there will be a reception at Rothamsted by Lady Lawes. The Rothamsted Laboratory, where the ceremony will take place, adjoins Harpenden-common, and is distant about half a mile from the Harpenden station of the Midland Railway Company.

IT is reported that disastrous floods and landslips, caused by heavy rains and cloudbursts, have occurred in Tyrol, the principal scene of destruction being the upper and lower Inn Valleys, the Oetzthal, and the Zillerthal. Many houses have been swept away, together with the inhabitants and their cattle, while others have been buried by landslips.

SOME very heavy falls of rain occurred in the southern part of England on Saturday and Sunday last, owing to the passage of a small and shallow cyclonic disturbance, which travelled quickly to the eastward. The amounts recorded in several localities exceeded an inch within twenty-four hours, while at Eastbourne the fall was from two to three inches, or more than the average amount for the month of July. The accumulation of water at the latter place was due to the intensity of the fall during a short period; the amount recorded during the whole day has frequently been exceeded at other places.

IN a recent number of the new Russian journal (*Archives des Sciences Biologiques publiée par l'Institut Impérial de Médecine Expérimentale à St. Pétersbourg*, vol. i. no. 5) an account is given of the latest endeavours to secure protection against glanders. It would appear from the experiments here recorded that as a means of diagnosing glanders the "malléine" (extracted from cultures of the glanders bacillus) is of great value. On being inoculated into horses suspected of having glanders, and into healthy animals or horses suffering from some other disease respectively, the different effect produced was constant and very clearly defined. In the case of the former, the existence of glanders was indicated by a distinct rise in temperature, from 1°·5 to 3° C., and the formation of a tumour, whilst in the latter the temperature did not rise, or only very slightly, and an insignificant tumour, or none at all, was produced at the place of inoculation. Innumerable experiments on horses by various investigators confirm these results, and as a proof of the importance which is attached to these researches, it may be mentioned that only last September a circular was addressed by the German Government to the commanders of cavalry, ordering the injection of "malléine" into the horses of those regiments where cases of glanders were proved to have occurred.

THE fact that some micro-organisms may stimulate or depress the vitality or virulence of others has been taken advantage of by both Sanarelli and Chantemesse and Widal in their recent researches on immunity and typhoid fever (*Annales de l'Institut Pasteur*, 1892). The typhoid bacillus very rapidly loses its pathogenic properties when cultivated for any length of time outside the living body. Its virulence may, however, be revived by introducing it into an animal along with sterilised cultures of some special organisms. Sanarelli used sterilised cultures of the *B. coli communis*, beginning with 10-12 cc., and gradually diminishing the dose, until the typhoid bacillus, as taken from the last animal, proved virulent without any addition. Sterilised cultures of the *Proteus vulgaris* may, according to Sanarelli, be also used. Chantemesse and Widal obtained the same results by employing sterilised cultures of the *Streptococcus pyogenes*, it having been found by Vincent that in the most serious cases of typhoid fever which he examined the latter was present along with the typhoid bacillus.

THE true origin of contrast colours is still a much-debated question among physicists. The Young-Helmholtz hypothesis of colour sensation assumes that the perception of a contrast colour by which, for instance, a shadow cast by a candle in daylight appears blue, is due to an error of judgment brought about by falsely taking the candle as representing white light and "dividing the difference of tint between the various portions of the surface equally between them." Mr. Alfred M. Mayer, in the *American Journal of Science*, attempts to show by a series of experiments that the perception of contrast-colour is due to purely physiological, and not to psychical causes. Some careful chronograph experiments showed that the perception of a contrast colour did certainly not require more than one-fifteenth of a second. A spark from a Holtz machine, lasting a millionth of a second and 8cm. long, made a grey ring on an emerald green ground appear a bright pink. The spark was also passed between brass knobs placed in front of a piece of silvered mirror half covered with a piece of green glass. The path of the spark presented a remarkable appearance. The portion reflected from the mirror only was white, while the other portion consisted of two images reflected by the green glass and the mirror respectively. The former appeared red by contrast, and the latter was coloured green by transmission through the glass. Thus a white source appeared both white and red at the same instant. The hypothesis of a knowledge of the real whiteness of the surface illuminated partly by a candle and partly by daylight influencing the perception of contrast colours was refuted by arranging such a surface behind a screen and letting two independent observers view it through a tube showing two semi-circles in juxtaposition. They were misled as to what to expect, but they both immediately described the patches as yellow and sky-blue respectively. These experiments tend to confirm Hering's hypothesis, which assumes that when a portion of the retina is stimulated, adjoining portions are affected by a sort of inductive action producing complementary perceptions.

AN interesting note on the variation of the earth's magnetism in the neighbourhood of a hill containing magnetic rocks, by Messrs. Oddone and Franchi, has appeared in the *Annali dell' Ufficio Centrale di Meteorologia e Geodinamica* (vol. xii. part 1). The hill was composed of serpentine, and had, roughly speaking, a lenticular shape, being 1500 m. long and 500 m. broad, with its greatest length north-west and south-east. The declination is the only element up to now observed, and the variation of this element along certain lines has been determined by means of a large compass, to which a telescope, moving in a vertical plane, was attached. The needle, about 16 c.m. long, had a fine pointer attached, and its position was read by means of a scale engraved on looking-glass. A preliminary series of observations, made on ground where there was no disturbance, showed that this instrument could be depended on to within one or two minutes of arc. The method of observing followed was to set up the instrument, and, looking through the telescope, note a series of points, all in a straight line with some distant object, then to clamp the horizontal scale to the telescope support, and read the ends of the needle. The instrument was then transported to the points which had been noted, and the telescope directed to the distant mark. Then the differences in the readings for the needle gave the differences in the declination at the stations along the line. As an example of the magnitude of the deviations obtained we may give the following set of readings (corrected for diurnal variation), along a line running north-east from the hill. At the out-crop of the serpentine the reading for the needle was 11° 20′; about 100 m. away, 10° 35′; about 500 m. away 9° 56′ 30″; while at a distance of 700 m. it was 9° 50′ 30′. In every case they obtained an attraction of the north pointing pole of the needle towards the serpentine, thus indicating that the mass of rock was magnetised with its upper end a south pole.

M. FÉLIX LECONTE has invented a simple form of automatic cut-out, consisting of a cylindrical metal vessel containing mercury and closed at the bottom by a plate of iron held up by springs. A copper rod dips into the mercury and forms one terminal, the current passing through the mercury to the metal cylinder, which forms the other terminal. Beneath the piece of iron an electro-magnet is placed, which is connected with an electric battery, whose circuit is closed at any pre-arranged time by a contact fixed to a clock. When this contact is made, the electro-magnet attracts the iron, allows the mercury to escape, and thus breaks the main current.

A MEMOIR on prehistoric naval architecture of the north of Europe, by Mr. George H. Boehmer, has been issued by the U.S. National Museum. 'Tis "a tale of the times of old," and therefore full of interest to the student of history. Furthermore, it is written with technical knowledge, and bristles with references, and therefore commands the respect of the scientifically-cultured mind. In the memoir the build of thirty ships, discovered in various places, is explained by text and illustration. And the whole discussion indicates that the maritime explorations of the people of the south, the Phœnicians, influenced the character of the naval structures of the ancient inhabitants of Scandinavia. Of all the boats that have been excavated none seem to excel in beauty that found at Gokstad, Norway, in 1880, and now in the Archæological Museum of the Royal Frederichs University at Christiania. In the opinion of experts this boat is a masterpiece of its kind, not to be surpassed by aught which the shipbuilding craft of the present age could produce.

WE have received the first number of *The Physical Review*, a journal of experimental and theoretical physics conducted by Mr. G. L. Nichols and Mr. E. Merritt, and published for Cornell University by Messrs. Macmillan and Co. The new publication is on much the same lines as the *Philosophical Magazine*. It contains five papers on physical subjects, a few notes, and critical articles on several new books. Mr. Nichols writes on the transmission spectra of certain substances in the infra-red, and Mr. B. W. Snow on the infra-red spectra of the alkalies. The relation between the lengths of the yard and the metre form the subject of a paper by Mr. W. A. Rogers. Messrs. S. Sheldon and G. M. Downing write on the critical current density of copper deposition, and the absolute velocity of migration of the copper ions, and Messrs. F. Bedell and A. C. Crehore give a geometrical proof of the three-ammeter method of measuring power. We wish the venture the complete success that its high character merits.

WE have received a copy of "The Brighton Life Table," based upon the mortality of the ten years 1881–90, by Dr. Arthur Newsholme. No previous life-table has been constructed for Brighton, so the vital statistics of 1881-90 could not be compared with those of any preceding decennium. Dr. Newsholme has, however, compared his figures with those for the whole of England and Wales between 1871 and 1880, and also with the 1881–90 life-table of Manchester. The comparison indicates that the probabilities of life among both males and females are at most ages greater in Brighton than elsewhere—a result that might have been expected.

WE learn from the *Victorian Naturalist* that Mr. D. M'Alpine, pathologist to the Victorian Department of Agriculture, is preparing for publication by the Department a *Systematic Census of Australian Fungi*, together with a host-index and list of works on the subject. He is desirous of making the list as complete as possible, and will be pleased to receive from workers any published papers, &c., especially on the microscopic forms. It is proposed to continue the list in annual supplements.

THE 1892 report of the Superintendent of the Royal Botanic Gardens, Trinidad, has been received. The experiments instituted by the Government having shown that tobacco of a suitable character for making good cigars can be grown in Trinidad, enterprising planters are beginning to cultivate a sufficient area to make the crop remunerative. Mr. Hart reports that the quality of the product of the district (always a tobacco producing one) in which the operations were conducted, has much improved. The native cultivators have partially adopted the methods employed by the skilled cultivator, hence it is anticipated that the industry will continue to make progress during future years.

MR. M. DUNN, of Trevagissey, has sent us a paper by him on "The Migrations and Habits of the Pilchard," which appears in the annual report of the Royal Polytechnic Society for 1892.

MESSRS. LONGMAN will shortly publish a work entitled and specially devoted to "The Micro-organisms in Water," by Prof. and Mrs. Percy Frankland. It will deal not only with the presence and significance of bacteria in water, but also with the various means of effecting their removal, and an account will be given of what is known concerning the vitality of pathogenic microbes in various waters. A tabulated description of the micro- and macroscopic characters of all the micro-organisms, both pathogenic and non-pathogenic, hitherto discovered in water will be appended, whilst a special part will be devoted to the methods involved in the bacteriological examination of water. The work is intended to serve as a handbook for all interested in the sanitary aspects of water supply.

A CATALOGUE of books issued by Mr. Charles Lowe, New-street, Birmingham, contains the titles and descriptions of a number of scientific works for sale and wanted.

A CONSIDERABLE number of metallic salts of sulpho-phosphoric acid, H_3PS_4, have been obtained in a pure state by Dr. Glatzel of Breslau, and are described in the current number of the *Zeitschrift für Anorganische Chemie*. They are prepared by heating an anhydrous mixture of the chloride or sulphide of the metal with phosphorus pentasulphide, being produced in accordance with the equations:—

$$3RCl + P_2S_5 = R_3PS_4 + PSCl_3,$$
$$3R_2S + P_2S_5 = 2R_3PS_4.$$

The metallic chloride or sulphide requires to be perfectly dry, if possible being fused previous to the experiment. When cold it is finely powdered, intimately mixed with excess of anhydrous pentasulphide of phosphorus and the mixture heated in a small retort, at first slowly and carefully, finally to low redness. If the chloride of the metal is employed, thiophosphoryl chloride distils over and is condensed in a receiver. The excess of phosphorus pentasulphide sublimes into the neck of the retort, leaving the metallic sulphophosphate behind. The latter is purified from any undecomposed metallic chloride or sulphide by washing first with dilute hydrochloric acid, and afterwards with water, filtering and drying. In this manner the normal sulphophosphates of manganese, zinc, ferrous iron, nickel, cadmium, lead, thallium, tin, copper, silver, mercury, bismuth, antimony and arsenic have been obtained in a pure state. In addition to these, normal potassium sulphophosphate K_3PS_4 has also been obtained, but it was found impossible to separate it entirely from phosphorus pentasulphide; efforts to prepare normal sulphophosphates of sodium, ammonium, barium, strontium and calcium have not yet been successful. The normal sulphophosphates of manganese, zinc, ferrous iron, nickel, cadmium and copper were obtained in the form of crystalline powders, the others as fusible solids, which crystallise upon re-solidification. The zinc and cadmium salts are white, the manganese salt green, the iron, nickel, lead, tin and bismuth salts vary from dark brown or grey to black; the thallium, copper, silver, antimony and arsenic salts are yellow; and mercury sulphophosphate is red and very sensitive to light. The whole of them, with the exception of the potassium salt, are insoluble in water and organic solvents, but are slowly attacked by dilute acids with evolution of sulphuretted hydrogen. The potassium salt is decomposed by water alone with liberation of the same gas. It would appear, indeed, that the more negative metals, such as bismuth, antimony and arsenic form sulphophosphates with the greatest facility. The bismuth salt $BiPS_4$ remains in the retort after distilling a mixture of bismuth chloride and phosphorus pentasulphide as a dark-coloured liquid which solidifies to a grey mass upon cooling, and yields upon pulverisation a powder of the colour of red phosphorus. Antimony and arsenic form similar crystalline sulphophosphates of a yellow colour, which are more volatile, however, and, moreover, may be distilled without decomposition. The arsenic salt solidifies in the receiver in a transparent form resembling amber.

IN attempting to prepare a ferric sulphophosphate by the action of phosphorus pentasulphide upon anhydrous ferric chloride, an unexpected artificial synthesis of iron pyrites, FeS_2, in crystals identical with those found in nature, was effected. The reaction occurs as represented by the equation:—

$$3Fe_2Cl_6 + 2P_2S_5 = 3FeCl_2 + 3FeS_2 + 4PSCl_3.$$

The crystals of iron pyrites were formed as a beautiful glistening sublimate just above the heated portion of the retort. They possessed the usual brass-yellow colour and brilliant lustre, and consisted of pentagonal dodecahedrons and cubes or combinations of these forms, together with faces of the octahedron and of the more complicated forms of the cubic system. Moreover, the same mode of striation was observed as is so characteristic of natural crystals.

NOTES from the Marine Biological Station, Plymouth.—Last week's captures include the Polychæta *Staurocephalus rubrovit-*

tatus and *Sphærodorum peripatus*, the Isopod *Apseudes Latreillii*, the Schizopoda *Mysidopsis gibbosa* and *Hemimysis Lamornæ*, specimens of the Brachyuran *Hyas coarctatus* decked with weeds and compound Ascidians, the Lamellibranch *Arca tetragona*, and the Ascidian *Perophora Listeri*. In the floating fauna little change has been observed, but numbers of the Leptomedusan *Laodice cruciata* have been taken on the beds of Zostera. The following animals are now breeding:—The Hydroid *Coryne vaginata*, the Polychæte *Polycirrus aurantiacus*, the Amphipod *Corophium Bonellii*, the Decapod *Palæmon squilla* and the Lamellibranch *Arca tetragona*.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*, ♀) from India, presented by Capt. R. D. Arnold; a Leopard (*Felis pardus*), a Striped Hyæna (*Hyæna striata*) from India, presented by Capt. Currie; a Malayan Bear (*Ursus malayanus*) from Malacca, presented by Mr. M. O. N. Rees-Webbe; four Prairie Marmots (*Cynomys ludovicianus*) from Texas, four Orbicular Horned Lizards (*Phrynosoma orbiculare*) from California, presented by Mr. G. B. Coleman; a Harnessed Antelope (*Tragelaphus scriptus*, ♂) from West Africa, presented by Mr. A. L. Jones; four Galapagan Doves (*Zenaida galapagensis*) from the Galapagos Islands, an Auriculated Dove (*Zenaida auriculata*) from Chili, presented by Capt. Hedworth Lambton, R.N.; a Guilding's Amazon (*Chrysotis guildingi*) from St. Vincent, W.I., three Boddaert's Snakes (*Coluber boddaerti*), three Carinated Snakes (*Herpetodryas carinatus*) from Grenada, W.I., presented by the Hon. Sir Walter F. Hely-Hutchinson, K.C.M.G.; two Red-tailed Buzzards (*Buteo borealis*) from Jamaica, presented by Mr. Charles B. Taylor; a Crested Porcupine (*Hystrix cristatus*) from Africa, an Australian Cassowary (*Casuarius australis*) from Australia, two Blyth's Tragopans (*Ceriornis blythi*, ♂ ♀) from Upper Assam, deposited; two African Tantalus (*Pseudotantalus ibis*) from West Africa, two Demoiselle Cranes (*Grus virgo*), six Moorish Tortoises (*Testudo mauritanica*) from North Africa, a Secretary Vulture (*Serpentarius reptilivorus*) from South Africa, two Common Rheas (*Rhea americana*, ♂ ♀) from South America, two Cabot's Tragopans (*Ceriornis caboti*, ♂ =) from China, four Crested Pigeons (*Ocyphaps lophotes*) from Australia, purchased; a Mule Deer (*Cariacus macrotis*, ♂), a Martineta Tinamou (*Calodromas elegans*), seven Summer Ducks (*Œx sponsa*), seven Mandarin Ducks (*Œx galericulata*), three Australian Wild Ducks (*Anas superciliosa*), six Magellanic Geese (*Bernicla magellanica*), three Peacock Pheasants (*Polyplectron chinquis*), three Cheer Pheasants (*Phasianus wallichii*), six Gold Pheasants (*Thaumalea picta*) bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

EPHEMERIS OF THE NEW COMET.—Prof. E. Lamp gives the following elements for Quénisset's comet in *Astr. Nach.*, No. 3173:—

$$\tau = 1893 \text{ July } 7{\cdot}3140, \text{ Berlin Mean Time.}$$

$$\left.\begin{aligned} \omega &= 47^\circ\ 6'{\cdot}72 \\ \Omega &= 337\ 20{\cdot}93 \\ i &= 160\ \ 1{\cdot}88 \end{aligned}\right\} 1893{\cdot}0$$

$$\log q = 9{\cdot}82948$$

From these elements the following ephemeris has been computed by Dr. Kreutz:—

1893	R.A. app. h. m. s.	Decl. app. ° ′
July 21	11 27 28	+25 19·1
22	11 32 44	24 1·0
23	11 37 19	22 49·8
27	11 50 50	18 59·8
31	11 59 24	16 12·8
Aug. 4	12 5 18	14 6·2

The comet is decreasing in brightness.

The following communication has been received from South Kensington:—

"The comet was observed by Mr. Shackleton as early as July 11, before any notice of it had been received, but owing to the unfavourable state of the sky he was unable to perfectly satisfy himself that it was a new object. Although the sky was partially clear on July 14, the comet could not be seen from the Observatory as it was unfortunately very low in the north-west, and fell within the glare of the illuminations of the Imperial Institute. On Sunday, July 16, the sky was much clearer, and the comet was easily picked up with a small telescope. Observations with the equatorial, however, were impossible. Its position was roughly estimated as R.A. 10h. 41m., Decl. 33° N., and it was about equal in brightness to a fourth magnitude star. On July 17 the sky was clear, and the comet was observed by Mr. Shackleton with a 6-inch telescope temporarily erected in an elevated position; a faint tail was then observed, extending further on the southern than on the northern side of the axis. Owing to the absence of an equatorial mounting to the telescope employed, spectroscopic observations were very difficult, but three bright bands—probably the well-known bands of carbon which so frequently appear in cometary spectra—were recognised. There was only a very feeble continuous spectrum."

COMET FINLAY (1886 VII.).—The ephemeris of this comet for the ensuing week is as follows:—

12h. *Paris. M.T.*

1893.	R.A. (app.) h. m. s.	Decl. (app.) ° ′ ″
July 20	4 30 54·16	+20 33 51·0
21	35 18·76	20 45 55·3
22	39 41·86	20 57 28·5
23	44 3·43	21 8 31·0
24	48 23·42	21 19 3·0
25	52 41·80	21 29 4·9
26	4 56 58·53	21 38 37·0
27	5 1 13·57	21 47 39·8

OBSERVATIONS OF THE PLANET VICTORIA.—Observations of this planet were specially undertaken in 1889 to determine the mean horizontal parallax of the sun, and afterwards to compare the calculated with the observed places of the planet with the object of proving the existence of a short periodic perturbation, as would occur if, for example, an erroneous value for the lunar equation had been adopted. The observations (*Bulletin Astronomique*, tome x., June 1893) were of three kinds, as Dr. Gill in this note informs us—(1) meridian observations of the planet and comparison stars, made at twenty-one observatories during the opposition in 1889; (2) heliometric triangulation of comparison stars, consisting of measures of the distances of the stars less than 2° apart and measures of the angles of position (these observations were made at the observatories of Yale College, Göttingen, Bamberg, and at the Cape during the year 1890); and (3) heliometric observations of the angular distance of the planet from two comparison stars, one above and the other below the apparent position of the planet in the sky. This work was accomplished by the same observatories with the addition of that at Leipzig.

In this preliminary note, Dr. Gill refers only to the general results of the discussion. The following table shows the values for the mean horizontal parallax of the sun as deduced from the discussion of the observations in groups:—

Group.	Limit of groups.	M.S. parallax.	Rel. weight.	$\Delta\alpha$ C−O.	$\Delta\lambda$ C−O.
		″		″	″
I.	June 10–12	8·723	0·8	—	—
II.	,, 15–19	804	12·3	−0·01	+0·00
III.	,, 19–26	828	15·4	+0·04	+0·02
IV.	,, 26–July 3	872	29·2	−0·02	−0·07
V.	July 3–9	789	9·8	−0·13	+0·03
VI.	,, 9–12	857	17·5	+0·09	+0·04
VII.	,, 15–20	793	19·5	+0·07	+0·12
VIII.	,, 20–23	809	20·0	−0·05	+0·09
IX.	,, 23–25	742	14·0	−0·03	−0·03
X.	,, 25–28	806	11·2	−0·07	+0·02
XI.	,, 28–Aug. 4	777	33·4	+0·01	−0·12
XII.	Aug. 4–10	826	20·0	+0·11	−0·04
XIII.	,, 10–17	816	26·0	−0·05	0·00
XIV.	,, 17–22	819	19·9	+0·04	+0·06
XV.	,, 22–27	8·738	13·3	−0·04	+0·01

The mean of these gives the value

$$\pi = 8''{\cdot}809, \text{ with a probable error of } \pm 0''{\cdot}0066.$$

The observed and calculated positions agree only in the limits of the errors of observations on the assumption "of a periodic term, the period of which is nearly identical with that of the lunar period, and whose maxima and minima occur at epochs when the longitude of the moon differs by 90° from that of the planet. Adopting 6″·40 in place of 6″·50 for the lunar equation, the residuals obtained from the corrected ephemeris and the observations are made very small, as can be seen from the last two columns of the above table.

The correction of −0″·1 in the lunar equation demonstrates, as Dr. Gill says, that the value adopted up to the present for the lunar mass ought to be diminished by one-hundredth.

DIFFERENCE OF LONGITUDE BETWEEN VIENNA AND GREENWICH.—In the fourth volume of the "Publicationem für die Internationale Erdmessung," entitled "Astronomische Arbeiten des k.k. Gradmessungs-Bureau," by Theodor v. Oppolzer, and after his death by Prof. Weiss and Dr. Robert Schram, we are presented with the results of the determination of the difference of longitude between Vienna and Greenwich, and with the Berlin time determinations and the personal equations of the separate observers relating to other longitude determinations, those between Vienna—Berlin—München—Greenwich. We may mention here that, with regard to the first-mentioned determination, another one, between the same places but after a method due to Döllen, by observations in the vertical of Polaris, will appear in a later volume.

The observations for the combined longitude determination between the above-mentioned places were commenced on July 7, 1876, and were completed on September 26 of the same year. Not only was the usual method of procedure adopted, but also that which we owe to Döllen, the instruments used being, for the former method those by Repsold, and for the latter those by Herbst. In the Vienna—Greenwich longitude determination at the beginning and at the end of the observations, time signals, both from Vienna and from Greenwich, were changed with Berlin; in the middle observations Vienna—Greenwich interchanged time signals; and towards the end München was included. In the following table, which gives the results for the single evenings, ΔL represents the longitude between the points of observation and $d\Delta L$ the deviations from the most probable value of the longitude difference:—

Date.	ΔL. h. m. s.	$d\Delta$L. s.
17 July, 1876	1 5 21·037	+0·043
21 ,,	21·028	+0·034
22 ,,	20·995	+0·001
26 ,,	20·955	−0·039
5 Aug.	20·832	−0·162
7 ,,	21·107	+0·113
17 ,,	21·146	+0·152
21 ,,	20·845	−0·149
27 ,,	21·016	+0·022
5 Sept.	21·037	+0·043
11 ,,	21·025	+0·031
21 ,,	1 5 20·902	−0·092

The result obtained, when the points of observations are reduced respectively to the centre of the Greenwich Transit Circle and to the centre of the large dome of the Vienna Observatory is

1h. 5m. 21·421s. ± 0·021s.

PHOTOGRAPHS OF THE MILKY WAY.—Prof. E. E. Barnard, who has recently been on a visit to Europe, has brought with him some wonderful photographs of the Milky Way, which are simply a revelation to many of us. These photographs (*The Observatory*, No. 203) were taken at the Lick Observatory with a lens made by Mr. Willard of New York in 1859, which is one of large aperture (6 inches) and short focus (31 inches). Such a lens tends to compress as well as intensify the characteristic features of these stellar clouds, the large field allowing one to embrace any of these forms as a whole, and not in detail, as is the case when they are viewed with a telescope. The first photographs, showing the cloud forms, were taken in August of 1890, the portion of the sky being that situated in Sagittarius, and the exposure 3h. 15m. A most interesting picture is that of a section of the constellation of Cygnus, near γ Cygni; this photograph shows some of those curious and almost weird dark spots and dark lanes the origins of which are very doubtful. Mr. Ranyard supposes them to be due to an obscuring medium between us and that part of the Milky Way, but Prof. Barnard's opinion is that they are real holes in the cloud structures themselves. Two photographs with different lengths of exposures (2h. 45m. and 4h. 30m.) of the region about M. 11 in the constellation of Sobeski raises an important point as regards the different structure of the Milky Way. The second picture exhibits details which considerably altered the configuration, not at all brought out in the first one. Not only in these photographs, but in several others of the Milky Way, this fact has been noticed, and Prof. Barnard suggests that there may be different orders or kinds of cloud structure implying distance or nearness, or possibly an entirely different order of stars in point of actual size.

THE INSTITUTION OF NAVAL ARCHITECTS.

THE summer meeting of the Institution of Naval Architects was held last week in Cardiff. This is only the fifth provincial meeting held by this Society since its foundation. The first was in Glasgow, the next in Liverpool, and the third in Newcastle. The fourth was held again in Glasgow. All these meetings were eminently successful, and it is somewat strange that the Council should not have made a point of holding a country meeting every year. We believe, however, that it is now the intention to follow that course, and certainly the great success of the meeting held in South Wales last week will support those who advocate two meetings a year.

We propose in our report dealing only with the sittings held for the reading and discussion of papers, but it may be stated that the excursions were very successful. Some of these were of a purely recreative nature, such for instance as that which occupied the whole of the last day, Friday, the 14th inst., when members were taken from Cardiff to Ilfracombe and back by the steamer *Lorna Doone*. The visit to Caerphilly Castle, with the luncheon in the ancient banqueting hall, could not by any means be construed as "business" for naval architects, and the same might be said of the visit to Lord Windsor's grounds at Penarth, illuminated for the occasion.

Mixed with these junkettings, however, there was a good deal of a more serious nature, as the following list of papers read will show:—

(1) "On points of interest in the construction and repair of vessels carrying oil in bulk," by B. Martell, chief-surveyor of Lloyd's Registry of Shipping.

(2) "On fast ocean steamships," by F. Elgar.

(3) Some experiments on the combination of induced draught and hot air, applied to marine boilers fitted with serve tubes and retarders," by J. D. Ellis.

(4) "On wear and tear in ballast tanks," by A. K. Hamilton, of Lloyd's Registry.

(5) "On the transmission of heat through boiler plates," by A. Blechynden, Barrow.

(6) "On water tube boilers," by J. T. Milton, chief-engineer-surveyor to Lloyd's Registry.

(7) "On the theory of thin plating and its applicability to calculations of the strength of bulkhead plating and similar structures," by G. H. Bryan, of Cambridge.

The last paper was not read, but distributed at the meeting, the discussion being deferred until the spring meeting of next year.

On the members assembling at the Town Hall, Cardiff, on the morning of Tuesday, the 11th inst., they were welcomed by the Mayor of Cardiff, and the chair was then taken by Sir Nathaniel Barnaby (late Director of Naval Construction), the President, Lord Brassey, not having arrived. Mr. Martell's paper dealt with various details involved in the construction of oil tank steamers. It would seem at first sight a simple matter to construct a steel vessel capable of carrying oil in bulk; but this is by no means the case, and in trying to solve the problem involved naval architects have been met by some altogether novel problems. One of these is the arrangement of riveting, and with this feature the author dealt at some length, going into details in the thorough manner which his unique position enabled him to do. Without diagrams it would be impossible to follow the author in his various lines of reasoning, more especially in the matter of arrangement of tanks, the disposition of stringers, brackets, and other parts of a ship's structure. We will therefore refer those of our readers interested in this matter to the Transactions of the Institution for details, which were fully set forth by the author.

Dr. Elgar's paper was largely of an historical nature. The author, who was until lately the Director of Dockyards, is now the chief technical and scientific adviser to the Fairfield Shipbuilding Company of Glasgow, the largest shipbuilding corporation in the world. This firm has recently constructed the Atlantic liners *Campania* and *Lucania*, at present the biggest ships afloat. The paper drew a comparison between the *Great Eastern* and these modern vessels, which more nearly approach in size the monster ship of nearly forty years ago than any vessels ever constructed. The following table is interesting as drawing a comparison between the past and present :—

	Great Eastern.	*Campania.*
	ft. in.	ft. in.
Length over all	692 0	622 0
Breadth moulded	82 2	65 0
Depth moulded to upper deck	58 0	41 6
Load draught	30 0	27 0
Indicated horse power ...	8,000	30,000
Gross register tonnage ...	18,915 tons	12,950 tons
	Knots.	Knots.
Speed at sea (full power) ...	14 to 14½	22 to 23

These figures show at once the advance in marine science and the extent to which the past naval architects more than anticipated the work we have yet done in the size of ships built ; and it must be confessed the honours appear to rest with the engineer. The *Great Eastern* was fitted with both screw and paddle wheels, an arrangement which proved a costly mistake. It should be said, however, that the marine engineer has an almost unlimited field for the exercise of his ingenuity, whilst the naval architect is fettered and bound in the most vital element of design, namely, the draught of water. It is useless to build a ship which can never enter the great ports of the world, and here we have reached a limit of 27 feet. The ship designer waits for the civil engineer to improve the chief harbours of nations before he can exercise to the full the resources which modern science has otherwise placed at his disposal. An addition of another 5 feet to the depth of some of the chief commercial ports would mean an advance in ship construction before which the growth of the last twenty years, great as it is, would be far eclipsed. For this reason it is likely that the bulk of the *Great Eastern* will be unapproached for very many years. Her length, great as it was, was a smaller proportion to her breadth than in modern ships, and to equal her displacement on the proportions of beam and length which are now considered desirable, a modern ship would require to be considerably longer than was the wonderful craft which was the embodiment of such high ambition forty years ago, and which found her most profitable employment in her last days as a show for trippers to the Liverpool exhibition.

Mr. Ellis described in his paper trials made at the steel works of John Brown and Co., of Sheffield, to show the advantage of a combination of features which the author considers desirable in the generation of steam. He uses induced draught, heating of the air supplied for combustion, and Serve boiler tubes. We have never been able to see what ground the supporters of induced draught have for claiming the great virtues supposed to exist in drawing the air through the furnace by means of a fan in the chimney, rather than driving it through by a fan in the stokehole. It is easier to grasp the advantages of heating the air supplied for combustion, supposing it is done by heat that would otherwise be wasted, but it is an open question whether this regenerative process could not be beneficially replaced by heating the feed water to be supplied to the boiler. It is certain that heat from the waste gases or products of combustion will be more readily absorbed by water than by air. In regard to the part of the system involved in the use of Serve tubes, there is perhaps less room for doubt as to the advantages to be reaped. The Serve tube may be described as an ordinary boiler tube, having on its interior a number of metal ribs which are formed in one with the tube itself. The object of these is to penetrate the stream of hot gases, often flame, passing from the furnace to the chimney, and thus act as collectors for the heat to be transferred ultimately to the water in the boiler. The principle may be described as that of the Constantine stove inverted. The device appears logical and we can accept the statement that whatever heat is taken up by the metal is readily transferred to water surrounding the tubes ; or, as one speaker during the discussion put the matter, "if we look after the absorbing surface, we know the distributing surface will look after itself." That is true so long as the distributing surface is clean, but it is to be feared such a desirable state of things is not often present in steam boilers. Later in the meeting Mr. Blechynden, in his paper, pointed out how even wiping a plate surface with greasy waste on the water side caused the rate of transmission of heat to fall off, and Mr. Durston some months back told us how bad is the inner side of tubes and plates in a marine boiler. However, the Serve tubes appear to have made a favourable impression upon engineers in spite of the difficulties in the way of sweeping, &c., which threatened them at first. The problem of their introduction appears largely to have established itself on a commercial basis. In the tables attached to his paper Mr. Ellis gave details of the trials made. From 10¼ to 10½ lbs. of water were evaporated per lb. of coal from and at 212° Fahr., burning 40 to 45 lbs. of coal per square foot of grate per hour. The temperature of the gases in the smoke box was from 653 to 692° Fahr., whilst after passing through the apparatus used for transferring the heat of the gases to the air supplied for combustion the chimney gases, 386 to 391° Fahr., the difference between the two representing the arrestation of heat units by the regenerative apparatus, less accidental loss. An analysis of the chimney gases would form a valuable addition to these details, as was pointed out at the meeting. In any case, however, the boiler tested had a much better chance at Messrs. Brown's works than it would have had on ship-board ; nevertheless, the results may be said to be encouraging.

Mr. Hamilton's paper on wear and tear in water-ballast tanks was of a very special character, although a most important matter to shipowners. The moral of his investigations may be summed up in keeping boilers well off the bottom, filling tanks right up, and applying good paint properly at sufficient intervals. If it could be managed to thoroughly dry the tanks when empty it would be of more importance than anything else, but it is difficult to see how this is to be done.

Mr. Blechynden's paper was also of a special character, and gave the results of some very pretty experiments made to determine the problem referred to in the title of his paper. It would be difficult, without illustrations, to describe the experiments, but the broad general fact brought to light was, as the author stated, "that the units of heat transmitted through any of the plates per degree of temperature between the fire and water are proportional to the difference." The inference might be also drawn from the results that the steel plates lowest in carbon were also lowest in conductivity ; but the experiments, as the author said, should be extended to confirm this.

Mr. Milton's paper on water-tube boilers dealt with the subject of the hour, at any rate from a marine engineer's point of view. The paper described the most prominent types of water-tube boiler now on trial before the engineering world. By the triple and quadruple compound engine we have placed the motor so far ahead of the steam generators that marine engineers must perforce turn their attention to the first source of power on board ship. The introduction of corrugated furnaces gave the boiler a considerable step in advance, and, together with the use of steel as a material for construction, made the advances in marine engineering so well illustrated by Dr. Elgar's comparison of the *Great Eastern* and *Compania*, at all possible. Leaky tubes, however, have set us all back again, and the conviction is growing among engineers that an entirely new departure is required in boiler design. The only thing that offers is the water-tube system, in which steam is generated in a series of pipes containing water and surrounded by hot gases, rather than in a cylindrical shell through which tubes run to convey the products of combustion through their interior from the furnace to the chimney. The water-tube boiler is almost as old as the more ordinary multi-tube (fire-tube) boiler ; but unhappily the lamentable failures of a generation ago—in which several lives were lost—threw such discredit on the system that it has been tabooed ever since. We are now beginning to see how to get over the errors of the past, and the great feature now to be solved is the question of durability. That can only be settled by time ; and it seems possible that the water-tube boiler may creep from smaller to larger vessels until the shell boiler becomes a thing of the past on shipboard ; at least that is the opinion of some marine engineers whose word is entitled to the highest respect. Possibly in the meantime a practical way may be found of generating power in the motor itself without the intervention of steam and the apparatus for generating it. Before that time arrives, and some form of gas engine (including oil engines) arrive, a distinctly new departure will have to be made equivalent to that of the separate condenser of Watt.

The last paper in the list, that of Mr. G. H. Bryan on bulkheads, was in some respects the most promising and most suggestive of the meeting. The bulkhead question has been troubling the most thoughtful of our naval architects for some time past. Dr. Elgar attacked the question some time back in a paper he read before the Institution, and Mr. Martell also read a memoir on the subject. Some time ago a strong Government committee was appointed to consider the problems involved in this matter, and a report was issued. Rightly or wrongly, some naval architects are not satisfied with the position in which the report left the question. It is considered by many of the more thoughtful that a more scientific method of dealing with the problem should be evolved. Mr. Bryan, who is a Cambridge mathematician of high reputation at his University, has been led to take the matter up, and the present paper is an effort to bring higher mathematics to the aid of the solution of the question. The paper, however, contains nothing that need appal any naval architect or engineer who can lay fair claim to the title, and it is eminently practical. The similes selected by the author are of the simplest nature; indeed, the memoir reads more like a contribution from the pen of the late Mr. Froude, who was a very prince of lucidity and simplicity. We are reluctantly obliged, through want of space, to treat this paper as we have the others read at this meeting, and only give a suggestion of its scope, referring our readers to the Transactions of the Institution for fuller details. Mr. Bryan attacks the theory, still held by many engineers, that the plate may be regarded as consisting of a series of parallel strips supporting pressure by their tensions. Euler's and Bernouilli's early theories have been abandoned by mathematicians, and Mr. Bryan is now trying to persuade engineers to do the same in effect in giving up the "parallel strip" illustration. The matter affords an excellent example of the manner in which the student of higher mathematics may assist the engineer. We may add that it is proposed to discuss the subject at the next meeting of the Institution to be held next spring, and doubtless Mr. Holmes, the secretary of the Institution, would forward a copy of the paper to any one wishing to take part in the discussion. The address of the Institution is 5, Adelphi Terrace, Strand.

SOCIETY OF CHEMICAL INDUSTRY.

THE Annual General Meeting of the Society of Chemical Industry was opened at University College, Liverpool, on July 12, when Sir John Evans, K.C.B., Treas. R.S., delivered his Presidential address as follows:—

"When I look at the list of those who in past years have occupied the Presidential chair of this Society, all of them men eminent in the departments of either theoretical or practical chemistry, or, indeed, of both, I cannot but feel my own insufficiency to succeed them in worthily fulfilling the duties of this post. I am, indeed, tempted to inquire how and why it was, that, in accordance with the pressing invitation of some members of the Council, I ever consented to allow myself to be placed in nomination as your President. It certainly was not on the grounds of any fancied chemical attainments; nor was it from my having been in former years associated with any industry that is usually regarded as being specially connected with chemistry. Far less was it in the hope that any remarks that I might be called upon to make while acting as your President could be of any particular interest or value to those who, in all probability, are far better acquainted than I can pretend to be with any subject that properly comes within the scope of such a Society as ours. I believe, however, that the main reason that I had for allowing myself to be brought forward is one that will, to a great extent, palliate my shortcomings in so many of the essential requisites for such an office. It was the hearty and entire appreciation that I felt of the work and aims of such a Society as that of Chemical Industry, that was the prime mover in the case. Whether I regarded the organisation of the Society, with its sections at all the principal centres of chemical operations, each to a certain extent independent, but all working harmoniously together, and forming one powerful and important body, with high objects and aspirations before it; or whether I looked at it as presenting a bond of union between industries apparently unconnected, while, at the same time, furnishing information of the most useful character to each and all, I could not but recognise it as a body in the highest degree conducive to the public welfare; so that on these, if on no other grounds, I should have been wanting in public spirit had I stood aloof when others urged me to accept the post of your President.

"It is, I firmly believe, only by some such cordial co-operation among the different industries of this country as that which our Society has inaugurated, that the commercial position of Great, or Greater, Britain is to be maintained; and the more fully the interdependence between one branch of manufacture and another is recognised and acted upon, the more likely are we, as a whole, to maintain our place in the keen race of competition with other countries.

"A merely cursory glance at our Journal will at once show how numerous are the departments of British industry that are more or less dependent on chemical knowledge, the information given on current literature and the specifications of new patents being arranged under no less than three-and-twenty different heads, many of them embracing several varying occupations. Not a few of these headings would, within my own memory, have conveyed but little meaning even to experts. I need merely carry back the minds of some of the elder members of the Society, not only to the days when aniline colours were not and Dr. Perkins was comparatively unknown, but to the time when lucifer matches had not been invented, when photography was practically non-existent, and when in most of those industries in which a knowledge of chemistry is now regarded as indispensable, the 'rule of thumb' reigned absolute.

"I can speak of those old times with some personal feeling, as it is now upwards of fifty years since, that having presumably completed my education, I first entered a paper-mill in order to learn the art and mystery of the manufacture of paper, with which the name of the firm of which I was until lately a member—that of John Dickinson and Co.—has been so long, and, I may venture to say, so honourably connected. It was, of course, recognised that some knowledge of chemistry was a requisite in such a manufacture, but I must freely confess that our methods were of the rudest, and that it was only as years rolled on, and first esparto fibre, and then the different kinds of wood pulp were introduced into the manufacture, and the various methods and results of sizing studied, that a thorough acquaintance with chemical laws became a *sine qua non* for those who hoped for success in this branch of industry.

"At the date that I have in view—say 1840—although rags were the staple material for the manufacture of paper, our consumption of them was but small, and they were principally used by us in producing paper for copper-plate work—steel plates at that time being rarely used—and for the highest class of printing papers. We consumed, however, a large quantity of raw material in the shape of the waste arising in the manufacture of linen and cotton goods, and we had collecting agents at Dundee, Belfast, Bradford, Leeds, and Manchester, who bought the waste upon the spot. At Manchester we had a mill, in which the cotton-waste was cleaned, boiled, and converted into what is known as 'half-stuff,' which was finally bleached and made into paper at our Hertfordshire mills. In that county we had another 'half-stuff' mill, at Rickmansworth, where the linen waste was treated. The boiling was carried on in open keirs, or such as were partially closed, and always at a low pressure, as high pressure boilers for such materials were practically unknown. Most of the waste was twice boiled, first with caustic lime, and secondly with a small amount of soda. The 'shieves,' or woody particles, that were unreduced by the boiling, were got rid of by a long process of screening, or 'devilling,' after the 'half-stuff' had been dried so far as possible in hydraulic presses. The material was then bleached in stone chambers by the direct action of chlorine gas, produced on the spot in retorts. At the mills, however, where the 'half-stuff' was converted into paper, the remains of the chlorine had to be washed out, and the final bleaching of the stuff to be effected with bleaching salts. No process for the recovery of the soda used in boiling was then known, and, indeed, the quantity used was so much less than that which is now necessary with esparto, that it would not have paid to recover it. I remember, however, being engaged in some experiments for the recovery of the manganese from the spent liquor of the retorts. Even when first Mr. Routledge introduced the use of esparto fibre no evaporating or recovery process was employed, but the double advantage was soon seen of avoiding the nuisance of polluting the streams into which the waste liquors were allowed to flow, and of regaining a quantity of soda at a small cost. With the general adoption of esparto as a material a radical change in the manufacture of paper was effected, and the difficulties in which the industry had been placed by reckless commercial legislation with regard to foreign rags in a great degree removed.

"What has taken place in the manufacture of paper has been paralleled in numerous other departments of commercial enterprise, and not the least in those connected with the manufacture of chemical products themselves, in many, if not indeed in most of which a complete revolution has been effected within the last fifty years, or even less. It would be a hopeless task to try to indicate the whole of the advances in chemical knowledge that have been made within that period, and yet I am tempted to give some few reminiscences of the condition of the science as exhibited in *Brande's Elements of Chemistry*, published in May, 1841, exactly twelve months after my first introduction to business, when compared with our knowledge at the present day.

"Chemistry at that time was by no means in its infancy. Its foundations had been securely laid not only on the Continent, but in this country, and the names of Priestley, Cavendish, Scheele, Lavoisier, Davy, Wollaston, and other English investigators were already household words. There were, in 1841, twelve simple non-metallic substances known, from oxygen to boron, including selenium, and forty-three metals from potassium to silicium, including lantanum and thorinum. For all fifty-five, symbols had been arranged, but these were in many respects different from those which are now in universal use. C, for instance, stood for chlorine and not for carbon, while B symbolised bromine and not boron. Potassium was designated by Po and not by K, and sodium by So and not by Na, while uranium was known as Urnm and not as U.

"The atomic weights of the various substances had been approximately determined, though modern investigations have in some instances materially changed their ratio. Though hydrogen has retained its place as the unit, oxygen is no longer represented by 8, but by 15·96, or even less. Sulphur that was then 16 is now 31·98. Selenium, instead of 40, has now 78 assigned to it; while the number for tellurium has been increased fourfold from 32 to 128, and phosphorus has gone up from 16 to 30·96. Whether all our present figures will stand the test of time remains to be seen, and indeed recent researches have shown cause to doubt the accuracy of some of the figures that I have quoted. For myself, as a somewhat profane outsider, I must confess that it would be a source of satisfaction if future investigations should show that the figures now having three or four places of decimals attached to them might more properly be converted into integers, and oxygen came out boldly as 16, and sulphur as 32. This is, however, a digression.

"Turning to the simple substances and metals of which, as already stated, 12 and 43 respectively were known in 1841, we find them now slightly increased. Of non-metals we reckon 15, and of metals 48. Some metals, like columbium and glucinum, have dropped out of our list, the latter having now become beryllium, while others, like cæsium, didymium, erbium and rubidium, have come in.

"On the whole, the changes and advances in inorganic chemistry have not been extreme. It is in organic chemistry that what cannot be regarded as anything short of a revolution has taken place. It is not a matter on which I can dilate, but as indicative of what has been going on I may mention that while three volumes have sufficed to Roscoe and Scholemmer for inorganic chemistry, no less than six have already appeared in continuation treating of organic chemistry, and more are to follow; so that the proportions have been reversed which prevailed in the days of Brande, who devoted 367 pages only to organic chemistry, and 1042 to introductory matter and inorganic chemistry.

"But whatever may have been the advances in chemistry within the last fifty years, whether as a pure or an applied science, the extension of its boundaries towards physics in the one direction, and biological studies in the other, is at least as remarkable. While the study of spectrum analysis has rendered most valuable assistance in the chemistry of the constituent substances with which we are familiar upon earth, it has enabled the astronomer to carry his speculations not only to the constitution of the sun and stars, but to that of nebulæ, comets and meteors, and in the hands of Mr. Norman Lockyer and Mr. Huggins may yet lead us to travel with some degree of confidence in paths hitherto untrodden. In the domain of electricity it is hard to say whether that science does not owe nearly as much to chemistry as chemistry does to it. In the practical application of electricity to lighting purposes, chemistry has still to be called on to produce some improved form of secondary battery, and some portable form of primary battery which shall prove of ready application by our miners. It is needless to recall how much our underground workers are indebted to chemistry for their comparative immunity from danger from fire-damp, a danger which the efforts now being made by chemists will, I hope, still further diminish. Electricity has also placed at the command of chemists greater intensity of heat than can be derived from ordinary sources.

"The study of heat, irrespective of electricity, has largely reacted on chemistry, and while the Bessemer process has entirely revolutionised the manufacture of steel, and almost annihilated the distinction in value between that and other forms of iron, the Siemens and other furnaces have led to unprecedented economies in the expenditure of fuel, and at the same time have facilitated the application of heat in various chemical processes. In the other direction—the absence of heat—Prof. Dewar has, during the present year, made most important advances. Although air had previously been liquefied, he has now been able, by means of intense cold alone, to reduce atmospheric air to the liquid condition. His further results, by a combination of enormous pressure and extreme cold, are well known, and now that oxygen and nitrogen have yielded themselves to the advances of science and have been obtained in quantities in a liquid state, it is hard to say that hydrogen is destined always to remain intractable. What may be the ultimate result of the investigations that can now be carried on at temperatures ranging from 100° to 200° centigrade below the freezing point of water, it is impossible to foresee. From researches already made in this country and in France, it would appear that most substances under extreme cold are, so to speak, dead, and that their ordinary affinities are in abeyance. Possibly what may be termed 'glacial chemistry' may eventually enlarge our views as to the various properties of matter.

"As to the advances in our knowledge of the chemistry of light, the present condition of photography may testify. When we can take the image of a bullet flying at the rate of 3,000 feet per second, with its accompanying cone of compressed air; when we can produce photographs which are practically permanent, and when we call in the action of light to engrave our steel or copper plates, and to produce efficient substitutes for woodcuts, we seem to be getting near the limits of the practical application of photography. And yet many of us may remember the days when the daguerrotype was regarded—and justly so—with wonder; and I can myself call to mind a still earlier form of photography, by which natural leaves were reproduced on paper sensitised with a salt of silver, of which I saw specimens in an exhibition at Dresden so long ago as the year 1839.

"In the introduction of artificial light much also has been done. It is true that Pall Mall was experimentally lighted by gas in 1807, but it was not until 1842 that gas found its way into Grosvenor-square and some other aristocratic quarters of the metropolis. Since that time immense strides have been made in the process of gas manufacture, while, in consequence of the waste products arising in the process having now found commercial uses, great reductions have been made in its cost. At the present time gas has to compete with electricity as an illuminant, while, in many cases, it has been superseded by mineral oils, which are now so abundant and cheap, and of which in this Society the flashing point may be said to be almost a burning question. If, however, gas is losing ground as an illuminant, it seems to be gaining it as a source of power, and there are prospects of a considerable increase in the use for this purpose of hydrogen and its compounds, containing far less carbon than ordinary coal-gas.

"In metallurgy also, in addition to the improvements in the manufacture of steel already mentioned, many noteworthy discoveries have been made. One of the most important of these is perhaps that of the production of aluminium on a cheap scale and in quantities sufficient for various applications to ordinary use. It seems somewhat remarkable that the progress in the use of a metal at once so light and so strong is not more rapid.

"The applications of some of the more modern alloys, such as phosphor-bronze, seem also susceptible of considerable further development.

"The extensive manufacture of sodium affords another instance of what was formerly the mere subject of a laboratory experiment, being now conducted upon a commercial scale.

"I may here just glance at the attempts that have been made to produce artificially some of the precious stones that occur in nature. Rubies have been manufactured, not indeed such as could rank as gems, but still such as will serve to 'jewel' the pivot-holes in watches; and though the results of attempts to produce the crystallised form of carbon, which is known as the diamond, have as yet had but doubtful success, it does not appear to me that the prospect of producing genuine diamonds under combined heat and pressure is absolutely hopeless.

"Another direction in which great advances have been made, and in which it seems probable that there yet remains something to be discovered, is the grouping of the various elements into small divisions, having more or less analogy the one with the other, and the classification of the atomic weights in one harmonious series. What is known as the Periodic Law of Mendeleeff and of our own Mr. John A. R. Newlands, has suggested the possibility that what we now know as metals or elements may have some at present hidden connections between them, so that eventually some of them may prove to be rather compound bodies than strictly elementary substances. This, however, is for the chemistry of the future.

"In organic chemistry, which has been defined to be the chemistry of the hydro-carbons and their derivatives, it is, as I have already observed, that the most wonderful development has taken place within the last half-century. Who, for instance, in 1840 could have foreseen the important part that aniline was to play in dyeing and colouring? It was not, I think, till 1856 that Perkins's mauve was really brought into commercial use, but since that time what a rainbow of colours has been produced from what would have seemed a most unpromising source! How brilliant are their hues, but as yet, in many cases, alas, how fugitive! Regarded from an artistic point of view these colours can hardly be esteemed an unmixed blessing; and even the fabrics of Eastern looms have not escaped their influence.

"Quæ regio in terris nostri non plena *coloris?*"

Turkey, Persia, India, and China have, I fear, in many cases, sacrificed taste to cheapness, and harmony to splendour in colour. It is a source of some satisfaction to know that the woad with which our ancient British predecessors stained their bodies is still cultivated among us for the purpose of dyeing wools, even though it has acquired the name of *Isatis tinctoria* and the colouring extract is now classed as an *Indigotin*.

"Among inorganic colours I may here briefly mention ultramarine, which instead of being patiently produced by the careful treatment of lapis lazuli and sold at many shillings an ounce, is now manufactured by the ton and quoted by the hundredweight. Would that the artificial colour was as fine and permanent as the natural! I have, in my own time, seen it supersede smalts as a colouring matter in paper-making, and I have known its use not unfrequently accompanied by the abundant presence of sulphuretted hydrogen as a product of its decomposition.

"Not only colouring matters but our flavours and scents have been synthetised, though art, if superseding nature for a time, must eventually acknowledge her inferiority even in pear-drops. Whatever our æsthetic feelings under these circumstances may be, we cannot but admire the skill and scientific energy by which such results have been attained. How far 'saccharine,' one of the lastest results of the chemist's ingenuity, is likely to supersede the use of ordinary sugar, is a question on which I decline to speculate. The manufacture of our every-day sugar has, however, itself undergone a complete metamorphosis within the last fifty years, with the result that it is now produced at what would formerly have been regarded as an absolutely impossible price. In 1840, beet-sugar was in its infancy, and such has been the improvement in the growth of the beet and the process of manufacture that nearly twice the weight of sugar is now produced from a ton of beetroot as there was at that date. In the production of cane-sugar also immense economies have been effected, especially in the process of evaporation. The study of the effects of saccharine solutions on the polarisation of light, and our acquaintance with the distinctions between dextrose and lævulose, and of the conversion of starch into sugar, all come within comparatively modern times.

"Much of our knowledge of the mysterious processes of fermentation is also of recent date, and it is in connection with these processes that the chemist finds himself brought into close contact with the botanist and the physiologist.

"Whatever suspicions Leeuwenhoek and the early microscopists may have had with regard to the vegetable character of yeast-cells, and however clearly Cagniard de Latour and Schwann may have established its plant-like nature and its connection with fermentation, it was not until Pasteur's researches from 1857 to 1861 that the true character of the yeast-plant, and of other micro-organisms which lie at the base of most fermentative processes, can be said to have been absolutely demonstrated. The beneficial effect of his inquiries, and of his methods of obtaining a pure cultivation of yeast, is universally recognised, and has reacted in the most remarkable manner on the brewing industry.

"But M. Pasteur's researches have also led to much wider results, as it has been mainly in consequence of his careful observations that the wonderful influence for good or for evil of organisms so minute as in some cases almost to defy the power of the microscope, has now been so fully recognised. The germ-theory of the origin of many diseases meets with much more general acceptance than it did but a few years ago; and though the bacilli and bacteria which are characteristic of some virulent diseases, such as anthrax, are only agents in certain fermentative processes by which poisonous matters are engendered, their existence and character seem to be placed beyond all doubt. The process of obtaining immunity from the action of these poisons by the gradual introduction of the virus into the animal system, thus rendering it insusceptible of receiving further injury from the same poison, has been successfully introduced, both among men and beasts, and hydrophobia and anthrax have been successfully combated.

"A recognition of the influence of germs has led to the introduction into surgery of that antiseptic system of treatment with which the name of Lister will always be associated, and which has done so much to diminish suffering and preserve life. While upon this topic I may just allude to another instance in which chemistry has come to the assistance of medical science, I mean in the production and investigation of those anæsthetic agents which play so important a part in modern surgery, and which have done so much to alleviate human suffering.

"But while the ferments produced by micro-organisms are on the one hand so pernicious, it is very doubtful whether, on the other, they are not equally beneficial, if it be really the case that such processes as digestion are in a great measure due to their action. How far the nitrification of the soil may be due to micro-organisms is a question not yet absolutely solved, though strong presumption has been raised of their being, at all events, potent factors in the case.

"Now that so many diseases have been traced to pathogenic organisms which are constantly present in water contaminated by sewage, the question of the vitality of these organisms and their germs has been rightly regarded as one of great public importance, and the Royal Society, in conjunction with the London County Council, has instituted an investigation into it, which is being diligently prosecuted both from the botanical and the chemical points of view. The remarkable power of light, whether that of the sun or electric, in sterilising the germs of some micro-organisms, already to some extent previously known, has been conclusively demonstrated by Prof. Marshall Ward.

"Much has been done of late years by chemists towards the purification of sewage with the view of rendering the effluents from the ultimate drains of our large municipalities as innocuous as possible, and the results obtained have been in many instances satisfactory. They would, no doubt, have been even more so had not the imperative demands of economy limited the cost. Still, whatever may be done, I am inclined to think that there is much truth in the metrical abstract of a paper read some years ago before the Royal Society:—

"Sewage, however disinfected,
Is not from ill results protected;
Though made to all appearance pure,
It still remains not safe, but sewer."

"I will not attempt to discuss the important question of the disposal of the sewage of our great towns, but to many it will appear as somewhat of a disgrace to our powers of applying chemical knowledge, that such vast accumulations of what were originally highly fertilising substances should be discharged into the estuary of the Thames, and not only be absolutely wasted, but converted into a perpetual nuisance, brought up at each tide within the limits of the metropolis from which they started.

"It is true that within the last fifty years we have imported enormous quantities of guano, phosphates, and nitrates, but of these there must eventually become a scarcity, if not an end. In the meantime, may not chemists do something to reduce the waste of fertilising agents that is now taking place among us? Agricultural colleges have been founded—agricultural chemistry is a recognised branch of science; but with increase of knowledge has come increase of foreign competition, fostered by improved means of transport and communication, and it is at the present time a doubtful point whether many soils, even if rent-free, can be cultivated in this country for cereals, except at a loss.

"While touching on agricultural chemistry, I cannot pass over in silence the experiments which have now been carried on continuously for a period of fifty years at Rothamsted, by Sir John B. Lawes, assisted during the whole half-century by Dr. Gilbert. The extremely liberal provision which, during his life-time, Sir John Lawes has made for the purpose of continuing and extending his experiments, would alone entitle him to a full measure of public gratitude. When, however, we consider the nature and extent of the experiments already conducted, we must feel that no expression of public estimation can be too high when, as will shortly be the case, the Rothamsted jubilee is celebrated. As to the results already obtained, and as to the nature of the experiments still being carried on, it would be out of place here to enlarge. Remarkable, however, as are the effects of different manures on the botanical character and growth of herbage, and on the strength and yield of cereals, the different results arising from the mere variation of the temperature, sunshine, and rainfall, in successive years, are more remarkable still.

"I feel, however, that I have detained you long enough with these crude considerations of topics more or less chemical in their character, and that it is time for me to conclude.

"We are here assembled on the borders of the two counties of Lancashire and Cheshire, in both of which are great centres of chemical manufactures, and the principal productions of which are in a great degree dependent on the knowledge and due application of chemical laws. We meet at the seat of one of the most active sections of the Society of Chemical Industry, which has received us with open arms, and has provided us with an 'Open Sesame,' which will admit us to inspect many of the most interesting of the works and factories of the district. We gladly avail ourselves of the opportunities thus liberally opened to us, and if by chance any of us can afford assistance, advice, or encouragement to our brethren in Liverpool, I am sure that all present will gladly render it, and not forget that we are all members of one body, and all mutually interested in the advance of chemical knowledge, and especially of Chemical Industry."

THE PLAGUE OF FIELD VOLES.

RATHER more than a year ago a Committee was appointed by the Board of Agriculture to inquire into and report upon the circumstances attending the existing plague of voles in some of the southern counties of Scotland; and to ascertain, either experimentally or otherwise, whether any, and if so what, preventive and remedial measures could be adopted, and under what conditions those measures were likely to be of value.

The committee consisted of Sir Herbert Eustace Maxwell, Bart., M.P. (chairman), the Right Hon. the Earl of Minto, K.T., the Rev. John Gillespie, Prof. D'Arcy W. Thompson, and Mr. Walter Elliot.

Mr. J. E. Harting, Librarian of the Linnean Society, acted as the Secretary to the Committee.

From the recently-published report we obtain the following information. "The animal, which by excessive multiplication has caused so much mischief on hill-farms in the southern uplands of Scotland, is the short-tailed field-vole (*Arvicola agrestis*). At all seasons it is a well-known inhabitant of our pastures and may be found at all heights from sea-level to near the summits of our highest mountains. It usually produces three or four litters a year, each consisting of from four to eight young, but in some seasons they are even more prolific, the breeding season is prolonged, young voles being observed from February to November, and the litters containing as many as ten young.

"The present outbreak may be traced back to the year 1888, when the voles were observed to be increasing on the farm of Glenkerry and others in Selkirkshire. In the summer of 1889 the low-lying pastures near Closeburn, in Dumfriesshire, were observed to be infested by enormous numbers of voles, which remained there during 1890, and disappeared in 1891, probably moving up to the hill pastures, where in June 1892 they were swarming.

"The districts principally affected are the hill pastures in the north-west of Roxburghshire, the south of the counties of Selkirk, Peebles, and Lanark, and the northern part of Dumfries from Eskdalemuir by Moffat to Thornhill. The voles have also appeared in great numbers in the parishes of Dalry and Carsphairn, in the stewartry of Kirkcudbright.

"Mr. R. F. Dudgeon has estimated that in Roxburghshire 30,000 to 40,000 acres had been affected, of which he considered 12,000 to 15,000 acres had been rendered useless; in Dumfriesshire 40,000 to 50,000 acres, and in the stewartry of Kirkcudbright 10,000 to 12,000 acres were described by him as infested by voles."

"The map accompanying the report of the Committee shows that an area not less than 600 miles in length and from 12 to 20 miles in breadth has been overrun.

We reprint the following conclusions and recommendations contained in the report.

"The Committee have reluctantly been led to the conclusion that they are unable to recommend any specific method of dealing with or putting an end to the present outbreak.

"It appears to be an instance of the power which small animals are well known to possess, of prodigiously rapid multiplication under favourable climatic conditions and with a plentiful supply of natural food.

"Experience shows that a combination of such favourable conditions will always tend to bring about a recurrence of the plague. That being so, it ought to be the endeavour of every farmer and shepherd to be on the alert, and report without delay to the land agent, and to the secretary of the local farmers' club, or agricultural society, the first signs of the multiplication of vermin, so that palliative measures may at once be adopted, not on isolated farms, but everywhere throughout the district.

"The most effective measures appear to be periodical and timely burning of grass and heather, followed by active pursuit of the vermin by men using wooden spades and dogs. If this were promptly done in the early stages of the outbreak, it is quite possible that it might be averted altogether, or greatly mitigated in severity.

"It is hardly necessary to point out that the proprietor of the land should be informed as soon as anyone else, because his keepers and others might be usefully employed in assisting to prevent what amounts, if unchecked, to a common calamity upon all classes connected with land.

"Where plantations of limited extent are attacked, pit-falls wider at the bottom than at the top and about 18 inches deep should be dug. The voles fall into them and cannot escape, and the ground is soon cleared of them in this way.

"The Committee cannot speak with approval of the use of poisoned grain, except where the area affected is very limited.

"Nor have they been able to come to any conclusion favourable to the adoption of Prof. Loeffler's method of destroying voles by means of bread saturated in a preparation of the *bacillus typhi murium*, or mouse typhus. The personal investigations made by the chairman and secretary in Thessaly (where in May 1892 Prof. Loeffler was employed at the expense of the Greek Government to combat the plague of field-voles then prevailing in that country) convinced them that the favourable reports circulated as to the complete success of the experiments have not been justified by the results. In certain parts of Thessaly the voles were reported by landowners and others to be as numerous in January 1893 as ever they were.

"The Committee readily admit that, when used in a fresh state, the bacilliferous fluid is an effective though somewhat dilatory poison for mice and voles, and has this advantage over mineral poisons that, as has been proved, it is innocuous to human and other forms of life.

"It has also been reported by Prof. Loeffler that the Scottish voles sent to him alive by instructions from the Committee have been found as susceptible of the mouse typhus bacillus as their

Greek congeners. But there are three objections which render this method almost worthless except for employment in houses, gardens, enclosed fields, or other limited areas:—

"(1) It is very expensive; the virus supplied to the Greek Government was paid for at the rate of 4s. a tube, containing enough when dissolved to treat about two imperial acres, a cost which in many instances would exceed the rent of the Scottish hill pasture. To this must be added the price of bread used in distributing the virus, which would appreciably raise the cost of the process. Thus to deal effectually with a hill farm of say 6000 acres, would entail an expenditure of from £700 to £1000, making the remedy more costly than the evil.

"(2) Mouse typhus is not contagious; it can only be communicated to those animals that will swallow some of the virus. The allegation that healthy voles will become infected by devouring the bodies of the dead has not been satisfactorily proved. That Greek voles when in captivity have been observed to feed upon the corpses of their fellows hardly warrants the assumption that Scottish voles in a state of liberty will do the same; and unless the disease were communicable from one animal to the other, it is not easy to see how the remedy could prove effective on extensive hill pastures.

"(3) The fluid loses its value in about eight days after preparation. Consequently much disappointment might ensue if, after a supply had been obtained, a fall of snow or wet weather were to interfere with its distribution over the land.

"The remedy which has been found most effectual in Thessaly is an injection of the fumes of bi-sulphide of carbon into the burrows. This, however, is a more expensive process than the other, besides being injurious to the health of those engaged in its application. It is, moreover, inapplicable to the Scottish vole (*Arvicola agrestis*), which does not burrow to a depth like the vole of Thessaly (*Arvicola Güntheri*), but lives in shallow runs amongst the roots of herbage.

"With the under-noted exceptions the natural enemies of the voles may be divided into two classes, viz., those which destroy the voles, and are harmless to sheep, crops, and game; and those which, though preying on voles, are so hurtful in other ways as to have no claim to preservation:—

(i.) Vole-killers, harmless, or nearly so, to sheep, crops, and game.	(ii.) Vole-killers, hurtful in other ways.
Owls of all sorts,	Foxes,
Buzzards,	Ravens,
Kestrels,	Carrion and Hooded Crows,
and the smaller Seagulls.	Great Blackbacked Gulls,
	and Adders.

"Strict injunctions ought to be given by landowners that the birds mentioned in the first class should not be destroyed. Their presence in full numbers, though inadequate to avert an outbreak, would undoubtedly tend to mitigate it, and, as has been proved in the case of the short-eared owl, they have the faculty of multiplying a normally in presence of an unusual supply of food. They are at all events most useful allies to man in combating attacks of ground vermin.

"The Committee further deprecate in the strongest manner possible the use of the pole-trap for the capture of hawks. Besides the inhumanity of this device, it is indiscriminate, and harmless owls, kestrels, and buzzards are just as likely to be taken by it as are the more mischievous species.

"Three animals, diligent vole destroyers, have been omitted from both these lists, because they are undoubtedly hurtful to game. The first of these is the common rook (known to the shepherds as the corn crow), of which, however, the services to agriculture are now generally recognised.

"The other two animals referred to are the stoat and weasel. Of all the smaller beasts of prey these are perhaps the most hateful to gamekeepers, and it is hardly reasonable to expect that stoats should be allowed to multiply in game coverts, or in the vicinity of pheasant coops. But the Committee have no hesitation in recommending that weasels, which are persistent mouse-hunters and do little damage to game, should not be molested, at least on moorlands and hill pastures, where they can do little harm and much good."

THE ZOOLOGICAL SOCIETY.

THE report of the Council of the Zoological Society of London for the year 1892 was read at the annual general meeting on April 28, and printed copies of it were distributed shortly afterwards. The following extracts are of general interest.

"The considerations which prompted the Council of the Society, as announced in their report last year, to award two of its medals to the representatives of families through whose exertions the Great Skua has been retained as a veritable member of the British fauna, have induced the Council to act this year in like manner in regard to a still scarcer species—the osprey (*Pandion haliætus*). It has been represented to the Council that for some years past but three pairs of this bird, which on many accounts is of great interest, have regularly bred in Scotland, and that their protection has been an object of much solicitude to those on whose property the nests are built. The Council are able to state that the effect of their former award has not only been beneficial to the birds concerned, but has been highly appreciated by the public at large, and they trust that the same good result will follow the bestowal of the Society's silver medal upon Donald Cameron, of Lochiel, and John Peter Grant, of Rothiemurchus, in recognition of the efforts made to protect the osprey in their respective districts."

These medals were presented to the above-named gentlemen at the general meeting of the Society on June 22.

Reference was made to the resolutions adopted by the Council in regard to steps proposed to be taken by the Government of New Zealand for the preservation of the native birds of that country. The resolutions were as follows:—

"That the Council of this Society have learnt with great satisfaction the steps that were proposed to be taken by the Earl of Onslow, when Governor of New Zealand, and by the Houses of General Assembly, for the preservation of the native birds of New Zealand, by reserving certain small islands suitable for the purpose, and by affording the birds special protection on these islands.

"That the Council much regret to hear that difficulties have been encountered in carrying out this plan as regards one of these islands (Little Barrier Island), and trust that the Governor of New Zealand may be induced to take the necessary steps to overcome these difficulties, and to carry out this excellent scheme in its entirety.

"The Council venture to suggest that, besides the native birds to be protected in these reserves, shelter should also be afforded to the remarkable Saurian, the Tuatera lizard (*Sphenodon punctatus*), which is at present restricted to some small islands on the north coast of New Zealand in the Bay of Plenty.

"The number of visitors to the Society's gardens in 1892 was 605,718. The corresponding number in 1891 was 598,730, showing an increase of 6988 entrances.

"The deaths during the past year have been 862 in number, being 40 in excess of the number of deaths during 1891. Of these the more important were—a lioness, a male cheetah, two common zebras, an aard wolf, a male beatrix antelope, and the last surviving giraffe.

"Two gentlemen have utilised the students' rooms for carrying on investigations. Mr. F. G. Parsons has been studying the comparative myology of the rodents; and Mr. P. Chalmers Mitchell has commenced an investigation upon the spleen of the vertebrata.

"The number of animals belonging to the first three classes of vertebrates living in the Society's menagerie at the close of 1892 was 2413. The corresponding number on December 31, 1891, was 2232.

"The total number of registered additions to the menagerie in 1892 was 1335, of which 698 were acquired by presentation, 315 by purchase, 141 were bred in the gardens, 142 were received on deposit, and 39 obtained in exchange.

"Among the deaths of animals in 1892 occurs that of the last remaining individual of the stock of giraffes, a male, purchased January 27, 1879. The Society is now, for the first time since the arrival of the four original giraffes on May 24, 1836, without any representative of this mammal in its series. Nor does there seem to be at present much chance of our being able to supply the deficiency. Owing to the closure of the Soudan by the Mahdists the supplies of this and other large African mammals, which were formerly obtained *via* Cassala and Suakim, have ceased, and, so far as can be ascertained, there are now no living giraffes in the European market. There have been thirty individuals of the giraffe in the Society's gardens since 1836, of which seventeen were born there, and thirteen acquired by purchase. Of these thirty, one was presented to the Royal Zoological Society of Ireland in 1844, five have been sold at prices varying from £450 to £150, and the remainder have died in the gardens.

"In concluding their Report the Council express their regret that it has not been possible, during the past year, to continue their former policy of adding to the permanent structures in the gardens. There are still several buildings much wanted for the better housing of certain parts of the collection, amongst which may be specified the anthropoid apes and the struthious birds, for which groups special accommodation is required. But in both these cases, to carry out the plans efficiently, a considerable expenditure would be necessary, and the margin of receipts over expenses is at present too slender to render it prudent to undertake the work. The Council look forward to the time when the small remaining balance of the mortgage-debt upon the Society's freehold house will be paid off, and when there will be at any rate a better prospect of devoting the surplus income to such purposes."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE following is the list of scholarships and prizes just awarded at the Royal College of Science, London, with which is incorporated the Royal School of Mines:—First year's scholarships, Robert W. Forsyth, George W. Walker, John Thomas, Harry R. Prescott; second year's scholarships, Bernard E. Spencer, George S. West; "Edward Forbes" medal and prize of books for biology, Henry Lacey; "Murchison" medal and prize of books for geology, Joseph B. Morgan; "Tyndall" prize of books, for physics (Course I.), George D. Dunkerley; "De la Beche" medal for mining, Samuel W. Price; "Bessemer" medal and prize of books for metallurgy, Allan Gibb; "Frank Hatton" prize of books for chemistry, Robert E. Barnett. Prizes of books given by the Department of Science and Art: Mechanics, William H. Pretty; astronomical physics, William E. Tubbs, Willie Whalley; practical chemistry, Robert E. Barnett, Gerald G. Quinn; mining, Samuel W. Price; principles of agriculture, Robert S. Seton.

DR. BUTLER, Master of Trinity College, Dr. Hill, Master of Downing College, Dr. Peile, Master of Christ's College, Dr. Sidgwick, Knightbridge Professor, Dr. Jebb, Regius Professor of Greek, Dr. J. Ward, Dr. Keynes, Mr. F. E. Kitchener, Mr. R. T. Wright, and Mr. A. Berry will represent Cambridge University at a conference on the relations between the work of the Universities and the work of secondary education in England, to be held at Oxford on October 10 and 11, 1893.

MR. HENDRICK, of the Royal Agricultural College, Cirencester, has been appointed lecturer and demonstrator in agricultural chemistry by the Glasgow and West of Scotland Technical College.

PROF. W. GARNETT, M.A., D.C.L., Principal of the Durham College of Science, Newcastle-on-Tyne, has been appointed director and technical adviser to the Technical Education Board of the London County Council.

SCIENTIFIC SERIALS.

THE most important papers in the *Botanical Gazette* for April and May are an account of a newly-discovered fungus, *Phyllogaster saccatus*, by Mr. R. Thaxter, proposed as the type of a new family, *Phyllogastreæ*, characterised by the absence of any volva or receptacle differentiated as such in the mature condition; on the tendrils of *Passiflora cœrulea*, by Mr. D. T. McDougal, in which the author states that the tendrils of the passion-flower are sensitive to contact with one another, contrary to Darwin's experience with *Bryonia* and *Echinocystis*; on the limitation of the term "spore," by Prof. C. McMillan, which does not seem to throw much light on the confusion at present prevailing; the commencement of a paper, by Mr. G. F. Atkinson, on the biology of the organism which causes the root-tubercles in the *Leguminosæ*; and on the genus *Corallorhiza*, by Mr. M. B. Thomas, who finds in the cells of the cortical tissue hyphal threads which he regards as the agent by means of which the plant is able to derive nutriment saprophytically from the decaying vegetable matter around it.

IN the *Journal of Botany*, for May and June, in addition to the serial papers to which allusion has already been made, Mr. W. Phillips describes the rare fungus, *Gyromitra gigas*; Messrs. E. F. and W. R. Linton, in a paper on British hawkweeds, add four more to the already too numerous British species or subspecies of *Hieracium*, viz. *H. graniticolum*, *clovense*, *Boswelli*, and *stenophyes*; in an article on some marine algæ from New Zealand, Mr. R. J. Harvey Gibson describes and figures a new seaweed, *Rhodocorton Parkeri*.

Meteorologische Zeitschrift, June.—On the climatic effect of forests upon their neighbourhood, by E. Ebermayer. The discussion is based upon observations made in Austria since 1866, and the results arrived at are that forests do exert an influence on temperature and humidity, but not to the same extent as mountains and large lakes. Within the forest the daytime is naturally cooler and the nights warmer, while some of the effects are beneficial and others injurious to vegetation. The connection between forests and rainfall is not proved; in any case the effect on local distribution of rainfall is quite subordinate.—Earth temperatures at Hamburg, in the years 1886–91, by W. J. van Bebber. Monthly and extreme values are given at depths of half a metre, and for each metre up to five, together with the temperature of the air and of the surface of the Elbe. The average extreme annual variation, at a depth of 0·5 m. amounts to 30°·6 F., but at a depth of 5m. the variation falls to 8°·1. At the former depth extreme temperatures of 66° and 30° occasionally occur, while at the latter depth temperatures exceeding 52°, or less than 39°, are very seldom recorded.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 15.—"On *Megaladapis madagascariensis*, an extinct gigantic Lemuroid from Madagascar." By C. J. Forsyth Major, M.D., For. Corr. Zool. Soc. (Communicated by Dr. Henry Woodward, F.R.S., V.P.G.S., &c.).

It is now forty-two years since Isidore Geoffrey Ste.-Hilaire announced to the French Academy of Science the discovery of gigantic eggs and a few bones of *Æpyornis* from superficial deposits in the island of Madagascar, anticipating that a rich fauna of extinct vertebrata would be speedily forthcoming.

Little has, however, been added to our knowledge since 1851 until the present time. In addition to the remains of a Crocodile, two Chelonians, and a *Hippopotamus*, first discovered by Grandidier, the number of distinct forms of *Æpyornis* is now rapidly increasing, and promises to rival in variety the New Zealand species of *Dinornis*, whilst the disclosure of a rich mammalian fauna seems only waiting to reward the carrying out of systematic exploration.

Four collections of sub-fossil vertebrates, from various regions of Madagascar, have recently been acquired by the British Museum of Natural History. Amongst one of these, sent over by Mr. J. T. Last (collector for Mr. Grose-Smith), is a somewhat imperfect skull of strange appearance obtained with numerous fragmentary Chelonian, Crocodilian, Hippopotamus, and Æpyornis-remains from a marsh at Ambolisatra on the south-west coast of Madagascar. For this remarkable fossil Dr. Major proposes the name of *Megaladapis madagascariensis*, and the establishment of a distinct family of the sub-order *Lemuroidea*, of which *Megaladapis* appears to be a much-specialised gigantic member, being approximately three times the size of the cranium of the largest existing Lemurid.

The salient features of the skull are the enormous lateral development of the anterior inter-orbital portion of the frontals, extending over the small, thick-walled tubular orbits. The post-orbital frontal region is comparatively narrow and elongate, and separated by a slight contraction from the equally narrow parietal region, bearing a thick and flattened sagittal crest. The brain-case is low, short, and narrow, and placed at a considerably higher level than the elongate facial portion. Both the cranial and facial portion are somewhat bent upwards, the former posteriorly, the latter anteriorly. A striking general character is the remarkable *pachyostosis* (thickening) of the cranium.

The author points out that, in its peculiar features, this skull only carries to an extreme characters which are present, but in a much lesser degree, and in varying gradations, in the different members of the *Lemuroidea*, both recent *Lemuridæ*, and extinct *Adapidæ*. In the very simple pattern of the molars, the superior of which are of the pure tritubercular type, *Megaladapis* approaches closely to the Malagasy Lemurids *Lepidolemur* and still more to *Chirogaleus*.

The diminutive size of the brain-case (comparable only with what we find amongst the Marsupialia and the Insectivora) is viewed by the author, in this instance, as a degeneracy, other characters being equally indicative of a retrogressive evolution undergone by this Lemuroid.

It is strongly insisted upon, generally, that "low" organisation in Mammalia is by no means always synonymous with "primitive" organisation, and that retrogressive evolution is more frequently to be met with amongst Mammalia than is generally admitted.

As regards the geological age of *Megaladapis* and its associated fauna, one of whose members, the *Crocodilus robustus*, is still living in the lakes of the interior, evidence of various kinds goes far to prove that these sub-fossil remains represent a fauna which was living at a comparatively very recent period, and that man himself was also contemporary with it, and in part responsible for its destruction.

The author adduced evidence in support of the proposition that an older Tertiary vertebrate fauna will ere long be forthcoming in Madagascar.

"On Operators in Physical Mathematics. Part II." By Oliver Heaviside, F.R.S.

It is first shown how the ascending and descending series for the first cylinder function may be algebraically harmonised. If A is the ordinary ascending series in even powers, B the equivalent series in odd powers, and C the equivalent descending series which is most useful for numerical calculation, then $C = \frac{1}{2}(A+B)$. This contains the explanation of a former anomaly. A and C were known to the author to be equivalent as operators, also algebraically and numerically equivalent with positive argument. But when the argument is a pure imaginary A remains real, whilst C becomes complex. A becomes the original oscillating first cylinder function. C contains it and the second oscillating function as well. But the identity $C = \frac{1}{2}(A+B)$ explains it. Both sides remain identical when the argument is imaginary. The second oscillating function is brought in by B.

The generalised formula of which C is an extreme case is then investigated.

The extreme forms of the binomial theorem are then examined. It is shown that when the index is a negative integer the generalised formula becomes indeterminate, consisting of the two extreme forms combined in any ratio.

A more general operator and the equivalences to which it leads are then examined. There is sometimes satisfactory equivalence for numerical purposes by employing only the initial convergent portion of the divergent series, but this fails when the index of the operator is in the neighbourhood of a negative integer.

The general question of the meaning of equivalent and of divergent series is then discussed. The difference stated by Boole to exist between divergent series of the alternating and of the continuous type, in that the former may, whilst the latter cannot, be employed for calculation, appears to be groundless. They are alike in the respect alluded to. But the true meaning of numerical equivalence is unsettled, for there are many cases in which formulæ believed to be analytically and algebraically equivalent show no visible numerical equivalence.

Some generalised formulæ involving the logarithm are then discussed, and some independent verifications found. A formula for Euler's constant is obtained and examined.

One of these formulæ brings in the second cylinder function, which is discussed by means of an operator leading to it; also its connexion with the first solution, and of both with the corresponding two oscillating functions. Various analogies are pointed out, especially through an operator containing two differentiators, leading to elastic wave solutions. Some applications and extensions will follow in Part III.

"On a Failure of the Law in Photography that when the Products of the Intensity of the Light acting and of the Time of Exposure are Equal, Equal Amounts of Chemical Action will be produced." By Capt. W. de W. Abney, C.B., F.R.S.

The above law has been generally assumed. In some recen experiments, however, I have discovered that this law breaks down under certain conditions. Quite lately I have described the method of comparing the photographic value of sunlight with that of candle light (*Photographic Journal*, June, 1893), which was as follows:—A beam light would be admitted through a narrow slit to sensitive bromide paper stretched round a drum of about 4 inches in diameter. The drum could be caused to rotate round its axis at any speed up to about sixty revolutions per second, by means of an electromotor. Part of the experiment was to place an amyl acetate lamp in position at any convenient distance from the slit exposure being given for a fixed time during rotation. The slit was next replaced by a small square aperture, of some $\frac{1}{2}$ inch side, and other portions of the same paper were exposed to the amyl acetate light at the same distance, for varying but known exposures, with the drum at rest. On development the paper showed, amongst other things, a narrow band of deposit of the width of the slit caused by the light from the amyl acetate lamp, and a row of squares of varying blackness of deposit due to the different exposures given with the drum at rest.

By comparing the blackness of the band with the scale of blackness, the width of the slit would evidently be calculated, supposing the usually accepted law to hold good under all circumstances. On making such calculations in every case the calculated width of the slit was always considerably less than what it was in reality, the difference being far beyond that which would be caused by any error in the measurement. This led to an investigation into the cause of this difference.

The following experiment was made. The circumference of the drum with the paper stretched round it was 12·25 in. The width of the slit was arranged to be 0·012 in. The amyl acetate lamp was placed 2 feet from the slit, and a rotation of 30 per sec. was given to the drum for one exposure, and 1 per sec. for a second exposure. In the first case the time of exposure during each revolution was $\frac{0·012}{12·25} \times \frac{1}{30}$ sec., or about 1/30,000 sec.

The sum of the exposures during 20 min. was thus 1·176 sec. In the other case the exposure was

$$\frac{0·012}{12·25}, \text{ or about } 1/1000 \text{ sec.,}$$

and the sum of the exposures was, as before, 1·176 sec. Thus the first individual exposures had only $\frac{1}{30}$ of the duration of the second exposures, though in the aggregate they were the same.

A scale of blackness was made on the same paper, through a square aperture, without shifting the lamp, the exposures being $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$, 1, 2, 4, and 8 sec. The scale and blackness of the bands were measured accurately, and the times of exposure which had been given to each band, on the assumption that the law enunciated held good, was calculated and found to be for the first band 0·6 sec., and for the second band 0·91 sec., instead of 1·176 sec. which was really given in all. Another example is where the slit was opened to 0·11 in., and the time of exposure reduced from 20 to 10 min. It was found that in this case the exposures given on the same assumption were 3·7 sec. and 5·28 sec., the real exposure given being 5·36. Other experiments are quoted.

It is to be remarked that the more sensitive a surface is to radiation the less marked are the differences observable for the same speeds of rotation. This is what might be expected.

As an outcome of the experiments so far made, it seems that when exposures less than 1/1000 sec. are made, and the source of illumination is an amyl acetate lamp (Von Altneck's) placed 1 foot from the sensitive surface, the law fails.

The question of very low intensities of light acting, and of the sensitiveness to different spectrum colours, is now under consideration.

[*Note by the author*. It may be stated that it has subsequently been proved that the law equally fails where feeble intensities of light act on the sensitive surface.]

Geological Society, June 21.—Dr. H. Woodward, F.R.S., Vice-President, in the chair.—The following communications were read:—On composite dykes in Arran, by Prof. J. W.

Judd, F.R.S. The author proposed to apply the term "composite dyke" to any fissure which contains two or more distinct varieties of igneous rock, differing from one another in chemical composition or mineralogical constitution. Such dykes fall into two classes:—(1) Dykes in which differentiation has evidently taken place in the materials after their injection, as in the examples described by Dr. Lawson in Canada and by Prof. Vogt in Norway. (2) Dykes in which there is evidence of the reopening of the fissure after its first injection and the introduction of materials of totally different composition. It is this class of dykes of which such interesting illustrations are found in Arran. These Arran dykes belong to the latest volcanic eruptions of the British Islands; their analogues are found alike in the south of Scotland, and in the north of England and of Ireland. They are the infilled fissures along which sporadic volcanic outbursts took place after the extinction of the great volcanoes of the Inner Hebrides. The subaerial products of these later, and, for the most part, insignificant volcanic eruptions, have been all swept away by denudation, except at Beinn Hiant and the Sgúr of Eigg. The materials filling these dykes belong to two totally different classes—one distinctly basic, with about 55 per cent. of silica; and the other markedly acid in composition, with from 65 to 75 per cent. of silica. The basic rock is an augite-andesite, which passes sometimes into an intersertal and occasionally into an ophitic dolerite (tholeite and diabase); the glass of this rock shows a great tendency to separate from the phenocrysts. The acid rock is often a highly vitreous material ("pitchstone" or "pitchstone-porphyry") which by devitrification passes into various forms of felsite and quartz-felsite. These rocks, if we class them according to the nature of the porphyritic minerals they contain, fall into the several groups of vitrophyric and trachytoid lavas, to which the terms pantellerite, quartz-pantellerite, rhyolite, andesite, and dacite have been applied. The glassy groundmass in the whole of these rocks, however, is always abundant and its characters are remarkably uniform however much the phenocrysts may vary. The author pointed out that, while the peculiarities of the first class of composite dykes can be accounted for by selective crystallisation and liquation going on within the magma which has been injected into the dyke, no such explanation is sufficient in the case of the composite dykes of the second class. That the association of two totally different rocks in the same dyke is not accidental, the numerous and varied examples at Tormore sufficiently prove. Where, as in these cases, it is found that there is the greatest dissimilarity between both the crystals and the glassy groundmass of the two rocks, the differentiation has taken place in the magma, prior to its injection into the dykes, and before the work of crystallisation had commenced. Prof. Bonney, Mr. W. W. Watts, Mr. Hulke, and Mr. Teall took part in the discussion on the paper, and the author briefly replied.—Notes on an intrusive sheet of diabase and associated rocks at Robin Hood, near Bassenthwaite, by J. Postlethwaite. The positions of the outcrops of the igneous rock were described, and a grit-band was recorded as running parallel to the diabase. The diabase, and vein-stuff associated with it, have furnished antimony, lead, copper, and arsenic; and the same ores, with the exception of the last two, were also found in minute grains in the grit. Analyses of the grit and diabase have been made by Messrs. Hellon and Brockbank. Prof. Bonney has examined slides submitted by the author, and allowed his notes to be used in the paper. The igneous rock has produced slight metamorphism in the surrounding rocks of the Skiddaw Slates.—On two dinosaurian teeth from Aylesbury, by R. Lydekker. Two teeth from the neighbourhood of Aylesbury, believed to be of Portlandian age, were referred to the sames species as a tooth figured by De La Moussay from the Portlandian of Boulogne. The Aylesbury teeth were described, and the nature of the animal which possessed them was discussed.—On a new plesiosaur from the Waipara River, New Zealand, by Capt. F. W. Hutton, F.R.S. This specimen was shortly described by Sir James Hector in 1873. The author considered it more prudent to follow Mr. Lydekker in referring all the known New Zealand Cretaceous Sauropterygians to Leidy's genus *Cimoliosaurus*, and he therefore described this form as a new species of that genus.—Observations on the affinities of the genus *Astrocœnia*, by Robert F. Tomes. Researches recently made by the author relative to the structure of certain undoubted *Astrocœniæ* of the Gosau beds, having for their primary object the better understanding of the supposed species of the genus obtained from the Glamorganshire conglomerate, have been productive of results which will render a complete modification in the classificatory position of the genus imperative. The author gave a new definition of the genus, in which he did not include any species of an earlier date than the cretaceous period, all the so-called Jurassic *Astrocœniæ* being referable to other and quite distinct genera.—Description of a new genus of *Madreporaria* from the Sutton Stone of South Wales, by Robert F. Tomes. In the *Quarterly Journal* for 1885 is a detailed description of a coral from the Sutton Stone named *Astrocœnia gibbosa*. This specimen is not the type of the species, and a re-examination of it by the author has proved that it is not an *Astrocœnia*. Two other specimens have also been examined, and as a result of examination of the three the author is enabled to found a new genus *Styloseris*, of which a diagnosis was given, and the specific name *gibbosa* was retained for this, the only known species. The genus will take its place near *Clausastræa*, from which it differs by possessing a well-developed columella and increasing by both fissiparity and gemmation. Mr. Etheridge and Dr. G. J. Hinde took part in the discussion that followed.—Study of the dykes of Hope, Idaho, by Herbert R. Wood. A description was given of the geographical distribution and characters of acid and basic dykes traversing slates and quartzites along the northern shore of Lake Pend'Oreille, Idaho, accompanied by notes on the glaciation of the area. The microscopic features of the igneous rocks were also described.—The rise and fall of Lake Tanganyika, by Dr. Robert Sieger. The author referred to Mr. Carson's paper on the same subject in the Society's Journal for 1892. He himself believed the oscillation of level to be analogous to variations reported as occurring in other African lakes, and to be due to climatic change. He brought forward evidence in favour of the coincidence of change of level and climatic change, but did not believe that his views are by any means contradictory to those of Mr. Carson, for the phenomena may be explained by a combination of the influences of climate with those of mechanical agencies.—On Cheilostomatous Bryozoa from the Middle Lias, by Edwin A. Walford. The author described some forms of bryozoa from the *spinatus*-zone of the Middle Lias near Banbury, some of which had previously been classed with the Cyclostomata. The new material not only shows the opercular aperture but the opercula *in situ*, together with appendages and supra-oral ovicells characteristic of the Cheilostomata. In addition he also found giant cells (cistern-cells) of form quite dissimilar from the ordinary zoœcia and probably reproductive. He cited M. Jules Haime as having described in his magnificent monograph somewhat similar cells from the Inferior Oolite; and in the Oxfordshire Great Oolite bryozoa Mr. Walford found cistern-cells like the Lias species on some colonies like *Diastoporæ*. He contended that it is merely the acquisition of very well-preserved material which is needed to show the necessity of removal of many such species to the Cheilostomata. The name *Cisternophora* was suggested for the genus, of which several forms were described.

Royal Microscopical Society, June 21.—The Rev. Canon Carr in the chair.—Dr. J. E. Talmage, of Salt Lake City, Utah, exhibited and gave an account of some specimens of selenite found in the interior of a mound at South Wash, near Fremont River, Utah. As a rule, portions of selenite useful for optical purposes are measured by inches and weighed by ounces, but here he had found some which weighed 1000 lbs. The formation around the mound was mostly sand and clay, and the region bore everywhere strong evidences of weathering, by means of which the mound had been weathered out into relief. He had removed some twenty tons of the crystals, amongst which were many single crystals, measuring 4 to 5 feet in length, and entirely perfect, the most regular being 4 feet long with faces of 6 inches. One fine crystal, 5 feet long, had no less than nineteen small ones jutting out from it; twins and groups were also very common. Inclusions of sand, clay, and liquid were often present. He believed this to be a unique formation.—Mr. G. C. Karop read a letter on the subject of diseased beard-hairs.—Prof. T. Jeffrey Bell read a letter from Capt. Montgomery on the subject of chicken-lice, ticks from grass, and other parasites found in Natal.—Dr. Nias read a paper on the development of the Continental form of microscope.—A discussion ensued, in which Dr. Dallinger, Dr. Braidwood, Mr. Karop, Mr. Teasdale, and the author took part.—Mr. C. Rousselet gave a *résumé* of his paper on *Floscularia pelagica* and other new rotifers.

EDINBURGH.

Royal Society, June 19.—The Hon. Lord Maclaren, vice-president, in the chair.—Dr. H. R. Mill communicated a paper on the physical geography of the Clyde sea area. He considered specially the question of the distribution of temperature, discussing the observations made by the Scottish Marine Station staff on the West Coast of Scotland for March 1886 to October 1888, along with some other earlier and later observations made by Mr. J. Y. Buchanan and the Fishery Board for Scotland. In the North Channel, between Scotland and Ireland, the temperature was uniform from the surface to the bottom because of the action of the tides in mixing the water. The yearly average of the temperature of the Channel water was 2 degrees higher than that of the air of the Mull of Cantyre. The air temperature reached its maximum in the end of July, while the water temperature was greatest in the middle of September. The temperature varied greatly from surface to bottom on the broad shallow which stretches from Cantyre to Galloway, except at the time of the annual minimum, when it became uniform. The Channel water mixes there with the water from the great Arran basin. In that basin the temperature is the same from the surface to the bottom at the spring minimum in March, the lower layers being only slightly affected during the year—most so at the autumn maximum. The surface layers heat and cool rapidly; but the average temperature of the whole is always lower than that of the Channel, except for a month at the spring minimum. The maximum temperature in the basin occurs in October. In the more isolated sea lochs, such as Loch Fyne and Loch Goil, the absence of oceanic influence is more marked. Thus in Loch Fyne, though the temperature is nearly the same as at other places at the minimum period, it is colder during the rest of the year, and the difference between the surface and bottom temperatures is more marked.

July 3.—The Hon. Lord Maclaren, vice-president, in the chair.—Prof. J. Gibson read a paper on the chemical composition of sea-water.—Dr. Alex. Buchan described a diagram exhibiting the hourly variations of rainfall at Ben Nevis Observatory. The diurnal variations at Ben Nevis Observatory are much more marked than those at any other station on the globe from which Dr. Buchan had been able to get observations.—Prof. Tait gave a further discussion of the path of a rotating spherical projectile.—Dr. Noel Paton communicated a paper by Dr. Chasseaud on an experimental study of intra-ocular therapeutics.

DUBLIN.

Royal Dublin Society, June 21.—Prof. G. A. J. Cole in the chair.—The following papers were read:—Note on a graphitic schist from County Donegal, by Mr. R. J. Moss. The schist yielded on analysis a little over three per cent. of carbon.—On some Pycnogonida from the Irish coasts, by Mr. G. H. Carpenter. Eight species are enumerated, including two forms of *Phoxichilus;* and the various species are considered by the author to be so nearly related as to indicate that they are as yet but in process of differentiation.—A paper was communicated by Prof. A. C. Haddon on the post-embryonic development of fungia, by Captain Gilbert C. Bourne.

NEW SOUTH WALES.

Linnean Society, May 31.—Prof. David, President, in the chair.—The following papers were read:—Descriptions of new Australian Lepidoptera, with additional localities for known species, by T. P. Lucas.—Australian plants illustrated. No. v. *Angophora subvelutina*, F.v.M., by R. T. Baker.—The Silurian Trilobites of New South Wales. Part 2. The Genera *Proëtus* and *Cyphaspis*, by R. Etheridge, Jun., and John Mitchell.—Description of a new *Murex* from South Australia, by John Brazier.—Mr. Brazier exhibited a specimen of the South Australian *Murex polypleurus*, n.sp., described in his paper, a species which in the past, by the late Mr. G. F. Angas and other authors, has been confused with *M. pumilus*, A. Ad., from the China Sea, and Darros Island, Amirantes. Also a fossil specimen of *M. octogonus*, Q. and G., from New Zealand.—Rev. J. Milne Curran read a note recording the presence of a fossil Buprestid beetle in an earthy limonite at Inverell, N.S.W. The insect is represented by a portion of a metallic green elytron, and it is associated with Miocene fossil leaves and a species of *Unio*. He also showed a specimen of a Silurian fossil coral (*Heliolites*) from Molong, N.S.W., in a beautiful state of preservation.—Mr. Baker exhibited drawings and specimens in illustration of his paper.—Mr. Trebeck showed a specimen of a large freshwater prawn (*Palæmon ornatus*, Oliv.) from the Rewa River, Fiji.—Mr. C. T. Musson sent for exhibition specimens of a European slug, *Arion hortensis*, Müll., from New Zealand, where it is now not uncommon, though not yet recorded from Australia. Also, from the Kurrajong, N.S.W., specimens of the peculiar slug *Cystopelta petterdi*, Tate.

PARIS.

Academy of Sciences, July 10.—M. Lœwy in the chair.—Note on the history of the facts which have proved the existence of the coronal atmosphere of the sun, by M. J. Janssen.—Natural introduction of terms proportional to ether displacements (Briot's terms) in equations of motion of light waves, by M. J. Boussinesq.—On the relation which exists between the co-efficients of the formulæ of Coulomb (the magnetic formula), of Laplace and of Ampère, by M. E. H. Amagat.—On a differential equation of the second order, by M. Mittag-Leffler.—Proper vibrations of a medium indefinitely extended outside a solid body, by M. Marcel Brillouin. Investigating the infinitely small proper motions of an infinite gaseous atmosphere external to a sphere which is deformed in any manner and then rendered motionless, M. Brillouin arrives at an equation which defines the pitch and quality of the sound emitted by the sphere, and also plays an important part in the motion of solids in fluids. Thus the form and dimensions of the bullet define the pitch and the damping of the sounds produced; the form of the vessel defines the periods of the different waves which it produces whatever may be its (small) velocity, the longest waves playing an important part in the resistance experienced. Thus, also, the presence of a rigid obstacle in a solid elastic medium determines the periods proper to the external medium, characterising the form and the properties of the body. There is every reason to believe that the waves emitted by metallic vapours correspond for the greater part to vibrations peculiar to the external ether, as will be shown in a detailed study of optical theories about to appear in the *Annales de Chimie et de Physique.*—On the realisation of constant temperatures, by M. Gouy. A criticism of M. Berget's work to determine the constant of gravitation, on the ground of the enormous difference produced in the gravimeter by a small difference of temperature.—On the electric transference of heat in electrolytes, by M. Henri Bagard. Two cylindrical glass tubes are fixed vertically in the corks of two vessels into which a current is conveyed so as to pass into the first vessel, up through the first tube into a reservoir containing a solution of some salt like zinc sulphate, down through the other tube and out by the other vessel. The lower portion of the tubes is kept at a lower, the upper at a higher temperature. A distinct Thomson effect was observed on sending a current from twelve small Daniell's through the arrangement, heat being conveyed in the direction of the current, as was easily shown by the variation of resistance, which in liquids decreases rapidly at higher temperatures.—On pyrosulphochromic hydrate, by M. A. Recoura.—On the combinations of selenious acid with molybdates, and on molybdoselenious acid, by M. E. Péchard.—On the iodosulphides of arsenic and antimony, by M. L. Ouvrard.—On the dissociation of calcium plumbate, by M. H. le Chatelier. In Kassner's process for the manufacture of oxygen, the following reaction is utilised:

$$PbO_2.2CaO = PbO + 2CaO + O.$$

Experiments were made with a view of determining the advantages or otherwise of this process as compared with barium peroxide. It was found that the disadvantage of the new method lay in the fact that it required a temperature of 900° instead of 700° for the oxygen to be dissociated at a pressure of 0·1 atmosphere. On the other hand, the plumbate, being easily fusible, absorbs oxygen more rapidly and completely, and the air need not be previously desiccated and decarbonated.—On benzoylcinchonine, by M. É. Léger. Action of sulphuric acid upon pyrocatechine and upon homopyrocatechine, by M. H. Cousin.—On a process of directly combining ethylenic and aromatic carbon compounds, by M. A. Brochet.—Attempt at the diagnosis of isomeric amido-benzoic acids and some other aromatic compounds, by M. Œchsner de Coninck.—On geraniol, by M. Ph. Barbier.—Influence of the acidity of musts upon the composition of the phlegms, by M. L. Lindet.—Greater assimilability of the nitrogen from recently formed nitrates, by M. P. Pichard.—On the composition of lime-tree "honey," by M. Maquenne.—On a new terrestrial Gregarina of the melolonthid larvæ of Provence, by M. Louis Léger.—On the *rôle* of the reserved secondary tissues of arborescent monocotyledons, by M. H. Jacob de Cordemoy.

BERLIN.

Physiological Society, May 19.—Prof. du Bois Reymond, President, in the chair.—Dr. Benda, in continuation of his remarks at the last meeting, spoke on certain questions connected with cell-division, dealing first with the value of double-staining. He then made a communication on the extra nuclear origin of the nuclear spindle and its relation to the centrosoma, and lastly on the median cell discovered by Flemming, which appears after the equatorial transverse division has become formed in the dividing cell.—Prof. Gad gave an account of experiments made by Dr. Rosenburg on the transplanting of slips of small intestine into the bladder. The experiment was successful; the functions of the bladder remained normal, and investigation showed that the muscular coat of the intestine had grown into that of the bladder, while the mucous membrane had grown up through the flattened epithelium of the organ.

June 9.—Prof. du Bois Reymond, President, in the chair.—Dr. Loewy had gone carefully into the methods of blood-titration, and concluded that the most convenient and certain way of determining the alkalinity of blood is to dilute it with a solution of magnesium sulphate and to add acid until a drop of the mixture just reddens litmus. In connection with this Prof. Zuntz gave an account of some experiments of his own and of Prof. Lehmann on the nature and compounds of the acids and bases of blood. He drew special attention to the results of passing carbon dioxide through blood whereby the alkalis leave the corpuscles and pass into the plasma as the result of a splitting up of their compounds with proteids and their conversion into diffusible carbonates.—W. Townsend Porter communicated the results of his experiments on the coordinating centres of the cardiac ventricle. Starting from the fact that the function of the centres is suppressed when the blood-supply is cut off, he had ligatured the coronary artery, supplying the septum, in a number of animals. In all cases the animals lived for many hours and even days after the operation, from which fact he considered he had disproved the existence of any coordinating centre in the septum.

Physical Society, June 2.—Prof. von Helmholtz, President, in the chair.—Dr. Rubens gave an account of experiments he had made, together with Dr. du Bois, on the permeability of metallic wire gratings to polarised heat rays. As is well known, Hertz's experiments on electric oscillations brought them into close relationship to the properties of light-vibrations, as shown by reflection, refraction, and polarisation. The fact that metallic gratings act as polarisers towards electric waves, inasmuch as the waves can only pass through when the wires of the grating are parallel to them, has no analogue in the case of light, since linearly polarised light can pass through a grating whatever be its position. On the assumption that this difference is dependent simply on the fact that light waves are too small for the gratings employed, the authors had experimented with the longer heat-rays and gratings of extremely narrow aperture. The latter were made of the finest wire (gold, silver, copper, and iron), the intervals between the wires being ·0025 mm., and the rays of a zirconium flame, up to W.L. 6μ were examined. The ocular of the spectroscope carried a very sensitive bolometer. It was found that with each of the gratings the ultra-red rays behaved like electric waves; those rays which vibrated at right angles to the plane of polarisation passed through a grating placed parallel to their plane, in threefold extent, as compared to the amount which passed when the grating was at right angles. This result was obtained with different metals with varying wave-lengths of the rays, *e.g.* with silver by W.L. above 2μ.—Dr. Krigar-Menzel reported on the present state of the experiments he is making together with Dr. Richarz on the diminution of weight at increasing altitudes. A balance is provided at each arm with two pans, one above the other at a distance apart of 2·2 m. With this balance two weights are determined, of which one lies in the upper pan, the other in the lower. The weighings are then repeated on both sides, and thus the difference of the weights when in the upper and lower pans is ascertained. In the next place a massive leaden block is built up between the two pans and the weighings are repeated. Up to the present time the weighings without the lead mass are alone complete. The block is, however, in position, and a few preliminary weighings have been made, from which it so far appears as if the presence of the lead had done away with the difference of the weights when in the upper and lower pans.

[NOTE.—In the report of the Physical Society, NATURE, vol. xlviii. p. 144, column 2, five lines from the top—"the vapours of these metals similarly gave an emission-spectrum following on the absorption spectrum"—for "similarly" read "neither," and for "following on" read "nor."]

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Heat: M. R. Wright (Longmans).—Aids in Practical Geology, 2nd edition; Prof. G. and J. Cole (Griffin).—An Introduction to the Study of the Diatomaceæ: F. W. Mills (Iliffe).—Diagnostik der Bakterien des Wassers: Dr. A. Lustig (Jena, Fischer).—Euclid's Elements of Geometry, Books v. and vi.: H. M. Taylor (Cambridge University Press).—Acoustics, Sound (Advanced), enlarged edition: W. Lees (Collins).—A Study of the Languages of Torres Straits, Part 1: S. H. Ray and A. C. Haddon (Dublin).—The Arctic Problem: A. Heilprin (Philadelphia, Contemporary Publishing Company)—Exploration of Mount Kina Balu, North Borneo: J. Whitehead (Gurney and Jackson).

PAMPHLETS.—Ueber die Typen der Küstenformen: Dr. A. Philippson.—Sir F. Ronalds, F.R.S., and his Work in Connection with Electric Telegraphy in 1816 (Simpkin).

SERIALS.—Medical Magazine, July (Southwood)—The Lingualumina, Parts 1 and 2: F. W. Dyer (London)—Proceedings of the Society for Psychological Research, June (K. Paul)—The Book of the Fair, Part 1: H. H. Bancroft (Chicago, Bancroft).—Botanische Jahrbücher für Systematik Pflanzengeschichte und Pflanzengeographie, Sechzehnter Band, iv. u. v. Heft (Williams and Norgate).—Annals of Scottish Natural History, July (Edinburgh, Douglas).—Notes from the Leyden Museum, July (Leyden, Brill.)

CONTENTS.

THURSDAY, JULY 27, 1893.

THE ROTHAMSTED JUBILEE.

ON Saturday next a large gathering of scientific men will assemble in the village of Harpenden to do honour to two investigators who have just completed fifty years of joint labour.

The occasion is unique. It can have happened but seldom that two men have continued their joint scientific investigations for a period like the present; but there are other circumstances, apart from this, which mark the event about to be celebrated as one of exceptional interest. The Rothamsted agricultural experiments are indeed a piece of work of which England may well be proud. They form a splendid example of what is sometimes accomplished amongst us by purely individual effort. The extensive series of costly experiments, carried out on a large scale both in the field and in the laboratory, and with results of national importance, has been maintained for more than fifty years at the sole expense of one man. Nor is this all. Sir J. B. Lawes has made provision for the continuance of these investigations. The laboratory and the experimental fields, with £100,000, have been placed in the hands of trustees, and the future management of the investigations has been entrusted to a committee, the members of which are elected by various scientific societies.

But it is not only as a striking example of individual zeal and munificence that the Rothamsted agricultural station is remarkable, it is equally so if we regard the character of the work performed. Many of the most important problems connected with agriculture can only be satisfactorily studied by actual experiments in the field; such experiments require to be carried out on a large scale and continued for many years. Boussingault was, we believe, the first who sought to ascertain the chemical statistics of agriculture by a quantitative examination of the actual crops of the farm, and by a study of the constituents of soil, of manure, and of rain-water—the various factors which determine the amount of the harvest. But if the work of Boussingault stands first in order of time, the work of Lawes and Gilbert at Rothamsted immediately follows it, and has been continued for such a much longer series of years, and developed in so many new branches of inquiry, that it is to Rothamsted that the agriculturist has long looked for information concerning the fundamental facts of agricultural chemistry.

The field experiments at Rothamsted are peculiar to the place; in very few of the now numerous agricultural stations in foreign countries has systematic work of this kind been attempted; in none has the work been so extensive and so long continued. No less peculiar to Rothamsted has been the laborious investigation into the composition of oxen, sheep, and pigs in various stages of fattening, and into the chemistry of the fattening process. Of the laboratory investigations we may mention the more recent inquiry into the causes and conditions of the production of nitrates in soil, and respecting the quantity of nitric nitrogen in soils of various history, and in drainage and well waters. But we must not here attempt an enumeration of published Rothamsted work, which, according to the last report, has furnished the matter for 125 papers.

Rothamsted is by much the oldest of existing agricultural stations. The earliest German experimental station was founded in 1852, the earliest in the United States in 1875. The first agricultural experiments of Mr. Lawes seems to have been made in 1837; in this and the two following years he tried numerous experiments on farm crops grown in pots. His trials in the field commenced in 1840. In 1843 he was fortunate in securing the services of Dr. J. H. Gilbert, a former pupil of Liebig's, who henceforth took the superintendence of the chemical part of the investigations. Dr. Gilbert has devoted his life to the conduct of the Rothamsted experiments, and the valuable results which have been obtained are largely due to his untiring energy, and to the method and order which his character has impressed upon the work. The jubilee to be celebrated this week is reckoned from the year when Dr. Gilbert began to take a share in the work; the same year also saw the first of the experimental wheat crops sown in Broadbalk Field, which, at the present time, bears its fiftieth successive crop, having grown wheat without intermission during half a century. Numerous honours have been conferred on Messrs. Lawes and Gilbert in the course of their long career. Our Universities have bestowed on them degrees. The Royal Society in 1867 awarded them a royal medal. The Society of Arts has during the current year decided to present them with its Albert Medal. Foreign societies and academies have elected them members of their body. In 1882 Mr. Lawes received a baronetcy from the Queen.

The jubilee commemoration of the present week took its rise at a meeting held in the rooms of the Royal Agricultural Society on March 1, the Prince of Wales occupying the chair. A committee of distinguished men, with the Duke of Westminster as chairman, and Mr. Ernest Clarke, Secretary to the Royal Agricultural Society, as secretary, was appointed to carry out the scheme. The celebration on Saturday will consist, as the readers of NATURE are already aware, in the unveiling of a granite memorial erected in front of the laboratory; in the presentation of congratulatory addresses to Sir J. B. Lawes and Dr. Gilbert; and in the presentation to Sir J. B. Lawes of his portrait, by Hubert Herkomer, R.A. It is hoped that the Right Hon. Herbert Gardner, M.P., the Minister for Agriculture, will preside.

The laboratory, in front of which the celebration is to take place, is itself a testimony to the appreciation with which the labours of Lawes and Gilbert have been regarded. It is not the laboratory originally employed in the early years of the experiments; this was a barn which had been fitted up for chemical work, and has long ago been pulled down. The present laboratory was built and presented to Sir J. B. Lawes in 1855 by a number of agriculturists, at a time when agriculture was a more profitable pursuit than it is at present. Since then the needs of the work have grown, and a large storehouse for soil and crop samples has been erected by the side of the new laboratory.

Of greater interest to most visitors than the laboratory is the old manor of Rothamsted. This charming red brick building dates from 1470, though, like most old buildings, it has since undergone alteration and enlargement. This manor house has been the home of Sir J. B. Lawes' ancestors since 1623. The history of the family is remarkable. It was in 1564 that Jacques Wittewronge came to England from Flanders in consequence of the religious persecution then prevailing. The family first resided in Buckinghamshire; they afterwards purchased the manor of Rothamsted. Sir J. B. Lawes is a descendant of this family through the female line.

In the manor house of Rothamsted Sir J. B. Lawes was born in 1814. His whole life has been one of great activity; probably few men have accomplished more work. Though for many years a hard-working man of business, he has always loved a retired country life, and has been rarely seen at public meetings. A keen observer and an untiring experimenter, he has given his whole mind to the problems of agriculture, while his great practical sagacity has enabled him to grasp at once the real bearing and importance of each new fact. Probably no one has taken a more practical and wide-reaching view of agricultural questions than Sir J. B. Lawes. When the present century is concluded, the work of Lawes and Gilbert at Rothamsted will be reckoned among the prominent achievements deserving a grateful record.

THE ORIGIN AND DEVELOPMENT OF MUSIC.

Primitive Music: an Enquiry into the Origin and Development of Music, Songs, Instruments, Dances, and Pantomimes of Savage Races. By Richard Wallaschek. (London: Longmans, Green, and Co., 1893.)

MR. WALLASCHEK has not only compiled with laborious care what appears to be an exhaustive account of the music of so-called savage races, but has based upon the foundations thus laid an able and interesting discussion on the origin and development of music. It is with the latter rather than the former part of his work that I propose to deal in this notice.

The author is led by his researches to regard rhythm as the primitive and primary constituent of music, while melody was in the primitive state, and has remained, secondary and accessory. Harmony is not to be looked upon as a comparatively recent invention among European races. "As soon as music passes the mere rhythmical stage the lowest races in the scale of man begin to sing in different parts in intervals as well as with a bass accompaniment." The order of development therefore is, first rhythm, and then, possibly coeval one with the other, melody and harmony. With what then is the rhythm of primitive music associated? With the rhythm of the dance. If I understand the author rightly this association is, in his opinion, an invariable one in the origin of music. Now, "in dance-music the idea is to excite the performer and to fatigue him even to exhaustion. The musical dance-chorus is of a social character; music keeps the company together and enables them to act simultaneously." I quote here from the author's summary, which is no doubt somewhat condensed and elliptical. One can hardly suppose that "fatigue even to exhaustion" was part of the primary "idea" (understanding by this word aim and object) of the dance. Would it not have been better to say that a part of the "idea" was to test and tax the powers of endurance of the performers? Be this as it may, war, the chase, and sexual passion afford the underlying motives of that emotional excitement which finds its expression in the rhythm of the dance; and thus this rhythm becomes most intimately bound up with practical life-preserving and life-continuing activities, or, in other words, with activities which are distinctly of natural-selection value. The large share taken by women in the dance and primitive music enables them to contribute not ineffectually towards the success of the tribe in its struggle with other tribes.

"If it be asked whence the sense of rhythm arises, I answer," says the author, "from the general appetite for exercise. That this occurs in rhythmical form is due to sociological as well as psychological conditions. On the one hand there is the social character of primitive music, compelling a number of performers to act in concert. On the other, our perception of time relations involves a process of intellection," and hence an appreciation of time, order, and rhythm. I would suggest that the psychological basis of the "sense of rhythm" might be found in experiences more primitive than any process of intellection—in the organic rhythms of our daily life. We cannot walk nor breathe except to rhythm; and if we watch a little child we shall obtain abundant evidence of rhythmic movements. This I should have placed first; and then the concerted rhythms of social activities. "Whence," asks Mr. Wallaschek, "does the general desire for exercise arise? Mr. Herbert Spencer's theory affords," he replies, "the most valid explanation. It is the surplus vigour in more highly evolved organisms, exceeding what is required for immediate needs, in which play of all kinds takes its rise; manifesting itself by way of imitation or repetition of all those efforts and exertions which were essential to the maintenance of life (*e.g.* the war-dance)." In explanation of the term "surplus vigour" the author does well to point out that this is not meant to imply a surplus beyond the needs of the organism at any time of its life, but a temporary surplus beyond its needs in times of unmolested peace and plenty.

While accepting Mr. Spencer's general theory of surplus vigour, Mr. Wallaschek is not prepared to accept the speech-theory of the origin of music. "Whereas Mr. Spencer," he says, "seems to think that musical modulation originates in the modulations of speech, I maintain that it arises directly from the rhythmical impulse." Without presuming to decide between Mr. Herbert Spencer and Mr. Wallaschek, I venture to point out how much depends upon the exact definition of "music" and of "speech." Mr. Wallaschek, as we have seen, regards primitive music as essentially rhythm without necessary association with either melody or harmony. It is a mere tone-rhythm in association with dance-rhythm. Whether to such tone-rhythm the term "music" can be satisfactorily applied, I am myself inclined to question. But that is another matter. We are bound to accept for the purposes of his argument the definition which an author sets forth. All that Mr. Spencer has written on the subject, however, leads us to suppose that for him music includes melody, or at least cadence. And I take it that in his speech-theory it was the melody or cadence of music that he specially had in view. Now "speech" may either mean intentional suggestion by means of vocal sounds, or such suggestion by means of vocal sounds rendered articulate and ordered in propositions. Taking the former and broader meaning, it appears to me that the vocal sounds associated with the dance must be regarded as having suggestive value to those who are acting in concert, and as possessed of rhythmic import; and that, further, from these vocal sounds arose the melodic and harmonic elements of music. Personally, I should advocate the more restricted use of the word "speech," and should prefer to say that both music (including melody) and articulate speech are of vocal origin. And this, I take it, comes very near, not only to Mr. Wallaschek's own view, but also to that of Mr. Spencer against whom he is arguing. The association of these vocal sounds with the concerted activity of the dance is quite in line with the suggestion of Noiré, adopted by Prof. Max Müller, that the origin of speech is to be sought in the vocal sounds uttered during the performance of common social actions.

There are many other points in Mr. Wallaschek's book to which I should be glad to draw attention did space permit. His discussion of the origin of the diatonic scale is of interest and value. He is on firm ground in his contention that primitive music is associated with life-preserving and life-continuing activities, and was thus in its early phases fostered and developed by natural selection. This few evolutionists would care to question. But concerning the development of music, *as an æsthetic activity*, he does not suggest anything very definite. He holds that there is nothing in the history of musical development to justify a belief that the inheritance of acquired faculty has been a factor in the process; and here I think he is right so far as definite evidence goes. He also holds that the great musician is a man of power who has devoted his faculties to music, and who would have been great as a painter or as a poet had circumstances led him to devote his faculties to these arts. And here again I believe that he is right. But the question is, What has guided musical development along the special lines that it has taken in Europe? I do not think that Mr. Wallaschek will contend that the guidance has here been that of natural selection. But guidance there has been. No doubt in this as in other matters of art, man has been giving objective expression to his ideals. But what has led the ideals to take the form they have taken? This is one of the most difficult problems presented by the psychology of æsthetics; and it no doubt lies somewhat beyond the field of primitive music on which Mr. Wallaschek has given us a work of real merit and value.

C. LLOYD MORGAN.

EARLIER RECOLLECTIONS OF MARIANNE NORTH.

Some Further Recollections of a Happy Life, selected from the Journals of Marianne North, chiefly between the Years 1859 *and* 1869. Edited by her sister, Mrs. John Addington Symonds. Post 8vo, pp. 316, with two portraits and a sketch. (London and New York: Macmillan and Co., 1893.)

THIS volume might very appropriately have borne the title of "Earlier Recollections," inasmuch as it describes the life of Marianne North antecedent to the period comprised in the two volumes previously before the public. On this point Mrs. Symonds says in her preface: "When publishing the former volumes of my sister's autobiography, it was thought wiser to cut out some of the earlier chapters describing well-known ground, in order to make room for those more distant journeys by which her name had become known to the to the world. But the unexpected success which that book met with induces me now to add those first European journeys, with one through Egypt and Syria."

It is probable that these sketches of travel in Europe, Egypt, and the Holy Land, from twenty-four to thirty-four years ago, will appeal to an even wider range of readers than the accounts of Miss North's later journeys to the furthermost parts of the earth, after she had become so widely known as a traveller and a painter. The same freedom in style and criticism pervades this as well as the former volumes. Briefly, it may be described as a rapid and graphic narrative of the incidents of travel, interspersed with lively observations on peoples and places, on plants and animals, and on the physical features of the countries traversed, with here and there historical allusions and reflections. The earlier journeys, that is from 1859 to 1869, were made in the company of her father; and her sister, who has edited these recollections of long ago, was also of the party up to 1867, and therefore well qualified for the task. The first trip was to the Pyrenees and Spain, by way of Jersey, St. Malo, Rennes, Tours, Bordeaux, and Pau. A stay of a month was made at Luchon, where Miss North made her first attempt at landscape painting. Thence they went to Barcelona, Tarragona, Valencia, Madrid, Toledo, Granada, Malaga, Seville, and Cadiz, and home by sea. This trip occupied nearly six months, and is described in less than thirty pages! In fact, the pace is tremendous, though the travelling in Spain was nearly all by diligence, which was very exciting if not absolutely dangerous. However, only the main incidents are touched upon, and the reader finds himself in a fresh place on every page. In 1865 and 1866 Egypt and Palestine were visited. Even at that period Miss North painted very assiduously, but a painting of doum and date palms, on the Nile above Philæ, is the only one in the North Gallery at Kew of that date. After the death of her father, in 1869, Miss North continued to travel, in order to forget her loss; first visiting Mentone and then Sicily. Much of her time was occupied in painting, though only one picture, the Papyrus growing in the Ciane, near Syracuse, is in the collection at Kew. All the rest, with one other exception alluded to above, are the work of her more distant journeys of later date. But all persons who have read the entertaining and interesting descriptions of the longer journeys will be anxious to possess the present volume, and will, we predict, not be disappointed with the contents. Should it, however, run to a second edition, the words and phrases from various foreign languages scattered through the book might be expunged or corrected. It is rather odd to find a priest or monk designated as "Signor Cannonico"; and an extra syllable in Beleuchtung does not improve it. There is, too, an unfortunate slip in the preface and on page 133, Elephantine Island being referred to as the Island of Elephanta. W. B. H.

OUR BOOK SHELF.

Elements of Psychology. By James Mark Baldwin, Professor Elect in Princeton College. (London: Macmillan and Co., 1893.)

UNDER the above title Prof. Baldwin has written a shorter text-book which, as he states in the preface, differs from his larger work, the *Handbook of Psychology* (reviewed in these pages vol. xliii. p. 100, and vol. xlvi. p. 2) mainly in its omissions. Like its larger predecessor, this book deals largely with "apperception" regarding, erroneously as we think, the selective synthesis observable in mental products as something wholly different from anything which is to be found in other departments of natural knowledge. "In the physical world," he says, "we find no such unifying force as that known in psychology as the activity of apperception." Although there is much in this work, as in its predecessor, with which we are in hearty but friendly disagreement, it appears to us to possess the great merit of giving abundant evidence of independent thought and treatment. It will, in the hands of senior students, stimulate them to thought and criticism—such criticism as the teacher who is in earnest welcomes like a breath of keen fresh air. The chief fault of the book is that its pages are somewhat unduly crowded with details. C. LL. M.

An Introduction to the Study of Geology. By Edward Aveling, D.Sc. (London: Swan Sonnenschein and Co. 1893.)

DR. AVELING has compiled a volume better, in many respects, than any of its kind. His arrangement of matter has much to commend it, and his descriptions are of the concise character regarded with favour by those who incline to a pabulum consisting of concentrated essence of knowledge. The book is another of that large class "specially adapted for the use of candidates for the London B.Sc. and the Science and Art Department Examinations." Intending examinees would do well to obtain it, but the student who loves geology for its own sake will hardly find the contents to his liking.

LETTERS TO THE EDITOR.

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

The Publication of Physical Papers.

As most people seem afraid to enter on this discussion, it is appropriate for others to rush in. I have not, however, anything very much to say, except (1) that it seems to be a subject which in its intersectional aspects is suited to oral discussion at a meeting of the British Association, and (2) that if the *Beiblätter* were regularly and intelligently translated a good deal of the necessary physical abstracting would *ipso facto* be done.

Abstracting on a large scale is difficult work, and the English genius scarcely runs in that direction. It seems to me a pity for a greater number of competent persons to be engaged on it than is really necessary, and if the Germans are good enough to do it for the world, why should we not recognise their work and utilise it to the utmost?

It will be answered, so we do; everyone sees the *Beiblätter*. Yes, and I suppose about half a dozen effectively glance through it. Not everyone is capable of taking in a page of German at a glance, as one can English, and, for myself, I find that what I have half-read in a foreign tongue has a fatal facility for slipping from the memory.

I need not labour the point, it is simply this—that whereas a weighty paper of known and conspicuous importance in one's own object can, if necessary, be worked at and utilised in almost any ordinary language, papers of uncertain value or of only approximate interest must be skipped altogether unless they can be skimmed; and that the skimming process in a foreign language is impossible to all but a few favoured physicists, whatever may be the case with chemists.

If an English edition of the *Beiblätter* were regularly published, the only abstracts that would remain to be done by us would be the contents of Wiedemann's *Annalen* and possibly of a few American or provincial publications.

But there are other questions besides that of abstracts; and chief among them is the question of central publication of all the English papers of importance which at present are difficult to procure.

These occur mainly in connexion with the Societies of Dublin, Cambridge, and Edinburgh. Few other Societies in the British Islands claim or possess a monopoly over papers presented to them. Nearly all except these three are, I suppose, now used chiefly for contemporaneous or *ad interim* publication, and any serious results are communicated by the author to some central organ. If that is not so it ought to be so. If an author has a good result which he will not publish, he can hardly be compelled. It ought, however, to be clear that mere printing in a half-known local journal is not proper publication at all; it is "printing for private circulation." Biologists are, I am told, given to err in this direction, each small society pluming itself on publishing memoirs in order to receive "exchanges," a ghastly and polyglot form of literature which may be catalogued but can hardly be read. However, biologists are doubtless the best judges of their own procedure, and what is suited to a copious and readily illustrated subject is not likely to be well adapted to physics.

Coming to the really central organs (whether general or special), the Transactions and Proceedings of the Royal Society, the *Philosophical Magazine*, and NATURE; most British and Colonial physicists can see them without trouble, and the *Phil. Mag.* is seen all over the world. Merely a few slight changes are needed in connexion with these organs. The Proceedings are largely a journal of the doings of the Royal Society, and as such are not specially edifying to outsiders. In consequence of this, perhaps, and also in consequence of the multifarious nature of the subjects treated simultaneously, the papers included therein do not get widely known. The Transactions are all published as separate memoirs, so that there need be no difficulty for an isolated worker not a Fellow to procure a copy, if the contents are freely advertised. But I would suggest that the cost of these separate copies and of each number of the Proceedings, is much too great. As one not at all behind the scenes, I am ignorant of the reasons for this high price, but I should think it might be a proper expenditure of some of the Society's wealth if their publications could by a considerable reduction in price, even to a nominal figure, be made much more widely available.

For most societies the method of publication invented, or at any rate adopted, by the Physical Society of London, seems to me well worthy of imitation. Until this is done, there remains the question of making the valuable papers which occasionally, or perhaps frequently, appear in NATURE or other weeklies, in the Transactions of the Cambridge, Dublin, and Edinburgh Societies,[1] and sometimes in the Proceedings of the Manchester and other provincial societies, more accessible to foreigners and incidentally to ourselves. This could be done by central reprinting, either in a new special publication, or in some extra

[1] I do not specifically mention the semi-technical societies, such as the Institution of Electrical Engineers, though often it is difficult to draw the line, and some of their papers, too, might be included.

volume of an already existing publication. I feel that it ought to be in some neutral, or non-society journal, to avoid arousing jealousy. If either the Royal or the Physical Society could take the matter up and arrange for, say, an extra half-yearly number or an extra annual volume of the *Phil. Mag.*, the thing could be done.

If they could also at the same time arrange for a prompt translation and republication of important foreign papers, many of us would be grateful; cash has hitherto been the main difficulty, but perhaps with the abundant funds at present available across the Atlantic, we may hope for something large and cosmopolitan in this direction before long from our co-linguists there. I commend this to the notice of the energetic secretary of the Smithsonian Institution. Everything tending to mitigate the miserable evils of the confusion of tongues would be eminently welcome, and whenever the whole earth has again the happiness of being "of one language and of one speech," I trust that that speech will be English.

OLIVER J. LODGE.

THE publication of a digest of the scientific papers which have appeared in the English language during even a limited period would entail serious difficulties. In the first place, the expense of printing would be considerable, and it would also be hardly possible to obtain the services of men competent to perform the task without paying them an adequate fee. In the second place, a satisfactory digest could not be published without the co-operation of the various scientific societies; and everybody who has had any experience as a member of the governing body of any club, society, or other institution is well aware of the difficulty of getting a dozen men, many of whom represent conflicting interests, to agree upon any definite scheme.

Still, I believe that the foundations of a scheme, which would be capable of development, might be constructed on somewhat the following lines:—

In 1889 the London Mathematical Society printed an index of all the papers published in the first twenty volumes of their Proceedings. The authors were arranged in alphabetical order, and their communications according to the dates of publication. This index will no doubt be brought up to date and reprinted, and I shall suggest (if I am then a member of the council) that an index of *subjects* shall also be printed, consisting of two parts viz. pure and applied mathematics, arranged in alphabetical order as regards *subjects*. Now if every scientific society which deals with pure and applied mathematics, or with experimental subjects which are capable of mathematical treatment, would co-operate with the London Mathematical Society in publishing an index of their own papers, arranged, printed, and paged in the same manner, it would be quite easy, by a rearrangement of the type, to print a joint index of all papers on these subjects which have been published, during the last twenty or thirty years, by the societies which co-operate. Each society would bear the expense of printing the original index of its own proceedings; and a proportionate part of the expense of printing and publishing the joint index, together with the profits derived from its sale, would be borne by and received by each society. It will be observed that the above scheme only contemplates a double index arranged according to authors and subjects, and not a *digest*; but every one who has had a little experience in hunting up papers, and also, I may add, law cases, will appreciate the value of such an index.

The editors of the Law Reports always insert under the title of each case a short paragraph in small print, giving an account of the points of law with which the case deals, from which the triennial digest is compiled; and if scientific societies would in future require authors to adopt the same course, the paragraph could be put into the index, and would be invaluable. The head-note need not amount to more than a few lines, and should describe the object of the investigation without entering into more detail than is absolutely necessary.

The various reports of the British Association on the progress of different branches of science contain much valuable information, and some of them might with advantage be printed in the index in a condensed form.

In conclusion, I would suggest that the governing bodies of the different societies should discuss this matter, and that a committee of delegates from those societies, which approve of united action, should be formed. The delegates ought, however, to be practical men well-versed in business, and able and willing to devote their time to the consideration of this question.

A. B. BASSET.

Birds' Methods of Steering.

THE flight of birds still presents several unsolved problems. How they steer, has never been fully explained. With the naked eye or, still better, with a field glass, many of them can be seen to use their tails, lowering the left or right side according to the direction in which they wish to go. This use of the tail as a rudder is much practised by pigeons, jackdaws, rooks, larks, swallows, housemartins, sandmartins, and I believe, by most of our common birds. Gulls let down a foot on one side or the other, and, no doubt, many other web-footed birds do the same. Still a rook or pigeon that has lost his tail manages to steer well, the chief result of the loss being that he cannot stop suddenly, nor float upon the air, but must take rapid strokes with his wings. What other method, then, has the bird of steering? One fact that bears upon this question can be easily observed. When a bird wishes to turn to the left he moves the centre of gravity of his body and flings himself on his left side, the right wing pointing upward and the left downward. How does he throw himself into this position? Most writers say that it is by striking harder with one wing than the other. In turning to the left the right wing would give a vigorous stroke, and so raise the right side of the body more than the left. At first sight it seems as if this explanation could not be the true one, since after a hard stroke the right wing should be lower than the left, which has only given a gentle one, and yet it is the right wing that is raised. But we must not be too hasty in drawing conclusions from this. When the down stroke takes place the wings do not descend far; the body rises so that the end of the wing appears to have described a much greater arc than it has done in reality. If, then, with the right wing a much harder stroke is given than with the left, the right side of the body will at once be raised, and the whole bird will be thrown upon its left side, while the movement of the wing itself may not be enough to be perceptible. If birds are watched as they fly, one wing seems always to be at the same angle to the body as the other, so that a straight line connecting the tips of the wings would pass through the two shoulder joints, or be parallel to a line passing through them. Instantaneous photographs of birds on the wing seem to me to bear this out. One wing may point up and the other down, but that is through the swaying of the whole body to one side or the other. In spite of this there may be an inequality of stroke that escapes detection, and without assuming this it seems on first thoughts difficult to account for the extraordinarily rapid turns made, for instance, by the swallow. But supposing that what appears to be the case is really so, viz., that equal force is put into both wings, there remains another possible explanation of this movement of the centre of gravity to the left or right in turning. If a bird wishes to steer leftwards, he may bend at the waist towards the left. So much has been said about the rigidity of the bird's backbone that its suppleness at a point just anterior to the ilium has been overlooked. I find that a swallow's vertebral column will bend at this point so as to form an angle of 150°; in the case of a kestrel it is 156°, of a tern 155°, of a sandmartin much the same as in the case of the swallow, in the case of a duck 165°; *i.e.* a duck can bend much less at the waist than the other birds mentioned, and you have only to watch ducks on the wing to see that they are very poor steerers. This is but meagre evidence, and, at present, I have not the means of collecting more. Still, as far as it goes, it seems to show that suppleness of waist goes along with the power of swerving rapidly, and, *a priori*, it seems extremely improbable that such a highly acrobatic feat should be performed without calling into play every power that is available. Direct observation can, I fear, afford little help, since the feathers obscure any slight bend in the back. But the habit that many birds have—it can be easily seen in the case of gulls—of turning their heads in the direction in which they wish to go, suggests that it may be by bending the vertebral column at a point where it would be more effective, that they make their turns, just as a skater changes edge and flies off on an opposite curve by swaying the weight of his shoulders across to one side or the other, a change of balance effected by a bend sideways at the waist. It is certain that birds do not depend entirely on movements of the head or neck, since gulls, for instance, may occasionally be seen to turn to the left while looking to the right and *vice versa*, a point which may be made out from instantaneous photographs. I cannot help thinking, then, that a bird avails itself of the suppleness of its waist to alter its balance when it wishes to turn. Whether this is the sole means, or whether at the same time the wings are worked unequally so as to conduce to the same end is difficult to decide. I may add that I have found the required muscles at the waist considerably developed. F. W. Headley.

Haileybury, Hertford, July 6.

Remarkable Hailstones.

On Saturday afternoon, July 9, a very violent storm burst over Harrogate and its neighbourhood, accompanied by remarkably loud thunder and most brilliant and almost continuous lightning.

At first a little rain fell, but it was soon mixed with small hailstones about the size of peas of the usual form. These were quickly followed by hemispheres of the size and character indicated in Fig. C. After a few minutes they rapidly grew to the size of those shown in Figs. A and B, which are drawn very carefully to actual scale. Most were flattened oval discs, as shown in the two drawings, which exhibit top and side view of one hailstone. I went out myself and measured a good

number while they were falling by putting them on a sheet of paper and marking their maximum and minimum diameters. These large stones usually had an opaque spherulitic-like nucleus, followed by two, three, and even a trace of a fourth clear ice shell intervening with opaque ice. Then followed a broad band of clear ice with a few radiating air cavities, finally enclosed in a mass of white granular feathery ice. The number of alternating laminæ seemed to be irregular, and must have varied with that of the different vapour strata traversed by each nucleus. The origin of the type (Fig. A from Fig. C) is very obvious. The quantity that fell was enormous, so that a lawn badly kept was entirely white, with the exception of the longer blades of grass that projected. The damage done in the near neighbourhood must amount to some thousands of pounds, and very few are the houses in this town that escaped without windows being broken. I did not time the duration of the fall, but I think it was about an hour.

5, Princes Square, Harrogate. H. J. Johnston-Lavis.
July 12.

A Substitute for Ampère's Swimmer.

I have long been dissatisfied with the rules commonly given in order to enable the relation between the direction of a current and that assumed by a magnet in its neighbourhood to be readily brought to mind. It is a small matter, but it causes a great deal of worry to many a student. The vagaries of Ampère's swimmer are "past the wit of man." Prof. Jameson's rule is not bad, but is not really easy to remember; the corkscrew is good, provided that you have a little time to think about it; but I have felt all along that it ought to be possible to devise something simpler than any of these. May I suggest that the following may perhaps be found useful?

If a pen be held in the right hand in the usual way, the penholder may be taken to represent the wire, and the direction of the flow of ink (that is, towards the point of the pen) the direction of the current; if, then, the thumb be stretched a little across the penholder it will represent the magnet, and the thumb-nail its marked or north-seeking pole. The hand may, of course, be twisted round into any position to represent any actual case. The same relation may be still more simply borne in mind by dispensing with the penholder, and merely laying the thumb across the forefinger of the right hand; either of these will then represent the current (flowing towards the finger, or the thumb-nail, as the case may be), the other the magnet.

Whether this is novel I do not know; it is so as far at I am concerned; but I think it is useful. Alfred Daniell.

Advocates' Library, Edinburgh, July 13.

The Jelly-fish of Lake Urumiah.

In Mr. Curzon's recently-published work "Persia and the Persian Question" (vol. i. p. 533), he writes as follows:—"When the wind blows on Lake Urumiah, sheets of saline foam are seen scudding along the surface, and the salt is left upon the shore in a solid efflorescence, sometimes several inches thick. No fish or molluscs live in the waters, whose sole living contents are a species of *small jelly-fish*, which sustain the swans and wild fowl that are occasionally seen."

When Captain F. R. Maunsell read his interesting paper on Kurdistan to the Royal Geographical Society in June last, I asked him whether he could give me any further information respecting this so-called "jelly-fish," to which he was kind enough to reply as follows:—"In reply to your inquiries regarding the existence of a jelly-fish in Lake Urmia, I have been going through my notes, and find that I visited the lake on July 20 at its west shore, not far from the town of Urmia. I bathed in the lake and found the jelly-fish in great numbers along the shores where the water was shallow. It was only about half an inch in diameter, of a greenish-white, almost colourless, with a small black centre. There are said to be no fish or other living creatures in the water, and I did not see any. As you probably know, the lake is extremely salt, more so than the Dead Sea. The specific gravity is given as 1·155, with 21·4 per cent. of salt. The lake is 4,100 feet above the sea level, and has no outlet. There is a British Consul in Tabriz, which is not far from the east shore of the lake, who might obtain a specimen, and would be able to ensure its getting home safely better than any one else. The lake is very shallow compared with its great size, nowhere being more than from thirty to forty feet in depth."

The only instance of a "jelly-fish" or Medusa as yet known to inhabit an inland sea is that of the *Limnocnida tanganjicæ*, recently described by Mr. R. T. Günther (Ann. and Mag. N. H. ser. 6, xi. p. 274 (1893)). It would be therefore of great interest to obtain specimens of the "jelly-fish" of Lake Urumiah and ascertain what it really is.

3, Hanover-square, W., July 17. P. L. Sclater.

Racial Dwarfs in the Pyrenees.

Being on the Riviera when I received Nature of January 26 with Mr. Haliburton's letter on the above subject, I proposed to act on his suggestion, and, on my way back to England, to explore the region indicated. To ensure, however, that the proposed exploration should not be a wild-goose chase, I first entered into communication with all the British consuls and French savants likely to have special knowledge of the subject, and more particularly with M. Cartailhac, director of *l'Anthropologie*, and who resides at Toulouse, "within little more than a half-day's journey" from the valleys named by Mr. Haliburton. I was favoured with interesting replies from all those to whom I had written with the single exception, very curiously, of our consul at Barcelona, a letter from whom you published, and who appears to have been Mr. Haliburton's chief authority. As to the replies I received, I need only say that they so strongly negatived the assertion of there being "racial dwarfs," though admitting that there are "certains goitreux de petite taille," in the Pyrenean valleys, that I did not think it worth while to make the proposed journey. And as Mr. Haliburton repeats, in the current *Asiatic Quarterly*, the assertions made in NATURE, I feel bound to state these facts, though I may say that I quite agree with him as to the probability of a former wide distribution of dwarf races, and should have found Pyrenean dwarfs, had they been discoverable, in most interesting relations to the Ligurian giants, whose caves I had been exploring at Baoussé Roussé—the "Red Rocks" of Grimaldi.

Athenæum Club, July 10. J. S. STUART-GLENNIE.

THE NOTTINGHAM MEETING OF THE BRITISH ASSOCIATION.

THE forthcoming meeting of the British Association in Nottingham recalls the year 1866, when the present Mr. Justice Grove presided over the meeting in the town, and delivered his epoch-making address. Although this was the only meeting held in Nottingham, national conferences and associations of all kinds are constantly gathering in this very convenient, healthy, and picturesque centre; the inhabitants are therefore accustomed to the entertainment of guests. The public buildings will also be found to offer special facilities for the usual work of the British Association.

The University College, a large building almost central in position, has naturally been allotted to the meeting of the various sections. The lecture-theatres and class-rooms of the College provide accommodation for all the sections with the exception of two, and these will gather in commodious rooms in the immediate vicinity.

The various laboratories of the College are to be devoted to the exhibition of scientific apparatus and diagrams, some of which will be used during the meeting for the illustration of papers in the sections; and since these laboratories are very convenient for the purpose and are in direct communication with the sectional meeting-rooms, it is hoped that authors of papers will be induced to bestow special attention to the illustration of their papers, as the illustrative matter will be permanently on view throughout the meeting.

The Corporation of Nottingham not only grants the use of the University College, but also gives permission for the Castle Museum to be used for the conversaziones, and throws open the Exchange as a luncheon hall, with smoking-room and ladies' room as adjuncts. The large luncheon room thus provided will be supplemented by another large and convenient room in the University College.

The large hall at the Mechanics' Institution will be fitted as the reception-room with all the usual conveniences, the Albert Hall being reserved for the popular lectures, the president's address, and for a special concert to be given on Saturday evening by the Sacred Harmonic Society of the town.

It will be found on reference to a local map that not only are these various buildings easy to find, but that they lie most conveniently within range of one another, the extreme distance not exceeding a walk of five minutes.

The inhabitants of Nottingham are quite alive to the duties of hospitality, and not only will the officials and working members of the Association receive entertainment in private houses, but the clubs of the town are also throwing open their doors with one consent. A list of hotel and lodging accommodation is nearly ready for issue.

The local excursions include visits to the Dukeries, Charnwood Forest, Lincoln, Belvoir Castle, and Derbyshire; and, in connection with these visits, hospitality has been offered by the Duke of Portland, the Duke of Newcastle, the Duke of Rutland, and the Bishop of Southwell. Many other offers of hospitality are expected. Important works in the town and neighbourhood will also be open for inspection.

The local programme and excursion handbooks are in an advanced stage of preparation. These will serve as guides to the public buildings used for the meetings and indicate the hotels and lodgings, and the routes followed in the various excursions; they will also give information concerning the natural history of the district.

The work of the local committee would be greatly facilitated if all those who intend to be present or to take part in the meeting would communicate with the local secretaries, Guildhall, Nottingham, as soon as possible.

Without unduly anticipating the information which will be found in the local programme and publications, enough has been said to indicate that the local committee are actively preparing for the reception and entertainment of the members of the Association; and it is proposed next week to give some statement of the more serious work which will engage the attention of the general meeting and of the sections.

FRANK CLOWES.

THE GREAT DROUGHT OF 1893.

THE draught of 1893 will unquestionably take its place among the recorded events of history, if regard be had to its intensity, the length of time during which it has lasted, and the wide extent of the earth's surface it has overspread. Treating the British Islands as a whole, the drought may be considered as embracing by much the greater part of the country for the fifteen weeks beginning with March 5. But while copious rains have fallen during the past few weeks in many places, it may be regarded as continued to near the present time in many of the more important agricultural districts in the south.

The drought was most severely felt in the southern division of England, and least in the north of Scotland. Over Scotland, England, and Ireland it increased in intensity, with pretty uniform regularity, from north to south. Thus the deficiency in percentages from the average rainfall of that portion of the year was 30 at Lairg and 59 in Berwickshire; 59 at Penrith, and 90 at Dungeness and Falmouth, and 38 at Londonderry and 67 at Waterford. The least deficiency at any of the stations of the *Weekly Weather Report* was 1 at Glencarron, in Ross-shire, and the greatest at Dungeness and Falmouth, as stated above. At Glencarron the amount of the rainfall was 16·91 inches, whereas it was only 0·60 inch at Dungeness, 0·77 inch in London, 0·92 inch in Scilly, and 0·94 inch at Falmouth. At places south of a line drawn from Cambridge to Scilly less than a fourth part of the average rainfall of these fifteen weeks was collected, and consequently over this large district the effects of the drought have been most disastrous to agriculture and horticulture, the hay crop, for example, being in many places a complete failure. It was altogether a unique experience, in travelling in June from London to Scotland, to mark the great and steady improvement in the condition of the crops in the northward journey.

During the period the type of weather prevailing was eminently anticyclonic, with the appearance, ever and anon, in localities more or less restricted, of small satellite cyclones with their attendant thunderstorms and rains. Hence the remarkably sporadic character of much of the rainfall, of which the most remarkable instance was a rainfall of 1·19 inch at Parsonstown on June 10 and no rain whatever at any other of the telegraph stations of the Meteorological Office in this country. Heavy local rains of this type, with downpours of an inch or upwards, were recorded on May 17, 18, 20, and 21, and June 10. It is also to be noted that many thunderstorms occurred during the period unaccompanied with rain, just as happened generally in the east of Scotland in June 1887, on the day of the Queen's Jubilee; and frequently large drops of rain fell, quite insufficient even to wet the ground, and scattered over narrow paths of inconsiderable length. Very heavy rains occurred over the eastern districts of Scotland, practically terminating the drought there, on June 22 and 23, when on these two days 4·20 inches fell at the North Esk Reservoir on the Pentland Hills, 3·32 inches at Roslin, 2·21 inches at Aberdeen, 2·06 inches at Logie Coldstone, near Ballater, and nearly two inches at many places, whilst generally in the west little and at many places no rain fell at all.

Temperature was phenomenally and almost continuously high in March, April, May, and June, specially as regards the first three of these months. Thus, for London the mean of the three months was 4°·3 above the mean of the previous 130 years; and in Edinburgh 3°·3. The only springs since 1763 with a mean temperature exceeding that of 1893 were for London, 1811 and 1794, which were respectively 5°·2 and 4°·3 above the average; and for Edinburgh, 1779 and 1781, which exceeded the mean by 4°·0 and 3°·8. It is highly interesting to note that large as these figures are, the Ben Nevis figures far exceed them, the mean temperature at this high-level observatory for March, April, and May last being 6°·6 above the mean of these months, a result due to the prevailing anticyclones, which so frequently are attended there with abnormally high temperatures.

The drought has also extended over nearly the whole of Europe, large portions of Canada, the United States, and other parts of the globe. In the north of Italy no living person recollects to have seen the Italian Lakes so low, and the southern Alps so greatly denuded of their snow covering. It is estimated that over the wheat-growing countries of the world this valuable crop will be to no inconsiderable extent under the average. On the other hand, in other parts of the world the rainfall has been exceptionally heavy, and followed with widespread disastrous floods, as in the cotton districts of the United States, and in Queensland.

In London, the total amount of rain that fell during the 110 days from March 4 to June 22 was 0·77 inch. Mr. Symons, our best authority on the question of droughts, enumerates eight droughts which have been recorded during the present century. Of these the longest continued was 105 days, from March 11 to June 23, 1844; and thus the drought of the present year is the greatest in the British Islands authenticated by meteorological records.

NICOLAS IVANOVICH LOBATCHEFSKY.

NICOLAS IVANOVICH LOBATCHEFSKY, the founder of Non-Euclidean Geometry, was born on November 2, 1793.

A student, and subsequently professor at Kasan, the Physico-Mathematical Society of that interesting University have determined to celebrate the centenary of his birth by founding an International prize for Mathematical, and in particular, for Geometrical work bearing upon the late-born but remarkable branch of mathematical science and philosophy which owes its existence to Lobatchefsy's genius and has earned for him the title of the Copernicus of Geometry.

A committee including the names of Tchebyche, Poincaré, Hermite, Darboux, Klein, Sophus Lie, Lindemann, Cayley, Beltrami, Newcomb, Mittag-Leffler, and over a hundred other notabilities of the mathematical world in both hemispheres, has been appointed to assist in carrying out the plan.

At this time of day it would he superfluous to dilate on the pre-eminent claims to honourable recognition of one who has played a principal part in reconstituting the basis of geometrical thought and realised his ideas in a series of memoirs with a thoroughness and precision which Gauss in 1846 characterised as the work of "a true geometer."

Any English mathematician (and it is to be hoped there will be many) desirous of co-operating in erecting this monument (if it may be so called) to the memory of a great scientific reformer, may do so by forwarding a subscription addressed to Prof. Vassilief, President of the Physico-Mathematical Society, University of Kasan.

NOTES.

WE greatly regret to record the death of Dr. John Rae, F.R.S., at the age of eighty-one. It was he who, in 1854, collected relics of the ill-fated Franklin expedition in the *Erebus* and *Terror*.

AMONG the Civil List pensions granted during the year ending June 20, 1893, we note one of £75 to Mrs. Dittmar, in consideration of the services to chemical science rendered by her late husband, Prof. William Dittmar, F.R.S., and one of £50 to Mrs. T. Wolstenholme, in consideration of the merits of her husband, the late Rev. Joseph Wolstenholme, as a mathematician, and of her straitened circumstances.

FOR the convenience of those who wish to be present at the Rothamsted celebration on Saturday next, a special train will leave St. Pancras for Harpenden at 2.2 p.m., returning at 5 p.m. In connection with the celebrations at Rothamsted, it is interesting to recall the circumstance that in the early part of the present century the signal services rendered by Francis, Duke of Bedford, to the theory and practice of agriculture were recognised by the erection, in Russell Square, of a colossal statue to his memory. The scheme, in the first instance, was initiated by Sir Joseph Banks, then president of the Royal Society, the first meeting on the subject being held at his house in Soho Square. Subscriptions were solicited from the various agricultural societies existing at the time, and from private individuals, and these flowed in with many expressions of approval of the object in view. The statue and its pedestal, the latter emblematical of the art of husbandry, were designed by Richard Westmacott, who received the sum of £6000 for the work, each subscriber receiving an engraving of the design. An inscription records that the statue to the Duke was erected by his fellow labourers in the field of agricultural improvement in gratitude for his unwearied endeavours to improve the theory and practice of agriculture.

THE French Association for the Advancement of Science will hold its annual meeting from August 3 to August 13, at Besancon, under the presidency of Dr. Bouchard. The subjects for discussion in different sections are the mechanical traction of tramways, the local records from which a forecast of the weather at a given place can be made, the *rôle* of humus, works of commerce, and the administrative measures necessary to prevent the use of unfit articles of food.

THE death is announced of Mr. Walter White, who for upwards of forty years served the Royal Society, first in the capacity of clerk and afterwards of assistant secretary and Librarian. Mr. White retired from the latter post in 1885, and has from that time received a pension from the society. His bent was literary rather than scientific, and he was the author of several books of holiday travel written in a pleasant style and in that correct English upon which he always prided himself. Mr. White died on Friday last, in the eighty-third year of his age.

THE annual congress of the British Institute of Public Health will be held at Edinburgh from July 27 to August 1, under the presidency of Dr. Henry D. Littlejohn and the auspices of the Lord Provost and Corporation of Edinburgh.

THE Société Belge de Géologie et d'Hydrologie has arranged an excursion of some interest for August 4 to 9, under the direction of M. E. Dupont, the special object being to study the hydrology of the district around Dinant, Namur, Rochefort, Madave, &c. The springs and surface-streams will be examined, and also the famous Grotte de Han. Attention will also be paid to other physical features of the districts, including the formation of valley-terraces and the origin of the loam on the plateaux.

THE annual exhibition of the Photographic Society of Great Britain will be held at the Gallery of the Royal Society of Painters in Water-Colours, Pall Mall, from September 25 to November 15. It will be opened by a reception held by the President, Capt. Abney. The last day for receiving pictures is September 11.

THE Aspatria Agricultural College, which has been rebuilt and greatly enlarged, was opened on July 21 by the Mayor of Carlisle, before a large and representative gathering.

A STATUE of Claude Chappe, the inventor of the system of semaphore signalling, has recently been erected on the Boulevard Saint-Germain, Paris.

THE Société Industrielle de Mulhouse has issued its programme of prizes to be awarded in 1894. Prizes will be given for works on the constitution of various colouring matters, mordants, dyes, the fixing of colours, areometry, drugs, bleaching, actinometry, and other subjects. In mechanical arts the prize-subjects relate to building construction, steam engines, motors, spinning and weaving, electric motors, and the comparative advantages of gas and electricity for lighting purposes. There are also prizes for subjects of natural history and agriculture, commerce, statistical and historical geography, and the fine arts. The prizes are open to persons of all nationalities. Competitors should send in their memoirs, plans, and specimens, marked with a pseudonym or motto before February 15, 1894, to the President of the Society. The same pseudonym or motto, with the full name of the sender, must be forwarded under separate cover at the same time. A detailed programme of subjects for which prizes will be awarded, can be obtainec by application to the Secretary of the Society, Mulhouse, Alsace.

WHEN it was resolved last January "That it is desirable that the eminent services of the late Sir Richard Owen in the advancement of the knowledge of the sciences of anatomy, zoology, and palæontology should be commemorated by some suitable memorial," it was confidently expected that there would be a generous response to the appeal for funds. A large number of circulars were sent out, yet the list published in June contains the names of less than 300 contributors. The donations then amounted to £935, and the amount promised has even now only reached £1000, whereas the committee hoped to obtain at least twice that sum. For those who have come orward there is nothing but praise; the cause of complaint lies in the paucity of subscribers. Only 300 admirers of Owen can be found desirous of giving concrete expression to their feelings of regard. The fact is humiliating, and, for the sake of British science, we trust it will soon be altered. Of Sir Richard Owen it can truly be said, that among students of science "Many shall commend his understanding; and as long as the world endureth, it shall not be blotted out; his memorial shall not depart away, and his name shall live from generation to generation." But Owen's greatness should not only be appreciated by men of science, it should be made known to the world by means of a monument. As a mark of respect to their master and an act of duty, all naturalists should add a stone to his cairn.

ONE of the conclusions arrived at in 1888 by the Commission appointed to investigate the action of light on water colours, was that "every pigment is permanent when exposed to light '*in vacuo*,' and this indicates the direction in which experiments should be made for the preservation of water-colour drawings." Actuated by this expression of opinion, Mr. W. S. Simpson has devised a simple and effective means whereby works of art can be isolated from the deteriorating effects of air and moisture. The picture which it is desired to preserve is placed face downwards in a shallow rectangular tray having a clear glass bottom, and is then covered at the back. The chamber thus formed is afterwards exhausted by means of a Spregnel pump, and hermetically sealed. Assuming that no leakage occurs, and that light has no intrinsic action upon pigment, the picture will be preserved in all its pristine beauty until the crack of doom. To test for leakage, a small manometer, constructed on the principle of the aneroid barometer, can be fixed to each isolated picture. Mr. Simpson's idea is a good one, and it possesses the inestimable advantage of being applicable to any picture, for all that is required is to take the picture from its frame and fit it into an airtight chamber of the same size before replacing it. Should the vacuum not maintain its integrity, the manometer will indicate its imperfections, and the chamber can easily be exhausted again. It appears, therefore, that the method has great possibilities before it.

WITH regard to the statement made by Mr. E. Douglas Archibald in our issue of May 25, that the highest rainfall in twenty-four hours was 40·8 inches, registered at Chirapunji, in the Khasi hills, a correspondent writes to the *Ceylon Observer* as follows:—"If the *Indian Planters' Gazette* of 28 Jan., 1893, is correct, the following paragraph establishes a still higher record. On page 59 one reads: 'Our Dera Doon correspondent writes on January 24, 1893: last night we had 48 inches of rain, and all the hills are covered with snow. It is still raining.'" For this to have any scientific value, however, it must be known who were the observers, and by what means the rainfall was gauged.

THE duration and form of temperature waves as they occur at Trieste has been studied by Herr Ed. Mazelle, and described in a recent communication to the Vienna Academy. Daily records during the period from 1871 to 1890 show a mean wave length of 4·23 days. The longest waves occurred in winter and summer, the shortest in spring and autumn at Trieste, in marked contrast to Central Europe, where the reverse occurs. The mean duration of increase of temperature was always longer than that of fall of temperature, in the proportion of 2·39 to 1·84. For dull days both the periodic and the aperiodic diurnal variation were of less extent, but both the maxima and minima of temperature occurred earlier in the day. The variability of mean daily temperatures was different for different parts of the year, showing maxima in January and July, and minima in September and April. The occurrence of the first day of frost was found to vary between wider limits than that of the last frost.

THE German Meteorological Office has issued a volume containing the results of rainfall observations for the year 1891, together with a circular stating that the number of meteorological stations has so greatly increased as to make it advisable to publish five volumes yearly instead of one, two of which will be devoted to the magnetical and meteorological observations made at the Observatory at Potsdam. The number of rain stations has increased from 35 to 1425 since the establishment of the office in the year 1847. In addition to the usual monthly and yearly summaries, the greatest amounts which have fallen in short intervals are given for a large number of stations. These values show clearly how the intensity of the fall decreases with the duration, and that erroneous ideas may be obtained by estimating the hourly fall from that of a shorter period, as is sometimes done. The greatest fall during five minutes in the year 1891 amounted to ·15 inch per minute, during thirty minutes to ·08 inch per minute, and during one hour to ·04 inch per minute. The greatest fall registered in any one day was 4·3 inches on the May 26; a fall of 4·2 inches was also recorded on July 21.

Some idea may be formed of the rate of increase of the known species of fungi from the fact that, in a recent issue of the Proceedings of the Philadelphia Academy of Sciences, MM. Ellis and Everhart describe no less than 149 new species from North America. Of these 53 belong to the Pyrenomycetes, 24 to the Discomycetes, 11 to the Uredineæ, 2 to the Ustilagineæ, 46 to the Sphæropsideæ, 13 to the Hyphomycetes.

A flora of Donegal, by Mr. H. Chichester Hart, is about to be published. Until recent years the north-west of Ireland had been greatly neglected by botanists, and the publication is likely, therefore, to be of much interest.

The first part of MM. Rouy and Foucaud's "Flore de France" is announced to appear in August. The geographical area of the work includes, in addition to France proper, also Alsace, Lorraine, and Corsica; and there will be comprised a bibliography and a list of botanists who have contributed to our knowledge of the flora of France. The first volume of M. Bounier's "Florede la France," published under the auspices of the Ministry of Public Instruction, is expected to appear in the spring of 1894.

Two recent numbers of the *Botanisches Centralblatt* (vol. liv. nos. 12 and 13) are largely occupied by a review by Dr. Otto Kuntze of the discussion on botanical nomenclature since the publication of his "Revisio generum plantarum" in 1891.

Mr. Mark Stirrup has just published further information as to the occurrence of boulders in the coal measures of Lancashire (Trans. Manchester Geol. Soc., vol. xxii. p. 321). Most of the boulders hitherto recorded are of quartzite; some of those here described are of crystalline rock. Petrographical notes are given by Prof. Bonney. Mr. Stirrup also prints a letter from Prof. E. Orton relating to the occurrence of boulders of vein-quartz—not quartzite—in the coal measures of Ohio (see also *Amer. Journ. Sci.*, July 1892).

Boulders have been recently described from the Kulm beds of the Frankenwald, by E. Kalkowsky (*Zeitsch. Deutsch. geol. Gesell.* 1893, p. 69), who thinks that they indicate glacial action. This explanation is not satisfactory for the English boulders in coal measures, the origin of which is still unknown.

Prof. Frank D. Adams has published an interesting description of the Norian Rock of Canada ("Ueber das Norian oder Ober-Laurentian von Canada" extracted from *N. Jahrb.*, Beilagebd. viii., 1893, pp. 419–498). This forms a thesis for the doctor's degree at the University of Heidelberg. The Norian rocks consist mainly of "anorthosite," in which plagioclase is the chief constituent, ferro-magnesian silicates being scarce or absent. These rocks are intrusive in the Grenville series—the upper division of the Lower Laurentian of Logan, who regarded the Norian series as Upper Laurentian. Prof. Adams shows that the anorthosites occur near the eastern edge of the great Archæan platform of Canada. He compares this with the distribution of modern volcanoes along the edges of the Continents. Some of the anorthosite masses are of great extent; that of the Saguenay district covers an area of nearly 6000 sq. miles, that of Morin 1000 sq. miles. These results may be compared with the conclusions already published by Prof. A. C. Lawson, that the Laurentian gneisses of the Rainy Lake region are intrusive in the so-called "Huronian" of that area, rocks which were previously considered to be later than the Laurentian. Prof. Adams's paper contains a map of the Archæan area of Canada and a full bibliography.

Experiments on the value of ammonia vapour as a disinfectant have been recently made by Rigler (*Centralblatt fur Bakteriologie*, vol. xiii. No. 20). The organisms employed were Koch's cholera bacillus, the typhoid bacillus, Loeffler's diphtheria bacillus, and the spores and bacilli of anthrax. Threads soaked in broth-cultures of these various organisms were freely exposed in a room filled with ammonia vapour, whilst other threads were wrapped up in dry and damp cloths respectively before being submitted to the vapour, and in every case control threads were simultaneously exposed to air. It was found that cholera bacilli were killed after two hours' exposure in the ammonia room, whether free or enclosed in dry cloths, whilst twice that time elapsed before they succumbed in moist surroundings. In ordinary air they were destroyed in three hours, but they were alive after two days when kept in *moist* cloths. Two hours' exposure in the ammonia vapour, whether freely exposed or in dry wrappers, sufficed to destroy the typhoid bacilli, but in moist surroundings six hours was necessary, whilst twenty-four hours' contact with ordinary air produced no effect upon them. Anthrax bacilli succumbed in three hours in the ammonia room, but their existence was prolonged for five hours when wrapped in dry cloths, whilst whether in dry or moist surroundings a day's exposure in ordinary air left them untouched. The spores, however, were only destroyed after being eight hours in the ammonia vapour, and in ordinary air were unaffected. Diphtheria bacilli, whilst surviving twenty-four hours' contact with ordinary air, were annihilated in four hours by the ammonia vapour, the nature of their environment making no difference in their powers of resistance. In consequence of its efficacy, cheapness, and harmless character as regards furniture and clothing, Rigler recommends ammonia vapour as an important means of disinfection.

The metric measures are in general use in Russia in scientific literature. They have also been adopted by the Mining Administration in all its publications, while the railway and water communications engineers are using the decimal divisions of the Russian *sagène* (7 English feet). Prof. Petrushevskiy, who has advocated since 1868 the adoption of metrical measures, now gives in the Journal of the Russian Chemical and Physical Society his scheme of metric measures, as near as possible to the present Russian measures, so as to make them easily acceptable to the population. It must be said that the general use of the *schoty* (reckoners, made of wires with ten beads on each wire, and used by all peasants, as well as by primary schools for the teaching of arithmetic) and the decimal division of money would greatly facilitate the acceptance of the metric system in Russia. The change is also facilitated by the fact that the Russian *sagène* is very nearly equal to 2 metres, the *versta* is nearly equal to the kilometre, and the *desiatina* differs but little from the hectare. The system proposed by Prof. Petrushevskiy is both plain and at once intelligible. It is that the *new sagène* shall be equal to the double metre (0·9374 of the present measure) and that a *half sagène* equal to one metre shall be divided into 20 *vershoks* (5 cm. are equal to 1·1248 of the present *vershok*). Also that the new *versta* shall be equal to the kilometre (0·9374 of the present *versta*), the *small desiatina* to the hectare and to 0·9153 of the present *desiatina;* the *big cube* to 10 cubic metres and to 1·0296 cubic *sagènes;* the *small vedro* to 10 litres and to nearly four-fifths (0·0131) of the present *vedro;* the *big measure* (1000 litres) to nearly five (4·795) *tchetveriks;* and finally the *big pound* (500 grammes) equal to 1·221 Russian pounds. It will be seen that the whole system is consistent with the spirit of the metric system, which fully admits of measures obtained from the multiplication of the metric ones by 2, 5, or 10, or from their divisions by the same members.

SIGNOR RICCARDO ARNÒ has communicated to the Reale Accademia delle Scienze di Torino his results obtained during an investigation of the diathermanous power of ebonite for heat waves of various lengths. He employed six different sources of light, whose radiant heat was sent through plates of ebonite of thicknesses varying from 0·12 to 0·52 mm. The thinnest of these absorbed 25 per cent of the heat radiated from an incandescent lamp, whose luminous heat rays were cut off by a thick plate of glass. When the source of light was very bright, this film was found to transmit a small portion of the visible red rays. Sixty-nine per cent. of the dark rays from the smoked surface of a Leslie cube containing boiling water were absorbed by the thinnest film, and 88 per cent. by the two others, thus showing that ebonite is less transparent for dark heat rays of low refrangibility than for those more approaching the visible spectrum. The greatest transparency was shown for the dark heat rays on the border of the luminous spectrum. The successive substitution of a hot iron plate, a glowing platinum wire, a Locatelli lamp, and an incandescent lamp for the Leslie cube brought about a steady increase of transmitting power in all the specimens of ebonite.

PROFS. BARTOLI AND STRACCIATI have brought their eight years' work on the specific heat of water to a close by reducing the values obtained with the nitrogen thermometer as a standard to the scale of the hydrogen thermometer. The corrected formula for the quantity of heat necessary to raise the temperature of 1 gramme of water from 0° to t° C., where t is less than + 31, as given in the *Rendiconti* of the Reale Istituto Lombardo, is

$$1{\cdot}006880t - 278 \times 10^{-6}t^2 - 205 \times 10^{-8}t^3 + 25375 \times 10^{-11}t^4 - 26 \times 10^{-10}t^5.$$

This formula, obtained by eight different methods and several thousand determinations, appears capable of serving as a reliable basis for calorimetrical science.

IN a further note contributed to the Academy of Lincei, Augusto Righi continues the description of experiments he has conducted with electrical oscillations of very small wave-length (see NATURE, June 22, 1893). The oscillator employed consists of two small metal spheres surrounded with oil and held by two rods of ebonite. These two spheres are placed between the discharging rods of a large Holtz electrical machine. With spheres 4 cm. in diameter the wave-length of the radiation obtained was 20 cm., while with spheres of 1·3 cm. diameter the wave-length was about 7 cm. The resonator employed was of a novel form and was made by taking a rectangular piece of ordinary silvered glass of such a size that its breadth was equal to the length of the resonator required. The varnish was then dissolved off the back of the silver, and a line drawn through the silver by means of a diamond, so as to divide the strip of silver into two equal parts, and form a spark gap. By this means a spark gap was obtained, having a breadth of between one and two thousandths of a millimetre. For radiation having a wave-length of 7·5 cm. the resonator was composed of a strip of silver 3·9 cm. long and 0·2 cm. broad. Although with these small wave-lengths the sparks cease to be visible when the distance between the oscillator and resonator is a metre, by placing a parabolic metallic reflector behind the resonator the sparks were visible at a distance of six metres from the oscillator. Using the above form of apparatus the author has repeated the experiments of Lodge and Howard and others on the reflection and refraction of electrical waves, he has also succeeded in producing interference between the rays reflected from two mirrors inclined at a slight angle (Fresnel's experiment). An interesting set of measurements of the transparency of various dielectrics gave (amongst others) the following results:—Ebonite, paraffin, and rock salt are perfectly transparent. A plate of mica 1·7 mm. thick absorbs 10% of the radiation, while a plate of ordinary glass 8 mm. thick absorbs 37%, and a piece of quartz cut normally to the axis 8 mm. thick absorbs 40%.

WE have received the first part of "The Book of the Fair," by Mr. Hubert Howe Bancroft. It is grandiloquently described on the title-page as "An Historical and Descriptive Presentation of the World's Science, Art, and Industry, as viewed through the Columbian Exposition at Chicago in 1893. Designed to set forth the Display made by the Congress of Nations, of Human Achievement in Material Form, so as the more effectually to illustrate the Progress of Mankind in all the Departments of Civilised Life." The part of the book before us deals with great fairs of the past, and the history of Chicago, the object apparently being to make the story as long as possible. Both the text and illustrations are excellent.

A COLLECTION of meteorological tables, compiled by Dr. Arnold Guyot, was issued by the Smithsonian Institution in 1852. The fourth edition was published in 1884, and the work had then grown to a bulky tome of more than 700 pages. Upon a demand for a fifth edition, Prof. S. P. Langley decided to publish the tables in three parts: Meteorological Tables, Geographical Tables, and Physical Tables, each independent of the other, but the three forming a homogeneous series. The volume of meteorological tables is before us, and it is of far more handy dimensions than formerly. Everything appertaining to meteorological work appears to be contained therein, and the fact that the work comes from the Smithsonian Institution vouches for its excellence. Our attention has been directed to a slip on p. 248. In the list of meteorological stations in the British Isles given on that page we find printed "Richmond (*Greenwich Observatory*)," lat. 51° 29′ N., long. 0° 0′. The first word should be omitted in future editions, for Greenwich, and not Richmond, is obviously referred to.

NINETEEN charts of the "Isle of Wight and Solent Tides," from Portland Bill to the Owers, have been prepared by Mr. T. B. C. West and Mr. F. Howard Collins, and are published by Mr. J. D. Potter, Poultry, E.C. They show by means of arrows the direction of tidal streams at all hours, and, at some places, for half hours of the tides. The rates given are for spring tides, but those for neap and average tides can easily be estimated. The charts are excellently engraved from an Admiralty chart, and the arrows are placed in accordance with the information contained in the "Channel Pilot." They are issued in an extremely compact form, and to the yachtsman of the Isle of Wight district must prove invaluable.

"EVOLUTION AND RELIGION," by Mr. A. J. Dadson, has been published by Messrs. Swan, Sonnenschein and Co. The first three chapters of the book are concerned with the doctrine of evolution, and the remainder deal with theological matters, while the whole has been written with the laudable object of bringing about a reconciliation between religion and science. May the truth prevail.

Messrs. West, Newman, & Co., have just published a book by Mr. S. T. Dunn on the flora of South-West Surrey, including Dorking, Godalming, Farnham, and Haslemere. The last flora including this district was Brewer's, dated 1863. Another county flora is in preparation by Mr. W. H. Beeby. It need scarcely be said that Mr. Dunn's little book is not intended to take the place of these more complete floras, but it will serve as a portable field guide to visitors.

The sodium salt of the as yet little-known perchromic acid has been isolated by Dr. C. Häussermann in the state of well-defined crystals, and is described in a communication to the current number of the *Journal für Praktische Chemie*. The possibility of the existence of an acid-forming oxide of chromium higher than the trioxide CrO_3 has formed a subject of discussion for many years. It was long considered that the deep blue coloration produced upon adding hydrogen peroxide to a solution of chromic acid was due to the formation of the hydrate of a peroxide of chromium. Both the first observer of this interesting reaction, Barreswill, and Ascher in a subsequent memoir, considered the peroxide to possess the composition Cr_2O_7, corresponding to the heptoxide of manganese, Mn_2O_7 present in the permanganates. Fairley has since attributed to the blue compound the composition $CrO_6.3H_2O$. Latterly, however, Moissan has adduced evidence in support of the view that the substance is nothing more than a molecular compound of chromic anhydride with hydrogen peroxide, $CrO_3.H_2O_2$. The work of Häussermann is therefore particularly interesting as showing that, whatever may be the truth concerning the blue compound above referred to, a higher acid of chromium is capable of existence. Moreover, it is not without some significance that the formula of the anhydride derived by Häussermann from the analyses of his sodium salt coincides with that, CrO_6, attributed by Fairley to the oxide present in the blue compound. Häussermann finds that when sodium peroxide is added in small quantities at a time to chromic hydrate suspended in a small quantity of water and maintained at a low temperature by means of an ice bath, a somewhat violent reaction occurs, rendering constant agitation necessary; the chromic hydrate dissolves, a brownish-yellow solution being produced. When this liquid is allowed to stand undisturbed for a time in a cold room, brilliant brownish red, transparent, monoclinic crystals separate. These crystals are found upon analysis to possess the composition $Na_6Cr_2O_{15}.28H_2O$. They rapidly effloresce upon exposure to the air, falling to a brown powder. They lose the whole of their water of crystallisation when placed in a desiccator over oil of vitriol, or when heated to 100°. At a temperature of 170° they explode with some violence, leaving behind a quantity of sodium chromate mixed with sodium hydrate. The anhydrous salt is tolerably stable and is only very slowly attacked by cold water. Hot water, however, immediately decomposes it with formation of a solution of sodium chromate and sodium hydrate and liberation of three molecular equivalents of oxygen gas.

$$Na_6Cr_2O_{15} + H_2O = 2Na_2CrO_4 + 2NaOH + 3O_2.$$

Analyses of the anhydrous salt agree with the formula $Na_6Cr_2O_{15}$, indicating an anhydride of the composition Cr_2O_{12} or CrO_6. It is most interesting that, upon the addition of dilute sulphuric acid to the salt, the deep blue coloration above alluded to is at once produced, as if it were due to the formation of the free acid, the hydrate of CrO_6. In a few minutes oxygen commences to be evolved, and chromic sulphate is formed in the solution. Alkalies are practically without action upon the salt, which would thus appear to be stable in alkaline solution.

Notes from the Marine Biological Station, Plymouth.—Last week's captures include a colony of a tall (1½ ins.) variety of the Hydroid *Coryne vermicularis*, Hincks, the Polyzoan *Pedicellina echinata*, and the Tunicata *Phallusia mammillata* and *Ascidia depressa*. An incursion of the Cladocera *Podon* and *Evadne* has characterised the floating fauna; and with these have been taken Cirrhipede *Nauplii*, *Cyphonautes* larvæ, and countless numbers of minute *Obelia* medusæ. The following animals are now breeding:—The Cephalopod *Sepiola atlantica*, the Malacostraca *Chelura terebrans*, *Limnoria lignorum* and *Eupagurus Prideauxii*, and the Echinoderm *Echinus acutus*.

The additions to the Zoological Society's Gardens during the past week include two Great Eagle Owls (*Bubo maximus*), European, presented by Lord Hill; two Barbary Turtle Doves (*Turtur risorius* var.) from the Pescadore Islands, China, presented by Mr. Theodore A. W. Hance, C.M.Z.S.; three Giant Toads (*Bufo marinus*) from Brazil, presented by Mr. Adamson; a yellow-cheeked Lemur (*Lemur xanthomystax*) from Madagascar, a Banded Ichneumon (*Herpestes fasciatus*) from West Africa, deposited; a Black Ape (*Cynopithecus niger*) from the Celebes; two Black-headed Mynahs (*Temenuchus pagodarum*), two Manyar Weaver Birds (*Ploceus manyar*), two Red-headed Buntings (*Emberiza luteola*) from India, purchased; two Dominican Gulls (*Larus dominicus*) bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

The Discovery of the New Comet.—The new comet seems to have been noted by a number of observers before they had seen its discovery announced. Mr. Edgar Richards writes to us as follows in a letter dated July 13:—

"On Sunday last, the 9th inst., at 9.30 p.m., the members of the Astronomy Club, composed of several of the lady guests of the Cliff House, Minnewaska, N.Y., U.S.A., saw in the north-western heavens a most brilliant comet with well-defined nucleus and bright tail. The comet was in the constellation Lynx, and its tail extended towards the North Star. Its motion was very rapid in a south-westerly direction, and the tail was momentarily increasing in length as long as the comet was visible. The Club suffers from the disadvantage of not possessing a good telescope, so observations have to be made unassisted. No notice in the newspapers of such a comet having been seen and noted, the ladies were filled with enthusiasm to be, as they supposed, its first discoverers."

"Monday night the comet was found to be near the feet of the Great Bear, and much diminished in brilliancy, proving that it was rapidly receding from the earth."

It seems desirable, for the sake of cometary history, to give the following translation of a note by M. Tisserand in *Comptes Rendus*, No. 3.

"On the 10th July last, in the morning, I received a telegram from M. Quénisset, of the staff of the Juvisy Observatory, announcing that he had the previous night, the evening of the 9th July, discovered a bright comet, visible to the naked eye, whose approximate co-ordinates he gave. I at once transmitted a telegram to Kiel. The following morning, July 11, there came a telegram from Kiel, announcing that the comet had been seen on July 8 at Utah, U.S.A. by Mr. Rordame. It is therefore certain that Mr. Rordame has discovered the comet, but that M. Quénisset has announced it first. Perhaps it will be convenient to call it the Rordame-Quénisset comet; there are analogous precedents."

Comet Finlay (1886 VII.).—The following is the ephemeris of this comet for the present week:—

12h. *Paris Mean Time*.

1893.		R.A. (app.) h. m. s.		Decl. (app.) ° ′ ″
July 27	...	5 1 13·6	...	+21 47 39·8
28	...	5 26·9	...	21 56 13·6
29	...	9 38·5	...	22 4 19
30	...	13 48·3	...	22 11 56·4
31	...	17 56·2	...	22 19 6·1
Aug. 1	...	22 2·4	...	22 25 48·6
2	...	26 6·6	...	22 32 4·6
3	...	5 30 9·0	...	22 37 54·4

CHANGES IN THE SPECTRUM OF β LYRÆ.—At the Pulkova Observatory, the new spectroscope has been adapted to the large refractor, and among many of the stellar photographs already obtained several are of β Lyræ, the changes in which are described by Belopolsky in the June number of the *Memorie della Società degli Spettroscopisti Italiani*. The measures of position of the lines were made relatively to the solar lines by superposing a solar spectrum on that of the star. A general examination of the plates showed the following details, the most remarkable lines being D_3, 501·4$\mu\mu$, 492$\mu\mu$, F, 471$\mu\mu$, 448$\mu\mu$, 447$\mu\mu$. F consisted nearly always of two brilliant rays, one of which would disappear or become very dim, and between these could occasionally be seen a dark line; in the vicinity of F occasionally is seen also another dark line. The analysis of the changes in the bright F line indicates that its duplicity depends on one or both of the dark lines, or in other words, that we have here a case of superposition of the bright and dark lines. The period is nearly of 13 days' duration. At the principal minimum of the star, the bright F becomes single, the dark lines being situated one on the edge and the other alone. At the maximum, F becomes double, but the component on the violet side is very thin. At secondary minimum, F is double and symmetrical. Little change takes place at the following maximum, the component on the red side being a little thinner than the other; after this maximum it becomes a dark line.

With regard to the dark F line, M. Belopolsky says that this seems to consist of two, but it is seldom that they are separated; it is suggested that a second ray may mask the changes in wave length of the other, thus accounting for the irregular changes.

The Helium line undergoes two changes; sometimes it disappears altogether, while at other times it appears double. Its period of duplicity is put down as 7 days. The group 448-447$\mu\mu$ is defined as very complicated, and presents the same changes as the F lines, consisting of dark and bright lines and changing their positions like the components of the F lines. This paper is accompanied by a diagram showing the positions of the star in the curve of brightness at the time of exposure, and also by copies of several of the spectra.

THE VARIABLE STAR Y CYGNI.—Among recent papers on variable stars, that by Prof. N. C. Dunér on the elements of the variable star Y Cygni is of great importance. (*Kongl: Vetenskaps Akademiens Forhandlinger*, 1892, No. 7). This star is of the Algol type, and its variation is limited nearly exclusively to a small portion of its period during which it descends in a few hours to a minimum, to regain in about the same time its ordinary brightness. Since its discovery by Chandler in 1886, it has been very constantly observed, and it is perhaps on this account that Prof. Dunér can give such a complete story. Considering the odd and even minima separately, he deduces a formula which gives very small values for the residuals obtained from the observed minus calculated times, and to put it shortly he is led to the conclusion that the star Y Cygni consists of two stars of equal magnitude and brightness, moving in an elliptic orbit, the plane of which passes through the sun, and whose line of apsides makes an angle with the line of sight. The time of revolution is 2 days 23 hours, 54 minutes, 43·26 seconds. Prof. Dunér, at the latter end of this paper, gives the ephemeris and tables of interpolation of the times of the odd and even epochs in Paris mean time.

NEW DETERMINATION OF THE CONSTANT OF UNIVERSAL ATTRACTION.—A new and original method of determining the mass and density of the earth was described in our issue of July 13 (p. 251).

The following further information on the same subject is interesting. The first experiments gave for the value of K—the constant of gravitation—

$$K = 6{\cdot}80 \times 10^{-8}.$$

Determining the mass of the earth, by substituting this value of K in the formula

$$g\mu = K.\ \frac{\mu M}{R^2}$$

when M and R represent the mass and radius of the earth respectively, and where

$$g = 981 \text{ and } R = 6{\cdot}37 \times 10^8 \text{ centimetres,}$$

the value obtained was

$$M = 5{\cdot}85 \times 10^{27} \text{ grammes,}$$

whence the density of the earth was found to be

$$D = 5{\cdot}41.$$

We here enumerate the different values that we possess with regard to the earth density—

Plumb-line at	Schiehallien (Maskelyne and Playfair)	4·713
,,	Arthur's Seat (James)	5·316
Pendulum at	Mont Cenis (Carlini and Giulis)	4·94
,,	Harton Coal Pit (Airy)	6·565
Torsion-Balance	(Cavendish, 1798)	5·48
,,	(Reich, 1838)	5·49
,,	(Baily, 1843)	5·66
,,	(Cornu and Baille, 1872)	5·5 –5·56

THE CORONAL ATMOSPHERE OF THE SUN.—Prof. Janssen, in *Comptes Rendus*, No. 2, for July 10, communicates an interesting note on the history of facts which have demonstrated the existence of the coronal atmosphere of the sun.

VARIABLE STARS.—In the *Astronomical Journal*, No. 299, M. Paul Yendell publishes more observations of the maxima and minima of variable stars. Among some of those referred to are Y Ophiuchi, X Cygni, T Vulpecellæ, X, W, Y, and U Sagittarii.

GEOGRAPHICAL NOTES.

THE *Times* has received the following telegram from Dr. Nansen, dated Berlevaag, July 21. Berlevaag is about sixty miles west of Vardö, on the north coast of Norway:—"We are leaving Vardö for Yugor Strait (between Waigatz Island, south of Nova Zembla, and the coast of Russia), where thirty sledge dogs will be waiting for us. We then proceed along the Siberian coast eastward past Cape Chelyuskin to the Olenets river, near the Lena, where another twenty-six dogs will be waiting for us. We then turn northwards, and hope to reach the west coast of the New Siberian Islands in the end of August if the ice is not bad. The latest information about the ice conditions in that quarter is favourable. We then proceed direct northwards until we get fast in the ice. If we meet with new land we shall follow along its west coast northwards. When there is no more open water we shall allow the *Fram* to drift with the ice. Everything has gone on well up to the present. The *Fram* is a splendid strong ship and will stand the ice-pressure well. She is deeply laden with coal, but that is a drawback which will soon be remedied. The accounts of the ice in the White Sea and the Barents Sea are not favourable. There has been much ice, but hope it has now improved; the ice changes quickly. I have good hopes; if we only get through the Kara Sea in good time I feel certain the prospects of success are good.—FRIDTJOF NANSEN."

THE July number of the *Geographical Journal* commences the second volume. Amongst other papers of interest there is one of some importance on South-west Africa by Count Pfeil, who has taken a leading part in settling the interesting German colony at Windhoek, east of Walfisch Bay. Regarding Port Nolloth, he points out the curious fact that the great waggon traffic set up by the copper mines of Ookiep has led to the uprooting for fuel of all the little bushes which formed the sole vegetation of the country. The light soil deprived of its protection has changed into drifting sand, and there is no prospect of this artificial desert being redeemed by natural agencies.

IN the last number of the *Scottish Geographical Magazine* there is an abstract of an important paper by Prof. H. Wagner on the teaching of geography in Germany, which gives an admirable *résumé* of the growth to university rank of that study, the adequate recognition of which is confined to Germany, and the true proportions of which have never yet been realised in this country.

IN the *Asiatic Quarterly Review* Prof. Sayce shows that the term Sinaitic peninsula applied to the region between the Gulfs of Suez and Akaba is a misnomer; all the evidence available proving that Mount Sinai really stands somewhere in the ranges of Mount Seir, the exact site being still unknown.

SOME RECENT RESTORATIONS OF DINOSAURS.

IF palæontologists are apt to be discouraged by the apparent hopelessness of ever arriving at a satisfactory conclusion as to the structure and affinities of some of the fossil vertebrates with which they have to deal, they ought assuredly to take fresh confidence from the marvellous advance which has taken place of late years in our knowledge of the organisation of those huge extinct reptiles commonly known as Dinosaurs. It was, indeed, as far back as 1824 that the carnivorous genus *Megalosaurus* was first made known to us by Buckland, from specimens obtained in the Great Oolite of Oxford, while the following year saw the first announcement by Mantell of the now well-known *Iguanodon* from the Sussex Wealden. These early pioneers in this branch of palæontology necessarily had, however, but a faint conception of the real structure, and still less of the morphological importance of the group of reptiles whose former existence they were the first to reveal. It was long, indeed (in spite of the efforts of anatomists like Cuvier, Owen, and Huxley), before the riddle of the structure of the pelvis of the *Iguanodon* was solved, the final solution being given by Mr. J. W. Hulke in a paper read before the Geological Society on June 9, 1875, and published in the following year. The appearance of this paper may be said, indeed, to mark the commencement of the epoch of rapid advance in our knowledge of Dinosaurs, for only two years afterwards (1878) was issued the first of Prof. O. C. Marsh's important series of memoirs on the American Jurassic Dinosaurs, from which it appears that the true nature of the Iguanodont pelvis had been independently discovered in America. About the same time that the first of the American palæontologist's memoirs saw the light the scientific world was startled by Monsieur E. Dupont's announcement of the discovery of numerous entire skeletons of Iguanodons in fissures of the Belgian coal-fields. And this unexpected and fortuitous discovery enabled Monsieur L. Dollo to publish in April, 1883, the completely restored skeleton of one of these monsters in its natural attitude.

Although as far back as 1861, Sir R. Owen had described the greater portion of a Dinosaurian skeleton from the Dorsetshire Lias, M. Dollo's figure was the first complete restoration of the skeleton of a Dinosaur based on actual specimens. Scarcely, however, had this figure appeared when Prof. Marsh (August, 1883) gave us the restoration of the entire skeleton of an American Dinosaur (*Brontosaurus*), of still more stupendous bulk than the *Iguanodon*, and belonging to a group hitherto but very imperfectly understood. From that date till 1891 (although much important work on the group was being done) there seems, however, to have been a lull in the work of Dinosaurian restoration, no foreign worker having apparently made any attempts at further complete restorations of the skeletons of these reptiles. In the United States specimens both from the Jurassic and the newly explored Cretaceous strata were, however, steadily accumulating; and during that year Prof. Marsh published restorations of the skeletons of two forms, which for strangeness and uncouthness exceed the wildest flights of the imagination.

In glancing at some of the more striking features of these different Dinosaurian restorations, we may remind our readers that Dinosaurs may be divided into three main groups, of which the first is represented by the Brontosaur (Fig. 1), the second by the Megalosaur, of which an authentic restoration has but recently been published, while in the third we have two sub-groups, one of which is typified by the Iguanodon (Fig. 5), and the other by *Hypsirophus* (Fig. 3).

In the first, or crocodile-like group (Sauropsida), we have the least specialised forms (Fig. 1), all of which were habitually four-footed, and distinguished by their solid limb-bones, and the excavation of the sides of the bodies of most of their vertebræ by large cavities, which may have been filled with air in the living condition. The pelvis, as will be seen from our figure, is of a comparatively normal structure, with a relatively short anterior process to the upper bone or ilium,[1] and with the lower bones known as the pubis and ischium respectively inclined forwards and backwards after the crocodilian fashion. Our figure is taken from Prof. Marsh's restoration of 1883, in which the skull is imperfect, but in a later figure given by the Professor the head is fully restored, with the characteristic spoon-like teeth in position. In referring to this restoration Prof. Marsh observes that "the diminutive head will first attract attention, as it is smaller in proportion to the body than in any other reptile hitherto known. The neck was very long and flexible. The body was rather short. The legs and feet were massive, and the bones all solid. The tail was very long and powerful. The animal during life must have been nearly sixty feet in length, and about fifteen feet in height. Its probable weight was more than twenty tons. *Brontosaurus* was herbivorous in habit, and its food was probably aquatic plants or other succulent vegetation. The skeleton here represented was found in the Upper Jurassic, in Wyoming, west of the Rocky Mountain range."

We may add that the first known members of this group were discovered in British strata, the Cetiosaurus having been described from the great oolite by Owen, in 1842, and the *Pelorosaurus* by Mantell, in 1850, on the evidence of a stupendous humerus from the Wealden. The fragmentary and disassociated condition of the English specimens rendered it, however, quite impossible to refer with certainty the various teeth, vertebra, and limb-bones to their respective owners until we had the American skeletons as a standard for comparison, and even with that advantage we are not altogether clear on these points. There is, moreover, still some degree of doubt as to the right of some of the American forms to be separated generically from their European allies.

Till 1892 we had no fully authentic restoration of the skeleton of any of the larger members of the Carnivorous, or Megalosaurian group; but this want has been supplied by Prof. Marsh, from whose figures the accompanying illustration (Fig. 2) has been reproduced. It will be seen that, with the exception of the anterior vertebræ of the back, the skeleton is nearly complete; and since the missing vertebræ are known from European specimens, there can be no doubt as to their general form. On account of the presence of bony protuberances on the skull of the species figured, as well as from certain other peculiarities, such as the soldering together of the bones of the pelvis and metatarsus, Prof. Marsh regards the American form as generically distinct from the European *Megalosaurus*, and has accordingly suggested for it the name of *Ceratosaurus*. We are persuaded, however, that Prof. Cope is right in regarding the two as generically inseparable.

Passing on to the third or bird-footed (Ornithopodous) group of these reptiles, we come to some of the most specialised forms, none of which attain, however, the stupendous dimensions reached by some of the first group. The more typical representatives of this third assemblage are characterised, it need

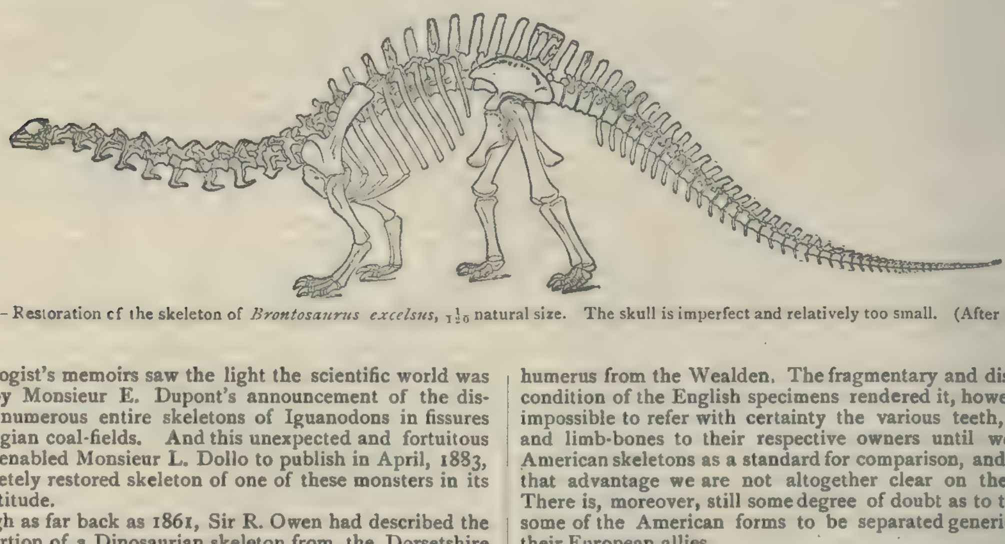


FIG. 1.—Restoration of the skeleton of *Brontosaurus excelsus*, $\frac{1}{150}$ natural size. The skull is imperfect and relatively too small. (After Marsh.)

[1] For these bones, see Fig. 3.

scarcely be said, by the generally bird-like arrangement of the pelvis, in which the front part of the ilium is much produced forwards, while the pubis has its main shaft (when present) directed backwards alongside of the ischium in a bird-like fashion (Fig. 3), and also giving off an anterior process which must not be confounded with the main shaft of the pubis of the Brontosaur (Fig. 1). The bird-footed Dinosaurs are subdivided into the armoured and the typical sections, of which the former has but lately been fully made known to us.

As our first example of the former, we take the skeleton of the Jurassic *Hypsirophus* represented in Fig. 3. The existence of this type of Dinosaur was first revealed by the discovery in 1875 of a considerable portion of a skeleton (now in the British Museum) in the Kimeridge clay of Swindon, which was described by Sir R. Owen during the same and following years under the name of *Omosaurus*;—a term which unfortunately proved to be a preoccupied one. This skeleton comprised many of a most marvellous monster. The Professor tells us that this restoration is based on a specimen which "had the skull, skeleton and dermal armour together when entombed, and almost in the position they were when the animal died. . . . In this restoration the animal is represented as walking, and the position is adapted to that motion. The head and neck, the massive fore-limbs, and, in fact, the whole skeleton indicate slow locomotion on all four feet. The longer hind limbs and the powerful tail show, however, that the animal could thus support itself as on a tripod, and this position must have been easily assumed in consequence of the massive hind-quarters. . . . . The neural spines of the vertebræ have their summits expanded to aid in supporting the massive dermal armour above them. The limb-bones are solid, and this is true of every other part of the skeleton. The feet were short and massive, and the terminal phalanges of the functional toes were covered by strong hoofs. There were five well-developed digits in the fore foot,

Fig. 2.—Restoration of a skeleton of a Carnivorous Dinosaur, $\frac{1}{30}$ natural size. (After Marsh.)

of the vertebræ and limb-bones together with some long spines similar to those represented at the end of the tail in Fig. 3. The skull is, however, missing, and there are no traces of the huge plates of bone shown in the restoration. If, however, we imagine the body of the reptile to which this skeleton pertained to have been drifting in the water sufficiently long to have lost its head by the action of decomposition, there is nothing more probable than that the row of plates along the back should have likewise disappeared. From 1877 onwards Prof. Marsh has been gradually completing our knowledge of allied reptiles from the upper Jurassic of Colorado and Wyoming, to which he applied the name *Stegosaurus*, but which appear to have been previously described by Prof. Cope under the title of *Hypsirophus*. First we had descriptions of some of the vertebræ and limb-bones, with isolated specimens of the plates and spines of the armour; then we had the head; and finally we are favoured with the restoration shown in the figure, which is certainly that and only three in the hind foot, the first toe being rudimentary, and the fifth entirely wanting."

"In life the animal was protected by a powerful dermal armour, which served both for defence and offence. The throat was covered by a thick skin, in which was embedded a large number of rounded ossicles, as shown in the figure. The gular portion represented was found beneath the skull, so that its position in life may be regarded as definitely settled. The series of vertical plates extended above the neck, along the back, and over two-thirds of the tail is a most remarkable feature, which could not have been anticipated, and would hardly have been credited had not the plates themselves been found in position. The four pairs of massive spines characteristic of the present species, which were situated above the lower third of the tail, are apparently the only part of this peculiar armour used for offence. In addition to the portions of armour above mentioned, there was a pair of small plates just behind the skull, which served to protect this part of the neck."

"All these plates and spines, massive and powerful as they now are, were in life protected by a thick horny covering, which must have greatly increased their size and weight. This covering is clearly indicated by the vascular grooves and impressions

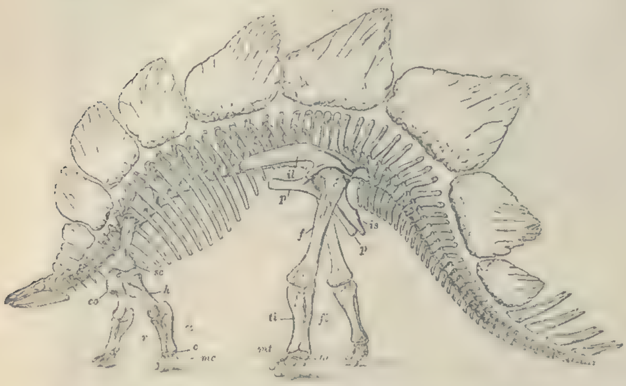


FIG. 3.—Restoration of the skeleton of *Hypsirophus ungulatus*, $\frac{1}{60}$ natural size. *sc.*, scapula; *co.*, coracoid; *h.*, humerus; *r.*, radius; *u.*, ulna; *c.*, carpus; *mc.*, metacarpus; *il.*, ilium; *p.*, pubis; *is.*, ischium; *fe.*, femur; *t.*, tibia; *fi.*, fibula; *ta.*, tarsus; *mt.*, metatarsus. (After Marsh.)

which mark the surface of both plates and spines, except their bases, which were evidently implanted in the thick skin."

To this graphic description of one of the most extraordinary creatures that lived in a world of monsters, it may be added that the remarkably tall neural arches of the dorsal vertebræ and the concomitant elevation of the proximal ends of the ribs nearly to the level of the summits of their neural spines appear to be for the purpose of aiding in the support of the enormous weight of the armour of the back.

Since we have already given more than one notice in NATURE of various portions of the horned armoured Dinosaurs of the Cretaceous of the United States, as represented by *Agathaumas* (= *Ceratops* and *Triceratops*), our notice of Prof. Marsh's recent restoration of this creature (Fig. 4) will be but brief. That these reptiles were nearly related to the Armoured Dinosaurs is undoubted; they attained, however, greater specialisation in the skull, which was of enormous size and armed with bony horn-cores, arranged as a pair above the eyes and a single one over the nose. The enormous size of the head and the proportionately large fore limbs indicate that these animals were always in the habit of walking on all fours; and, as we have previously suggested, the loss of the posterior shaft of the pubis, so well shown in the figure, is probably due to a reversion to these quadrupedal habits.

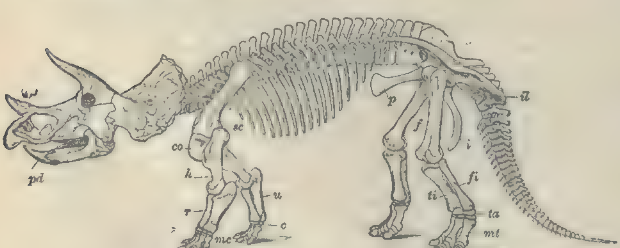


FIG. 4.—Restoration of the skeleton of *Agathaumas prorsus*, $\frac{1}{60}$ natural size. Letters as in Fig. 2. (After Marsh.)

In regard to this restoration Prof. Marsh remarks that "the skull is, of course, without its strong horny covering on the beak, hon-cores and posterior crest, and hence appears much smaller than in life. The neck seems short, but the first six cervical vertebræ are entirely concealed by the crest of the skull, which in its complete armature would extend over one or two vertebræ more. . . . . No attempt is made in this restoration to represent the dermal armour of the body, although in life the latter was more or less protected. Various spines, bosses, and plates, indicating such dermal armour, have been found with remains of this group, but the exact position of these specimens can at present be only a matter of conjecture. . . . . The size in life would be about twenty-five feet in length and ten feet in height."

The extraordinary contrast between the skeletons of *Agathaumas* and *Brontosaurus* will be sufficiently apparent from a comparison of the respective figures.

The typical section of the bird-footed Dinosaurs, as represented by the Iguanodons (Fig. 5) is now so well known that but few remarks are necessary. They differ from the armoured forms in their perfect adaptation to a bi-pedal mode of progression, their digitigrade feet, hollow limb-bones, and absence of armour; the Iguanodons being further distinguished by the curious modification of the thumb into a stout conical spine. Those who have visited of late years the Brussels Museum will not fail to retain a vivid impression of the imposing show made by two mounted skeletons of these enormous reptiles displayed in a case in the court-yard of the museum. According, however to a striking picture which appeared a couple of years ago in the *Graphic*, these two skeletons have now been removed to within a special gallery in the Museum, where, together with three others, they must excite the admiration and wonder of all who have the good fortune to behold them. With such a lavish display of their own, it is, perhaps, scarcely too much to hope that the authorities of the Royal Brussels Museum may before long see their way to enriching our own National Collection

FIG. 5.—Restored skeleton of *Iguanodon lernissartensis*. About [illegible] natural size. (After Dollo.)

either with an original specimen, or at least with a plaster reproduction of one of the already mounted Iguanodon skeletons.

Although there is no lack of work remaining to be done among the Dinosaurs, yet when we reflect that practically our whole definite knowledge of the group dates from within the last twenty years, and that all the five restorations at which we have glanced have been made within the last ten, we cannot but fail to be gratified at the enormous progress that has been made by this branch of palæontology within that comparatively short period. If this progress cannot be justly entitled to be termed one advancing by "leaps and bounds," yet we think that it may, on the whole, be truly described as "slow and sure."

R. LYDEKKER.

THE INTERNATIONAL MARITIME CONGRESS.

DURING nearly the whole of last week a most important congress was being held in London at the Institution of Civil Engineers. This was the International Maritime Congress, an institution founded in Paris in 1889, when no less than twenty-two papers on various maritime subjects were read and discussed, and visits were made to some of the most important seaports on the north and west coasts of France. The international commission, which constitutes the executive, determined that the second meeting of the congress should be held this year in London, and as a result the first sitting took place on July 18, when the opening proceedings were got through in the morning by the delivery of various complimentary addresses, whilst in the afternoon the more serious business of the congress commenced.

The proceedings were divided into four sections, as follows :—

Section I. Harbours, Breakwaters, &c.
,, II. Docks and their Equipment.
,, III. Shipbuilding and Marine Engineering.
,, IV. Lighthouses, Fog-signals, &c.

There were in all over forty papers set down for reading and discussion, and all but a few were so disposed of, only one or two being taken as read. Such a feat speaks highly of the industry of the various sections, and it will be understood that in this general notice we can do little more than give a list of the various papers read. Lord Brassey was president of the congress, and Mr. James Forrest, honorary secretary. Mr. C. F. Findlay was secretary. The headquarters were 25, Great George-street, Westminster.

Section I. met in the theatre of the Institution of Civil Engineers at 2 p.m., on Tuesday, July 18. It should be stated that arrangements had been made for different chairmen to officiate at the various meetings. Mr. L. F. Vernon-Harcourt was the moving spirit in this section, and naturally presided at the meetings although he did not occupy the chair.

The first business was the reading of two papers, one on "The Breakwaters and Harbours of Middlegrunden," by Capt. P. Hansen ; and a second on "The Harbour and Breakwater of Copenhagen," by H. C. V. Möller. These papers were taken together, but the meeting voted that the discussion should be deferred to the next day. A paper on "Recent Breakwaters and Sea Defences in Italy," by Chev. L. Luiggi, was next read ; and a fourth paper on "The Construction of Breakwaters," by Baron Quinette de Rochemont, brought the proceedings of the first day in this section to a close. All these papers were of a special and strictly professional character. It is to be regretted that the order in which they were originally set down was not followed, and Baron de Rochemont's contribution was not taken first. The whole of them might well have been then discussed together.

The second meeting of Section I. was held on the afternoon of the following day, when the proceedings were opened by Mr. A. G. Lyster (the Assistant Engineer of the Mersey Dock and Harbour Board) reading a paper on "Dredging the Mersey Bar." This perhaps was the most important paper of the section, inasmuch as it dealt with a practical example of what is being done to meet the most pressing maritime necessity of the day. In our last issue we pointed out that the naval architect and marine engineer had progressed so far that they had completely outstripped the harbour engineer. Advance in ship construction is really barred by the want of depth of water over dock-sills and at the mouths of ports. This is not only apparent in cross-channel service with small swift packet boats, but also with our great ocean liners. Every increase in size in steamships appears to be attended by success, but limits of draught seem now to stop progress in this direction. A paper by M. Feret on mortar in sea works was also read at this sitting ; a paper by MM. Cimino and Verdinois on rock-dredging at Palermo being taken as read.

The next sitting of Section I. was on the following Thursday afternoon, when three papers were set down for reading. The first taken was by M. P. Demey on ports on sandy coasts ; the second, by M. V. E. de Timonoff, a Russian Professor, having a similar title. The latter contribution was an interesting communication of a general nature, in which the various points involved in the consideration of the subject in regard to tideless seas were considered at large. In the discussion an interesting point was raised by an English engineer, Mr. Wheeler, as to the movement of beach. The matter was perhaps somewhat outside the legitimate scope of the discussion, as Mr. Wheeler attributed the movement of beach to the tidal movement, whilst M. de Timonoff dealt only with tideless seas. Mr. Wheeler said that the travel of beach is always in the direction of the flood—a theory which does not support the author's line of argument ; but it must again be said the action of tide was eliminated from the author's reasoning. A paper by Mr. C. Spadon on the Lido entrance to the port of Venice was taken as read.

The last sitting of Section I. was held on Friday afternoon. Two papers were on the list, one by Mr. A. E. Carey on "La Guaira Harbour Works, Venezuela," and a second, "Harbours and Ferry Systems of Denmark," by the same author.

In Section II. the first meeting was held on Wednesday morning, when the following papers were down for discussion :—"The Docks of Bordeaux," by H. Crahay de Franchemont ; "The Equipment and Working of Ports," by A. Guerard ; "The New Docks of Antwerp," by G. A. Rogers ; and "Hydraulic Installation at the Port of Genoa," by L. Luiggi and E. Borgatti. The next sitting was on the following day, when three other papers were read, viz. :—"The Port of Calais," by A. Charguérand ; "The Port of Dunkirk," by Paul Joly ; and "Lengthening of Leghorn Dry Dock," by J. Inglese. The last day of the meeting was devoted by this section to the reading of papers descriptive of the London Docks, and of the Havre and Alexandra Docks.

In the Shipbuilding Section, Section III., the papers were mostly of a moderate degree of excellence. Mr. A. E. Seaton, of Hull, opened with a good historical paper on "Cross Channel Steamers," which led to an interesting discussion. It was followed by a paper by Prof. Biles, on "Ocean Passenger Steamers." The subject has been so often dealt with, that it is difficult to say anything new upon it. On the following day, Thursday, July 20, Sir Thomas Sutherland, the chairman of the P. and O. Company, gave a general address, after which a paper by Mr. A. Blechynden, on the "Sand-pump Dredger for the Mersey Bar," the vessel already referred to, was read. This is a hopper dredger, and, we believe, the largest in existence, the capacity being no less than 3000 tons. A paper by Mr. Flannery on "The Transport of Oil in Bulk" followed. The subject is one which has been largely dealt with lately, and the author necessarily trod again a good deal of the ground occupied by Mr. Martell at Cardiff the week previously. On Friday, the last day of the meeting, a paper by Mr. C. E. Stromeyer, on "Marine Boiler Construction," was read. The scope was general, and were it not known that the author, from his position at Lloyd's, must be fairly in touch with recent practice, one might almost fancy that he had ceased to study his subject four or five years ago. The most original, and perhaps the most suitable paper to the occasion was that last taken. It was a contribution by Mr. A. Denny, of Dumbarton, entitled "Shipowners and Shipbuilders in their Technical Relationships." The subject is one that may be considered with advantage by both sides.

In the business of this section Dr. W. H. White, the Assistant-Controller of the Navy and Director of Naval Construction, took the leading part, assisted by Mr. G. Holmes, who, as Secretary to the Institution of Naval Architects, was well qualified to conduct the detail business of the section.

Section IV., that devoted to lighthouses, &c., had an attractive programme, but the proceedings were, in some cases, rather disappointing. Our space will allow us to give no more than a list of the papers set down for reading. They were as follows :—"On Compressed-air Fog Signals," by C. Ribière ; "Ship Signal Lights," by J. Kenward. These were taken on the first day, Tuesday, July 18th. A discussion was brought on by arrangement upon "Communication between Lightships and the Shore." The result was disappointing on the whole. The next day a good paper on "Feux-Éclairs, and the Physiological Perception of Instantaneous Flashes" was contributed by M. A. Blondel. M. Bourdelles also gave a paper on "Methods and Formulæ for Calculating the Luminous Power of Lighthouse Apparatus." The following day an interesting and practical paper on "The Illumination of Estuaries and Rivers" was contributed by Mr. W. T. Douglass. Two other papers were on the list for this day, the first on "Harbour Lights, Buoys, and Beacons in Italy," by D. Lo Gatto, and another on "Researches as to Continuous and Alternate Electrical Currents for Lighthouse Purposes," by A. Blondel. The last day of the meeting had three papers down for reading, viz. : "On Recent Improvements in Lighthouses," by D. A. Stevenson ; "Efficiency of Recent Gigantic Lighthouse Apparatus compared with Electric Light," by D. Lo Gatto ; and "Lighting and Light Dues in the Red Sea," by Commander G. Hodgkinson, R.N.

In connection with the Congress there were numerous dinners and other festivities, at which the foreign members were the lions of the occasion; indeed, international courtesy reigned throughout the proceedings. This was carried so far in one section that hardly anything but French was spoken, those who wished to take part in the discussions receiving but little encouragement from the chair unless they addressed the meeting in the French tongue—or, rather, in French words. This was satisfactory to the majority, so far as the remarks of foreign members were concerned; but when the language was exotic in its character to follow was sometimes laborious. This week a series of excursions are being made to some of the chief ports of the United Kingdom.

THE LUMINIFEROUS ETHER.

AT the anniversary meeting of the Victoria Institute on June 29, Sir G. G. Stokes delivered his presidential address. After a few introductory remarks on the functions of the Institute, he said:—"I intend to bring before you to-night a subject which the study of light has caused me to think a good deal about: I refer to the nature and properties of the so-called luminiferous ether. This subject is, in one respect, specially fascinating, scientifically considered. It lies, we may say, in an especial manner on the borderland between what is known and what is unknown. In the study of it it is quite conceivable that great discoveries may be made, and, in fact, great discoveries have already been made, and I may say even quite recently, and we do not at present know how much additional light on the system of Nature may be in store for the men of Science; possibly even in the near future, possibly not until many generations have passed away. I will assume, as what is familiarly known to you all, and what is well established by methods into which I will not enter, that the heavenly bodies are at an immense distance from our earth. More especially is this the case with the fixed stars. Their distance is so enormous that even when we take as a base line, so to speak, the diameter of the earth's orbit, which we know to be about 184 millions of miles, the apparent displacement of the stars due to parallax is so minute as almost to elude our investigation. Nevertheless that distance is more or less accurately determined in the case of a few of the fixed stars. But the vast majority, as we have every reason to believe, are at such an enormous distance that even this method fails with them."

"To give a conception of the immense distance of the fixed stars, I will assume as known that light travels at the rate of about 186,000 miles in one second, a rate which would carry it nearly eight times round and round the earth in that time; and yet if we take the star which, so far as we know, is our nearest neighbour, it would take three or four years for light from that star to reach the earth. Now as we see the fixed stars there must be some link of connection between us and them in order that we should be able to perceive them. Probably all of you know that two theories have been put forward as to the nature of light, as to the nature accordingly of that connection of which I have spoken. According to one idea, light is a substance darted forth from the luminous body with an amazing velocity; according to the other, it consists in a change of state taking place, propagated through a medium, as it is called, intervening between the body from which the light proceeds and the eye of the observer. For a considerable time the first of these theories was that chiefly adopted by scientific men. It was that, as you know, which Newton himself adopted; and probably the prestige of his name had much to do with the favourable reception which for a long time it received. But more recent researches have so completely established the truth of the other view, and refuted the old doctrine of emissions, that it is now universally held by scientific men that light consists in an undulatory movement propagated in a medium existing in all the space through which light is capable of passing."

"This necessity for filling all space, or at least, such an inconceivably great extent of space, with a medium, the office of which, so far as was known in the first instance, was simply that of propagating light, was an obstacle for a time to the reception by the minds of some of the theory of undulations. Men had been in the habit of regarding the inter-planetary and interstellar space as a vacuum, and it seemed too great an assumption to fill all this supposed vacuous space with some kind of medium for the sole purpose of transmitting light. Notwithstanding, even long ago strong opinions were entertained to the effect that there must be something intervening between the different heavenly bodies. In a letter to Bentley, Newton expresses himself in very strong language to this effect: 'That gravity should be innate, inherent and essential to matter, so that one body may act upon another at a distance through a *vacuum*, without the mediation of anything else, by and through which their action and force may be conveyed from one to another, is to me so great an absurdity that I believe that no man who has in philosophical matters a competent faculty of thinking, can ever fall into it. Gravity must be caused by an agent acting constantly according to certain fixed laws; but whether this agent be material or immaterial, I have left to the consideration of my readers.'"

"What the nature of the connection between the earth and the sun, for example, may be whereby the sun is able to attract the earth and thereby keep it in its orbit—in other words, what the cause of gravitation may be—we do not know; for anything we know to the contrary, it may be connected with this intermediate medium or luminiferous ether. There are other offices, we believe, which this luminiferous ether fulfils, to which I shall have occasion to allude presently."

"In connection with the necessity for filling such vast regions of space with this medium, a curious question naturally presents itself. We cannot conceive of space as other than infinite, but we habitually think of matter as occupying here or there limited portions of space, as, for example, the different heavenly bodies. The intervening space we commonly think of as a vacuum, and it is only the phenomena of light that led us in the first instance to think of it as filled with some kind of material. The question naturally presents itself to the mind—is this ether absolutely infinite like space? This is a question to which science can give no answer. Though we cannot help thinking of space as infinite, yet when we turn our thoughts to some material existing in space perhaps we more readily think of it as finite than infinite. But if the ether, however vast the portion of space over which it extends, be really limited, we can hardly fail to speculate what there may be outside its limits. Space there might be wholly vacuous, or possibly outside altogether this vast system of stars and ether there may be another system subject to the same laws, or subject to different laws, as the case may be, equally vast in extent; and if there be, then so far as we can gather from such phenomena as are open to our investigation, there can be no communication between that vast portion of space in part of which we live and an ideal system altogether outside the ether of which we have been speaking."

"But the properties of the ether are no less remarkable than its vast or even possibly limitless extent. Matter of which our senses give us any cognisance is heavy, that is to say, it gravitates towards other matter which agrees with it in so far as being accessible to our senses. The question presents itself to the mind, does the ether gravitate towards what we call ponderable matter? This is a question to which we are not able to give any positive scientific answer. If the ether be in some way or other connected with the cause of gravitation, it would seem more likely that it itself does not gravitate towards ponderable matter."

"Again, we have very strong reason for believing that ponderable matter consists of ultimate molecules. First, that supposition accords in the simplest way with the laws of crystallography. Chemical laws afford still stronger confirmation of the hypothesis, through the atomic theory of Dalton, now universally accepted. Comparatively recently, the deduction of the fundamental property of gases from the kinetic theory, as it is called, affords strong additional confirmation of that view of the constitution of matter. Still more recently, the explanation which has been afforded by that theory of that most remarkable instrument the radiometer of Crookes has lent further confirmation in the same direction. None of these evidences apply to the ether, and accordingly we are left in doubt whether it too consists of ultimate molecules, or whether on the other hand it is continuous, as we cannot help conceiving space to be."

"The undulatory theory of light was greatly promoted in the first instance by the known phenomena of sound, and the explanation which they received from the hydrodynamical theory. Accordingly, since sound, as we know, consists of an undulatory movement propagated through the air (or it may be through other media), and depending upon condensation and rarefaction, it was supposed naturally that light was propagated in a similar manner, by virtue of the forces brought into play by the condensation and rarefraction of the ether. But there is one whole class of phenomena which have actually no counterpart in those cf sound; I refer to polarisation and double refraction."

"The evidence for the truth of the theory of undulations as regards the phenomena of common light depends in great measure upon the fact of interference and the explanation which the theory gives of the complicated phenomena of diffraction. But in studying the interference of polarised light, additional phenomena presented themselves which ultimately pointed out that the vibrations with which we are concerned in the case of the ether differ altogether in their character from those which belong to sound. The phenomena of the interference of polarised light prove incontestably that there exists in light an element of some kind having relation to directions transverse to that of propagation, and admitting of composition and resolution in a plane perpendicular to the direction of transmission according to the very same laws as those of the composition and resolution of forces, or velocities, or displacements in such a plane. This requires us to attribute to the ether a constitution altogether different from that of air. It points out the existence of a sort of elasticity whereby the ether tends to check the gliding of one layer over another. Have we no example of such a force in the case of ponderable matter? We have. We know that an elastic solid, which for simplicity I will suppose to be uncrystalline, and alike in all directions, has two kinds of elasticity, by one of which it, like air, tends to resist compression and rarefraction; while by the other it tends to resist a continuous gliding of one portion over another, and to restore itself to its primitive state if such a gliding has taken place. There is no direct relation between the magnitude of these two kinds of elasticity, and in the case of an elastic solid such as jelly the resistance to compression is enormously great compared to the resistance to a gliding displacement."

"If we assume that in the ether there is really an elasticity tending to restore it to its primitive condition when one layer tends to glide over another, an elasticity which it appears to be absolutely necessary to admit in order to account for the observed laws of interference of polarised light, the question arises, can we thereby explain double refraction?"

"The earliest attempts to explain it in accordance with the theory of transverse vibrations were made by attributing to the ether a molecular constitution more or less analogous to that which we believe to exist in ponderable matter. Following out speculations founded upon that view, the celebrated Fresnel was led to the discovery of the actual laws of double refraction; the theory, however, which he gave was by no means complete, inasmuch as the results were not rigorously deduced from the premises. Cauchy and Neumann, independently and about simultaneously, took up Fresnel's view of the constitution of the ether and applied it to explain the laws of double refraction. In their theory the conclusions arrived at were rigorously derived from the premises; but the results did not altogether agree with observation; that is to say, although they could by the adoption of certain suppositions be forced into a near accordance with the observed laws of double refraction, yet they pointed out the necessity of the existence of other phenomena which were belied by observation. Our own countryman Green was the first to deduce Fresnel's laws from a rigorous dynamical theory, although nearly simultaneously MacCullagh arrived at a theory in some respects similar, though on the whole I think less satisfactory."

"Still all these theories followed pretty closely the analogy of ponderable matter; and at least in the first three mentioned the ether was even imagined to consist of discrete molecules, acting on one another, like the bodies of the solar system regarded as points, by forces in the direction of the joining line, and varying as some function of the distance. I have already quoted the very strong language in which Newton rejected the idea of the heavenly bodies acting on one another across intervening spaces which were absolutely void. But the conception has nothing to do with the magnitude of the intervening spaces; and the conception of action at a distance across an intervening space which is absolutely void, is not a bit easier when the space in question is merely that separating two adjacent molecules, when the ether is thought of as consisting of discrete molecules, than it is when the space is that separating two bodies of the solar system, though in this latter case it may amount to many millions of miles. If the ether be in some unknown manner the link of connection whereby two heavenly bodies are enabled to exert on one another the attraction of gravitation, then according to the hypothetical constitution of the ether that we have been considering, we seem compelled to invent an ether of the second order, so to speak, to form a link of connection between two separate molecules of the luminiferous ether. But since the nature of the ether is so very different as it must be from that of ponderable matter, it may be that the true theory must proceed upon lines in which our previous conceptions derived from the study of ponderable matter are in great measure departed from."

"If we think of the ether as a sort of gigantic jelly, we can hardly imagine but that it would more or less resist the passage of the heavenly bodies—the planets for instance—through it. Yet there appears to be no certain indication of any such resistance. It has been observed indeed in the case of Encke's comet, that at successive revolutions the comet returned to its perihelion a little before the calculated time. This would be accounted for by the supposition that it experienced a certain amount of resistance from the ether. Although at first sight we might be disposed to say that such a resistance would retard perihelion passage, yet the fact that it would accelerate it becomes easily intelligible, if we consider that the resistance experienced would tend to check its motion, and so prevent it from getting away so far from the sun at aphelion, and would consequently bring it more nearly into the condition of a planet circulating round the sun in a smaller orbit."

"Many years ago I asked the highest authority in this country on physical astronomy, the late Prof. Adams, what he thought of the evidence afforded by Encke's comet for the existence of a retarding force, such as might arise from the ether. He said to me that he thought we did not know enough as to whether there might not possibly be a planet or planets within the orbit of Mercury which would account for it in a different way. But quite independently of such a supposition it is worthy of note that the remarkable phenomena presented by the tails of comets render it by no means unlikely that even without the presence of a resisting medium, and without the disturbing force arising from the attraction of an unknown planet situated so near to the sun as not to have been seen hitherto, the motion of the head of a comet might not be quite the same as that of a simple body representing the nucleus, and being subject to the gravitation of the sun and planets and nothing else. It appears that the tails consist of some kind of matter driven from the comet with an enormous velocity by a sort of repulsion emanating from the sun. If the nucleus loses in this manner at each perihelion passage an exceedingly small portion of its mass, which is repelled from the sun, it is possible that the residue may experience an attraction towards the sun over and above that due to gravitation, and that possibly this may be the cause of the observed acceleration in the time of passing perihelion even though there be no resistance on the part of the ether. So that the question of resistance or no resistance must be left an open one."

"The supposition that the ether would resist in this manner a body moving through it is derived from what we observe in the case of solids moving through fluids, liquid or gaseous, as the case may be. In ordinary cases of resistance, the main representative of the work apparently lost in propelling the solid is in the first instance the molecular kinetic energy of the trail of eddies in the wake. The formation of these eddies is, however, an indirect effect of the internal friction, or if we prefer the term viscosity, of the fluid. Now the viscosity of gases has been explained on the kinetic theory of gases, and in the case of a liquid we cannot well doubt that it is connected with the constitution of the substance as not being absolutely continuous but molecular. But if the ether be either non-molecular, or molecular in some totally different sense from ponderable matter, we cannot with safety infer that the motion of a solid through it necessarily implies resistance."

"The luminiferous ether touches on another mysterious agent, the nature of which is unknown, although its laws are in many respects known, and it is applied to the every-day wants of life, and its applications are even regulated by Acts of Parliament; I allude to electricity. I said that the nature of electricity is unknown. More than forty years ago I was sitting at dinner beside the illustrious Faraday, and I said to him that I thought a great step would have been made if we could say of electricity something analogous to what we say of light, when we affirm that light consists of undulations; and he said to me that he thought we were a long way off that at present. But, as I said, relations have recently been discovered between light and electricity which lead us to believe that the latter is most closely connected with the luminiferous ether."

"Clerk-Maxwell showed that the ratio of two electrical constants which are capable of being determined by laboratory experiments, and which are of such a nature that that ratio expresses a velocity, agrees with remarkable accuracy with the known velocity of light. This formed the starting-point of the electro-magnetic theory of light which is so closely associated with the name of Maxwell."

"According to this idea, light may be looked on as the propagation of an electro-magnetic disturbance, whatever the appropriate idea of such a thing may actually be. The theory has quite recently received remarkable confirmation by the investigations of Hertz, who has shown that what are incontestably electro-magnetic disturbances, and are investigated by purely electrical means, exhibit some of the fundamental phenomena of light, such, for example, as interference and polarisation. It appears that these electro-magnetic waves are strictly of a similar nature to the waves of light, though there is an enormous difference in the scale of wave-lengths, which in the case of light range about the $\frac{1}{50000}$th part of an inch, while the electro-magnetic waves which have been investigated by purely electrical methods range from a few inches to many yards."

"I have ventured to bring this interesting subject before you in the course of the address which I have just delivered. I have not attempted to lay before you the evidence on which scientific men rely for the truth of the conclusions which I have mentioned as well established. That would have required, not merely an evening address, but a whole course of lectures. Neither have I made any allusion to possible bearings of the scientific conclusions on questions relating to religious beliefs. Anything of that kind I leave to your own minds; my object has been simply to present to you very briefly the conclusions of science in that limited branch which I have selected, distinguishing as impartially as I could what is well established from what is debatable or even merely conjectural."

THE NATURE OF DEPOLARISERS.[1]

WHEN an electric current is passed between plates of platinum through a solution of sulphuric acid, the hydrogen and oxygen are partly retained at the surfaces—and apparently also within the plates—and under these conditions are capable of interacting, as in the well-known Grove gas battery: so that in so far as the "gases" thus circumstanced are concerned the change may be expressed by a reversible equation. This reversal constitutes the well-known phenomenon termed polarisation by physicists.

Reversal owing to the retention of hydrogen in circuit is promoted to different extents by different metals—hence apparently the varying electromotive forces of single fluid cells containing different negative plates; and when the pressure is sufficient to retain the whole of the hydrogen at the plate, it becomes total—hence it is, for example, that zinc does not dissolve in sulphuric acid under great pressure.

Various substances known generally as depolarisers are used to prevent the accumulation of products of electrolysis and the consequent reversal of the action—such as copper sulphate in the case of the Daniell cell and "nitric acid" in the case of the Grove and Bunsen cells; but whereas the action of copper sulphate is easy to understand, that of "nitric acid" offers many difficulties. As the heat of dissolution of copper in dilute sulphuric acid is a negative value (about 12,000 units), the displacement of copper by hydrogen—*i.e.* the heat of dissolution of hydrogen in copper sulphate—is a positive value, so that not only does the presence of the copper sulphate prevent the accumulation of hydrogen, but in removing hydrogen it also serves to increase the electromotive force of the cell from about 37/46ths to about 50/46ths of a volt. The principle underlying this is extensible even to cases in which one part of the cumulative effect of the cycle of change is a negative value. Thus, although copper has a negative heat of dissolution, it will readily dissolve in dilute sulphuric acid if it be used in place of zinc in a Grove cell, the negative heat of dissolution of copper being more than compensated for by the positive heat of dissolution of hydrogen in "nitric acid"; and it is well known that copper dissolves in many weak acids in presence of oxygen. It is easy to understand how oxygen acts in such cases, but the facts show that the effect produced by "nitric acid" is not so readily interpreted, and their consideration raises important questions of general application.

Russell has shown that when "nitric acid" is freed from nitrous compounds it does not dissolve silver, but that action sets in when a trace of nitric oxide is introduced, and continues with increasing rapidity as the quantity of the nitrous compound—a necessary product of the action—increases; Veley's later experiments have shown that the same is true of copper, without, however, affording any further explanation of the phenomena. Although it is not to be expected that such metals would dissolve in nitric acid even when coupled with a relatively electronegative conductor, as they have negative heats of dissolution, yet if the acid also acted as depolariser a cycle might be formed in which sufficient energy would be developed to condition change: it therefore follows that in such cases *nitric acid* does not act as the depolariser in accordance with the equation: $2Ag + 2NO_3H + ONO_2H = 2AgNO_3 + H_2O + NO_2H$, and that in point of fact the nitrous compound is the depolariser, although the nitric acid is the actual solvent of the metal, the hydrogen of the acid being virtually directed displaced by the metal with the assistance, however, of the current energy derived from its own oxidation by the nitrous compound.

But what interpretation is to be given of the behaviour of more active metals, such as zinc, magnesium, &c., which have positive heats of dissolution, and therefore are capable of dissolving in the pure dilute acid if coupled with a relatively negative conductor; does nitric acid in their case directly act as a depolariser? If it be capable of thus acting, such metals even when uncoupled should dissolve in the pure diluted acid. It is noteworthy that when such metals are dissolved in nitric acid hydrogen is sometimes evolved. It has been suggested that this hydrogen is derived from the interaction of the metal and water, but I cannot now regard this as a probable explanation; its production serves rather to suggest a deficiency of the depolarising agent, which cannot well occur if nitric acid be the depolariser. Indeed, if nitric acid be regarded as directly active, it is remarkable that in presence of the large excess of the acid which is always present any hydrogen should escape; and also that the reduction should extend so far as it often does, and not extend merely to the formation of nitrous acid. If, however, the acid be incapable of directly acting as a depolariser, and a nitrous compound be the initially active depolarising agent, it is no longer surprising that owing to the nitrous compound suffering further reduction it should be deficient in parts of the circuit, and that consequently hydrogen should escape. Why the reduction should extend so much further when metals having positive heats of dissolution are used, however, still requires elucidation.

In the case of sulphuric acid, whatever metal be dissolved in the *diluted* acid, no reduction takes place; and it is only when the concentrated and more or less heated acid is used that sulphurous oxide and other reduction products are obtained. It appears not improbable that reduction only takes place under conditions under which the presence of sulphuric *oxide* is possible, *i.e.* that depolarisation is effected by sulphuric *oxide* and never by sulphuric *acid*, although this latter may be regarded as the actual solvent of the metal. There is at present no evidence forthcoming to show that nitric acid can dissociate into the anhydride and water, and even if such a change took place in concentrated solutions, there is no reason to assume that it can also take place in dilute solutions, and that this is the explanation of the difference between nitric and sulphuric acids. It is well known, however, that nitric acid is resolved with extreme facility into nitrogen dioxide, water and oxygen, and that it is excessively sensitive to the action of nitric oxide—a trace of nitric oxide would therefore exercise a fermentative action and condition, the formation, it may be, of nitrous acid, or—as there is no evidence compelling us to suppose that the compound represented by the formula HNO_2 exists—it may be of nitrogen dioxide. In this latter case, solutions of nitric acid would resemble concentrated sulphuric acid in containing a reducible oxide, and it may be that their depolarising action is initially exerted through such an oxide alone.

To arrive at a clear conception of the function of acids in dissolving metals, and of the nature of depolarising agents, it would therefore appear to be necessary to take into account many circumstances to which hitherto but little attention has been paid.

HENRY E. ARMSTRONG.

[1] Reprinted from the Proceedings of the Chemical Society, No. 125.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

IN a letter to the *Times* of July 25, Mr. J. Parker Smith, M.P., describes the action that has been taken by Wykehamists with a view of commemorating the 500th anniversary of the opening of Winchester College by some permanent memorial. It was resolved last May that any fund which might be raised should be applied, first, to the restoration of the Founder's Chantry in the Cathedral, and secondly, to establishing a group of memorial buildings for the preservation of Wykehamical antiquities and the encouragement of art, archæology, natural history, and other sciences. Mr. Smith is the Chairman of the Executive Committee formed to administer the funds, and he says that the aims of the collection of archæology and art would be to illustrate and encourage the regular course of school study, and to furnish boys with interests outside that course. As to science, the idea is that the science collections should be a development of the present collection of the Natural History Society, which is good though not large. Mr. Smith thinks that special stress would doubtless be laid on the collection of local minerals, fauna, and flora. An attempt might also be made (as has been done at Harrow) to imitate the admirably instructive series of type forms exhibited in the Museum of Natural History at South Kensington; and it would be highly desirable to connect some moderate provision for elementary biological and botanical work with the natural history museum. Contributions to the fund will be received by the hon. secretary, Mr. Percy R. T. Toynbee, 109, Gloucester Terrace, Hyde Park, W.

THE sixth annual meeting of the National Association for the Promotion of Technical and Secondary Education was held on July 24. The Duke of Devonshire, who occupied the chair, said that public funds had been so rapidly secured for purposes of technical instruction that in some cases both county councils and municipal authorities were at a loss to decide upon the best means of administering them. He thought that it might be advisable for another Royal Commission to be appointed to inquire and report upon the progress made since 1881 in our own and in Continental countries. He was glad to see that the county councils of Staffordshire, Bedfordshire, and Manchester had sent their organising secretaries to the Continent to ascertain the latest developments of technical education abroad, and hoped that their example would be followed by others. Sir Henry Roscoe presented the report of the Society, and its adoption was moved by Mr. Mundella, and supported by Sir F. S. Powell. The officers of the Society were re-elected, with the addition of Sir W. Hart-Dyke as a vice-President, and Sir A. Rollit as a member of the executive committee.

AS an outcome of the Technical Instruction Act, a scheme was promoted, and plans subsequently adopted, for the erection of technical schools at Maidstone, and the foundation stone of the new buildings has just been laid. The schools, which are commodious and well adapted for the purpose for which they will be used, have received the sanction of the Science and Art Department, and comprise, on the ground floor, science, lecture, and class rooms—the former capable of seating from sixty to eighty-four students—large lecture hall, and a library, together with physical and chemical laboratories, and a wood-carving workshop. On the first floor is the art school, with painting and modelling rooms, and a life studio. The basement is designed for an electric installation and stores. There being a large available space in the vicinity of the Maidstone Museum, the new buildings will form an adjunct, and both in the science and art departments direct communication may be had with that institution, which will thus mutually further the objects of the whole group.

THE following alterations, among others, have been introduced into the programme of techniological examinations of the City and Guilds of London Institute for the session 1893-94. 1. An examination in cabinet-making and one in metal-work as a branch of manual training have been added. 2. The syllabus in boot and shoe manufacture has been divided into two grades, and separate practical tests are added to each grade. 3. The honours examination in photography is divided into two sections—(1) pure photography and (2) photo-mechanical processes—and the practical examination will be held in connection with the honours grades only. 4. The examination in cotton weaving in the ordinary grade is divided into two sections—(1) plain weaving and (2) fancy weaving. 5. An examination preliminary to that in the ordinary grade will be held in electric lighting and in typography; and the examination in typography in the ordinary grade is divided into two sections. 6. The syllabus in silk weaving is enlarged so as to include riband weaving. 7. The syllabuses in cloth weaving, flax spinning, hosiery, goldsmiths' work, brick-work, and in other subjects have been revised.

DR. DENDY, who for the past five years has held the position of demonstrator and assistant lecturer in biology in the University of Melbourne, has been appointed lecturer in biology at the Canterbury College, in the University of New Zealand, and will enter upon his duties there in February next. At present Dr. Dendy has sole charge of the biological department during the absence of Prof. Spencer in England.

MR. STANLEY DUNKERLY, M.Sc., has been appointed assistant-lecturer in engineering at the Walker Engineering Laboratories, University College, Liverpool.

LAST year the Staffordshire Technical Education Committee sent a number of teachers to Leipzig for a course of manual training in wood-work, iron-work, &c., at Dr. Gotze's Institute. The plan is again being followed this year, not only in Stafford but by other counties that have come to recognise its usefulness.

SCIENTIFIC SERIALS.

American Journal of Science, July.—The following are among the papers appearing in this number:—Studies of the phenomena of simultaneous constrast colour; and on a photometer for measuring the intensities of lights of different colours, by Alfred M. Mayer. The photometer was constructed in such a manner that the two tints to be compared were reduced to the same by the effects of contrast. Two discs, 13cm. in diameter, and having half of their surface removed in the shape of eight equidistant sectors, were made of thin Bristol board. Between them was placed a circle of white translucent tracing paper, and the discs were clamped together with the open sectors coinciding. The compound disc was mounted on a rotator and placed opposite two silvered mirrors inclined at an angle of 150°. The plane of the disc bisected the angle formed by the mirrors, so that the surfaces of both sides could be seen simultaneously. On rotating the disc while illuminated by daylight on the one side and by lamplight on the other, the side illuminated by daylight appeared white tinted with yellow, the other appeared white tinted with blue. A compound disc of red lead, of chrome yellow, and of white cardboard was placed on the daylight side, and an ultramarine, emerald green and white disc on the lamplight side. The greenish-blue produced by the latter combination made the light blue on the lamplight side appear faintly orange-yellow by contrast, while on the other side of the ring the orange-yellow disc had diminished the orange-yellow tint of the ring to the same feeble orange-yellow as seen on the other side.—On the ammonium-lead halides, by H. L. Wells and W. R. Johnston, and on the rubidium-lead halides, and a summary of the double halides of lead, by H. L. Wells. The authors are of opinion that not one of the many complicated ammonium-lead halides described by André really exists, but that the bodies obtained by him were mixtures. They themselves succeeded in preparing five salts representing three different proportions of ammonium and lead.—A one-volt standard cell, by Henry S. Carhart. This is a calomel and zinc chloride cell adjusted to an E.M.F. of one volt by a proper concentration of the zinc chloride solution. In the bottom of the tube is pure mercury in contact with platinum wire; then follows a paste of mercurous chloride and zinc chloride held in position by a cork diaphragm; and finally an amalgamated zinc rod immersed in zinc chloride solution of density 1·391 at 15°C. The cell has a small positive temperature coefficient.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 8.—"The Influence of Exercise on the Interchange of the Respiratory Gases," by W. Marcet, M.D., F.R.S.

The following is a summary of the contents of this paper:—1st. It was shown that in three persons out of four who submitted to experiment there was a great tendency to an uniformity of figure for the oxygen *consumed* under similar physical circumstances (food, temperature, &c.), so that, if the CO_2 expired fell, the oxygen absorbed rose, and *vice versâ;* this was accounted for by assuming that an increase of CO_2 in the blood in the state of repose is produced at the expense of the O absorbed. The fourth person experimented upon exhibited no such tendency, the CO_2 expired and O absorbed rose and fell together, which was ascribed to the fact that he was still growing.

2nd. Experiments were made on the influence of exercise on respiration, which showed that if stepping exercise (stepping at the rate of sixty-eight times per minute) is taken after a period of rest, there occurs for a few minutes an accumulation of CO_2 in the blood; of course the storage of CO_2 after exercise must be controlled by the normal amount of CO_2 produced in repose, and the kind of exercise taken; this storage would in the cold winter weather, and between one and two hours after food, continue for about eighteen or twenty minutes. In my case the volume of CO_2 retained in the blood amounted to a mean of 500 c.c. while stepping sixty-eight times per minute. The CO_2 in store is next given out in the form of a wave, which is renewed after a certain lapse of time, so that there does not appear to be in respiration under exercise a fixed relation between the CO_2 expired and the CO_2 left in the blood. With practice and training this relation would probably become more and more uniform.

The storage of CO_2 in winter and after food was found to exhibit a certain relation to the excess of CO_2 expired under exercise over the CO_2 expired in repose; but eighteen or twenty minutes after exercise had been commenced this relation failed to show itself any longer.

The ratio in question was the same with two different persons; but further experiment is required to determine whether this ratio can be looked upon as general; the mean relation found is shown by the figure 0·123; therefore, so far as the present inquiry goes, by multiplying this figure 0·123 by the excess of CO_2 given out per minute under exercise over the CO_2 expired in repose during the same lapse of time, the result will show the volume of CO_2 absorbed in the blood per minute.

3rd. After the exercise adopted in this inquiry had been followed by a complete repose of ten minutes, the CO_2 expired had returned to the normal in repose, but the volume of O absorbed per minute had considerably fallen, apparently owing to the blood having charged itself with oxygen during exercise, so that the first few minutes after rest was taken, the blood was in a condition to supply oxygen for tissue-changes without taking it from the air breathed at the time. After half an hour's perfect rest following exercise the respiratory changes had returned to their normal state of repose, or nearly so, the oxygen absorbed still occasionally showing signs of being a little lower than before exercise had been taken.

June 15.—"On a Graphical Representation of the Twenty-Seven Lines on a Cubic Surface." By H. M. Taylor, Fellow of Trinity College, Cambridge. Communicated by A. R. Forsyth, F.R.S.

The converse of Pascal's well-known theorem may be stated thus: if two triangles be in perspective, their non-corresponding sides intersect in six points lying on a conic. An extension of this theorem to three dimensions may be stated thus: if two tetrahedrons be in perspective, their non-corresponding faces intersect in twelve straight lines lying on a cubic surface. This theorem may be deduced from the equation

$$xyzu = (x + a\mathrm{T})\ (y + b\mathrm{T})\ (z + c\mathrm{T})\ (u + a\mathrm{T}),$$

where $\mathrm{T} = \alpha x + \beta y + \gamma z + \delta u$; and $a, b, c, d, \alpha, \beta, \gamma, \delta$ are constants. The equations of twelve lines on the surface are evident.

This paper shows how the remaining fifteen straight lines on the surface may be obtained by means of nothing higher than quadratic equations, and determines which of these lines intersect each other.

The paper then proceeds to give a graphical method of representing all the intersections of the twenty-seven lines on a cubic surface by means of a plane diagram, which admits of many interesting transformations.

By the help of such diagrams some of the known relations of the twenty-seven lines to each other are deduced, and some theorems with respect to the lines which it is believed are new are established; for instance, the number of closed quadrilaterals, pentagons, and hexagons on the surface is determined, as well as the number of ways in which nine triple tangent planes can be drawn to pass through all the twenty-seven lines, and the number of ways in which twelve of the lines can be chosen, so that they are the intersections of two tetrahedrons in perspective.

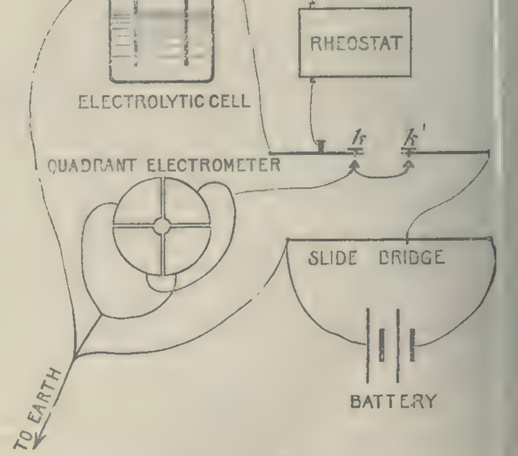
"Polarisation of Platinum Electrodes in Sulphuric Acid." By James B. Henderson, B.Sc. Communicated by Lord Kelvin, P.R.S.

This investigation was begun about the beginning of February, 1893, at the instigation of Lord Kelvin, and was conducted in the Physical Laboratory of Glasgow University. The object of the investigation was to obtain the difference of potential between two platinum electrodes immersed in a solution of sulphuric acid immediately after the stoppage of a current which had been electrolysing the solution, and to find how this difference varied with a variation in the intensity of the current or in the strength of the solution.

Former experiments by Buff and Fromme have given for the maximum polarisation with platinum wires of very small surface in the electrolysis of dilute sulphuric acid 3·5 and 4·6 volts.

Dr. Franz Richarz says of the above:—"In these experiments the polarisation is calculated from measurements of the intensity of the galvanic current during the electrolysis, tacitly assuming that the resistance of the decomposition cell is independent of the intensity of the galvanic current. The correctness of the supposition has not been proved." By employing a different method he found values for the polarisation never greater than 2·6 volts with small wire electrodes, and also got the same maximum with large platinum plates.

The electrodes in the present investigation were rectangular plates of platinum foil 7 cm. long by 5·5 cm. broad, and were immersed in the solution to a depth of 5 cm., having their planes parallel, and about 1 cm. apart. There were thus 55 sq. cm. of surface of each plate wetted. To find the polarisation one of Lord Kelvin's Quadrant Electrometers was used. The method used can be best understood from the diagram. By means of



the key k the breaking of the electrolysing current circuit and the switching of the electrodes on to the terminals of the electrometer were done simultaneously. Before switching as above, however, the needle of the electrometer was deflected by keeping the key k' down, thereby making a difference of potential between the pairs of quadrants equal to that between the slider and the earthed end of the high resistance slide bridge, and this deflection was adjusted by trial and error, so that when k was pressed no further deflection took place. To secure this, at the beginning of an experiment, the slider was placed so that when k was momentarily pressed, the deflection of the electrometer needle was increased impulsively. The amount of this impulsive deflection was noted, and the slider moved so as to increase the steady deflection nearly up to the point on the scale reached by the impulsive one, and then another trial was made. In this way, by watching the point reached by each impulsive deflection, and then increasing the steady one almost up to that point, the latter was increased until the former vanished—that is, until the potential of the quadrants was that of polarisation. The magnitude of this deflection was then noted and the polarisation calculated from it.

All the results point to the polarisation being constant with large electrodes, being independent of the strength of the solution and the intensity of the current. The results of one series of experiments are given in the accompanying table. The variations in the figures do not occur in any order, and are all such as might be expected in experimental results of this nature. Some of the greatest variations were obtained in exactly similar experiments performed at different times.

Percentage strength of solution.	Strength of current in ampères.	Time the current had been passing.	Polarisation in volts.
		h. m.	
30	0·2	3 25	2·066
,,	0·5	0 45	2·060
,,	1·0	0 35	2·060
,,	1·0	0 45	2·124
20	0·1	3 22	2·126
,,	0·5	1 25	2·139
,,	1·0	0 25	2·090
,,	1·0	0 35	2·124
10	0·1	17 40	2·139
,,	0·5	1 19	2·066
,,	1·0	0 44	2·066
5	0·1	18 30	2·116
,,	0·5	1 36	2·078
,,	1·0	1 0	2·083
,,	1·0	3 15	2·054

Mean olarisation = 2·09 volts.

"On the Displacement of a Rigid Body in Space by Rotations. Preliminary Note." By J. J. Walker, F.R.S.

Having been led to study more particularly than, as far as I am aware, has hitherto been done the conditions of the arbitrary displacement of a rigid body in space by means of rotations only, the results arrived at in the case of the single pairs of axes seem to me of sufficient interest and completeness to warrant their being recorded.

A comparison of these results with those arrived at by Rodrigues in his classic memoir "Des lois géométriques qui régissent les déplacements d'un système solide dans l'espace . . . ." Liouville, vol. v. 1840, at once suggesting itself, it may be proper here to recall the substance of the latter, and show how far they fall short of the object I propose to myself. The case of displacement by successive rotations round a pair of axes is discussed in § 13 (pp. 395–396), where it is shown that (p. 390), "Tout déplacement d'un système solide peut être représenté d'une infinité de manières par la succession de deux rotations de ce système autour de deux axes fixes non convergents. Le produit des sinus de ces demi-rotations multipliés par le sinus de l'angle de ces axes et par leur plus courte distance, est égal, pour tous ces *couples* d'axes *conjugués*, au produit du sinus de la demi-rotation du système autour de l'axe *central* du déplacement, multiplié par la demi-translation absolue du système."

Then (p. 396) the converse of this theorem is affirmed, viz., that "*Tout déplacement . . . peut toujours provenir, d'une infinité de manières, de la succession de deux rotations autours de deux axes non-convergents* pourvu que *le produit. . . .*"

In this conversion of the theorem above, it is strangely overlooked that a displacement is not defined by the direction of axis, and amplitude, of the resultant rotation, together with the magnitude of the component of the corresponding translation along that direction (for in this form the proof is given, the axis being drawn through one end of the common perpendicular to the particular couple in respect of which the theorem is demonstrated), since these elements are common to an infinity of displacements.

These being premised, the laws connecting pairs of axes by successive rotations round which a given displacement of a rigid body in space may be effected are as follows:—

If the first axis is taken parallel to a given vector, ζ', there are four directions, to any one of which (ζ) its conjugate may be parallel, viz., the sides common to two quadric cones, the constants of which are functions of ζ' and the vectors defining the displacement.

One of these cones, whatever the direction of ζ', passes through the vector which is the axis of resultant rotation for the origin, or, in other words, which is parallel to the *central* axis for the given displacement. The other cone (K) passes through a vector covariant with ζ', say ζ_1.

The direction ζ' and any selected one of the four vectors ζ being taken for a pair of axes of rotation, the corresponding amplitudes are thus determined, viz. that of the second rotation is double the angle between the planes of the vectors ζ, ζ' and ζ, ζ_1. And as, ζ being fixed, ζ' lies on two cones, one of which, K′, contains a side (ζ'_1) corresponding to the side ζ_1 of K, the angle of rotation round the first axis is double that between the planes of the vectors ζ', ζ and ζ', ζ'_1. The planes of ζ, ζ_1 and ζ', ζ'_1 meet in the vector parallel to the central axis.

The directions of the axes being fixed in accordance with the above conditions, the locus of either axis is a plane, the places of the axes in which are so related that the connector of the feet of perpendiculars on them from any fixed point generates a ruled quadric surface.

As regards the *reality* of the conjugates (ζ) corresponding to an arbitrary direction (ζ') assumed for the first axis, it may suffice here to state that one real conjugate, at least, is insured by taking as ζ' any side of the quadric cone which is defined by replacing ζ in the cone K with the vector parallel to the *central* axis. The two cones, whose common sides are directions of the corresponding conjugate, then both passing through that vector, will meet in at least one other real side.

PARIS.

Academy of Sciences, July 17.—M. de Lacaze-Duthiers in the chair.—On the discovery of the comet b 1893, by M. F. Tisserand.—Expression of the resistance offered by each ponderable molecule to the vibratory motion of the ambiant ether, by M. J. Boussinesq.—On the generalisation of a theorem of Euler relating to polyhedra, by M. H. Poincaré.—Experiments on the resistance of air and diverse gases to the motion of bodies, by MM. L. Cailletet and E. Colardeau. The experiments previously made on the resistance of air to the motion of falling bodies, and performed at the Eiffel Tower, led to varying results according to the pressure of the atmosphere. In order to determine the influence of the pressure upon the resistance, and also that of the nature of the gas, the apparatus was enclosed in a cast-iron receiver of 300 litres capacity, into which air or other gas could be pumped up to pressures of 8 or 10 atmospheres. The apparatus consisted of a paddle-wheel set in motion by a weight suspended by a string wound upon the shaft. A double cock, with intermediate reservoir, permitted the introduction of a known quantity of shot into the cylindrical hollow of the driving weight, so as to increase the weight without affecting the pressure. A key, worked from the outside through a stuffing-box, enabled the experimenters to replace the weight as often as desired without loss of compressed gas. The downward motion of the weight became uniform as soon as the resistance of the gas equalled the driving weight. An electric contact inside the receiver connected with a bell outside indicated the rate of rotation of the paddle-wheel. The resistance opposed by any gas to the motion of a plane was found to be proportional to its surface, the square of its velocity, and the pressure and density of the gas. If two planes are placed one behind the other at a distance equal to their breadth, the total resistance is about 1·1 times that offered to a single plane. Placing two planes 0·15 m. broad 1 m. apart, the sum of their resistances did not come up to twice the resistance of each.—Observations of the new comet Rordame, made with the great equatorial of the Bordeaux Observatory, by MM. G. Rayet and L. Picart.—On a relation which exists between the formulæ of Coulomb (magnetic), Laplace, and Ampère, by M. E. H. Amagat. It is shown that W. Weber's method of arriving at the values of the constants of Ampère's formula is incorrect. M. Amagat hopes shortly to obtain some more accurate results.—On glycolysis in normal and diabetic blood, by MM. R. Lépine and Métroz. In diabetic blood the absolute loss of sugar *in vitro*, although quite perceptible, is very much less than it would be if the glycolytic energy were normal; it is, therefore, evident that the glycolytic energy must be lowered.—On the new comet *b* 1893, by M. Quénisset.—Observations of the new comet, *b* 1893, made at the Paris Observatory (west equatorial), by M. G. Bigourdan.—On studies of the discharge of vapour through orifices, by M. H. Parenty.—On the simplicity of samarium, M. Eug. Demarçay. From experiments upon solutions of samarium salts it appears that the suspicions entertained as to its elementary nature were unfounded.—On cyclic condensations of carbon, by M. Gustave Rousseau. M. Rousseau succeeded in preparing artificial black diamonds by the decomposition of calcium acetylide in a current of moist gas in a Ducretet electric furnace. Some of the grains obtained were 0·5 mm. in diameter.—On aminobutenediamide and butanonediamide, by M. R. Thomas-Mamert.—On the saturation of the nitrogens of nicotine and on an acetyl nicotine, by M. A. Étard.—Rotatory powers of quinic acid derivatives, by M. S. G. Cerkez.—Derivatives and constitution of rhodinol and essence of roses, by M. Ph. Barbier.—Laws of evolution of digestion; their interpretation, by M. J. Winter.—Does the elasticity of the muscle diminish during contraction? by M. N. Wedensky.—On the mechanism of the production of light in the *Orya barbarica* of Algiers, by M. Raphael Dubois.—On the pelagic fauna of the lakes of the French Jura, by MM. Jules de Guerne and Jules Richard.—On a parasitic fungus of *Cochylis*, by MM. C. Sauvageau and J. Perraud.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* from January 18 to April 12 contain the following papers of scientific interest:—

January 18.—E. Riecke: Thermodynamics of tourmaline, and the mechanical theory of muscular contraction; a criticism of Müller's hypothesis. H. Weber: Researches in the theory of numbers in the domain of elliptic functions, I.

January 25.—A. Peter: Contributions to our knowledge of the *Hieracea* of Eastern Europe. I. The *Piloselloidea* of the Moscow district. P. Drude: The relation of the dielectric constants to indices of refraction. The following theorem is obtained: "The difference between the dielectric constant and the square of the refractive index is equal to the sum of the polarisation-constants of the molecular groups whose free vibrations lie in the ultra-red." W. Voigt: Observations on the torsional rigidity of rocksalt prisms. W. Voigt: Observations on the tensile strength of rock crystal and fluorspar. F. Klein: The composition of binary quadratic forms. H. Weber: On the theory of invariants. D. Hilbert: On the transcendency of the numbers e and π.

February 8.—E. Ritter: Automorphic algebraic forms of arbitrary species.

AMSTERDAM.

Royal Academy of Sciences, June 24.—Prof. van de Sande Bakhuyzen in the chair.—Mr. Kamerlingh Onnes gives the results of some experiments made in the Leyden Laboratory (1) by Dr. Kuenen, on the surface of v. d. Waals for mixtures. One of the phases observed by Wroblewski in compressing air with CO_2, and by Prof. Dewar in compressing CS_2 with CO_2 is due to insufficient mixing. (2) By Dr. Siertsema, on the magneto-optic dispersion of oxygen. The apparatus used is like that of Kundt and Röntgen, but the polariser and analyser are Nicols', and the coil is magnetised by a dynamo of 8 h.p. The magnetic rotation of the plane of polarisation diminishes regularly as the wave-length increases.—Mr. J. A. C. Oudemans communicated some remarks concerning Sir John Herschel's second method of calculating the most probable orbit of a binary star, (Mems. of the R.A.S., vol. xviii.). The apparent orbit is here determined analytically by applying the method of least squares to the solution of the equations

$$\alpha x + \beta y + \gamma x^2 + \delta xy + \epsilon y^2 + 1 = 0,$$

where α, β, γ, δ, ϵ are the unknown quantities, x, y the coordinates given by the normal places. Sir John gave these equations equal weights, whereas the speaker proved that the weight of each equation $= p = \frac{1}{P^2 + Q^2}$, P being $= \alpha + 2\gamma x + \delta y$, and $Q = \beta + \delta x + 2\epsilon y$. In the example given by Sir John (the orbit of γ Virginis) p varies from the single to the treble. If the weight of a normal place is estimated, from other considerations (*i.e.* the power of the telescopes, the number of observations, &c.), $= p'$, the weight of the corresponding equation is to be taken $= pp'$. Mr. Franchimont asserts the possibility that glucose, being aldehyde and alcohol together, would, by the known interaction of these two functions, *i.e.* an addition, give in some circumstances derivatives of a tautomeric form, an oxide, whenever this does not exist in the free state. In such a tautomeric form (the most probable is 1·2) there is one asymmetric carbon atom more than in the aldehydic form, and he inclines to consider the two pentacetates as the stereoisomeric derivatives of this carbon atom. The two pentacetates (also the tetracetate chloride of Colley and the pentabenzoate of Skraup) have no properties of aldehyde, neither of alcohol. They cannot be compared with oxides, such as ethylenic-oxide, nor with the lactones (olides). They differ in melting-point, solubility, and optical activity. Both are dextro-rotatory, but the power of rotation of the one is very small, that of the other very great. In association with Mr. Lobry de Bruyn he could not find any difference in the chemical behaviour, so that no reason exists to admit that they are structural isomeric. With ammonia they seem to produce acetamide and the same product that is given by glucose itself, isomeric with glucosamine and isoglucosamine. The pentacetate with the higher melting-point can be transformed in that with the lower by heating with zinc-chloride, the presence of a solvent as xylene being favourable but not necessary. The above considerations on the tautomeric form of glucose can be applied on other aldols (olals) and throw new light on their peculiar behaviour in some circumstances.

CONTENTS.

THURSDAY, AUGUST 3, 1893.

A CATALOGUE OF SNAKES.

Catalogue of the Snakes in the British Museum (Natural History). Vol. I. By George Albert Boulenger. (London: 1893.)

IN the present volume Mr. Boulenger, the author of the Catalogues of Batrachia, and of the Lizards, Tortoises, Rhynchocephalians and Crocodiles, amongst the Reptilia, commences the description of the only order of living reptiles not hitherto treated by him in the octavo series of British Museum Catalogues.

The Ophidia, whether regarded as a distinct order, as they appear in the text of the catalogue, or as one of the suborders of Squamata, with the Lacertilia and Rhiptoglossa (Chameleons) forming the other sub-orders, as advocated in a foot-note, are by far the most important group of living reptiles after the lizards, and are, like the latter, of comparatively recent origin. No remains of true snakes have been recognised in deposits older than upper cretaceous.

Few groups of vertebrate animals have proved as difficult to classify correctly as snakes. The absence of limbs and the peculiarly specialised (elongate form have made species, genera, and even in some cases families resemble each other far more exactly than is usually the case. The result in this and in some similar instances has been that characters of little or no intrinsic value have long been regarded as distinctive, and that an artificial system has been adopted. Certainly in the case of the snakes there was every excuse for characters which are now known to be adaptive and of secondary value in classification, being long supposed to be of primary importance, for the principal of these characters consisted in the presence or absence of weapons by which the life of large animals, including man, could be destroyed with extraordinary rapidity. The first inquiry naturally made by any person confronted by a snake is, "Is it poisonous?" and as the question whether the animal can or cannot inflict an injury that may be, and very often is known to be, fatal, can be certainly decided by examining the structure of the teeth, it is far from surprising that that structure should long have been accepted as the criterion for dividing snakes into primary groups. It was of course recognised that vipers and rattlesnakes, which present marked external differences from such poisonous serpents as the cobra, must be kept distinct from the latter, and consequently all ophidians were until quite recently divided into three groups, (1) harmless snakes; (2) venomous colubrine snakes, and (3) viperine snakes, both the two latter, or poisonous sections, being distinguished by having a grooved or perforated tooth situated at the anterior extremity of the maxillary on each side, and supplied with a poisonous secretion from the very slightly modified salivary gland.

But it had long been known that amongst the so-called harmless colubrine snakes there were several genera such as Dipsas, Psammophis, and Homolopsis, with grooved teeth exactly similar in structure to those characteristic of poisonous forms, but situated at the posterior instead of the anterior termination of the maxillary. These snakes, the Opisthoglypha, as they are termed, were kept apart from other colubrine snakes by several herpetologists, but it is only within the last few years that their poisonous character has been distinctly ascertained. It is true that owing to the position of the grooved fangs, and also to the small quantity of poisonous secretion, the bite of these snakes is harmless to man and to the larger animals, but it has been ascertained that some of them certainly, and probably all, paralyse or kill the small mammals or other animals on which they feed.

The last few years too have shown that grooved teeth, connected with a poison gland occur in the mandible of a lizard (Heloderma), and this recurrence of the same kind of tooth in different positions, and in very distinct reptiles destroys the value of the character as evidence of genetic affinity. But if the distinction between poisonous and non-poisonous snakes is disregarded, the differences between harmless colubrines (Aglypha), such as Tropidonotus, and the forms with grooved teeth, like Dipsas or Homolopsis (Opisthoglypha), Naja or Elaps (Proteroglypha), are insufficient to justify placing them in separate subdivisions of the group.

Three years since, in his work on the Reptilia and Batrachia of British India, Mr. Boulenger rejected the old division of snakes into venomous and harmless, and proposed a new classification of the whole group founded on the characters of the skull, and the presence or absence of particular cranial bones. The occasion was a good one, for, singular to state, India is the only country in the world where all families of snakes are represented. Time only can show whether the present classification will stand; it is far from improbable that future discoveries may result in some modification of the system now adopted, but there can be not the slightest question that the principle is sound, and that the present system is a distinct improvement on its predecessors. The whole order of snakes is, by Mr. Boulenger, divided into the following nine families: (1) Typhlopidæ, (2) Glauconiidæ, (3) Boidæ, (4) Ilysiidæ, (5) Uropeltidæ, (6) Xenopeltidæ, (7) Colubridæ, (8) Amblycephalidæ, (9) Viperidæ.

Of these only three are generally known—(1) the Boidæ, containing the boas, pythons, and the curious Eryx, the two-headed snake of Indian jugglers; (2) the Viperidæ, which comprise ordinary vipers and Crotalinæ, (rattlesnakes and their allies); and (3) the Colubridæ, which play much the same part amongst snakes that the Passeres do amongst birds, and form a considerable majority of the living species. In the Indian list, out of 264 known snakes, 182, or about two-thirds, belong to the Colubridæ, and probably a similar proportion will be found to prevail throughout the world. The Colubridæ are in fact the dominant type of the present time. They are in all probability of comparatively recent origin, and the generic distinctions amongst them are frequently small and difficult to recognise.

Of the care bestowed upon the present work it is difficult to speak too highly. One instance may be quoted, as it illustrates the author's anatomical research, and at the same time shows the light thrown on other biological inquiries by accurate systematic knowledge. The snake fauna of Madagascar has long been known to present some remarkable peculiarities. The other reptiles and the batrachians of the Mascarene Islands are distinguished by the absence of many characteristic African families, and the presence of peculiar types, in so far conforming to the distinguishing features of the vertebrate fauna in general; whilst a few reptiles and batrachians exhibit remarkable relations to Indian genera on the one hand, and to South American on the other. The ophidians of Madagascar alone, including the Colubrine snakes, have been believed to belong almost wholly to South American genera. Mr. Boulenger, however, has ascertained that the Madagascar Colubrine species possess hæmal processes (hypapophyses) to the vertebræ, and are consequently generically distinct from their neotropical analogues, whilst some of the Madagascar Boidæ, belonging to what is very probably a family of more ancient origin than the Colubridæ, are of South American genera. Thus the Madagascar snakes agree with the lizards, tortoises, and frogs in their foreign relationships.

Nor has the thoroughness of the scientific work prevented due attention being paid to the details that are important as aids in the identification of species. The number of ventral and subcaudal shields is given for every specimen in the collection. Now as the ventral scutes alone are usually about 150 to 250 in different kinds of snakes, the mechanical work of counting them in nearly 3000 individuals (a few snakes have no ventral shields) catalogued in the volume before us may easily be conceived.

At a time when systematic zoology is not greatly studied by many biologists, and is even, it may be feared, despised by some of them, it is some satisfaction to point to the monographs that are issued from the British Museum as evidence of the work that is being done with the unrivalled collections there available for study. There is scarcely any branch of biological research in which the systematic relations to each other of different organised beings is not of importance, and if systematic biology does not represent the knowledge of the day, all biological studies are likely to suffer. It may fairly be doubted whether any branch of biological work demands greater scientific capacity, higher powers of generalisation or harder work than that of which Mr. Boulenger has afforded a good example in his Catalogue of Snakes.

W. T. BLANFORD.

AN ALPINE GUIDE.

A Handbook for Travellers in Switzerland. Eighteenth edition. (London: John Murray, 1892.)

IN the early days of mountaineering, when the Alpine climber wished to scoff at guide-books, he referred sarcastically to Murray's Handbook to Switzerland. It was so emphatically a *vade mecum* for middle-aged prosperity, and was more successful in limiting its information than in restricting its words. But times and editors have changed. The book for several years past has been up to the high standard attained by the other members of the series; and the edition of 1891, of which the present issue is a revision, even improves upon its predecessors. In the initials "W. A. B. C.," appended to the preface, it would be affectation not to recognise the name of one who unites a knowledge of the Alps, unique, perhaps, in its completeness, to an infinite capacity for taking pains.

We are told, and the book fully justifies the statement, that in preparing this edition, "every line of the text has been very carefully revised and corrected, the historical information having been considerably increased; the notices of the towns have been practically rewritten, particular attention having been devoted to their architectural monuments." The historical notices, indeed, are admirable models of terseness and clearness. That this is so, and that the information concerning the mountain districts has been brought quite up to date, while many places at present little known have been introduced to the notice of English travellers, is only what was to be anticipated in a book edited by Mr. Coolidge.

Six new maps of districts much frequented by English travellers form a special feature of this revised edition. One, of Zermatt, is on a scale of 1 : 50,000, while those of the environs of Lucerne, of Grindelwald, of the Upper Engadine, the Saasthal, and the district round Evolena, Arolla, and Zinal, are on half that scale. They are contoured at distances of 200 metres; the mountains are tinted brown, darkened as the height rises; the snows and glaciers are a pale blue. The maps themselves are excellent, but the tints do not produce a very satisfactory stereographic effect; indeed, we think that actually they have a contrary tendency. It may be that as the higher ground bears the darkened colour, and the snow region is almost white, the contrast is too violent. Be the cause what it may, the result is not quite a success. Still, notwithstanding this, the maps will be a boon to travellers. The introductory matter in this handbook is excellent, and we have observed only one omission. Avalanches, glaciers, structural geography are duly noticed, even natural history is not wholly forgotten, but geology is excluded. But in the course of two or three pages a general outline of the structure and geology of the Alps might have been given, and the attention of travellers called to the significance of the wonderful sections which are so often exhibited in Alpine regions.

We have dipped here and there into the two volumes, which include not only Switzerland, but also the Alps of Savoy and Piedmont, the Italian Lakes, and part of the Dauphiné, reading the accounts of the districts with which we are personally more familiar. Needless to say that we find them clear, accurate, and terse, yet full of information. The book, good before, is even better now, and cannot fail to be most useful to the British tourist.

T. G. B.

OUR BOOK SHELF.

A Handbook on the Steam Engine. By Herman Haeder, Civil Engineer. English Edition. Translated, with considerable additions and alterations, by H. H. F. Fowles, Assoc.M.Inst.C.E. (London: Crosby Lockwood and Sons, 1893.)

THIS is an excellent book, and should be in the hands of all who are interested in the construction and design of medium-sized stationary engines.

It is a real pleasure to find so much information gathered together, particularly when it is from the practical side of the subject. The number of text-books on the steam engine is legion, but few are of any use to the engineer as distinguished from the student.

The book appears to largely consist of notes accumulated both in the drawing office and in the works. These are of great value, and particularly so because all dimensions have been reduced to British units, thus rendering possible a comparison between Continental and British practice.

A careful study of the contents of this book and the arrangement of the sections, leads to the conclusion that there is probably no other book like it in this country. The volume aims at showing the results of practical experience, and it certainly may claim a complete achievement of this idea.

It must not be imagined from these remarks that the steam engine has not been treated in any other manner than that of rule of thumb, a term often used by those who would place theory before practice in the training of an engineer. Take, for instance, the diagrams intending to illustrate the defects in valve gears, which may often be met with in practice; these make the different defects perfectly clear, and one can see at a glance where the mistake is to be found.

Section x. deals with the calculations for power and steam consumption, and section xi. explains the effect of the inertia of the reciprocating parts of a steam engine; with an ordinary amount of mathematics all these can be easily followed. Section xiv. is on boilers. This section is the weak part of the book, and in future editions should be considerably augmented with information having reference to the design and strength of boilers.

The book is fully illustrated, in fact, we are told in the preface that the letter-press has been reduced as much as possible to allow of the introduction of the numerous tables and drawings; among the latter there is an excellent illustration of a compound Willan's central valve engine with two cranks—probably the best engine of the kind to be had. Some of these illustrations have evidently been especially prepared with the intention of giving an idea of principles of construction to the reader, particularly those having reference to types of steam engines, various ways of arranging cylinders and cranks in double and three-cylinders, compound, and triple expansion engine. These outline diagrams are exceedingly clear. Other illustrations are sectioned and finished in such a way so as to render the details evident. All these points add considerably to the value of the work as a text-book for senior students in our technical colleges; for draughtsmen engaged in stationary engine work, and for mechanic engineers generally.

N. J. LOCKYER.

Heat. By Mark R. Wright. (London: Longmans, Green, and Co., 1893.)

"OF making many books there is no end, and much study is a weariness of the flesh." Truer words than these were never written, and they are specially applicable at the present day. Mr. Wright's addition to the literature of science is avowedly "written specially to meet the requirements of the Advanced Stage of Heat as laid down in the Syllabus of the Directory of the Science and Art Department." To say that the author has satisfactorily accomplished his design is, therefore, to give him praise. In an examinational text-book there is little, if any, scope for originality, and all the author can do is to develop new methods of treatment. This Mr. Wright has done to a small extent, and he seems to be in touch with the work that has been done in connection with his subject during the last few years. Of the 136 illustrations only thirty-five have been drawn for the book: the majority of the others being of the well-known stock character, which have "had their day" and should have "ceased to be" long ago.

LETTERS TO THE EDITOR.

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

Slickensides.

IN the account of M. Daubrée's experiments on the geological work of high-pressure gas (NATURE, July 6, p. 228), the following sentence occurs:—"In any case it is perhaps a little difficult to understand how a *single* movement of one rock surface over another . . . could produce anything like a perfect polish."

This recalls to my mind a freshly-made fault I examined in 1890, in a pit at Longcliff, Derbyshire. The rock was a moist, sandy fireclay or gannister; an area of about 80 feet square, lying on a slope of 35°, had slid down some 3 or 4 feet. The operations at the foot of the slope removed the support of the mass of rock above the sliding plane, and shortly afterwards it split across the middle, and the lower portion moved about

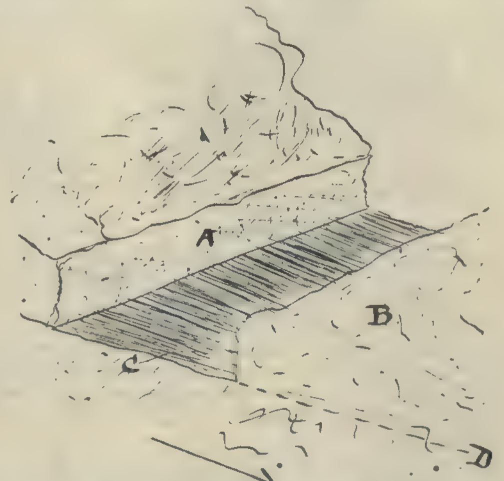


Diagram of fault at Longcliff Clay Pit.—A, Mass that slid down 4 ft. and then stopped: B, portion of A that slid 4 ft. further; C, Slickenside surface; D, fault or sliding plane.

3 feet further down, disclosing in the gap thus made the surface of the stationary rock. This surface exhibited every appearance of a typical slickenside; it was *highly polished*, *striated*, and even *blackened*, though the clay itself is cream-coloured. The striations corresponded with the direction of the movement, which had been a simple downward one.

Some slickensides may possibly be explained by reference to the action of high-pressure gas, but here at Longcliff was an unmistakable example of one caused by a "single movement of one rock surface over another," and it is very probable that the majority of ordinary slickensides have had a similar origin.

Mile End Road, London E., July 12. J. ALLEN HOWE.

Potstones found near Seaford.

PARAMOUDRA or potstones are known to geologists as existing in the chalk strata around Norwich and Belfast, but till lately I had supposed they were confined to those districts.

Last Whitsuntide, whilst enjoying a ramble along the chalk cliffs, east of Seaford, I was surprised to come across what seemed a real, but unusual potstone, lying among the stones below high-water mark, but which must, presumably, have originally fallen from the chalk above. Although consisting of a mass of chert, instead of pure flint like those near Norwich, in every other respect it resembles them. In form it is a large irregular cylinder and lies on its side, so that the sea water, when the tide rises, flows freely through it. It measures roughly between four and five feet in each direction, and the aperture has a diameter of twelve inches.

The enclosure of several large black flint nodules indicates that this peculiar shaped mass of chert has been formed since the flint itself segregated.

It seems probable that the "pipes" frequently found in sand will give us a clue as to its formation. In that case silica in the form of quartz is held together by ferruginous matter; here water holding silica in solution must have passed through the chalk like a vortex, and cemented together masses of chalk with its enclosed flints, with the result that we have a "pipe" of cretaceous matter held together by silica.

Here also, as on the Norfolk coast, are to be seen rings of flint on the shore, sometimes so placed as to form two or three concentric circles.

These instances, as well as others, point to the fact that masses due to segregation often assume the form of rings or cylinders. In flint this arrangement of growth is probably much more common than is generally known. I have already suggested (*Geol. Mag.*, June, 1893) a theory to account for the existence of these forms in flint, which, since Lyell's description of them, have been an enigma to geologists.

Tunbridge Wells, July 18. GEO. ABBOTT.

Simplified Multiplication.

THE object of this note is to explain a process of simplifying multiplication. To most people multiplication by 2, 3, 4, 5 is *sufficiently* easy (and not worth incurring any trouble to make easier); whereas multiplication by 6, 7, 8, 9 is decidedly more difficult, so is *sometimes* worth while simplifying.

Now, by admitting the use of *negative digits* (which may be marked by a minus sign placed over the digit), we may write—

$$6=10-4=1\bar{4},\ 7=10-3=1\bar{3},\ 8=10-2=1\bar{2},\ 9=10-1=1\bar{1},$$

This notation is pretty concise, being no longer than the ordinary notation whenever the extreme left-hand digit is <5, thus—

$$17=2\bar{3},\ 39=4\bar{1},\ 278=3\bar{2}\bar{2},\ 196=20\bar{4},\ \&c.$$

whilst it requires one digit more than the ordinary notation when the extreme left-hand digit is not <5, and is followed by a negative digit, thus—

$$99=10\bar{1},\ 789=1\bar{2}\bar{1}\bar{1},\ 676=1\bar{3}\bar{2}\bar{4},\ 5678=1\bar{4}\bar{3}\bar{2}\bar{2},\ \&c.$$

The preparation of a number so as to contain no digit >5 (by introduction of negative digits, each not >5) will be called (for shortness) *Reduction*: the process is so very simple that the "reduced" number can always be *written down at sight* (a most important matter).

To form the product P of two given numbers M, N, either one or both of the factors M, N may be "reduced" as a preliminary to multiplication. If both factors be reduced, the rule of signs of algebraic multiplication must be used, viz.

$$+\times+=+,\text{ and }-\times-=+\text{ ; but }+\times-=-,\text{ and }-\times+=-$$

This "reduction" of both factors is particularly useful when many large digits occur in succession in both factors, in which case the whole of the multiplication can often be done mentally (without even writing out at length), thus—

$$\begin{aligned}99^2&=10\bar{1}^2=10\bar{2}01=9801\\999^2&=100\bar{1}^2=100\bar{2}001=998001\\998^2&=100\bar{2}^2=1004004=996004\end{aligned}$$

The following factors become particularly simple by this "reduction," viz.

$$999\ldots9=1000\ldots\ldots\bar{1},\quad 888\ldots9=1\bar{1}\bar{1}\bar{1}\ldots\ldots\bar{1}$$
$$777\ldots8=1\bar{2}\bar{2}\bar{2}\ldots\ldots\bar{2},\quad 666\ldots7=1\bar{3}\bar{3}\bar{3}\ldots\ldots\bar{3}$$

When the results cannot be readily done mentally, the multiplication may be done by writing out at length *in the usual way* (attending of course to signs), thus—

$$\begin{array}{rr}89 & =1\bar{1}\bar{1}\\89 & =1\bar{1}\bar{1}\\\hline & \bar{1}11\\ & \bar{1}11\\ & 1\bar{1}\bar{1}\\\hline\end{array}$$
$$\therefore\ 89^2=1\bar{2}\bar{1}21=7921$$

$$\begin{array}{rr}789= & 1\bar{2}\bar{1}\bar{1}\\789= & 1\bar{2}\bar{1}\bar{1}\\\hline & \bar{1}211\\ & \bar{1}211\\ & \bar{2}422\\ & 1\bar{2}\bar{1}\bar{1}\\\hline\end{array}$$
$$\therefore\ 789^2=1\bar{4}22521=622521$$

It will be seen that the ease of the above procedure depends chiefly on the digits being so small (in both factors) as not to involve any *carrying* from digit to digit in the multiplications; this will always be the case when no digit exceeds 3 or $\bar{3}$ (because the greatest product $3\times3=9$ only). But when the digits 4, 5, 6 occur *in either factor*, this will usually involve *carrying* in the multiplications (because 3×4 and 2×5 are both >9). In this case it is generally better to "reduce" one factor only, and by preference that factor which has the greatest number of large digits (*i.e.* 7's, 8's, 9's), and further to use this factor as "multiplier," keeping the other factor unreduced as multiplicand. Further, it is often convenient in this case (especially when the factors are large) to completely separate the positive and negative products, add them separately, and finally take the difference of these sums; this will be the required product: this procedure (of using negative digits only in the multiplier, and then separating the + and − products) has the great advantages that (1) no further attention need be paid to the signs, and (2) the final line has all its digits necessarily positive, so is itself the required product (in ordinary notation).

Ex.—Given $M=34,892$, $N=89,795$; to find $M\times N$. Choose N as "multiplier," because it contains four large digits. The work proceeds thus—

$$\begin{array}{rl}34\,892 & =M\\1\bar{1}0\,\bar{2}\bar{1}5 & =N\\\hline 174\,460 & =5\times M\\3\,489\,2 & =1\times M\\\hline 3\,489\,374\,460 & =\text{Positive sum}=p\\\hline\end{array}$$

$$\text{All negative}\left\{\begin{array}{rl}348\,92 & =\bar{1}\times M\\6\,978\,4 & =\bar{2}\times M\\348\,92 & =\bar{1}\times M\\\hline 356\,247\,32 & =\text{Negative sum}=n\end{array}\right.$$

$$\therefore\ p\ldots n=3\,133\,127\,140=\text{Product }M\times N$$

It will be seen that this process requires two more lines than the ordinary process (viz. the two lines p, n), but the *actual multiplications are far easier.*

It is obvious that the two lines p, n may be separately tested by the usual processes of "casting out the nines, elevens, &c."

The whole process above is so simple that it might well find a place in works on elementary algebra immediately after the explanation of the rule of signs in multiplication; it is thoroughly practical, and having been much used by the author, can be confidently recommended.

The use of negative digits, as above explained, may also be applied to the process of division, and in some cases with advantage. This application is, however, in general by no means quite easy, so cannot be recommended as a practically useful process.

[This process—as applied to multiplication—is not of course new; but it seems worth while to attempt to revive it now; as a process, somewhat the same in principle, has just been published (in the *Annales des Ponts et Chaussées* for April 1893, p. 790) by Mr. Ed. Collignon. The only *actual multiplication* required in his process is by the digits 2 and 5; the elimination of actual multiplication by 3, 4, 6, 7, 8, 9 is of course an immense advantage. To this end he first shows how to "reduce" any number N to the algebraic sum (say $N_1+N_2-N_3$) of three others, N_1, N_2, N_3, composed solely of the four digits 0, 1, 2, 3. To multiply two numbers M, N, one of them, say N, is to be "reduced" as explained: the products MN_1, MN_2, MN_3 are then to be formed in the usual way; their algebraic sum $MN_1+MN_2-MN_3$ is the product required. The process has two decided defects, viz.—(1) the "reduction" of N is somewhat troublesome; (2) the forming and adding the three products ($MN_1+MN_2-MN_3$) is a good deal longer than the ordinary process.] ALLAN CUNNINGHAM.

Thunderstorm Phenomena on the Matterhorn.

IN 1888-1889 I witnessed some eight-and-twenty thunderstorms on the Pampas of South America; and came to the conclusion—

(1) That there was no reason to suppose that the so-called "sheet-lightning," or "summer-lightning," is anything more than the glare of distant spark-discharge;

(2) That by far the greater number of discharges took place between different layers of cloud, and not between clouds and the earth;

(3) That the origin of these storms lay in the electrical excitation due to the friction between opposed currents of air (carrying cloud), upper and lower respectively.

This year I was witness of a thunderstorm under very different circumstances, and I observed a phenomenon that appears to me to be of interest.

On July 10 I was on the Matterhorn in very doubtful weather. It appeared as though the Föhn (or southerly wind) were struggling with a northerly wind, and as though the former conquered. Clouds or mist pressed up from Italy, and rose higher and higher, covering the other mountains before the Matterhorn. We had some snow at intervals even before mid-day, and by the time that we had, on return from the summit, descended as far as the upper hut, it was snowing steadily. I think that, as regards the Matterhorn, the electrical hissing of ice-axes, rocks, &c., began about 3.30 p.m. or 4 p.m., and lightning began rather later.

At last came one flash, apparently very near to us, the thunder following close with a crash. *Before the thunder*, however, and apparently *with* the flash, came a curious splitting, cracking, and shivering sound, with a kind of "splash" from the rocks—as it seemed. I give many adjectives for want of one good expressive word. This sound preceded the thunder, and was both sharp and faint; I felt that I only heard it because I was on the spot.

Later, another flash came close to us. This time I heard no "splash" from the rocks; but, apparently *with* the flash, and before the thunder-crash, there came a light, shivering, branching crack again, something like the "ghost" of thunder, one might say. It reminded me this time of the shiver that passes over the surface of new snow, only very slightly crusted, when first broken in any part by the feet of a traveller. (Some climbers will know this sound; but I myself have only occasionally noticed it, and that only when I have been the first on a snowfield soon after a heavy fall of snow.) I received a slight shock in the head this time. A third flash gave the same sound as the second; but no others seemed so close, and I never heard this sound again.

It was dark when we reached the lower hut; and all down the arête the brushes of purple light that streamed from our fingers (when held up) and from our axes, hats, hair, &c., were very beautiful. The fingers gave better brushes when wetted. There were numerous brushes streaming from the rocks, these being wet with water melted from the snow.

Some other people who were on the Gorner Grat the same day told me, before I mentioned my experiences, that the lightning seemed to give a splashing sound on the rocks. They also told me that those who wore felt hats, felt return shocks, while those with straw hats did not. All the hats were wet.

So much for observation; now for a theory.

To begin with, since the thunder distinctly crashed *after* the lightning-flash, it would seem that the phenomenon that caused the sound I heard must have preceded the spark.

I would suggest the following explanation.

I do not think that those who have never been actually in a storm realise how very indefinite, in substance and boundaries, "a thundercloud" is. It seems certain that we must not regard it as if it were a polished conductor that is gradually charged until it sparks to earth or to other clouds. More probably there is a fall (or rise) of potential through the substance of the cloud itself. When the stress is too great, there is probably a breakdown along many paths in the form of the fine branching sparks observed when a Wimshurst is used without a condenser. This preliminary breakdown suddenly gives a very much larger potential-difference between the portion of the cloud-masses towards which it takes place; so suddenly in fact, that a spark-discharge occurs before more diffuse modes of readjustment can obtain. It seems to me that it is only by some such preliminary discharge from behind that such irregular "surfaces" as those of clouds could attain the condition requisite for the true spark. In something the same way we can pass a spark between two rough or pointed metal terminals by a sudden discharge through them, while we could not raise them in any slower way to the necessary condition.

According to this view, a slighter and more branching discharge in the body of a cloud would be the necessary preliminary to a regular flash; and the, relatively faint, sound of it would precede the "thunder" of the final flash. When once the flash occurs, resistance is much diminished, and the stress of the whole region is relieved through the path created.

An obvious objection to this view, however, will occur to many. "Would the time-interval be long enough? Would not the first sound be practically heard with the thunder, and be drowned in it?'

Another explanation might be, that (as is often the case with a Wimshurst or other machine) there are fainter, tentative, branching discharges that precede the bright spark. But, if this were the case, they should surely be heard in some cases before any spark occurs at all.

Finally, the sound, though it appeared to come out of the air, might have been due to the movements of the stones and rocks over the surface of the mountain, occurring when the stress was relieved. Such a sound might well reach one before the sound of the spark. WALTER LARDEN.

R. N. E. College, Devonport, July 24.

Highest Rainfall in Twenty-four Hours.

WITH reference to the paragraph quoted in your notes of this week's NATURE from the *Indian Planters' Gazette* of Jan. 28, 1893, the most elementary knowledge of Indian meteorology would suffice to show that the remarkable figure, 48 inches, supposed to represent the fall of a single night in January at Dehra Dun, is simply a misprint for 4·8. The entire rainfall of the winter season in no part of India exceeds one-half this amount, and I have no hesitation in declaring such a figure as 48 inches in twenty-four hours to be absolutely without precedent, and, in my opinion, so extraordinary at such a season, that, if it really were 48, it would require us to regard all existing Indian meteorological data with suspicion. Thirty inches in twenty-four hours has often been recorded at Chirapunji in June and July. Can any one show a single instance of even 20 inches in twenty-four hours at Dehra Dun?

Moreover, the whole annual supply at Dehra Dun is only 75 inches, while that of Chirapunji is 600 inches!

July 29. E. DOUGLAS ARCHIBALD.

Vivisection.

THE recent remarkable discoveries in connection with Myxœdema conclusively prove the value of vivisection as a means whereby human suffering may be alleviated, and only those who are blinded by ignorance or prejudice would dare deny that hundreds of sufferers from goître, and other distressing symptoms of cretinism, have obtained relief solely through experimental research upon animals. Inconsistency is closely linked to prejudice, and the greatest anomaly is the Anti-Vivisectionist who, while objecting to the alleviation of human suffering on the score of "cruelty to animals," enjoys and countenances, for the gratification of his or her own individual pleasures, the most horrible cruelty and torture to helpless creatures. Only a few of such cases now occur to me, and these I herewith append, but there are many others as disgustingly cruel.

Boiling lobsters, prawns, etc., *alive.*

"Whitening and tendering" veal by bleeding, and beating with sticks, the calf *while still living.*

Skinning and cooking eels *alive.*

Maiming, and shattering to pieces, pigeons and other birds ("sport"), hundreds dying a lingering death.

Hacking and mauling rabbits by gins.

Hounding to death harmless hares, and exulting over this torture ("sport").

Plucking feathers from *living* birds, and skinning *living* animals.

When every professed anti-vivisectionist undertakes to endeavour to put a stop to these, and similar cruelties, their sincerity will at least be visible.

Bournemouth, July 24. CECIL CARUS-WILSON.

A Correction.

IN my "Preliminary Note," as read at the Royal Society meeting, June 15 last (NATURE, vol. xlviii. p. 311), the first paragraph reciting "The laws connecting pairs of axes, by successive rotations round which a given displacement of a rigid body in space may be effected," should read: "If the first axis is taken arbitrarily in a plane parallel to that of the 'central axis,' and any given direction ζ' meeting it, to which latter the axis remains parallel, there is a direction determined to which its conjugate must be parallel, in the side common to three quadric cones the constants of which are functions of ζ' and the vectors defining the displacement and the position of the first axis."

The next two paragraphs will require slight modifications accordingly; and the last will, of course, be unnecessary.

I owe this correction to a correspondence with which Prof. W. Burnside, F.R.S., has favoured me since the meeting.

July 29. J. J. WALKER.

THE ASTRONOMICAL HISTORY OF ON AND THEBES.

In a previous article I have attempted to show that there was a considerable difference of astronomical thought between those, on the one hand, who built pyramids and temples facing true east and west and those, on the other, who built solar temples not oriented to the equinox, but rather, though not exclusively, to the solstice.

It was suggested that although in the matter of simple worship the sun would come before the stars; in *temple* worship the conditions would be reversed in consequence of the stable rising and setting places of the latter as compared with those of the sun at different times of the year.

Another suggestion was hazarded that sun temple-worship might have been an accidental result of the sunlight entering a temple which had really been built to observe a star; and that such temple sun-worship might possibly have preceded the time at which the solstices and equinoxes, and their importance, had been made out. I think it is possible to show that this really happened, and we owe the demonstration of this important fact to the Egyptian habit of having two associated temples at right angles to each other, because this habit justifies the assumption that at On the single obelisk which now remains not only indicates the certain existence in former times of one temple, but in all probability of two at right angles to each other.

But this is only one point among many to which one may appeal in approaching the study of the question. Another of great importance is brought before us in the masterly essay by M. Virey, entitled "Notices Générales," on the discoveries made at Der el-Bahari by MM. Maspero and Grébaut.

In his account of the confraternity of Amen and of the various attempts made by the Theban priests to acquire political power he refers to the action of Amenhetep IV. (Chu-en-Aten).[1]

In the time of Thotmes III. the alliance between the royal and the sacerdotal power was of the closest, and in no time of the world's history have priests been more richly endowed than were then the priests of Amen. Not content, however, with their sacred functions, they aimed at political power so obviously that Thotmes IV. and Amen-hetep III., to check their intentions, favoured the cults and priesthoods of On and other cities of the north. Amen-hetep IV. went further; he looked for alliances out of Egypt altogether, and entered into diplomatic relations with the princes of Asia, including even the king of Babylon. This brought him and the priests to open warfare. He replied to their anger by prescribing the cult of Amen. The name of Amen was effaced from the monuments, still the priestly party was strong enough to make it unpleasant for the king in Thebes, and to deal them yet another blow, he quitted that city and went to settle at Tell el-Amarna, at the same time reviving an old Heliopolitan cult. He took for divine protection the solar disc *Aton*, "which was one of the most ancient forms of one of the most ancient gods of Egypt, Rā of Heliopolis."[2] Now let us say that the time of Amen-hetep IV., according to the received authorities, was about 1450 B.C. The lines of the "Temple of the Sun" at Tell el-Amarna are to be gathered from Lepsius's map, the orientation is 13° north of west. This gives us a declination of 11° north, and the star Spica at its setting would be visible in the temple, and the sunlight at sunset would enter the temple on April 18 and August 24 of the Gregorian year.

Hence, then, the temple was probably built really to observe the sunset on a special day in the year. In this view how appropriate was the prayer of Aahmes, Chu-en-Aten's chief official.

"Beautiful is thy setting, thou sun's disk of life, thou Lord of Lords and King of the worlds. When thou unitest thyself with the heaven at thy setting, mortals rejoice before thy countenance and give honour to him who has created them, and pray before him who has formed them, before the glance of thy son who loves thee the King Khu-en-aten. The whole land of Egypt and all peoples repeat all thy names at thy rising, to magnify thy rising in like manner as thy setting."

Still perhaps more beautiful was the prayer of the queen.

"Thou disk of the Sun, thou living God! there is none other beside thee! Thou givest health to the eye through thy beams. Creator of all beings. Thou goest up on the eastern horizon of heaven to dispense life to all which thou hast created; to man, four-footed beasts, birds, and all manner of creeping things on the earth, where they live. Thus they behold thee, and they go to sleep when thou settest.

"Grant to thy son, who loves thee life in truth, to the lord of the land, Khu-en-aten, that he may live united with thee in eternity.

"As for her, his wife, the Queen Nefer-it-Thi, may she live for evermore and eternally by his side, well pleasing to thee; she admires what thou hast created day by day."[1]

Still the light of Spica would not enter it axially if the orientation is correct. This would have happened in 2000 B.C., that is 600 years before the time of Amen-hetep IV. This is a point which Egyptologists must discuss;[2] it is quite certain that such a pair of temples as those of which Lepsius gives us the plans could not have been completely built in his short reign, and they would not perhaps have been commenced on *heretical* lines in any previous reign during the 18th dynasty. It must therefore have been commenced before 1700 B.C., perhaps in the 17th dynasty In any case it was certainly finished by Chu-en-Aten.

But this "temple of the Sun" was not built alone. There was another at right angles to it, and while Spica was seen setting in one, a star near γ Draconis was rising in the other.

Remembering then that the temple attributed to Amen-hetep IV. pointed to Spica, let us recur for a moment to the temple conditions at Thebes. There, as we have seen, the temple of Mut is associated with one at right angles to it, facing north-west. The amplitudes are $72\frac{1}{2}°$ north of east and $17\frac{1}{2}°$ north of west. I have shown that the temple of Mut would allow γ Draconis to be seen along its axis about 3200 B.C. *I now state that* Spica *would be seen along the axis of the rectangular temple at the same time.*

We have next to consider what had taken place at Thebes, so far as we can trace it on the orientation hypothesis since 3200 B.C.; but to understand thoroughly what was done another reference to M. Virey's essay is necessary. One of the chief aims of the confraternity of Amen was to abolish the worship of Set, Sit, or Sutech, that is generically the stars near the north pole, and, as it can be shown, in favour of the southern ones. The temple of Mut was the chief temple at Karnak, in which the cult of the northern stars was carried on.

We can now realise what the Theban priests got Thotmes to do.

In his day the cult of Spica (the solar disc, Aton, Min, Khem), and γ Draconis (the Hippopotamus and Lion Isis) was supreme. The little shrine of the Theban Amen was enlarged and built right aross the fairway

[1] "Notices des Principaux Monuments Exposés au Musée de Gizeh," p. 260. 1893.

[2] Gizeh Catalogue, 1893, p. 68.

[1] Translated by Brugsch, "Egypt," p. 221.

[2] Since the above was written, Prof. Flinders Petrie has been good enough, in reply to an inquiry, to state his opinion that the temple was entirely built by Chu-en-Aten. Should this be confirmed, it may have been oriented directly to the sun, on the day named, or more probably built parallel to some former temple, for traces of other temples are shown on Lepsius' plan, and I presume Chu-en-Aten is not supposed to have built all of them.

of the temple of Mut, so that the worship was as effectively stopped as the worship of Isis was stopped at Pompeii by the town authorities (when it was prohibited by law), bricking up the window through which the star was observed.

Further, the shrine so restored was of such magnificence that the Spica temple, which had hitherto held first rank, became an insignificant chapel in comparison. Nor was this all. In order still to emphasise the supremacy of Amen, a third-rate temple was erected to Ptah.

We may now return to Amen-hetep's doings at Tell el-Amarna. The worship he emphasised there exactly resembled that which had in early times been paramount at Heliopolis. One based on it, but not identical with it, had been in vogue at Thebes from 3200 B.C. to the time of Thotmes, who, as the tool of the confraternity of Amen, intensified the solstitial worship, and did his best to kill that which had been based upon the Heliopolis cult.

The next question we have to consider is whether the researches at Heliopolis bear this surmise out. It is true we have but one poor obelisk, but let us see what we can make of it. As I have shown, the north and south faces bear 13° north of west—13° south of east. Amen-hetep or some one of the preceding kings of Egypt, when reintroducing the old worship at Tell el-Amarna orients the solar temple 13° north of west according to the data available. Now when we take the difference of latitude between Heliopolis and Tell el-Amarna into account we find that the same declination (within half a degree) is obtained from both.

I have elsewhere shown that there is good reason for believing that the original foundation of the temple at On dates from the time when the north member of the system was directed to α Ursæ Majoris. This was somewhat earlier than 5000 B.C.

Bearing in mind the facts obtained with regard to other similar rectangular systems, we are led to inquire whether at that date a temple oriented to declination 11° north was directed to any star.

We find that the important star Capella was in question.

Now so far in my references to stars no mention has been made of Capella. It is obvious that the first thing to be done on the orientation hypothesis is to see whether any other temple, and if of known cult so much the better, is found oriented to Capella. There is one such temple; it is the small temple of Ptah, just mentioned as having been erected by Thotmes. (Time of Thotmes III. 1600 B.C. Amplitude of temple ± 35° west of north = with hills 3° high $32\frac{1}{2}$° north declination; Capella 33° north declination about 1700 B.C.)

And now it appears there is another. During the year 1892 the officers of the Museum of Gizeh, under the direction of M. de Morgan, excavated a temple at Memphis to the north of the hut containing the recumbent statue of Rameses, and during their work they found two magnificent statues of Ptah, "les plus remarquables statues divines qu'on ait encore trouvées en Egypte,"[1] and a colossal model in rose granite of the sacred boat of Ptah.

These discoveries have led the officers in question to the conclusion that the building among the ruins of which these priceless treasures have been found is veritably the world-renowned temple of Ptah of Memphis. It may therefore be accepted as such for the purpose of the present inquiry, although it is difficult to reconcile its *emplacement* in relation to the statues with the accounts given by the Arab historians.

In January, 1893, Captain Lyons, R.E., was good enough to accompany me to determine the orientation of the newly uncovered temple walls. We had already, two years previously, carefully measured the bearings of the statues of Rameses. We found the temple in all probability facing westwards, and not eastwards, this we determined by a seated statue facing westwards; and its orientation, assuming a magnetic variation of $4\frac{1}{2}$° west—to be $12\frac{3}{4}$° north of west and the hills, in front of it, assuming the village of Mit-Rahineh non-existent, to be 50′ high.

Here, then, we get reproduced almost absolutely the conditions of the obelisk at Heliopolis in a Ptah temple oriented to Capella 5200 B.C.

We are driven then to the conclusion that the star Capella is personified by *Ptah*, and that as Capella was worshipped setting, Ptah is represented as a mummy. If this be so we must also accept another conclusion. That the temples both at Heliopolis and Memphis were dedicated to Ptah. About 5300 B.C. we seem almost in the time of the divine dynasties, and begin to understand how it is that in the old traditions Ptah precedes Rā and he is called "the father of the beginnings, and the creator of the egg of the Sun and Moon.[1]

What, then, was this worship which had been absent from Thebes, but which had held its own to the north to such an extent that Amen-hetep IV. went back to it so eagerly? It could not have been the worship of Capella as a star alone, for such worship had been provided for by Thotmes III. by building temple G. Nor could it have been the worship of Spica as a star alone, for in that case the precedent of On would not have been appealed to. We are driven to the conclusion that it was the worship of the sun's disc when setting, at the time of the year heralded by these stars, when it had the declination of 10° north. The dates on which the sun had this declination were, as already stated, about April 18 and August 24 of our Gregorian year. The former, in Egypt, dominated by the Nile, was about the time of the associated spring and harvest festivals.

So much for the Ptah mummy form of the Sun-God, to which the Theban priests erected no temples. There was still another, the worship of which existed at Thebes, but which they did their best to abolish by the intensification of the worship of Amen-Rā. I refer to the worship carried on in the temple oriented to Spica. This, there can be no doubt, was the worship of Min, Khem in ithyphallic mummy form. This was associated with the harvest home festival on May 1. (Amplitude of temple, $17\frac{1}{2}$ north of west, declination 15° = sun's declination on May 1.)

It seems, then, that the suggestion that *possibly* sun-worship existed before the solstitial solar worship is amply justified.

Now so far as my inquiries have yet gone, there is not above Thebes, with the single exception of Redesieh, any temple resembling the On-Thebes ones to which I have directed attention as having a high north-east amplitude.

Similarly, with one or two exceptions which may be late, there are no temples facing the south-east below Thebes.

In short, in Lower Egypt the temples are pointed to stars rising near the north point of the horizon or setting west of north. In Upper Egypt we deal chiefly with temples directed to stars rising in the south-east.

Here again we are in presence of as distinct differences in astronomical thought and methods of observation as we found among those who directed temples to the sun at the equinox, as opposed to those who worshipped that luminary at some other time of the year.

Now with regard to the northern stars observed rising in high amplitudes we have found traces of their worship in times so remote that in all probability at On

[1] New Gizeh Catalogue, p. 61.

[1] Brugsch, "Religion and Mytologie," p. 111. Pierret, "Salle Historique de la galerie Égyptienne" (du Louvre), p 199.

and Denderah α Ursæ Majoris was used before it became circumpolar. We deal with 5000 B.C.

Since undoubtedly *new* temples with nearly similar amplitudes (such as that denoted by M at Karnak) were built in late times, we find so long a range of time indicated that the utility of the stellar observations *from the yearly point of view* could scarcely have been in question.

It may be suggested therefore that the observations made in them had to do with the determination of the hours of the night; this seems probable, for in Nubia at the present day time at night is thus determined.

It may be that such stars as Canopus were used by the southern peoples for the same purpose as α Ursæ Majoris first and then γ Draconis were used by the northerners. In other words, the question arises whether the extreme north and south stars were not both used as warners of the dawn all the year round.

It is well known that in quite early times means had been found of dividing the day and night into 12 hours. In the day shadows cast by the sun, or sundials, might have been used, but how about the night?

We have seen that the Egyptians chiefly, if not exclusively, observed a heavenly body and the position of other bodies in relation to it, when it was rising or setting, so that it was absolutely essential that the body which they were to observe should rise and set. Everybody knows that as seen in England there are many stars which neither rise nor set. The latitude of London being 51°, the elevation of the pole therefore is 51°.

Hence, any star which lies within that distance from the pole cannot set, but sweeps round without touching the horizon at all. The latitude of Thebes being 25°, the distance from the pole to the horizon is much smaller, and so the number of stars which do not rise and set is much smaller. The stars which do not rise or set are stars near the pole, and therefore stars which move very slowly, and the stars which rise most to the north and most to the south are those bodies which are moving most slowly while they yet rise or set. Can this slow rate of motion have had anything to do with such stars being selected for observation, the brightest star to the north, most slowly moving, the brightest star to the south most slowly moving? It is possible that observations of these stars might have been made in such a way that at the beginning of the evening the particular position of γ Draconis, for instance, might have been noted with regard to the pole star: and seeing that the Egyptians thoroughly knew the length of the night and of the day in the different portions of the year, they could at once the moment they got the starting point afforded by the position of this star practically use the circle of the stars round the north pole as the dial of a sort of celestial clock. May not this really have been the clock with which they have been credited? However long or short the day, the star which was at first above the pole star, after it had got round so that it was on a level with it, would have gone through a quarter of its revolution.

In low northern latitudes, however, the southern stars would serve better for this purpose, since the circle of northern circumpolar stars would be much restricted. Hence there was a reason in such latitudes for preferring southern stars. With regard both to high north and south stars then, we may in both cases be in presence of observations made to determine the time at night. So that the worship of Set, the determination of the time at night by means of northern stars, might have been little popular with those who at Gebel Barkal and elsewhere in the south had used the southern ones for the same purpose, and this may be one reason why the Theban priests, representing Nubian astronomical culture and methods, were pledged to drive the cult of Sutech out of the land.

Since then the observations of γ Draconis might be used to herald the sunrise almost all the year round, and since the modern constellation Draco is the old Hippopotamus, we can readily understand Plutarch's statement that "Taurt presides over the birth of the sun," and why Taurt or Maut should be called the Mistress of Darkness.[1]

It does not seem too much to hope that the continuation of such inquiries may ultimately enable us to solve several points connected with early Egyptian history. We read in Brugsch:—[2]

"According to Greek tradition, the primitive abode of the Egyptian people is to be sought in Ethiopia, and the honour of founding their civilisation should be given to a band of priests from Meroë. Descending the Nile, they are supposed to have settled near the later city of Thebes, and to have established the first state with a theocratic form of government."

"But it is not to Ethiopian priests that the Egyptian Empire owes its origin, its form of government, and its high civilisation; much rather was it the Egyptians themselves that first ascended the river to found in Ethiopia temples, cities, and fortified places, and to diffuse the blessings of a civilised state among the rude dark-coloured population."

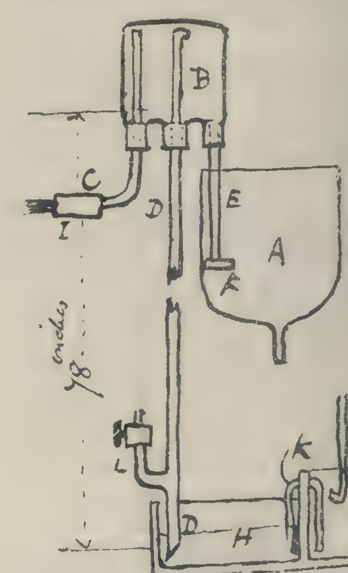
. . . "Strange to say, the whole number of the buildings in stone, as yet known and examined, which were erected on both sides of the river by Egyptian and Ethiopian kings, furnish the incontrovertible proof that the long series of temples, cities, sepulchres, and monuments in general, exhibit a distinct chronological order, of which the starting point is found in the pyramids, at the apex of the Delta."

J. NORMAN LOCKYER.

(*To be continued.*)

A PERIODIC MERCURY PUMP.

I HAVE designed and constructed the instrument described in the following lines to reduce the labour of working pumps of the Sprengel class. It has proved itself to be so serviceable in our laboratory that I believe a short descripion of it may be useful to those who



are engaged in work in which the mercurial pump is employed.

A is the cistern of the Sprengel pump (not shown), B is a bottle having three necks: it is furnished with three tubes, C, DD, EF; C, which has a valve at I, is attached

[1] Rawlinson, i. 337.
[2] "Egypt under the Pharaohs," ed. 1891, p. 3.

to an ordinary water-pump through a wash bottle containing sulphuric acid (I find that which is known as the University College pump the best); EF dips into the cistern A, and is closed at its end F by a small glass ball fitting the ground out end of the tube which acts as a valve. The tube DD dips in the cistern H into which the mercury from the Sprengel pump is discharged. The siphon K causes the supply of mercury to be periodic; upon this the action of the pump depends. By means of a stopcock L air is admitted to the tube DD. The mercury is raised thus: A partial vacuum is formed in B by the water-pump; this raises the mercury to the point where L joins DD; a piston of mercury is then formed, and it is at once carried up into B; this goes on till all the mercury in H is raised to B, then air is drawn through DD and the vacuum ceases in B, and the mercury falls through EF; in a short time H refills, and the operation is repeated.

The instrument at work in my laboratory raises 90 lbs. of mercury 6·5 feet high in one hour. The pump requires no attention after it has been started. The valve I stops the tube C, should the supply of water to the water-pump be accidentally cut off when the pump is lifting. I have made many experiments with mercury elevators, and from these it appears that the periodic supply of mercury to the cistern from whence it is drawn greatly contributes to the certainty of the action of the instrument.

FREDERICK J. SMITH.

THE LATE DR. JOHN RAE.

DR. JOHN RAE, F.R.S., whose death we announced last week, was perhaps the most persevering and successful of the Arctic travellers by land whose journeys called forth the admiration of the world forty years ago. He was a native of Orkney, born in 1813, and studied medicine at Edinburgh, where he qualified in 1833. Rae was early brought face to face with his life-work, his first engagement on leaving college being as surgeon to the Hudson Bay Company's ship which carried supplies to the fur-forts in Hudson Bay. He entered the service of the company, and for ten years lived at Moose Factory, gaining familiarity with Arctic life during the severe winters. In 1845 his true career as an Arctic explorer began in his undertaking the leadership of a small expedition to explore a considerable extent of the coast-line of the Arctic Sea. In June, 1846, he set out on this expedition from York Factory, coasted along the west side of Hudson Bay, and wintered on the shore of Repulse Bay. Early in 1847 he made an extensive land journey to the north and west, with the result that 700 miles of new coast were surveyed, almost filling the gap between Ross's work in Boothia and Parry's at Fury and Hecla strait. In 1850 Dr. Rae published an account of this expedition in the form of a book of 250 pages. This was, curiously enough, his only permanent contribution to geographical literature, his subsequent journeys being recorded merely in formal reports published in the *Journal* of the Royal Geographical Society. After this journey Rae came to London, but was almost immediately induced to join the first land expedition sent to seek for Sir John Franklin, under the leadership of Sir John Richardson. The expedition was unsuccessful as to its primary purpose of finding traces of Franklin, but it effected a satisfactory survey of the whole coast between the Mackenzie and Coppermine rivers. In 1851 Rae received the command of another boat expedition for the Hudson Bay Company, in the course of which he thoroughly explored and mapped the south coast of Wollaston Land and Victoria Land, still searching vainly for traces of Franklin's party. On his return from this arduous undertaking, which he conducted throughout with conspicuous daring and sagacity, he had to travel on snow-shoes, and himself dragging a sledge, across the whole length of Canada from the Arctic Sea, through Fort Garry (now Winnipeg) until he reached United States territory. His total walking on this expedition was over 5000 miles, of which 700 miles were traversed for the first time. On returning to England in 1852 the gold medal of the Royal Geographical Society was presented to him by Sir Roderick Murchison in a speech, the cordial terms of which showed how fully Dr. Rae's genius for Arctic travel with the minimum of equipment and at infinitesimal expense was appreciated by the highest authorities. In no wise deterred by the hardships of his earlier campaigns, Rae left England early in 1853 to continue his work in the far north; the Hudson Bay Company equipping an expedition on condition that he would lead it personally. He completed the survey of King William's Land on this occasion, proving it to be an island; 1100 miles of sledging were accomplished in the process, of which 400 miles were new discovery. But the really important result of this expedition was Dr. Rae's meeting with the first evidence of Sir John Franklin's fate, from the story of a party of wandering Eskimo. The tribe encountered were in possession of many personal relics of members of that ill-fated expedition, which Rae secured and brought home. When he returned to England with the news so long searched for and so anxiously awaited, the Admiralty, which had spent large sums in fitting out successive expeditions, concluded that the fate of Franklin was decided beyond a doubt, and accordingly awarded to Dr. Rae the sum of £10,000 offered by Government to the first who brought back decisive information. The justice of this award was at the time strongly objected to by Lady Franklin, and although no further action was taken by Government she continued to organise private expeditions, which, while proving in effect the correctness of Dr. Rae's information from the Eskimo, served in no small degree to advance the geographical survey of the polar area.

In all his expeditions, Dr. Rae made collections of characteristic plants and animals as well as physical and meteorological observations. The material, described by other workers, went to swell the sum of our knowledge of the general conditions of climate and life in the Arctic basin.

In 1860 and subsequent years Dr. Rae made a series of interesting journeys in Iceland, Greenland, and in North America with the object of exploring and arranging routes for telegraph lines. His later years were spent in this country, where he made himself conspicuous by his zeal in forwarding the volunteer movement, being himself an excellent shot. The feeling which grew upon him to a painful extent as he became older, that his brilliant explorations were not adequately recognised and acknowledged on the Admiralty charts, unfortunately somewhat embittered his last years. But to the end he took the keenest interest in Arctic travel and was ever ready to take part in discussions bearing on the region in which he had lived so long and suffered so much. He was a regular attendant at meetings of the Royal Geographical Society and Colonial Institute, and for many years attended the gatherings of the British Association.

NOTES.

THE Senate of Edinburgh University has conferred the honorary degree of Doctor of Laws upon Prof. Arthur Auwers, in recognition of his astronomical labours. The same honour has been given to Dr. Littlejohn, the President of the British Institute of Public Health.

A Reuter's telegram states that a cloud-burst occurred at Pueblo, Colorado, on July 28, and destroyed property to the value of 25,000 dols. Seven lives were lost. The Arkansas River for many miles was turned into a raging torrent. The buildings along the river, comprising small boarded shanties, tents, and houses occupied by workmen, proved an easy prey to the rising waters. The storm extended over a large area, and at Denver the electric street cars were prevented from running by the electrical disturbances.

We are glad to see that an attempt is being made to bring together members of the Royal and learned societies by the formation of a club in which membership will be limited exclusively to presidents, members of council, fellows, and members of the principal Royal and learned societies of the United Kingdom, India, and the colonies, academicians and associates of the Royal Academies, together with the presidents, members of convocation, council, and professors of the Universities and various Royal institutions. The club has already been joined by many distinguished men in science, art, and literature, and forty societies are represented either by past presidents, vice-presidents, presidents, and members of council. Premises comprising the whole of the block No. 63, St. James's Street, have been secured for the club house, which is expected to be ready for occupation early in October. The temporary offices are at 3, Waterloo Place, Pall Mall. Colonel W. P. Hodnett is the hon secretary.

The sixty-first annual meeting of the British Medical Association commenced at Newcastle-on-Tyne on Tuesday. The committee on hypnotism presented a report stating that they had satisfied themselves of the genuineness of the hypnotic state, but, after a discussion, the congress decided to receive the report without adopting it. In the evening Prof. Philipson, of Durham University, delivered an address, in which he described the diseases prevalent among mining populations, and suggested means by which to improve the machinery for guarding public health.

The Congress of the British Institute of Public Health met on July 27 at Edinburgh, and the Presidential address was delivered by Dr. Henry D. Littlejohn. On the following day Mr. Ernest Hart read a paper on "Cholera Nurseries and their Suppression." Mr. Hart claims to have established on a basis of evidence collected from every part of Europe the dicta—founded upon the original investigations by Snow and Simon on the British epidemics of 1848 and 1854, and by himself and Radcliffe of the East London epidemic of 1866. 1. "That cholera is a filth disease, carried by dirty people to dirty places, and diffused by specifically poisoned water." 2. "That you may eat cholera and drink cholera, but you cannot catch cholera." 3. "That cholera may be considered for all practical purposes as an exclusively water-carried disease, and that it is carried only by water poisoned by human discharges." Mecca is the nursery of cholera, holds Mr. Hart, and is the place in which to stop it. He formulates the following steps which ought to be taken to save the Mohammedans from the danger caused by their pilgrimages, to save the world from the danger caused by Mecca. 1. The Indian sanitary services should be re-organised. 2. A complete sanitary regulation of all Indian fairs should be undertaken, the precautions so successfully instituted at Hurdwàr in 1891 being taken as a type. 3. A rigid system of medical inspection of all pilgrims should be instituted at the ports from which they start, the sick being detained and the healthy alone allowed to proceed. This, it may be added, would be all the more effectual in regard to Indian ports from the fact that a second weeding out of the infected can take place at Camaran. 4. The medical inspection at Camaran should be so conducted as to ensure its complete efficiency. A large number of communications were read in the various sections, but the majority of them were not of general scientific interest. The congress was brought to a close on the afternoon of July 31.

In the August number of the *Entomologist's Monthly Magazine* Lord Walsingham gives a description of the manner in which the late Mr. Stainton's collection of *Lepidoptera* have been disposed by the Trustees of the British Museum to whom they were presented. The collection is now accessible to students at the Natural History Museum. With regard to a large cabinet containing a great number of European and exotic *Tineidae*, Lord Walsingham writes: "It has been determined, after making an inventory, to keep the contents of this cabinet for the present undisturbed, although it is hoped that they may be incorporated from time to time in the future together with other material: for instance, my own collection (including that of the late Prof. Zeller) left by my will to the Museum; the *Grote* collection, still untouched as regards the *Tortricidae* and *Tineidae*; and the Frey collection, lately purchased by the trustees."

In a letter to the *Times* the Vicar of Selborne solicits subscriptions in order to supply water to the village from the well-head eulogised by Gilbert White. The sum required to do this is only £300, of which about £30 has been collected. A Selborne water supply would be an excellent memorial to White, and there should be little difficulty in raising the modest amount which would lead to its realisation.

The Institution of Mechanical Engineers opened its summer meeting, on Tuesday, at Middlesbrough, under the presidency of Dr. W. Anderson, and a discussion took place on recent developments in the Cleveland iron and steel industries.

A meeting of the Yorkshire Naturalists' Union will be held at Hellifield on August 7, for the investigation of the valley of the Ribble from Gisburn to Sawley Abbey.

It must be gratifying to writers in English journals of science to know that their literary labours are read and appreciated on the other side of the Channel. The current number of a French scientific journal of some standing contains translations of two articles that have appeared in these columns, running altogether into nearly six pages. There are also eight notes which have the same derivation. Every one knows that the code of journalistic ethics is more respected in the breach than the observance, yet it is rarely that one journal reprints an article which has appeared in another without acknowledging the original source. However, even the briefest form of acknowledgment is omitted in the case of the articles and notes to which we have referred. This is probably unintentional, for no editor with any regard for the reputation of his journal would purposely omit reference to his contemporary, though he might, of course, overlook the omission.

Though the feathered tribe of St. James's Park pass an existence remarkably free from danger, their lives are not without vicissitudes, if one may judge from a letter by Mr. T. Digby Pigott to the *Times*. It appears that on July 8 a dabchick's nest broke from its moorings in the dipping boughs of a black poplar, and drifted into the open. For twelve days the hen bird, who was sitting on the nest at the time of the accident, was buffetted about on the waters, yet she remained at her post. Her constancy received a reward which she doubtless regarded as sufficient recompense for all the anxiety, for she floated safely back to the place where her raft was built with two newly-hatched balls of down on her back. Was there ever a dabchick that had such a happy return from so long and adventurous a voyage?

A violent sandstorm occurred at Bärwalde, Pomerania, in the afternoon of April 30 last. A correspondent writing to *Das Wetter* for June states that after a fairly bright morning, with a light wind from south-east, the wind suddenly shifted to south-west, accompanied by heavy rain clouds. At about 2 p.m. some reddish-grey bands, such as are usually seen with hail-storm clouds, were observed, and rapidly spread over the sky. The whole air was literally filled with sand which the storm had apparently carried from a mountain about half a mile distant, and objects a hundred paces off were almost invisible. The phenomenon only lasted five minutes, after which time rain fell and cleared the atmosphere.

Although some large amounts of rain have fallen in part of these islands during July, the month, as a whole, has not been exceptionally wet. The greatest excess has been in the south of England, where the fall amounted to about 2·5 inches above the average; at Cambridge the excess was 1·4 inch, and in the north of Scotland 1·3 inch. In parts of the country, however, the stations reporting to the Meteorological office showed a considerable deficiency, amounting to 1·11 inch at Holyhead, 1 inch at Leith, and 0·9 inch at Yarmouth and Valencia, while in the neighbourhood of London the deficiency was about 0·3 inch. The temperature recorded at Greenwich for the month was 2° above the average of the last 50 years; on five days the readings exceeded 80°.

The Royal Meteorological Institute of the Netherlands has issued the second part of an atlas of observations made in the Indian Ocean, for the months of March, April, and May, the part for the first quarter having been published about three years since. The work has been drawn up with great care, the observations having been carefully examined for instrumental errors, and the data supplied by their own observers have been supplemented by observations from the London Meteorological Office, so that the results are both reliable and fairly complete. Among the principal charts we may mention those of the surface temperature of the sea, in which the limits of the warm and cold currents are clearly marked, especially to the south of the Cape of Good Hope. The currents of the ocean are represented by six charts, showing in two colours the observations plotted in position, and also arrows showing the general drift. The isobaric curves show a certain regularity in the monthly changes; for instance, there is a small centre of high pressure, 30·2 inches, in March, between 33° and 38° S. lat., and 87° and 91° E. long., while the isobar of 30·1 inches only extends from long. 82° to 102° E. In April this isobar extends over the whole Southern Indian ocean, from Africa to Australia; that of 30·2 inches also extends over the same area, while a centre of 30·3 inches is found at lat. 30° S., between 90° and 95° E. long. In the month of May the conditions are nearly similar to those of March; the centre of 30·3 inches has disappeared, the isobars of 30·2 inches and 30·1 inches lie more to the north, and another centre of 30·1 inches is formed, which extends from the coast of Africa to 75° E. long. The charts of air temperature are very similar to those of the sea-surface temperature, the temperature of the air being rather lower than that of the water.

The success which followed Loeffler's attempt to root out the mouse plague in Thessaly by means of his *bacillus typhi murium* has not apparently been so uniform in other and similar epidemics. But Loeffler, although quite recently acknowledging its failure in some cases, does not attribute this to any shortcomings in his bacillus, but rather to the lack of care and intelligence in those entrusted with the carrying out of the plan of campaign. The question has been reopened quite lately by the publication in a Stuttgart paper of some investigations made by Lüpke on the efficacy of Loeffler's microbe. According to these researches, the bacillus in question is not endowed with all the virtues which have hitherto been ascribed to it, and Lüpke states that although in his experiments weakly mice succumbed, some rapidly, and some only at the end of fifteen days after being fed with it, vigorous specimens invariably resisted its action, and, further, were rendered immune, so that even subcutaneous inoculations of the bacillus failed to destroy them. In consequence of these results Laser (*Centralblatt f. Bacteriologie*, vol. xiii. May, 1893) has brought forward an organism, *bacillus der Mäuseseuche-Laser*, which he isolated during an epidemic which broke out amongst the mice kept for experimental purposes in the hygienic laboratory at Königsberg. This bacillus threatens to become a formidable rival to Loeffler's microbe, for, apparently, whilst its action on field mice is more rapid and more certain than the latter, it is quite as harmless to other animals such as horses, guinea-pigs, pigeons, cats. The experiments require, however, further expansion and confirmation, and it is to be hoped that Laser will pursue his investigations, which may lead to the discovery of a satisfactory means of suppressing the farmers' *bête-noire*.

It has been proved during the last few years that at depths of more than 100 fathoms, the water of the Black Sea contains so much sulphuretted hydrogen that it is totally unfit for organic life. The amount of sulphuretted hydrogen increases with depth, and attains 655 cubic centimetres in one hundred litres at a depth of 1185 fathoms. In order to determine whether this gas is a product of micro-organisms, samples of ooze, which had been brought to the surface by Thomson's apparatus from various depths of 16, 40, 389, 870, and 1207 fathoms, have been carefully analysed at the Odessa bacteriological station. The analyses show that the ooze contains several different species of micro-organisms, all of which are capable of producing sulphuretted hydrogen. One of these is endowed with this capacity to a high degree. Its dark coffee-coloured pigment gradually becomes black when the microbe is cultivated on agar-agar with free admission of air; but its elongated, mobile rods an live under anaërobic conditions as well, and in such a case the exhalation of sulphuretted hydrogen is increased. The name of *Bacillus hydrosulfuricus Ponticus* has been given to the microbe. Further research has proved that the bacillus remains active, not only in cultures of albumen substances, but also in such as contain no sulphur of organic origin, but only mineral sulphates (gypsum), and sulphites. The multiplication of this bacillus thus does not require an accumulation of considerable amounts of decaying animal matters at the bottom, for it lives chiefly upon the cellulose of vegetable remains, and breathes the oxygen of the sulphates of mineral origin which it decomposes.

Six samples of ice obtained from London depôts and restaurants have been subjected to chemical and bacteriological analysis in the *Lancet* laboratory. The outcome of the inquiry is stated as follows:—"(1) By far the greater proportion of ice supplied in London is natural (generally Norwegian). Of the specimens procured only one had been produced artificially, and this specimen gave indifferent results on chemical analysis, but results of an eminently satisfactory kind in the light of bacteriological inquiry, practically no development of colonies of organisms taking place on culture. (2) Two out of five specimens of ice imported into this country from Norway, whilst yielding a satisfactory chemical analysis, were decidedly bad according to bacteriological examination, the number of colonies of organisms counted on culture varying from 400 to 700 per cubic centimetre of the melted ice. (3) Three out of five specimens of imported ice, though furnishing no condemnatory evidence on chemical examination, yielded bacteriological results such as might under certain circumstances give rise to suspicion, though they may be regarded as of fairly good quality." It is therefore urged that ice for table use should always be produced by the artificial freezing of freshly-distilled or sterilised water.

In the "Monthly Report of the Maryland State Weather Service" for May, 1893, Prof. W. B. Clark again refers to "The Leading Features of Maryland Climate" (see Nature, vol. xlvii. p. 585), giving tables of temperature, rainfall, &c. The same parallels of latitude show great variations in climate due to the complexity of the surface configuration.

In the same Report Prof. Clark describes "The Available Water-power of Maryland," only a small portion of which is at present utilised. Most of this occurs in the Piedmont Plateau, the central area of Maryland bounded by the Coastal Plain and the Appalachian Region. The north fork of the Potomac, draining an area of about 1300 square miles, has a maximum discharge of over 700 times its minimum. This great variability, which is nearly fatal to the extensive use of water-power on this river, is attributed to the absence of lakes, the steepness of the mountain-sides, and the narrowness of the valleys. Some of the tributaries of the north fork are fairly constant in flow.

We learn from the *Botanical Gazette* that the University of Minnesota has established an inland biological station at Gall Lake, in Minnesota. The laboratory of marine biology of the University of Pennsylvania, at Sea Island City, New Jersey, is now open for its third summer session. The same journal informs us that Baron von Müller is intending to publish a volume which shall complete Bentham's "Flora Australiensis."

Messrs. Krigar Menzel and Raps have contributed another instalment of their work on the motion of vibrating strings to the Prussian Academy of Sciences. Their beautiful experiments on the continued vibrations of bowed strings have been supplemented by the photographic study of the peculiar motions exhibited by plucked strings. To confine the vibrations strictly to one plane, and also to control the instant of exposure, a special plucking apparatus was designed. The string was kept resting against a small plate in the vertical plane by means of a hook which could be released by pressing upon a lever. The motion of the lever also closed a circuit which released the instantaneous shutter of the camera. The wire vibrated in front of a slit illuminated by an arc light, an image of the slit being projected upon the wire so that the screen of the camera showed a well-defined bright slit interrupted by a dark spot where it was crossed by the wire. This dark spot would vibrate during the oscillation of the string, and a trace of its motion was obtained by receiving the image upon a revolving drum covered with bromide emulsion paper. The point at which the string was plucked was determined by observing the interval between the sounds emitted by the two parts on either side of the hook. Different vibrating points along the string were photographed, and beautiful white-on-black traces were obtained. The general type of these is represented by a zig-zag line with straight flat portions at the top and bottom of each wave. All the component lines are straight, showing that the point of the string moved from one extreme of displacement to the other at constant velocity, then had a period of complete rest, and afterwards returned to the first position, again at constant velocity. As the vibrations succeeded each other, the top and bottom portions gradually slanted towards the middle, some of them showed ripples, and the up and down lines exhibited a slight convexity towards the left, *i.e.* the past. The authors further showed that all these observations are to be explained by the accepted theory of the vibration of strings, as worked out by Kundt and others.

The last number of the *Journal* of the Institute of Electrical Engineers contains an important paper by Mr. W. B. Sayers on the prevention and control of sparking; continuous-current dynamos without winding on the field magnets, and constant-pressure dynamos without series winding. Both Mr. Swinburn and Mr. Esson have given expressions for the maximum load, which can be carried without sparking, in terms of the ampere-turns upon the armature, the length of the air-space, the angle subtended by the polar surfaces of the field magnets, and the forward induction. Thus in ordinary ring and drum armature machines the considerations of sparking limit some of the most important elements in the design of the machine. So that the lightening of machines by putting the conductors in tunnels, reducing the air-space to a mere clearance, which is the condition in which minimum exciting force is required, has not been hitherto practicable. In order to secure the sparkless reversal of the commutator section under the collecting brush at any desired place between the horns of the pole-pieces, the author has designed a machine whose chief peculiarities are as follows:—The air-space is a mere clearance—one millimetre. The reversal of the sections is effected by inductors, or coils, which he calls commutator coils, and are independent of the winding. These commutator coils are not inserted in the closed or re-entrant circuit of the ring or drum, but are inserted in the connections that run at intervals from the re-entrant winding to the several bars of the commutator. The function of these coils is to furnish electromotive forces that will balance those due to back-induction and self-induction in the sections as they are successively reversed. These commutator coils are so arranged as to be acted on by the pole-tip which is strengthened by the armature current, and the brushes of the machine when run as a generator are set with a backward lead instead of a forward one. These auxiliary coils also permit of the reversal of the armature sections just after they have emerged from under the strengthened pole, the result being that those turns of the armature which have hitherto been called back turns become forward turns, and the effect of the cross induction is to increase the reversing field instead of to diminish it. The machine is self-exciting by means of the armature windings only, that is, it generates a current without any winding on the field magnets, which may, therefore, more properly be called keepers, and runs absolutely without sparking at the brushes.

Apparently Humboldt's description of the combats designedly brought about between wild horses and electric eels, in order to effect the capture of the latter, has to go the way of many others. A writer in the *Spectator*, who has travelled on the llanos of Caracas—the scene of Humboldt's account—says that he failed to find any confirmation of this method of capture. He adds that those who have investigated the matter have come to the conclusion that *trembladores*, as the eels are termed, could not be taken with the help of horses. The method of capture usually adopted is by nets, and it is found that by wearing indiarubber gloves, the fish can be handled with impunity.

The *Photographic Annual* for 1893, edited by Mr. Henry Sturmey, has been published by Messrs. Iliffe and Son. It is a remarkably fine production, and contains a vast store of information of interest to all concerned with photography and its various applications. Among articles of bibliographical importance we note one on the progress of photographic chemistry during 1892, by Mr. C. H. Bothamley, and Mr. Albert Taylor's concise description of all that was done in astronomical photography during the same year. Photography in relation to meteorology is the work of the late Mr. G. M. Whipple; and Mr. Chapman Jones is responsible for a portion of the volume devoted to photographic optics. In addition to this section on the making of photographic history, there is one containing articles on "Practical Subjects by Practical Men," which consists chiefly of "dodges" devised by devotees of the art. Numerous excellent specimens of half-tone engravings embellish the pages of the book, and render it one of the best publications of its kind. Another excellent work of the same kind as the preceding is the "Annuare Général de la Photographie," published under the auspices of the International Union of Photography and the National Union of Photographic Societies in France. Some of the illustrations in it are marvellous examples of photographic reproduction.

MESSRS. SIMPKIN, MARSHALL, AND CO. have published a pamphlet by Mr. John Sime containing an account of the work of Sir Francis Ronalds, F.R.S., in connection with electric telegraphy. In an essay, entitled "Descriptions of an Electrical Telegraph," published as early as 1823, Ronalds gave an account of his experiments in sending signals through a line of overhead wires erected in 1816 in the garden of the house at Hammersmith now occupied by Mr. William Morris, the distinguished poet. A tablet commemorating the fact has been placed on a wall of the house. Says Mr. Sime—"Twenty years before Wheatstone and Cooke or Morse had patented their improvements in the telegraph—indeed, while the first two were respectively lads of twelve and fourteen years of age—Ronalds had sent messages over *eight miles* of overhead wires of his own construction, and had laid and worked a serviceable underground line of telegraph of sufficient length to demonstrate the practicability of communication by telegraph between long distances."

THE first part of "A Study of the Languages of Torres Straits," with vocabularies and grammatical notes, was read before the Royal Irish Academy two years ago by Mr. Sidney H. Ray and Prof. A. C. Haddon. The paper has been reprinted, and is published by the Dublin University Press. It is of scientific importance, because a study of the languages in the neighbourhood of Torres Straits must throw some light on the relations between Papuans and Australians. The three Papuan languages of the district with which the authors deal are (1) the Miriam; (2) the Saibai; (3) the Daudai.

MR. AUBREY RICHARDSON, a son of Sir B. W. Richardson, F.R.S., has brought together the ancient and modern law relating to cremation, together with the rules and regulations of various cremation societies at home and abroad, in a book entitled "The Law of Cremation," published by Messrs. Reeves and Turner. All interested in the legal aspect of cremation would do well to obtain it.

TWO more volumes of the excellent series of reprints being published by Engelmann, of Leipzig, have been issued. No. 41 is Dr. Kölreuter's "Preliminary notice of some experiments and observations on the Sex of Plants" (1761–1766), and No. 42 contains a communication made by Humboldt and Gay-Lussac in 1805 on "The Volume Law of Gaseous Compounds."

THE annual report of the Connecticut Agricultural Experiment Station for 1892 has been received. Among the investigations carried on during the year, was one dealing with the chemical composition of different parts of the tobacco plant in different stages of growth, and another on the chemical changes which take place in tobacco during the fermentation in the case.

MESSRS. W. COLLINS, SONS, AND CO. have issued an "Acoustics," by Mr. W. Lees. It is an extension of the portion devoted to sound in the author's book on "Sound, Light, and Heat," and is adapted to meet the requirements of the new syllabus of the Science and Art Department.

"ELECTRICAL ENGINEERING"—an illustrated monthly magazine published in Chicago—gives in each number an excellent synoptical index of current electrical literature.

A NEW edition of "Practical Solid Geometry," by Mr. J. Payne, that has just been published by Mr. Thomas Murby, contains, in addition, a section on graphic arithmetic and statics by Mr. J. J. Prince.

MESSRS. CHARLES GRIFFIN AND CO. have issued a second edition of Prof. Grenville A. J. Cole's useful book, "Aids to Practical Geology."

WE have received the second volume of "Faunæ Mediterraneæ," in which Mr. J. C Carns continues his descriptive lists of animal life in the islands of the Mediterranean Sea.

THE Museum and Laboratory report of the Colonial Museum and Geological Survey of New Zealand has been issued.

AN interesting memoir upon the action of liquefied ammonia on the anhydrous chlorides of chromium and iron is contributed by Prof. Christensen, of Copenhagen, to the *Zeitschrift für Anorganische Chemie*. The products of the reaction in the case of chromium are two of the best known of the remarkable ammoniacal compounds of that metal, namely those to which the somewhat formidable names of purpureo- and luteo-chromium chloride have been given, which compounds have consequently now for the first time been obtained by direct synthesis. Purpureo-chromium chloride may be represented empirically by the formula $CrCl_3 . 5NH_3$; its constitution, however, is usually represented as $ClCr . 5NH_3 . Cl_2$, inasmuch as two of the chlorine atoms are much more readily replaceable than the third. The compound crystallises in small carmine-red octahedrons. Luteo-chromium chloride contains one more molecule of ammonia in its composition; it is represented empirically by the formula $CrCl_3 . 6NH_3$. It is a very soluble substance, but yields a precipitate of the nitrate with nitric acid, which takes the form of lustrous yellow plates. The synthetical experiments of Prof. Christensen were briefly as follows:—A small quantity of violet chromium chloride, previously thoroughly dried at 100°, was placed in a small glass beaker immersed in a freezing mixture consisting of solid carbon dioxide and ether, and liquid ammonia (NH_3) was slowly added to it. No reaction was found to occur at this temperature, but upon removing the beaker and contents from the freezing mixture and warming it with the hand, at the moment when the temperature approached that of the boiling-point of ammonia ($-38°·5$), a sudden interaction took place, accompanied by a hissing noise, and resulting in the conversion of the chromium chloride into a red mass largely consisting of the purpureo-chloride. The excess of ammonia was usually eliminated as gas, but if a very large excess was employed a portion of it remained as unchanged liquid capable of reacting with a further quantity of chromic chloride. At the conclusion of the reaction the product was washed with cold water and hydrochloric acid, finally dissolved in water and the solution allowed to fall into concentrated hydrochloric acid, in which the purpureo-chloride is insoluble, when the small red crystals of the pure salt were precipitated. The first aqueous washings of the product of the reaction were always yellow and yielded a yellow crystalline precipitate of the luteo-nitrate upon the addition of concentrated nitric acid. Hence the product of the action of liquid ammonia upon anhydrous chromic chloride would appear to consist of both purpureo- and luteo-chromic chloride, the latter, however, in smaller quantity than the former. The reaction between anhydrous ammonia and chromic chloride occurs only between comparatively narrow temperature limits. At the ordinary temperature gaseous ammonia is without action. If the chloride is cooled by a mixture of ice and salt, there is a minute quantity only of purpureo-chloride produced after a considerable length of time. Even when a freezing mixture of crystallised calcium chloride and ice is employed, the amount of interaction is but insignificant. It is only in the neighbourhood of the boiling-point of ammonia ($-38°\cdot5$) that the vigorous reaction above referred to occurs, and the action practically ceases immediately above and below this point.

PROF. CHRISTENSEN has made the further interesting observation that anhydrous ferric chloride, $FeCl_3$, likewise reacts with liquefied ammonia. The reaction occurs the moment the liquid touches the chloride, even when surrounded by a freezing mixture of solid carbon dioxide and ether. The product of the reaction is an orange compound probably consisting of an ammoniacal compound analogous to purpureo-chromic chloride. It is, however, more unstable than the latter compound, rapidly evolving ammonia at the ordinary temperature, and it is completely decomposed by water, even the moisture of the air rapidly converting it into a mixture of ferric oxide and sal-ammoniac.

NOTES from the Marine Biological Station, Plymouth.—Last week's captures include the Polyclad *Prostheceræus vittatus*, the Crustacea *Idotea linearis*, *Schistomysis spiritus*, *Crangon trispinosus*, *Polybius Henslowii* and *Portunus holsatus*, and the Mollusca *Calyptræa chinensis*, *Polycera Lessonii* and *Galvina Farrani*. In the floating fauna there has been a marked increase in the numbers of the Siphonophore *Muggiæa atlantica*, which has been present in the townettings from time to time for several weeks past. The larvæ of the Polychæte *Chætopterus insignis* have made their first appearance for the year, and numbers of the Dinoflagellate *Peridinium* and of Echinoid *Plutei* have also been taken. The following animals are now breeding :—The Polychæte *Chætopterus insignis*, the Isopod *Idotea linearis*, the Schizopoda *Mysidopsis gibbosa* and *Schistomysis spiritus*, and the Decapod *Crangon trispinosus*.

THE additions to the Zoological Society's Gardens during the past week include a Yaguarundi Cat (*Felis yaguarundi*), a Brazilian Hare (*Lepus brasiliensis*) from Brazil, presented by Mr. J. E. Wolfe, C.M.Z.S. ; a Common Paradoxure (*Paradoxurus typus*) from India, presented by Mrs. Oswald Walmesley ; two Azara's Foxes (*Canis azaræ*), a Crab-eating Raccoon (*Procyon cancrivorus*) from South America, presented by Lord Lilford, F.Z.S. ; two Common Foxes (*Canis vulpes*) British, presented by Mr. Reginald Chandos Pole ; a Red Deer (*Cervus elaphus*, ♀) British, presented by Mr. C. J. H. Tower, F.Z.S. ; a Spotted Eagle (*Aquila clanga*) from India, presented by Lord Lilford, F.Z.S. ; a Golden Eagle (*Aquila chrysaëtus*) from Scotland, presented by Mr. Hugh Cameron Ross ; a European Pond Tortoise (*Emys europoea*), European, presented by Mdlle. Lajeunesse ; four Midwife Toads (*Alytes obstetricans*) from Belgium, presented by Prof. Gustav Gilson ; a Crab-eating Opossum (*Didelphys cancrivorus*) from Tropical America, an Australian Cassowary (*Casuarius australis*) from Australia, an American Tapir (*Tapirus americanus*), an American Jabiru (*Mycteria americana*) from British Guiana, a Wild Cat (*Felis catus*), European, deposited.

OUR ASTRONOMICAL COLUMN.

METEOR SHOWERS.—In the following list of radiant-points of meteor showers, which we owe to Mr. Denning (*Companion to Observatory*, 1893), that dated for August 10 is stated as being the radiant of a most brilliant shower.

1893.	Radiant. α.	Radiant. δ.	Meteors.
	°	°	
August 4	30	+ 36	Swift : streaks
10	45	+ 57	Swift : streaks
16	61	+ 48	Swift : streaks
21	73	+ 41	Swift : streaks
22	291	+ 60	Slow : bright
23	70	+ 50	Swift : streaks
25	5	+ 11	Slow : short

COMET FINLAY, 1893.—The following is the ephemeris for this comet for the ensuing week :—

12h. M.T. Paris.

1893	R.A. app.	Decl. app.
	h. m. s.	° ′ ″
August 3	5 30 9·0	22 37 54·4
4	34 9·4	22 43 18·4
5	38 7·9	22 48 17·3
6	42 4·4	22 52 51·7
7	45 58·9	22 57 2·1
8	49 51·4	23 0 48·9
9	53 41·8	23 4 12·8
10	5 57 30·2	23 7 14·3

RORDAME-QUÉNISSET COMET, 1893.—In *Astronomischen Nachrichten*, No. 3174, several observations of this comet are inserted. Prof. E. Lamp, July 10, describes the comet as 0′·6 diam., brighter in centre, but no proper nucleus. Dr. F. Restenpart for the next day gives the diameter as 4′, the nucleus being of the 5· magnitude with a shining nebulous envelope. Prof. Schen, for the same day (July 11), estimates the diameter as 2′, and says, that by the 12th the brightness had distinctly increased. On the 13th Herr. Archenhold describes the comet as nearly one-half a magnitude dimmer than λ Ursæ Majoris, of an intense blue colour, and a nucleus 1′ in diameter. M. Bigourdan (*Comptes Rendus* for July 17, No. 3) describes the comet (July 16) as a round nebula of 3′·5 diam., with a small stellar nucleus of 2″ to 3″ diam., surrounded by a brilliant nebulosity. This nebulosity had a diameter of about 20″.

EARTH MOVEMENTS.—In the account of the pendulum observations made by Herr E. von Rebeur-Paschwitz, attention was frequently drawn to the fact that in several cases of earth motions or disturbances, the records indicated that sometimes one followed the other in a short space of time, such as two to three hours, a hint being thrown out that these double perturbations originated from one shock. Happening to examine one of the volumes of the "Transactions of the Seismological Society of Japan," Herr Paschwitz was surprised to find that the earthquake at Kumamato, a town on the west coast of the Island of Kiusiu (lat. 32°·8, long. E. 130°·7), which occurred on July 28, 1889, was the severest that had taken place in Japan in that year, and its time of occurrence coincided with the double perturbation that was recorded at Potsdam and Wilhelmshaven (*Astronomischen Nachrichten*, No. 3174.) Deducing the most probable times for the arrival of the chief disturbance at a mean place (long. 10°·61 E., lat. + 52°·97) he obtained the hours, 3·47h. and 6·10h. M.T. Greenwich. From this point the distance of Kumamato, reckoning on a great circle, is about 8860 kilometres, the complement of this great circle amounting to 31,140 kilometres. Taking into consideration the difference of time of 9h. 19·3m., and that the earthquake occurred at 3h. 28·2m. M. Greenwich time, he deduced the time difference of 67·5m. and 225·3m., or velocities of movement of the wave, as 2·188 and 2·304 kilometres, or about 2·3, taking into account the time inaccuracies. This value was obtained approximately also from the Japan earthquake of April 18 of the same year, the distance being 9000km., the time-difference 64·3m., the velocity of propagation resulting 2·334km.

OBSERVATIONS MADE DURING THE ECLIPSE OF APRIL, 1893.—In the *Memorie della Società degli Spettroscopisti Italiani* for June, 1893, several communications are made concerning observations made at the time of the last solar eclipse. Lona at Palermo, Eugenio, Garibaldi, and Tacchini all give their time observations, while Fenyi, in addition to these, gives a list of the prominences observed at a height of at least 30″ at the epoch of the total eclipse at Chili and Brazil. The following is the list referred to :—

M.T. Greenwich.	Position. N. by E.	Latitude. Mean heliographic.	Height.
h. m.	° ′ ° ′	°	″
0 55	201 4–169 30	−59 W.	103
1 12	130 50–124 32	−64 E.	54
25	75 48– 73 34	−11 E.	33
27	60 6– 53 16	+ 9 E.	51
31	33 24– 28 30	+33 E.	44
—	295 24–294 26	+51 W.	54
—	292	+48 W.	59
—	287 8–286 30	+42 W.	41
1 47	233 48–229 22	−13 W.	34

Father Fenyi gives also a very exhaustive table, or rather diagram, of all the minor disturbances at this time, showing how they were situated with respect to the axis of the sun at the time of the eclipse.

THE OBSERVATORY OF YALE UNIVERSITY.—Dr. Elkin reports as follows to the Board of Managers of the Observatory of Yale University :—"The work with the heliometer has been carried forward during the past year in the directions outlined in my last report. We have examined so far fifty-one stars of large proper motion making in general three sets of measures at each parallax maximum. We have not, however, been able to keep the reductions quite up to date, so that I cannot at this moment give any definite results of our search for large parallaxes. I have also continued the series of parallax measures on the first magnitude stars—Aldebaran, Procyon, Regulus, Arcturus, and Vega having been followed up this year. Dr. Chase has continued the work on Algol, and has commenced a series on β Cygni to test the large parallax deduced by Mr. Jacoby from the Rutherfurd photographic plates. He has also been engaged upon and nearly completed the reduction of his measurements in Coma Berenices. Miss Palmer has been mainly occupied with the computations of our series on Jupiter's satellites, a work of considerable extent." The record is one which Dr. Elkin must regard with the satisfaction that comes to all who make a good use of time.

ASTRONOMISCHEN GESELLSCHAFT.—The following are the articles contributed to the first and second parts of the *Vierteljahrschrift der Astronomischen Gesellschaft* for 1893 :—H. Gyldén, "Untersuchungen über die Convergenz der Reihen welche zur Darstellung der Co-ordinaten der Planeten angewendet werden," and "Nouvelles recherches sur les séries employé dans les Théories des planètes;" E. Anding, Lambert's Photometrie, "Photometria sive de mensura et gradibus luminis, colorum et umbræ; Robert Grant, Second Glasgow Catalogue of 2156 Stars for the Epoch 1890; J. G. Porter, a Catalogue of 1340 Proper Motion Stars; and Charles Pritchard, Researches in Stellar Parallax by the Aid of Photography. There is a list also of all the planet discoveries and comet appearances of the year 1892.

GEOGRAPHICAL NOTES.

DR. H. R. MILL has recently made a systematic bathymetrical survey of the larger lakes of Cumberland and Lancashire, the cost being defrayed by a grant from the council of the Royal Geographical Society. The soundings designed to delineate the general configuration of the various lake basins, were made at close intervals along a series of lines crossing the lake at right angles to its axis, and never more than half a mile apart. These tranverse sections were connected by oblique sections, along which the soundings were more widely spaced, and in addition longitudinal sections were made whenever it was practicable to do so. In Derwentwater the greatest depth found was 72 feet, but the surface of the lake was much below its usual level, being lower, probably, than has ever previously been recorded. Bassenthwaite Lake, though simpler in configuration, was found to have about the same maximum depth. Ullswater, the largest lake in England except Windermere, was found to have a depth of 208 feet, but it is quite possible that deeper soundings might be obtained. This lake was remarkably interesting on account of its division into a series of deep basins separated from each other by wide bars, from the most pronounced of which a rocky islet rises showing the characteristic marks of ice-erosion very clearly. Coniston Lake is simpler, being one practically straight deep trough, the deepest part of which is at least 184 feet below the surface. Wastwater was similar in configuration, though of much greater depth, an area one mile long and a quarter of a mile wide being deeper than 250 feet. The flatness of the floor of this depression may be judged by the fact that 258 feet was the greatest depth found in it. Samples of the deposit from different parts of each lake were secured, and will be examined by a specialist. Temperature observations were also made. It is probable that a similar survey of Windermere will be undertaken in the beginning of September.

MR. F. G. JACKSON sailed last week with a complete equipment for Nova Zembla, where he intends to spend next winter alone, exploring the island and thus gaining practical experience to aid him in his ultimate attempt to reach the North Pole by Franz Josef Land.

THE Paris Geographical Society promotes the study of geography amongst its members by conversational meetings for the discussion of various geographical problems. There are three groups of subjects: (1) mathematical and physical geography; (2) ethnography, anthropology, and the geographical distribution of plants and animals; and (3) historical and economic geography. Those willing to read papers or take part in the discussions at any group enter their names, and are notified of the meetings of their particular section by the general secretary. The importance of this method of promoting an active interest in geography is very considerable, and might well be introduced in this country, where the advantages of informal discussion are rarely recognised.

THE authorities of Owen's College, Manchester, have decided that Mr. Yule Oldham may continue his duties there concurrently with those of the lectureship of geography at Cambridge University to which he was recently appointed.

CELEBRATION OF THE ROTHAMSTED JUBILEE.

THE weather fortunately permitted the celebration on July 29 to take place, as originally intended, in the open air. The lawn in front of the laboratory was filled by the subscribers to the jubilee fund, while, on the common adjoining, a large crowd of spectators was assembled.

The memorial erected in front of the laboratory consists of a natural boulder of Shap granite, weighing nearly eight tons, standing on a rough granite base. On one side of the boulder a part of the surface has been dressed and polished, and bears the following inscription :—

To commemorate
the completion of
Fifty years
of continuous experiments
(the first of their kind)
in Agriculture
conducted at
Rothamsted
by
Sir John Bennet Lawes
and
Joseph Henry Gilbert
A.D. MDCCCXCIII.

The chair was taken by the Right Hon. Herbert Gardner, M.P., Minister of Agriculture, at 3 p.m.

The Secretary of the Jubilee Committee, Mr. Ernest Clarke, then read a list of names of persons who had sent letters or telegrams regretting their absence on the occasion. The list was a long one, and included H.R.H. the Prince of Wales, H.R.H. Prince Christian, the Marquis of Salisbury, Lord Kelvin, Mr. Chaplin, Sir G. Stokes, Prof. Huxley, L. Pasteur, P. Dehérain, E. Tisserand, E. Wolff, F. Nobbe, the Association of Agricultural Colleges and Experiment Stations in the United States, and many others.

The Chairman said they had met to do honour, as far as lay in their power, in the name of agriculture and of the agricultural classes, to two distinguished men, who had rendered invaluable services to our great national industry, and to dedicate that day an outward and enduring memorial of the admiration which the agricultural world felt for the work which they had accomplished. Nothing could be more appropriate for such a purpose than the massive granite boulder which they saw before them. It had already witnessed many of the experiments of nature; they hoped it might stand for many generations to come, as an outward and visible sign of the manner in which the life-long work of Lawes and Gilbert had been appreciated by the men of their time.

He believed, although Sir John Lawes commenced the work of his life as far back as about 1834, it was only in 1843 that the actual field experiments, on which our reliable records were founded, were begun, and in which he was joined by Dr. Gilbert, who had since been the partner of the labours of his life; they were, therefore, commemorating the jubilee of both gentlemen. It must be interesting to all at such a moment to recall the varied succession of agricultural prosperity and depression those two had seen during the past fifty years. During that period their friends had seen wheat rise as far as 78*s*. He thought that was in 1855; and, he regretted to say, since he had had the honour to be President of the Board of Agriculture, it had fallen as low as 24*s*. 8*d*. in May last, making a difference of 50*s*. per quarter. In a meeting like the present, so interested in agricultural subjects, he might say that he thought the development of steam ocean traffic had done more than Free Trade to bring down the price of wheat. There was one ray of hope—he admitted it was a very small one—with regard to the present low and phenomenal prices of wheat. There seemed little doubt, from a calculation he had made, that the extremely low prices were partly due to the extraordinary reserves of that article they had in the country since this 1891. The normal reserve of wheat in this country was calculated to be about 2,000,000 quarters, but since 1891 that reserve, following upon the scare of Russian famine, rose at a bound to over 6,000,000 quarters. At the present moment it had fallen again by something like 2,000,000, and as there was every reason to expect there would not be the same influx of wheat into our country in the present year as there had been in the past, it was possible, when the reserve reached the normal standard again that prices might recover.

A memorial more enduring than the granite boulder before them was furnished by the published records of the experiments. It would always be a pleasant recollection to him to know that since he had occupied his present position he had been able to place some fifty memorials of Sir John Lawes and Dr. Gilbert over the country amongst agricultural institusions—he alluded to copies of their works, which, with the sanction of the Treasury, he had been able to purchase at the public expense.

Mr. Gardner, in conclusion, said it was with the sincerest pleasure and profoundest respect he expressed to Sir John Lawes and Dr. Gilbert, in the names of the agriculturists of this country, their felicitations on their jubilee, and their hopes that they might long enjoy the honour and admiration of all classes of their fellow-countrymen.

The Duke of Westminster said he owed the agreeable position he occupied on that occasion to the fact that he was the ex-President of the Royal Agricultural Society of England, and that during his year of office he had been chosen President of the Rothamsted Jubilee Fund. He had the pleasure of asking Sir John Lawes to accept his own portrait, painted by Mr. Herkomer, and he hoped Lady Lawes, their children, and grandchildren would consider it worthy alike of the subject which it represented and of the old walls which it was destined to adorn. He had further to present both to Sir John and to Dr. Gilbert an illuminated address, signed on behalf of the subscribers by the Prince of Wales, and couched in the following terms .—

"TO SIR JOHN BENNET LAWES, BART., D.C.L., LL.D., F.R.S., &c.

"On behalf of the Committee of the Rothamsted Jubilee Fund and of the numerous subscribers to that fund in all parts of the world, I offer you the most hearty congratulations on the completion of half a century's uninterrupted investigation of agricultural problems of the highest practical value and interest."

"These investigations, which originated with you, relate not only to the growth of cereal and other crops under the most varying conditions, but also to the economic effect of different foods on the development of the animals of the farm. They have embraced, moreover, most important researches concerning the chemical constituents of soils, the rainfall, drainage waters, and the sources from which plants derive their supply of nitrogen."

"During the whole of this period of fifty years you have had the zealous co-operation of your lifelong friend Dr. Joseph Henry Gilbert, whose name will ever be associated with yours, and whom jointly with you we desire on the present occasion to congratulate."

"For the continuance of the experiments and investigations which have already extended over so long a period, you have munificently provided by the establishment of the Lawes Agricultural Trust, so that our successors will profit even more, if possible, than we of the present day have done by your enlightened labours."

"The Memorial which is now erected will, it is hoped, preserve your joint names in honoured remembrance for centuries to come, while the portrait that is presented to you herewith will hand down to future generations the likeness of one of the most disinterested as well as the most scientific of our public benefactors." "ALBERT EDWARD P."

"July 29, 1893."

"TO JOSEPH HENRY GILBERT, M.A., PH.D., LL.D., F.R.S., &c.

"In celebrating the Jubilee of the Rothamsted Agricultural Experiments, it is impossible to dissociate your name from that of Sir John Lawes, and on behalf of the subscribers to the Rothamsted Jubilee Fund in all parts of the world I offer you the most hearty congratulations on the completion of your fifty years of continuous labours in the cause of agricultural science."

"The nature and importance of those labours are so well known that it is needless to dilate upon them; but if the institution of the various investigations and experiments carried out at Rothamsted has been due to Sir John Lawes, their ultimate success has been in a great measure secured by your scientific skill and unremitting industry. Moreover, by your lectures and writings, you have been a leading exponent in this and other countries of the theoretical and practical aspects of the researches that have been undertaken at Rothamsted."

"A collaboration such as yours with Sir John Lawes, already extending over a period of upwards of fifty years, is unexampled in the annals of science. I venture to hope for an extended prolongation of these joint labours, and trust that the names of Lawes and Gilbert, which for so many years have been almost inseparable, may survive in happy conjunction for centuries to come."

"July 29, 1893." "ALBERT EDWARD P."

Continuing, the Duke said it was also his pleasing duty to ask Dr. Gilbert to accept, on behalf of the subscribers, the handsome silver plate which was before them, and which bore the inscription—"Presented by the subscribers to the Rothamsted Jubilee Fund to Dr. Joseph Henry Gilbert, F.R.S., in commemoration of the completion of 50 years of unremitting labour in the cause of agricultural science, 29 July, 1893."

M. Johannet then read an address from the Société des Agriculteurs de France, and M. Aubin, from the same Institution, followed with a congratulatory speech delivered in French.

The Duke of Devonshire, President of the Royal Agricultural Society, said they had not come there to make speeches, but to do honour to the benefactors of their country. He appeared that afternoon, in the name of the 11,000 members of their great Society, to present to Messrs. Lawes and Gilbert the illuminated addresses which were upon the table, and to offer them their most hearty congratulations on the completion of half a century's investigations at Rothamsted. The Rothamsted experiments were a model of what all experimental inquiries ought to be; they had stimulated the carrying out on a lesser scale of other experiments, as those at Woburn and those of numerous local societies. "Practice with Science" was the motto of their Society; it might well be applied to Rothamsted work, which had shed light on many of the vexed questions of practical agriculture. For forty-five years the Society had had the advantage of the personal advice and assistance of Sir John Lawes as a member of its council, and it was proud to recognise in Dr. Gilbert one of the most distinguished of its honorary members. Their contributions to the Society's *Journal* from 1847 to the present time constituted the most valuable series of papers which had appeared in its pages, and they alone would have made the *Journal* famous. For this and all the Society offered to Sir John Lawes and Dr. Gilbert their hearty thanks, hoping that they might long be spared to continue their labours, which, in the words of the Society's charter, were for "the general advancement of agriculture."

Prof. Michael Foster, as senior secretary of the Royal Society, presented two addresses from the Society, and with their hearty congratulations, expressed the hope that the Rothamsted Station might be as fruitful of scientific results in the future as in the past.

Dr. H. E. Armstrong, the President of the Chemical Society, presented an address from that body. He remarked that Rothamsted work was appreciated by none more than by the Fellows of the Chemical Society.

Prof. Stewart, the President of the Linnean Society, presented an address on behalf of the Society. They regarded the Rothamsted experiments as the highest contribution that had ever been made to the science of agriculture.

Prof. E. Kinch presented an address from the Royal Agricultural College, Cirencester. He alluded to the great educational value of the Rothamsted experiments, to the kind reception of the students at their annual visit to the Station, and to the debt of gratitude they owed to Dr. Gilbert for his services as honorary professor at the College.

Mr. Ernest Clarke, in the absence of M. Tisserand, then read an address from the Société National d'Agriculture de France. Mr. Clarke mentioned that several other addresses were on their way to this country.

Sir John Lawes, who, on rising to reply, was received with hearty cheering, said that it was only a very few months since he and his wife received the congratulations of many friends on having attained fifty years of married life, which was occasionally called a golden wedding. That afternoon he had to return thanks to that distinguished company for congratulating himself and Dr. Gilbert on the work they had carried on together for fifty years. When two persons were joined together in marriage they could not part—they were bound together by a solemn tie. Dr. Gilbert and himself were bound by no ties. During the whole of the fifty years Dr. Gilbert had been perfectly at liberty to leave him, and he to leave Dr. Gilbert; they had remained together from their mutual love of the work they had undertaken. He had given to this work all the time that he could spare consistently with other duties; but Dr. Gilbert had given his whole time to it, and had it not been for the labours of Dr. Gilbert, the affairs of Rothamsted would have been in a different state to that in which they now were. Dr. Gilbert had given his life to the experiments—had given the most arduous part of his life—had given his holidays, and this very year he was going to Chicago to deliver a course of lectures on the work at Rothamsted.

He had now had sixty years' experience of agriculture. When he began farming in 1834 the country was suffering from agricultural depression, the crops were so large that they more than supplied the wants of the nation; now our wheat crop only sufficed for one-third of our consumption, and the rest had to be furnished by other countries. He was afraid that their investigations had been of more use to the foreigner than to the English farmer, for the latter had always grown good crops, and thus could not meet lower prices by an increased production, while the foreigner had been able to do this.

Sir John Lawes expressed his cordial thanks for the various presentations made to him that day, and especially for the granite boulder, which he playfully said would probably still be in existence when the portrait had been transferred from the drawing-room to the bedroom, and from the bedroom to the garret, and people had forgotten whom it represented, and who painted it.

Dr. Gilbert expressed himself as unable to return thanks adequately for the ovation of that day. Referring to the early years of their investigations, he said that they commenced with orthodox views; but that, as they could not alter the laws of nature, they presently found that they were at variance with received opinion, and their scientific friends looked on them with pity. Their first paper was subjected to merciless excision by the editor of the journal to which it was sent, and they with difficulty secured its publication. Those who opposed became, however, finally their firm friends, and they had since published in that very journal papers occupying about 2,000 pages. The reason they had been able to steer clear of error in their numerous experimental inquiries at Rothamsted was that they had adhered resolutely to the motto of the Royal Agricultural Society, and had associated practice with science throughout the whole course of their researches. Agriculture, more perhaps than any other art or industry, was dependent upon the intelligent application not of one but of many branches of science, and hence it was that the experimental agriculturist found himself in contact at one time with the botanist, at another time with the physiologist, and again with the chemist and the geologist, the statistician and the economist. He mentioned that he had in preparation a jubilee edition of the memorandum sheet on the Rothamsted experiments, and concluded by expressing his warmest thanks for the sympathetic kindness which his friends had shown him that day.

Sir Joseph Hooker, in proposing a vote of thanks to the executive committee of the Jubilee Fund, said that he had never seen chemistry and botany united to such good purpose as in the investigations of Lawes and Gilbert.

Sir John Evans, treasurer of the fund, in responding, said that the boulder of Shap granite which they saw before them weighed nearly eight tons, and had twice broken down on its way to Harpenden. He need hardly say that a considerable weight had been taken off his mind when he at last had the satisfaction of seeing the huge monolith firmly planted in the place it now occupied.

The Earl of Clarendon proposed a hearty vote of thanks to the Chairman, which was carried by acclamation, and the formal proceedings terminated.

The portrait of Sir John Lawes, by Hubert Herkomer, R.A., was afterwards on view in the laboratory.

A garden party at Rothamsted was held later in the afternoon, which was attended by most of the visitors.

THE GEOLOGISTS' ASSOCIATION IN IRELAND.

THE visit of the Geologists' Association to the counties of Dublin and Wicklow, under the direction of Profs. Sollas and Cole, extended officially from July 24 to July 29; but a number of members arrived in Dublin for Sunday, July 23, and visited the cathedrals and places of historic interest in the city, under the guidance of Rev. Denis Murphy, S.J. On Monday the full party examined the grits and *Oldhamia*-slates of Bray Head. The Rev. Dr. Haughton, F.R.S., delivered a speech of welcome, standing on the rocks of the headland, and Prof. O'Reilly and Prof. Sollas, F.R.S., explained the structure of the mass, showing how the more resisting grits have caused a wrinkled flow of the shales and slates between them. The excursion was continued to the fine intrusive junction of the Leinster granite and the Ordovician rocks at Killiney, the latter being metamorphosed into mica-schists with abundant andalusites and some garnets.

On Tuesday, July 25, the promontory of Portrane was visited, under the direction of Prof. Grenville Cole. The basal carboniferous conglomerates ("Old Red Sandstone") were seen above the Bala series, which is here finely fossiliferous. The igneous rocks, ashes, agglomerates, and some lavas, associated with the great volcano of Lambay, are well seen upon this coast, and a true conglomerate of volcanic blocks and of pebbles, worn from the contemporaneous coral-reefs is one of the most interesting exposures. The brecciation, under pressure, of the alternating layers of shale and limestone produces, near the Priest's Cave, a rock resembling a coarse conglomerate of limestone-pebbles in a matrix of black clay.

On Wednesday, Howth was visited; Prof. Sollas conducted the party, and Dr. V. Ball, Mr. G. H. Kinahan, and Mr. A. B. Wynne were also present. The glacial drift on striated surfaces of Carboniferous Limestone, the dolomitisation of the limestone, the Ordovician dykes of diabase in the quartzites, and the quartzites, grits, and many-coloured shales, of the Howth and Bray series, were studied along the southern shore. Casts of worm-burrows were pointed out in some of the sandstones near the Needles.

On Thursday, July 27, an early start was made for Rathdrum, and cars were taken to Glendalough and the Seven Churches. Prof. Sollas and Prof. Cole led the party to the high ridge above the upper lake to examine the amphibolite in the Ordovician slates. Prof. Sollas showed how the slates had been converted into schists by contact with the Leinster granite, and how pressure has produced a foliated structure even in the intrusive mass; but the amphibolite has converted the schists locally into a "Desmosite," consisting of quartz, garnet, and dark mica, the latter lying in planes across those of the first foliation.

On Friday the Rev. Maxwell Close acted as guide to the shell-bearing sands and gravels, 1,000 feet up on the slope of Two-rock Mountain, near the house called Ballyedmondduff. Small fragments of marine shells were freely found in the upper pit. The party then descended into Glencullen, where Prof. Cole pointed out how the valley had been at one time choked with "drift," full of striated blocks of limestone and *débris* of granite and Ordovician rocks, and how the river has now cut down into this mass, as is the case in so many valleys of the southern and eastern Alps. From Enniskerry the geologists drove through the Scalp, a bold notch in the granite ridge, with an exposure of the junction with contorted Ordovician rocks.

On Saturday a joint excursion was carried out with the Dublin Naturalists' Field Club; some members of the Belfast Field Club being also present by invitation. The whole party drove from Bray up Ben Cree to Loughs Bray, the Rev. Maxwell Close explaining the glacial dam that separates the two lakes, and the moraines in the mountain-hollows round them. The descent was made by the romantic grounds of Luggela, which were kindly thrown open by Mr. Stepney. Here the granite abuts on the metamorphosed Ordovicians, and displays, on Lough Tay itself, a fissile foliated structure of unusual delicacy. On climbing out of the deep hollow to the main road, abundant large erratics of granite, resting on Ordovician schist, were seen on all the moorland slopes.

On Sunday, July 30, Dr. V. Ball, F.R.S., conducted the party over the geological and antiquarian collections in the Museum of the Science and Art Department, Dublin, Major M'Eniry pointing out the treasures of the Royal Irish Academy collection.

THE DEVELOPMENT OF ECHINOCYAMUS PUSILLUS.[1]

THE year 1891 will remain memorable to echinologists for the richness of its products upon the morphology of the class with which they deal, not the least brilliant and far-reaching of which is the discovery by Brooks and Field of the primary bilateral symmetry of the water-vascular system of *Asterias*; but the following year will not pale beside it, if only on account of the magnificent treatise to which we now call attention. The amount of solid work which the author has compressed into his fifty-seven pages is little short of astonishing. The monograph is written in excellent English, and illustrated by nine plates well worthy of the text; and from whatever standpoint it is judged, a verdict of unstinted praise must be given.

After a short introduction, the author furnishes an account of his methods, incidentally alluding to a remarkable result obtained by fertilising ova derived from females reared in a dirty locality with spermatozoa obtained from males dredged in the open sea; and he next proceeds to the detailed consideration of the sexual elements and fertilisation, in the course of which evidence pointing to a possible chemiotaxis is adduced, in what is termed the "attractive forces" of the ova and spermatozoa. The segmentation of the oosperm is next considered. The author remarks that he has more than once seen very delicate connective filaments crossing the cleavage-cavity from one segment to another at the earliest stages in the formation of the former; and later on, in dealing with the phenomena of mesenchyme formation, he calls attention to the significant fact that in young gastrulæ it is common to find mesenchyme cells "attached by one pseudopodium to the ectoderm, and by another to the archenteron," giving the impression "that they facilitate the process of invagination." Interesting as are these facts in their bearing upon the general question of protoplasmic continuity in the animal body, they fall into insignificance beside that portion of the work which deals with the vital phenomena of segmentation itself. In the course of it the author remarks that when studying the phenomena alluded to "one gets the impression that the segments alternately attract and repel each other, and that the highest degree of attraction occurs when the nuclei after a completed segmentation have obtained their rounded distinct form and are in a state of repose." This conclusion is reached after extensive and careful observation, and the tendency of current research in cytology appears to us to suggest that the near future may show the author to have herein formulated a general law.

Dealing next with the blastula and gastrula stages, an apical disc bearing a tuft of long cilia, akin to that of the annelid larva, is described; and the author, having proved that it has nothing to do with locomotion, provisionally suggests that it may be a larval sensory organ. The formation of calcareous deposits is recorded to first occur during the blastula stage, and the spines, interradial plates, and spherids of the young urchin, are alike traced to a "first indication" in the form of a minute tetrahedron originated by the agency of mesenchyme cells; and the author, after full consideration, inclines to the belief the "teeth" also "originate as small tetrahedrons." The detailed observations incorporated in this section of the work are of intense interest, especially in their bearing upon the attempt of Dreyer to reduce the skeletogenesis of the echinodermata and certain other invertebrated animals to a common principle of purely mechanical origin.

The young urchin is traced to a "first indication" in an ectodermic invagination of the Pluteus, as previously described by Agassiz and Mentschnikoff, and the author observes that the disc-like sac thus formed becomes differentiated into a "thick-walled bottom," which plays an important part in the development of the young urchin, and a remaining portion which "only serves as a kind of amnion."

One very curious and interesting discovery which is announced is that of a choano-flagellated condition of the cells of the ciliated band of the Pluteus, which, in the author's words, "curiously remind one of collar-cells in the Porifera;" and it is not a little remarkable that this observation should have been closely followed by that of Franzé that Bütschli's so-called "*mund vacuole*" of the Choano-flagellate Infusoria (*Codosiga botrytis*) is in reality a delicate membrane connecting the collar with a specialised sucking vacuole.

In his introduction the author confirms the surmise of Johannes Müller that certain of his (now classical) descriptions of Echinoid larvæ were those of *Echinocyamus pusillus*, and in so doing points out that nobody has in the meantime published anything on the development of that animal. Our appreciation of the excellence and value of the author's work may, perhaps, be best expressed in the assertion that it appears to us in every way worthy of this unique association with that of the great founder of our modern comparative anatomy.

[1] A Monograph, by Prof. Hjalmar Théel, Nova Acta Reg. Soc. Sci. (Upsala: Ser. iii. pp. 1-57. 1892.)

FRANCE AND INTERNATIONAL TIME.

THREE years ago M. W. de Nordling made a communication to the French Geographical Society with regard to a universal hour. In a further communication to the same society, on April 7, he traces the changes that have been made since 1889. The state of things at the present time are summarised as follows:—

(1) The time of eastern Europe, which differs by only one minute from that of St. Petersburg, is employed in Russia, Roumania, Bulgaria, and Roumelia, to Constantinople.

(2) The time of Central Europe prevails in Sweden, Germany, Austria, Hungary, Bosnia, Servia; and its adoption is assured in Switzerland, Italy, and Denmark.

(3) The time of Western Europe (Greenwich time) is in use in Great Britain, Holland, and Belgium, and, to complete its European domain, needs the addition of France, Spain, Portugal, and Ireland.

With regard to France, M. de Nordling dwelt on the fact that while civil time is referred to the Paris meridian, the railway service runs according to Rouen time, which is five minutes behind Paris time. The French Commission of 1891 remarked upon the absurdity of this system in the following words:—

"In order that there should be no ambiguity in the use of the uniform hour adopted, it will be necessary to put an end to the curious habit that exists only in France, where two timepieces are seen at all railway stations having between them a constant difference of five minutes.

"It is useless for the railway companies to say that the interior time of their stations concern them particularly, and only refer to their service; only error and confusion can result from the system. The hours of departure being regulated by the interior clock, there must always be a tendency to consider these indications as the most exact.

"To our knowledge, in no other country outside our own, is this peculiarity found, which perpetuates an error, and, in fact, puts the trains behind by five minutes."

"It is said," remarked M. de Nordling, "that the five minutes retardation are regarded with approval by travellers.

"This was probably true in 1840, when one would only go to Saint-Germain and Versailles, but to-day, when everybody discounts the five minutes, they have lost their virtue, and only force the passenger to make incessant calculations. The uncertainty is increased in the buffets, where it is doubtful whether the clock on the wall indicates interior or exterior time.

"It is not only from a national point of view that this dual hour is vexatious, but also from an international point of view. In fact, it renders our hour absolutely inappropriate to all international usage. Suppose Switzerland had adopted Paris time;

its railways would not be less in discord than our own, ruled by Rouen time, and the principal object of the pretended unification would be lost. At the present time, it is true, this consideration is only retrospective, since it is evident to those who have eyes to see, that in the future any international horary amalgamation will be based on the united times of all meridians.

"What sacrifices would a similar amalgamation impose on France? In the first place, it would retard the clocks of our railways by four minutes, and civil time by nine minutes. But, from the experience furnished by the law of March 15, 1891, it can be affirmed that—were it not for the difference between interior and exterior timepieces of the stations—the reform would pass absolutely unperceived by the public.

"It can no longer be said that the change implies a question of national self-respect, since it is not to adopt English or German time, but to take up a universal system already adopted by the greater part of Europe, by all North America, and by a part of Asia (Japan).

"It is true that the new system will be imperfect so long as France will not adhere to it. It is not only by the adherence of France, however, that this system will be crowned. If France wants to justify the provisions of the 1891 Commissioner of the Senate, it will delay the execution for a hundred years. But we do not delude ourselves with views of this kind. During the time of waiting, our horary system will produce in the eyes of Europe—in the eyes of the world—the same effect as an old building out of line, encroaching on the public view, breaking the perspective of a beautiful straight avenue, and from which passers-by will only turn with displeasure. Is this a dignified situation for France?

"The situation is made worse from another cause. It has been said that Spain and Portugal are becoming friends again. If, according to the opinion of to-day, these two countries desire to unite their times, it is probable that, in order to avoid a conflict between the meridians of Madrid and Lisbon, they will take the time of Western Europe. If that occurs the isolation of France will be complete.

"There are two ways of escape from this difficulty. The first is based on the question of legality, and is that the Minister of Public Works shall invite our railway companies to retard their clocks by four minutes, and that the Minister of the Interior shall prescribe in his turn that all the public clocks be put back nine minutes with regard to the meridian of Paris. This international unification would have been made had not the law of March 15, 1891, been violated up to now.

"The other way, and the one altogether more frank and dignified, is this—that France should say to Spain, 'Would you be willing to unite our times? Let us adopt, with Portugal, the time of Western Europe, and agree as to the day when it shall be put in force simultaneously.' If France obtains this understanding, it will have done more for the unification of hours than any other nation; for each nation has only acted on its own account, while France, in bringing its adherence, would bring at the same time that of two companions. This would be at once the crowning of the system.

"I guarantee that France would receive the plaudits of the entire world, both of the old and the new, and in this question we should, at the first onset, have resumed the place which we generally occupy at the head of progress."

The editor of the *Revue Scientifique* remarks, in a footnote to M. de Nordling's article, "It is false patriotism that is willing to remain apart from other lands. Are the English who do not wish to adopt the metric system, and the Chinese who built a great wall at their frontier, good patriots? And are these two examples so worthy of admiration that our ambition should be to imitate them by refusing to accept the unification of hours. The conclusion can be formulated in three simple propositions:—

"(1) Adopt a single time for all France, without having the time in the interior of railway stations five minutes behind.

"(2) Adopt the time known as that of Western Europe—that is, Greenwich time, which is nine minutes behind Paris time, and which is in reality the time of central France (Havre, Le Mans, Tours, Poitiers, Angouleme, Auch, and Oran).

"(3) Urge Spain and Portugal to adopt this time."

It is satisfactory to find that the subject of international time is being seriously considered in France. The changes required to refer the times to the Greenwich meridian are so small that, but for national prejudice, they would doubtless have been made long ago. However, we are not in a position to moralise upon the opinions of our neighbours as to the adoption of the time of Western Europe, for they point to our absurd system of weights and measures, and we are humiliated. There is little doubt that the French will adopt Greenwich time before the metric system is introduced into this country.

OLIGODYNAMIC PHENOMENA OF LIVING CELLS.

AMONG the botanical papers left by the late Prof. Carl v. Nägeli is a very remarkable one bearing the above title, which is now published in the *Denkschrift* of the *Schweizerische naturforschende Gesellschaft* by Prof. Schwendener and Prof. Cramer. The observations referred to occupied the closing years of Nägeli's life since 1880.

By oligodynamic phenomena Nägeli means those produced by excessively small quantities of metallic substances in solution. The experiments were made chiefly on two species of Spirogyra, *S. nitida* and *dubia*. If in water which is previously "neutral," *i.e.* not pathogenic to Spirogyra, a gold coin containing ten per cent. of copper is placed, the water acquires the oligodynamic property of killing the alga, and the poisoning may begin to manifest itself in as short a period as from three to six minutes. Nägeli satisfied himself that this effect is not due to the action of electricity or of any similar force, but is the result of infinitesimally small quantities of copper dissolved in the water, in the form of CuH_2O_2 combined with carbon dioxide. In this way one part of copper in 1000 million parts of water may act pathogenically on the alga. Similar results were obtained with silver, zinc, iron, lead, and quicksilver, while the absolutely insoluble metals gold and platinum were without effect. In this way distilled water is often poisonous to Spirogyra, and it is a remarkable fact that the poisonous metals communicate the property to glass vessels in which they are placed. The poisonous properties of the water may be diminished or entirely neutralised by placing in the water particles of some insoluble solid substances, such as sulphur, graphite, cellulose, wood, coal, silk, wool, &c., which present a large surface on which the metal is precipitated. For the same reason, while the alga will be killed if only a few filaments are present in the water, a much larger quantity will be entirely uninjured.

Oligodynamic poisoning manifests itself in the living cell in a different way from true chemical poisoning. In the former case the cell does not at once lose its turgidity; the protoplasmic uricle remains for a time adherent to the cell-wall, while the spiral band of chlorophyll detaches itself and becomes transformed into a solid mass surrounding the rounded nucleus of the cell. The substance of the band swells up, and presents, on transverse section, a cylindrical or oval form. The phenomena present some resemblances to those produced by electricity.

The very remarkable results here described are confirmed by Prof. Cramer, who has repeated the experiments, and finds, in all essential points, the phenomena to resemble those obtained by Nägeli. A. W. B.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A COURSE in Naval Architecture has been recently established at the Massachusetts Institute of Technology to provide a thorough training in the theory and methods of designing and building ships, together with a study of the properties requisite for safety and good behaviour at sea. It is intended to cover the same ground and accomplish the same results as the English and French government schools for training Naval Constructors. Like all the courses at the Institute it gives, in addition to professional and technical training and equipment, a good scientific and liberal education. Attention is directed mainly to the construction of merchant steamships; but some attention is given to problems arising in the design of men-of-war, which offer at once the most definite and the most intricate questions presented to the naval constructor. The theory of the construction of sailing vessels is also included in the course.

THE *Westminster Budget* of July 28 contains a record of the scholarships obtained by boys at our public schools during the scholastic year 1892-93. Though the record cannot be regarded as the best criterion of efficiency, owing to the fact that many of the scholarships are confined to certain schools, and that their values vary considerably, still an indication is obtained of the attention paid by schools to different subjects. The highest number of science scholarships, four, was obtained by Manchester. Epsom and St. Paul's follow with three each, and then Charterhouse, Dulwich, Shrewsbury, and Tonbridge with two each. In mathematics, Clifton, Tiverton, and Merchant Taylor's each obtained three scholarships. The following schools obtained two: Christ's Hospital, St. Paul's, Bristol, Chester, Leatherhead, Liverpool, Wolverhampton, Liverpool Institute, and Wellingborough.

The vote of £6,200,000 for public education in England and Wales which was agreed to on Monday, is the largest that has ever been requested for that purpose. In his speech on the subject, Mr. Acland referred to the suggestion that the Bethnal Green Museum should be handed over to the London County Council, and said that if the Council should desire to have the site and the building on reasonable conditions for educational purposes, the Government would be glad to meet them in a reasonable way.

Mr. R. W. Stewart, Assistant Lecturer and Demonstrator in Physics in the University College of North Wales, Bangor, has just been granted the degree of Doctor of Science by the University of London. Mr. Stewart's thesis contained the results of a series of experimental determinations of the thermo-conductivities of iron and copper, made in the Physical Laboratory of the University College of North Wales. The results are embodied in a memoir which was recently communicated to the Royal Society by the President (Lord Kelvin), and which has been accepted for publication by the Council of the Society.

The *British Medical Journal* says that several changes have recently taken place in the teaching staff of St. Bartholomew's Medical School. Among them we note that Dr. F. D. Chattaway has been elected to the Demonstratorship of Chemistry; and Mr. Alfred Howard has been appointed to the Assistant Demonstratorship. Mr. J. S. Edkins, at present George Henry Lewis student, and late Senior Demonstrator of Physiology at Owens College, Manchester, has been elected Demonstrator of Physiology.

Mr. D. T. MacDougal has been appointed Instructor in Vegetable Physiology at the University of Minnesota.

SCIENTIFIC SERIALS.

The Quarterly Journal of Microscopical Science, for July, 1893, contains:—On the morphology and physiology of the brain and sense-organs of Limulus, by Dr. W. Patten (Plates 1 to 5). Some two years ago the author published a paper in the *Quarterly Journal of Microscopical Science* calling attention to many striking resemblances between Arachnids and Vertebrates, and maintaining that the latter are descended from a great group of the former, in which he included the Arachnids, Trilobites, and Merostomata. Attention was called to the evidences of relationship as shown in the invaginations which in insects give rise to the optic ganglia, and in scorpions and Limulus become so extensive as to enfold not only the optic ganglia but the eyes and the forebrain as well. A cerebral vesicle is thus formed, from the floor of which arise the forebrain and the optic ganglia, and from the roof a tubular outgrowth, at the end of which lie the inverted retinas of the parietal eye. Such a condition is to be found only in Arachnids and Vertebrates, and the author thinks it affords as trustworthy evidence of relationship as the presence of a notochord or of gill-slits. Other relationships were indicated between the lateral eyes in Limulus and Vertebrates, between the cartilaginous endocranium in Arachnids, and the primordial cranium of Vertebrates, between the subneural rod in scorpions and the notochord, and in the correspondence between the neuromeres and nerves in Arachnids and Vertebrates. To this long array of evidence the author now adds others: identifying nearly all the important lobes and cavities characteristic of the Vertebrate forebrain in the forebrain of Limulus; showing that the coxal sense-organs are gustatory, and correspond to the supra-branchial sense-organs of Vertebrates, and describing a remarkable organ in Limulus, which has all the characteristic morphological features of the olfactory organs in Vertebrates. The author believes that it may now be regarded as beyond any reasonable doubt that the Vertebrates are descended from the Arachnids. The very interesting palæontological aspect of the subject is promised in a separate memoir.—On the structure of the pharyngeal bars of Amphioxus, by Dr. W. Blaxland Benham (Plates 6 and 7), gives a detailed account of the tongue (or secondary) bar in Amphioxus, and institutes a comparison between it and the primary bar, and there is a *résumé* of the observations of recent observers and an account of certain abnormal bars.—On the perivisceral cavity in Ciona, by A. H. L. Newstead, B.A. (Plate 8). The author found (1), that there are no communications between the perivisceral cavity and the atrial cavity (such as were described by Kupffer, though denied by Roule); (2) that definite communications exist between the perivisceral cavity and the pharynx, and as these openings occur in the same position as the orifices described by Kupffer, it is probable that the supposition of van Beneden and Julen is correct, that the orifices observed by Kupffer open into the perivisceral and not into the atrial cavity. The perivisceral cavity is regarded as a specially modified epicardium, which has become greatly enlarged.—On the early stages in the development of *Distichopora violacea*, with a short essay on the fragmentation of the Nucleus, by Dr. Sydney J. Hickson (Plate 9). In this paper we have first an account of the early stages of the development of *Distichopora violacea* from material collected by the author in North Celebes and by Prof. Haddon in Torres Straits; then an account of the formation of the germinal layers in the Cœlenterata. A sketch of the developmental histories, as known up to the present, is given, with the typical invaginate gastrula at one end and the multinucleated plasmodium at the other; and, lastly, the important question of the "fragmentation" of the Oosperm nucleus is very ably and judiciously discussed, the following conclusions from the evidence adduced being drawn: (1) Fragmentation of the nucleus is a normal method of nuclear division, and is not always a sign of pathological change; (2) in many cases where the nucleus is supposed to disappear, there is, as a matter of fact, only a minute fragmentation; (3) that fragmentation only occurs when there is no cell division; and (4) that karyokinetic division of the nuclei is caused by the forces in the cell protoplasm which bring about the division of the cytoplasm. The phenomena of pluripolar mitosis may afford examples of intermediate types.

Bulletin de l'Académie Royale de Belgique, No 5.—On negative hydrostatic pressure (continued), by G. Van der Mensbrugghe. A test-tube is completely filled with water, and another, with thin walls and a little narrower, is plunged into it to about half the depth. On inverting the two tubes the smaller one rises through the water in the other in spite of gravitation, owing to the suction exerted by the water, whose internal pressure is less than that of the atmosphere. If a tube of paper or of waxed silk be substituted for the smaller test-tube, the flexible tube is flattened when plunged down into the other, but regains its circular section on placing the system upside down. Just as it is possible to subject a large vessel to an enormous internal pressure by ordinary hydrostatic pressure, so it is possible, on the other hand, to subject it to a corresponding external pressure by inverting the hydrostatic tube.—Researches on monocarbon derivatives, by Louis Henry (continued). This contains an account of the mono-chloric, mono-bromic, and mono-iodic oxides of methyl.—Contribution to the study of trichinosis, by Dr. Paul Cerfontaine. A study of some cases of the epidemic of Herstal, near Liège, in January, led to the following conclusions. As soon as the infected meat is introduced into the system, the cysts are destroyed, and the larvæ liberated in the stomach, whence they pass after some time into the intestine. There they grow rapidly, and fecundation takes place in the intestine after the second day of infection. The males are then expelled from the system, and many of the females penetrate the walls of the intestine and even enter the mesentery, where they produce offspring after the sixth day of infection. This penetration of the walls of the intestine gives its peculiarly fatal character to trichinosis. The young entozoa are dissiminated throughout the system by the lymphatic vessels, which carry them into the blood. Owing to their small size they penetrate into the capillaries, and produce congestion of the blood-vessels and œdema. Death is often due to what amounts to a maceration of the respiratory muscles, producing asphyxia

Wiedemann's Annalen der Physik und Chemie, No. 7.—On the specific heats of glasses of various compositions, by A. Winkelmann. The specific heats of the various constituents of different glasses were calculated or experimentally determined, and those of the glasses made up of them were calculated by Wöstyn's law, according to which a specific heat of a compound is obtained by adding together the products of the specific heats, the atomic weights, and the number of atoms of the elements contained in the compound, and dividing by the sum of the products of the atomic weights and numbers of atoms. On comparing the values thus calculated with those found by experiment, it was found that they agreed to within one per cent.—On a surface connected with the electric properties of tourmaline; thermodynamics of tourmaline and the mechanical theory of muscular contraction; and molecular theory of piezo-electric and pyro-electric phenomena, by E. Riecke. The author makes the attempt of formulating a thermodynamical theory of muscular contraction, and investigates its connection with the pyroelectric phenomena of tourmaline. He arrives at a formula in which the state of the muscle can be expressed by two variables only, the temperature and the tension.—Concerning the theory of electric oscillations in wires, by A. Elsas. The author shows that the Hertzian oscillations may be completely explained on the older electromagnetic theory, without reference to Maxwell's amplifications. He does not contend that Maxwell's theory is superfluous, but finds out how far the older theory is capable of proceeding without having recourse to Maxwell's conceptions.—Objective representation of Hertz's experiments, and the high tension accumulator, by L. Zehnder. A collection of practical hints for the performance of oscillation experiments by means of the 600-cell Planté accumulator.—Contributions to the theory of secondary batteries, by Franz Streintz. With comparatively low current densities, the resistance during discharge attains a maximum. As the current increases, the resistance slowly falls to a value equal to that in open circuit, and falls still further at higher current strengths.—On the determination of the length of a solenoid, by F. Himstedt. Contrary to Heydweiler's opinion, the length and radius of a solenoid as determined by its electromagnetic effect are not appreciably different from their geometrically calculated values.

IN the *Botanical Gazette* for June Mr. R. H. True has a paper on the development of the caryopsis, which supports the ordinary view respecting the formation of the fruit in grasses. Prof. Atkinson continues his account of the biology of the organism which causes the tubercles on the roots of Leguminosæ.

IN the *Journal of Botany* for July, Mr. A. B. Rendle describes and figures a case of the production of tubers within a tuber in the potato. Yet two more "species" are added to the long list of British *Hieracia* by Messrs. E. F. and W. R. Linton, *H. enstales* and *orcadense*.

IN the *Nuovo Giornale Botanico Italiano* for July is a paper by Sig. E. Baroni on the anomalous genus *Rohdea*, which he prefers to place in the order Liliaceæ and tribe Asparageæ, rather than in the Araceæ. The minute structure of *Rohdea japonica* is described, and the mode of pollination, which appears to be effected partly by insects, but largely by snails, and even by spiders.

THE *Bulletino della Società Botanica Italiana*, Nos. 5–7, are largely occupied by papers chiefly interesting to Italian botanists. In addition, Sig. A. Baldacci has some observations on the sympodial branching in *Symphytum* and in other Borragineæ, and on the mode of branching in the Apocynaceæ, which appears to be also sympodial. Sig. U. Brizi enumerates the fossil Musci and Hepaticæ found in a locality within the Roman territory. Sig. C. Acqua describes the mode of formation of the wall in the growth of the pollen-tube of *Vinca major*, which presents a strong resemblance to that described by Buscalioni in the aerial hairs of *Lavatera*. Sig. C. Massalongo has several papers on galls.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 1.—"On the Colours of Sky Light, Sun Light, Cloud Light and Candle Light." By Captain W. de W. Abney, C.B., D.C.L., F.R.S., P.R.A.S.

The author has made several comparisons of the above lights throughout the different parts of their spectra, and has been able to verify their correctness by means of templates rotating in the spectrum of electric light, as described in Part II., "Colour Photometry," Phil. Trans., 1889. It seemed, however, that it would be useful if the colours of these lights could be expressed in single wave-lengths, together with the amount of added standard white light, the latter being expressed in terms of the luminosity of the dominant colour, in accordance with the method brought before the Royal Society in Proc. Roy. Soc., 1891.

When measuring light from the sky, a beam from the zenith or other desired part was reflected through a blackened tube into a darkened room in which the colour patch apparatus ("Colour Photometry," Abney and Festing, 1886) was placed, and the image of the end of the tube was focussed on to the front surface of a cube, the front surface of which was coated with zinc white, its background being black velvet. The patch of colour from the apparatus was also thrown on the cube. A rod placed in the paths of the two beams enabled the sky light and the spectrum colour to be examined side by side. The slit in the spectrum was an adjustable one so that any intensity of colour within limits would fall on the cube. A beam of white light reflected from the first surface of the first prism was again reflected from the surface of a thin prism on to the cube, a rod placed in its path cast a shadow on that part illuminated by the sky light, and by suitable adjustment the boundaries of the two shadows were caused to exactly coincide. The colour was thus diluted with white light, and rotating sectors, described in other papers, being placed in the path of the white beam, enabled the dilution to be regulated.

Sky Light.—On June 27, 1892, at 2.30 p.m., the sky was a good blue, but not a dark blue, and perhaps rather milky. The slit was moved into the part of the spectrum which appeared to be near the dominant colour. The colour was diluted to approximately the required amount. The slit was shifted and the dilution altered until the two colours made a perfect match. It was found that on the standard scale of the spectrum the dominant colour was represented by 28·6, which is λ 4800. The mean value of the sector aperture was 32°, and recollecting that the sectors are double sectors the comparison has to be made with 180°. The next operation was to compare the luminosity of the whole beam of white light with that of the colour. The sectors still remained in the white; the sky light was cut off, and the rod altered till the colour and the white were alongside each other with the boundaries of the shadows touching. The luminosities of the two were compared, and it was found that the aperture of the sector was 14°. As it required 32° of white to make the dilution of the colour, it follows that 32/14, or 2·286, parts of white were required to dilute 1 part of the blue. This may be expressed thus—

$$\text{Sky light} = \lambda\ 4800 + 2{\cdot}3\text{W}.$$

On July 4, 1892, at mid-day, the same procedure was adopted, and the dominant wave length was again λ 4800. In this case the amount of added white was thus—

$$\text{Sky light} = \lambda\ 4800 + 3{\cdot}1\text{W};$$

in other words, the sky was more milky.

At 4 p.m. on the same day the sky to the east, and about 30° above the horizon, was evidently slightly greener, and it was found that the colour agreed with scale No. 29·6 or λ 4834, and that it required three parts of white to be mixed with it.

$$\text{Sky light} = \lambda\ 4834 + 3\text{W}.$$

On other days, when the light of the portion of the sky near the zone of maximum polarisation the dominant wave-length was found to be between these two limits, and was never found bluer, and the smallest admixture of white light was found to be 1·9.

From these measures it may be concluded that the dominant colour of a blue sky is λ 4800.

Amongst artists it is not uncommon to employ cobalt to render this colour, and in many instances this is mixed with Chinese white.

The dominant colour of cobalt was found to be at scale No. 29, or λ 4812, when illuminated by ordinary day light, whence it seems that, as far as colour is concerned, it is singularly fit for the purpose.

Sun light was compared in the same manner, but the beam was reflected from the surface of a prism into a dark room, and again diminished in intensity by placing in its path rotating sectors with very narrow apertures.

Near mid-day on July 8 the sun was very clear, the sky being free from clouds, and a strongish wind blowing from the west. Two separate sets of measures were made with an interval of an hour between each. It was found that the dominant colour was λ 4885 in both cases, and in the first set it was diluted with 5·45 of white, and in the other with 5·14 of white. This indicates that sun light contains slightly more green-blue rays than the light emitted from the crater of the positive pole of the electric light. This agrees with the spectrum measures made in "Colour Photometry."

Cloud light was next matched on days in which the sky was overcast. A comparison of the general light of the zenith was all that was attempted, and near mid-day.

It was found that it required 1 part of λ 4864 diluted with 5·5 parts of white to make a match. It will be seen that the dominant colour of cloud light lies between that of the sky and of the sun, as might be expected, and is decidedly whiter than the sky, as might also be anticipated.

Various comparisons of sunset colours have been made, and found to range from λ 6300 up to λ 4800; in some cases it was necessary to match by means of complementary colours.

The light from a paraffin candle it was found could be very closely matched with D sodium light. The equation may be expressed as follows :—

$$\text{Candle light} = \lambda\, 5880 + 0{\cdot}4\text{W}.$$

The amount of added white varied from 0·1 to 0·5, and it is in this part of the spectrum that a large number of separate observations are required in order to get a good and fairly trustworthy mean.

June 15.—"Some of the Effects and Chemical Changes of Sugar injected into a Vein." By Vaughan Harley, M.D., Teacher of Chemical Pathology, University College, London, and Grocer Research Scholar. Communicated by George Harley, M.D., F.R.S.

When 10 grams of grape-sugar per kilo. of body-weight of a dog are injected into a vein and elimination by the kidneys prevented, the sugar so rapidly disappears from the circulating blood that it reached the normal quantity within six hours. The quantity of glycogen in the liver and muscles is not markedly increased.

The amount of lactic acid in the blood is increased to so marked a degree as in some cases to be more than the quantity of sugar. The greatest amount of lactic acid is found in the liver. Alcohol, acetose, and aceto-acetic acid are also present in the blood after the introduction of the sugar. There is no increase in the quantity of ammonia in the blood.

The introduction of the sugar causes marked disturbance of the nervous system, shown by the appearance of muscular spasms, hurried breathing, and finally coma. These are probably due to some of the products derived from the breaking down of the sugar molecules acting as a poison, which by further breaking up into other substances become harmless and the animals recover.

"Studies in the Morphology of Spore-producing Members. Part I. Equisetineæ and Lycopodineæ." By F. O. Bower, D.Sc., F.R.S., Regius Professor of Botany in the University of Glasgow.

The first pages are devoted to the discussion of points of general morphology of the sporophyte, as it is seen in archegoniate plants, together with a sketch of the history of opinion as to the morphological "dignity" of the sporangia, and their relation to the parts (usually sporophylls) which bear them. The position of Goebel is adopted, that sporangia are as much organs, *sui generis*, as are shoots, roots, &c., no matter where they may be seated.

It is customary to assume that the ontogeny will serve as a guide to the history of descent in plants as in animals. As applied in detail to the sporophyte generation this assumption cannot be upheld: for the conclusions drawn from wide comparison would be directly antagonistic to such a history. The young sporophyte of a fern first forms foliage leaves, stem, and roots; only after a considerable period are sporangia produced. On the recapitulation theory it would be concluded from this that the vegetative system was the first to appear, while sporangia were of subsequent origin, and it might further be held that sporophylls are metamorphosed foliage leaves. But the whole comparative study of the sporophyte of lower forms leads to the opposite conclusion; spore-production was the first office of the sporophyte, and if the lower Bryophyta really illustrate the mode of origin of the sporophyte, the production of spores preceded the existence of a vegetative system of the sporophyte, and has apparently been a constantly recurring event throughout evolution. It must therefore be concluded that the history of the ontogeny does not truly recapitulate the history of the descent as regards the neutral generation; the sporophyte is, in fact, an intercalated phase which has acquired vegetative characters. Comparative study of the Bryophyta leads to the conclusion that the whole vegetative region was the result of progressive sterilisation of potentially sporogenous tissues.

A brief review of the progress of this sterilisation as it has already been recognised among the Bryophyta is next given; it is pointed out that (*a*) the sterilisation may involve the whole thickness of the sporophyte, as in the formation of the seta, or (*b*) it may make itself apparent only in individual cells of the sporogonial head (elaters). But the Bryophyta are clearly marked from vascular plants by two characters: (1) the absence of appendicular organs; (2) the single continuous archesporium.

There are, at least, three possible ways in which plants with numerous separate archesporia may have originated from plants of some Bryophytic type: (1) by branching (chorisis) of a sporogonial head; (2) by formation of entirely new archesporia, having no direct connection by descent from pre-existent ones; (3) by partitioning of a continuous archesporium.

The frequent presence of synangia in eusporangiate Vascular Cryptogams suggests either coalescence accompanying reduction in a descending series, or partitioning by means of septa in an ascending series; the first question in connection with such synangia will be whether in any natural sequence of Vascular Cryptogams the progression from a non-septate to a septate condition can be traced; or the converse. Though the facts at hand do not amount to an actual demonstration, the Lycopodineæ and their allies are believed to be an ascending series, and they are seen to supply important evidence. *Phylloglossum*, *Lycopodium*, and *Selaginella*, *Lepidodendron*, and the Psilotaceæ show natural affinities. To this series *Isoetes* may be added.

As regards the sporangia, there can be no doubt of the homology of the sporangium of *Phylloglossum*, *Lycopodium*, *Selaginella*, and *Lepidodendron*. Within the genus *Lycopodium* differences of detail have been observed analogous to such differences as would result in the production of more bulky sporangia, such as those of *Lepidodendron* and *Isoetes*, though it is true these differences are not so extensive. In these very large sporangia trabeculæ are found, as rods or plates of sterile tissue, which may project far upwards into the sporangial cavity (*Lepidodendron*), or may extend the whole way through it to the upper wall (*Isoetes*). In the latter case it has been shown by Goebel that the trabeculæ are the result of differentiation of a potential archesporium, part of which is sterilised and forms the trabeculæ.

The next step is to the Psilotaceæ; and the first question is that of the real nature of the synangium in these plants. Sections both of *Psilotum* and *Tmesipteris*, show the synangium to originate below the apex of the sporangiophore, and from its upper surface, in a manner very similar to the sporangium of *Isoetes*. The form of the young synangium resembles that of the sporangium of *Lepidodendron*, with which genus also there is extraordinary anatomical similarity. The septum is similar in its origin to the sporogenous masses, and is not at first distinguishable from them; in this respect it also resembles *Isoetes*. It would thus appear that the whole synangium is comparable in origin and position, in the broad lines of development, and in function to the sporangia of other Lycopods, *that is, a septate comparable with a non-septate body*.

Tmesipteris appears to be a variable plant as regards the form and structure of its synangia; there is, however, some method in its irregularities; smaller synangia of simpler form and structure are found at the limits of its fertile zones, while about the middle of it synangia have been found with three loculi, corresponding to those of *Psilotum*. Examination of those of simpler form shows *that they may be only partially septate, or the septum may be absent from the first*. I have been able to prove in young synangia of this type that *the tissue which would normally form the septum may be sporogenous*; this is exactly the converse of what has been proved by Goebel in *Isoetes*, and the conclusion which may be drawn is that *there is no essential difference between the tissue which will form septum or trabeculæ and that which will form spores, since they can mutually undergo conversion.*

It has already been shown by others that in *Psilotum* the number of loculi in the synangium may vary, being sometimes two, normally three, but occasionally four or five. In *Tmesipteris* it may be one, two, or three; and as there is no doubt of the homology of these within the Psilotaceæ, we may conclude *that in homologous parts the loculi may vary in number from one upwards.*

We may recognise within the species *Tmesipteris* a correlation of size to number of loculi; the smallest specimens have no septum, and these are produced at the limits of the fertile zone, where nutrition may be failing; those which are of normal size have two loculi: occasionally, when of large size and well nourished, as at the middle of the fertile zone, the loculi may be three. Here is illustrated in one species much the same sequence as is seen elsewhere for distinct genera, such as *Lycopodium*, *Isoetes*, *Lepidodendron*: where the sporangium is small there are neither trabeculæ nor septa, the exigencies of nutrition, and perhaps also of mechanical strengthening, not being felt (*Lycopodium*): where the sporangium is large sterile bands of tissue are present; these appear as trabeculæ or incomplete septa *Lepidodendron* or *Isoetes*, but as complete septa in the large synangia of *Tmesipteris*. To those who accept the homology of the synangium of *Tmesipteris* with the sporangium of other Lycopodinæ the probability of this will appear specially strong. Such facts as these and their theoretical bearing are discussed at length in the memoir: the opinion is finally expressed that progressive sterilisation and formation of septa are factors which will have to be taken into account in solving the problems of origin of vascular plants.

"Magnetic Qualities of Iron," by J. A. Ewing, M.A., F.R.S., Professor of Mechanism and Applied Mechanics in the University of Cambridge, and Miss Helen G. Klaassen, Lecturer in Physics, Newnham College.

The paper describes a series of observations of magnetic quality in various specimens of sheet iron and iron wire. A principal object was to determine the amount of energy lost in consequence of magnetic hysteresis when the iron under examination was carried through cyclic magnetising processes. Many cycles of B and H were gone through in the case of each of the specimens, the limits between which B was reversed being varied step by step in successive cycles, to allow the relation of the energy expended or of $\int H dI$ to B to be determined. The iron examined was, for the most part, thin sheet metal or wire such as is used in the construction of transformer cores. The experiments show that there are marked differences in the values of $\int H dI$ in different specimens, even when all are nominally soft iron.

In connection with these results a formula proposed by Mr. C. P. Steinmetz $\left(\int H dI = cB^{1.6}\right)$[1] to express the relation of the hysteresis losses to B is discussed, and it is shown that although such a formula may serve fairly well as an approximate statement of the relation within those limits of B which are important in practice, it fails when applied to the more extreme portions of the curve.

The authors go on to describe a second group of experiments, in which direct measurements were made of the heat developed by magnetic reversals. The method consisted in using two rings, alike in all respects, with divided magnetising coils. One ring had its coils coupled so that the two parts opposed each other, and the core was consequently not magnetised when a current passed. The other ring was active, and its coils (coupled inductively) were connected in series with the non-inductive coils of the inactive ring. Alternating currents were passed through both, and the active ring became heated by the effects of hysteresis and Foucault currents. To balance this a steady current was caused to flow in the core of the inactive ring, and the energy was measured which had to be expended by this current in order that the temperature of the two rings might continue equal. In some cases the rings used were miniature transformers, and no difference was found in the amount of energy consumed in the core when the "load" was taken off or put on the secondary.

[1] "Trans. American Inst. of Electrical Engineers," vol. ix. No. 1.

In a third group of experiments the magnetic curve tracer was used to examine certain features of the curves of magnetisation. This instrument, invented by one of the authors, draws curves which exhibit the relation of the magnetisation of given samples of iron or steel to the magnetising current. Amongst other points referred to in this connection is the time-lag in magnetisation, which is shown by the curve tracer to be immensely great in soft thick bars. The work spent per cycle is a maximum at a particular frequency, which in such bars is very low.

The fourth and last section of the paper relates to the molecular theory of magnetisation, and describes experiments made with groups of small pivoted magnets. Results are given which tend to confirm the theory.

The particulars of the observations are set out in about forty sheets of curves which accompany the paper.

SYDNEY.

Royal Society of New South Wales, May 3.—Annual Meeting.—Prof. Warren, President, in the chair.—The report stated that thirty-three new members had been elected during the year, and the total number on the roll on April 30 was 477. During the year the Society held eight meetings, at which the following papers were read:—Presidential address, Hailstorms, and is Mars inhabited? by H. C. Russell, F.R.S.—On the importance and nature of the Oceanic languages, by Sidney H. Ray.—On certain geometrical operations, Part I., by G. Fleuri.—A determination of the magnetic elements at the Physical Laboratory, University of Sydney, by C. Coleridge Farr.—Analyses of some of the well, spring, mineral, and artesian waters of New South Wales, and their probable value for irrigation and other purposes, by John C. H. Mingaye.—Ventilation of sewers and drains, by John M. Smail.—Flying-machine work and the ¼ I.H.P. steam motor weighing 3¼lbs., by Lawrence Hargrave.—The venom of the Australian black snake (*Pseudechis porphyriacus*), by Dr. C. J. Martin and J. McGarvie Smith.—On the effect which settlement in Australia has produced upon indigenous vegetation, by Alex. G. Hamilton (for which essay the Society's bronze medal and prize of £25 were awarded).—Some folk-songs and myths from Samoa, translated by the Rev. G. Pratt, with introductions and notes by Dr. John Fraser.—Preliminary note on limestone occurring near Sydney, by Henry G. Smith.—Observations on shell-heaps and shell-beds, significance and importance of the record they afford, by E. J. Statham.—Notes on the recent cholera epidemic in Germany, by Dr. Schwarzbach.—On native copper iodide (Marshite) and other minerals from Broken Hill, New South Wales, by C. W. Marsh.—On the comet in the constellation Andromeda.—Results of observations of Wolf's Comet (II.), 1891, Swift's Comet (I.), 1892, and Winnecke's Periodical Comet, 1892, at Windsor, New South Wales, by John Tebbutt.—On the languages of Oceania, by Dr. John Fraser.—Notes on some Australian stone weapons, by Prof. Liversidge, F.R.S. The following papers were read before the various sections, viz.:—Medical Section: Recent work on the pathology of cancer, by Dr. G. E. Rennie.—Notes of a case of hydatid of the brain, by Dr. W. Chisholm.—Notes on a case of sarcoma of the testis in a cryptorchid removal, by Dr. Fiaschi. Engineering Section: Description of the engines recently erected at Ryde Pumping Station, with results of the tests applied, by C. W. Darley.—Various systems of tramway traction, by W. F. How.—Recent bridge-building in New Zealand, by A. H. Alabaster.—Notes on the economical use of steam, by T. H. Houghton.—Light railways for New South Wales, by C. O. Burge. Chemical and Geological Section: An account of a visit to New Guinea, together with some notes on the community of life between Australia and New Zealand, by Charles Hedley.—On the occurrence of platinum and associated minerals in the sands of the Richmond river; also in the lode material of Broken Hill, by J. C. H. Mingaye.—On a remarkable specimen of auriferous quartz containing fossil encrinites.—An account of some intrusive rocks in the neighbourhood of Sydney, by Rev. J. Milne Curran.—On a new mineral containing iodide of copper found at Broken Hill, by W. M. Hamlet.—The Clarke medal for 1893 had been awarded to Prof. Ralph Tate, University, Adelaide. The Council had issued the following list of subjects, with the offer of the Society's bronze medal and a prize of £25 for each of the best researches, if of sufficient merit, to be sent in not later than May 1, 1894:—On the timbers of New South Wales, with special reference to their fitness for use in construction, manufactures, and other similar purposes.—On the raised sea-beaches and kitchen middens on the coast of New South Wales.—On the aboriginal rock-carvings and paintings in New South Wales. To be sent in not later than May 1, 1895: On the silver ore deposits of New South Wales.—On the physiological action of the poison of any Australian snake, spider, or tick.—On the chemistry of the Australian gums and resins. The chairman read the Presidential address, and the officers and council were elected for the ensuing year, Prof. T. P. Anderson Stuart being President.

PARIS.

Academy of Sciences, July 24.—M. de Lacaze-Duthiers in the chair.—Diverse considerations on the theory of luminous waves, by M. J. Boussinesq.—Researches on samarium, by M. Lecoq de Boisbandran.—On the alleged fossil ferns of the coarse Parisian limestone, by M. Ed. Bureau.—On the distribution of the intensity of gravitation on the surface of the globe, by M. Defforges. This memoir has been submitted to the judgment of the Academy by the Minister of War. It contains a summary of the observations of the value of g at thirty-five stations, twenty-six determinations having been made with the "reversible invertible" pendulum invented by Commander Defforges, which eliminates the error due to the sliding of the knife edges. In this pendulum a displacement of the centre of gravity takes the place of the interchange of knife-edges, and the influence of curvature and of any dissymmetry in the action of the air is avoided. In the list of values enumerated, extending from Spitzbergen to Scotland, England, France, Corsica, and Algiers, there are certain anomalies which cannot be explained by supposed inaccuracies of observation and reduction. Clairaut's law, true in general, is almost everywhere masked by these anomalies. On the littorals of the various seas, gravitation presents slight anomalies, which are constant on the same coast, and characteristic of it. The islands show a considerable excess of gravitational force. On the continents the reverse obtains, and the defect appears to grow with the altitude and the distance from the sea. As the real surface of the ellipsoid, according to Clarke, does not depart from the theoretical surface by more than 18·4 feet from the Shetlands to the Mediterranean, the discrepancies cannot be attributed to irregularities in the figure of the earth, but must probably be accounted for on geological grounds.—Observations of Rordame's comet, made with the *equatorial coudé* (0.32m.) of the Algiers observatory, by M. Rambaud.—On the equations of the second degree whose general integral is uniform, by M. Paul Painlevé.—On certain systems of ordinary differential equations, by M. A. Guldberg.—On a nomographic method applicable to equations which may contain up to ten variables, by M. Maurice d'Ocagne.—Density of sulphurous anhydride, its compressibility and expansion in the proximity of normal conditions, by M. A. Leduc. The density of sulphurous acid under normal conditions was found to lie between 2·2638 and 2·2641. The coefficient of expansion between 0° and 20° was, at normal pressure, 0·003963, and at a pressure of 334mm., 0·003787.—On residues of polarisation, by M. E. Bouty. For defining capacities of polarisation it is implicitly admitted that, at least to a first approximation, the whole quantity of electricity which traverses the voltameter circuit during charge is employed in establishing polarisation, and will be recovered during discharge; also that to a given polarisation there corresponds a single and unique value of recoverable charge. M. Bouty shows that the effective capacities of discharge increase in proportion as the polarisation of the voltameter decreases. Even the initial capacities of polarisation cannot be relied upon to give rigidly constant values.—On some new interference fringes which are strictly achromatic, by M. Georges Meslin.—On the oxidation of sulphide of nickel, by M. Ph. de Clermont.—On crystallised cuprous phosphide, by M. A. Granger.—On bismuth subgallate (dermatol), by M. H. Causse.—On the condensation of the alcohols of the fatty series with the aromatic carburets, by MM. A. Brochet and P. le Boulenger.—On the effects of the slow destruction of the pancreas, by M. E. Hédon.—On the interference of excitations in the nerve, by M. N. Wedensky.—Comparison between the anterior and posterior members of some Urodelæ, by M. A. Perrin.—A parasitic entomophagus of the European silk-worm, by M. E. L. Bouvier and G. Delacroix.—Further researches on coccidia, by M. P. Thélohan.—On certain facts which permit a comparison between the central nervous systems of the Lamellibranchiata and the Gasteropoda, by M. A. d'Hardiviller.—On the Rhizoctone of Lucerne, by M. A. Prunet.—On the glacial origin of the breccia of the coal-bearing basins of Central France, by M. A. Julien.—On two Turkish meteorites recently added to the Natural History Museum, by M. Stanislas Meunier.—Desert sands of Lower Egypt, by M. A. Andouard. An analysis of the sands between the Ismailia canal and the Menzaleh Lake showed them to consist of 96·5 per cent. silica, 0·384 water, 0.507 organic matter, and small quantities of other substances such as carbonic acid, alumina, lime, and ferrous oxide. These deserts are gradually being reclaimed by irrigation and by the use of the "black earth" gathered among the ruins of ancient habitations.

GÖTTINGEN.

Royal Society of Sciences, February 22.—H. Weber: Researches in the theory of numbers in the domain of elliptic functions, II. A. Hurwitz: Proof of the transcendency of the number e. H. Burkhardt: On vector-functions which are themselves vectors, an application of invariantal methods to a question of mathematical physics. W. Holtz: On the immediate perception of magnitude in its relation to distance and contrast. W. Ramsay: The isomorphic stratification and the intensity of double refraction in epidote.

March 22.—W. Voigt: Determination of the constants of thermal dilatation and pressure for certain quasi-isotropic metals.

April 12.—O. Wallach: New observations on compounds of the camphor series. W. Voigt: The specific heats c_p and c_v of certain quasi-isotropic metals; determination of the elastic constants of chloride of sodium; remarks on the problem of the transverse vibrations of rectangular plates.

CONTENTS.

THURSDAY, AUGUST 10, 1893.

THE PROTECTION OF WOODLANDS.

The Protection of Woodlands. Authorised translation by John Nisbet, D.Œc., of the Indian Forest Service, of Kauschinger's "Waldschutz." Revised by Dr. Hermann Fürst. One volume, demy 8vo, 252 pages. (Edinburgh: David Douglas.)

FOREST Protection, termed *Waldschutz* or *Forstschutz* in German, is the art of protecting woodlands from external dangers, such as injurious meteoric influences, bad soils, injurious plants and animals, and human agency. The subject ranks in Germany as a separate branch of Forestry, distinct from silviculture, utilisation of forest produce, or forest management. In France, however, this is not yet the case; and the dangers to which forests are liable, together with the various preventive and remedial measures which experience suggests against them are described under the heads of forest botany, zoology, forest law, silviculture, and forest utilisation.

A strong reason for this difference of treatment of the same subject in the two countries is that the professors of subjects taught as auxiliary to Forestry at the French National Forest School at Nancy are experienced forest officers, but these subjects in Germany are taught by scientific specialists who have not sufficient forest experience to enable them to estimate the amount of damage likely to occur to forests from any form of injury, and the permissible limits of time and money in combating it. There is much to be said in favour of foresters studying botany and entomology from a general point of view and attending lectures on these subjects by eminent professors, instead of by foresters who may have worked up a branch of natural science more or less thoroughly, but it then becomes necessary that *Forest* Protection should be studied in a manual written by an experienced forester. The chief danger to the writer of a manual of forest protection is that he may be tempted to give undue preponderance to one branch of the subject, and in the work under notice the account of forest insects extends over 108 pages out of 246. This may be warrantable in Germany, where forest insects are unusually numerous and destructive, but in a treatise intended for practical use in the British Isles only confusion and bewilderment can result when insects which are destructive to forests in Central Europe, many of which do not exist here, while others that are rare and occur under different conditions, are described without any comment.

Mr. Nisbet has, in the section treating of forest offences, omitted certain matters relating only to German conditions of forestry. He should have carried his omissions further. No purpose is served by the inclusion of species such as *Chrysobothris affinis*, *Deudroctronus micans*, *Cnethocampa processionea*, &c., all unknown to the British forester, nor of varieties like *Tomicus sexdentatus*, *Lytta vesicatoria*, *Agelastica alni*, *Ocneria dispar* (apparently extinct), the Agrili, &c., unless the statements made are qualified by foot-notes, or otherwise. It is misleading to say that *Myelophilus minor*, whilst remaining unknown in many localities, often occurs in very large numbers in other places, whereas but a single British specimen is known; or that *Polyphylla fullo* occurs rather frequently here and there throughout sandy districts. A few species, though not British, like *Gastropacha pini*, or of rare occurrence, like *Tomicus typographus*, deserve notice in any boo dealing with forest entomology, provided that the freedom from them of our British woodlands is pointed out. This is done for the latter insect alone. If Mr. Nisbet had omitted about half the insects which he includes, he would have space to extend the diagnoses of the remaining species, which are too meagre to be of any use, and are little assisted by the roughly-coloured copies of some of the figures in Ratzeburg's "Forst Insecten." To give some account of insect attacks and methods of treatment in Britain, some species have been added, which, though rarely important, have occasionally annoyed tree-growers in this country, such as *Tomicus acuminatus*, *Earias chlorana*, *Pygaera bucephala*, *Sesia sphegiformis*, and particularly the wire-worms and millepedes often most destructive to seedlings. Many general statements appear which require modification, as, for instance, "in the *Diptera*, instead of any cocoon, a sort of bladder or shel is formed by the last larval skin"; and in the timber-boring *Scolytidæ*, "the larvæ hollow out short cone-like galleries at right angles to the main gallery," which is only true of *Trypodendron*, and not of *Xyleborus* or *Platypus*. Mr. Nisbet follows the German phraseology closely in his translation with curious results, such phrases as "raw localities," "ovi-depositor," "rostral beetle," seed owlet moths (*Agrotidæ:—Saat Eulen*) "multannual," are not welcome additions to the English language. One does not make "sections" of caterpillars to discover the presence of ichneumon larvæ; the Longicornia are not "cervicorn," but capricorn beetles; and the name Gold Beetle applied to *Clerus formicarius* is unintelligible.

The accounts of some of the more important insects, such as *Curculio abietis*, the cockchafer, and *Liparis monacha* (unimportant in Britain), are good, and the treatment recommended is in accordance with sound forestry; the section on decoy trees is one of the best, but if another edition is called for, the translator should submit the chapters dealing with forest insects to a competent entomologist and alter them so as to give a just account of forest entomology in Britain.

As regards the remaining parts of the book, in the account of the damage done by winds, "the system of cutting free or strengthening," *Loshieb* might have been rendered by the term *severance felling*, as proposed by Brandis in his notes on forest management in Germany published in 1888 by the India Office. Mr. Nisbet states that this system has not up to the present time enjoyed any very extensive adoption; but it is a fact that severance fellings are extremely common in the forests of Saxony. The term Scotch pine is surely preferable to that of Scots pine; and the English names of several birds on page 115 require revision. *Corvus frugilegus* is the rook and not the raven, and *Monedula turrium* is the jackdaw and not the rook.

The book is well printed and of useful size, being very similar in these respects to Dr. Schlich's manual of forestry, and apart from the chapter of forest insects, it will be very useful to the practical forester and to other students of forestry. The annexed table of contents explains its general scope—

Section First. Protection of Woodlands against Injuries due to Inorganic Agencies.—Chap. I. Damage caused by unusually High or Low Temperature. (*a*) Frost. (*b*) Heat. II. Damage caused by Atmospheric Precipitations. (*a*) Rain. (*b*) Snow. (*c*) Hoar-frost, ice, hail. III. Damage caused by Aerial Currents. IV. Damage caused by Lightning. V. Disadvantages arising from Unfavourable Soil and Situation. (*a*) Excess of moisture; wetness. (*b*) Deficiency of moisture; dunes, sand-drifts. VI. Diseases of Timber Trees.

Section Second. Protection of Woodlands against Injuries due to Organic Agencies.—Chap. I. Damage caused by Plants. (*a*) Noxious forest weeds. (*b*) Parasitic plants. II. Damage caused by Animals. (*a*) Mammals. (*b*) Birds. (*c*) Insects. (*a*) On coniferous trees principally. (*b*) On broad-leaved trees principally.

Section Third. Protection of Woodlands against Human Agencies.—Chap. I. Protection of Forest Boundaries. II. Protection against Misuse of Rights or Servitudes. III. Protection against Forest Offences and Misdemeanours. IV. Protection against Forest Fires. V. Protection against Damage by Smoke and other Atmospheric Impurities.

NORTH AMERICAN BUTTERFLIES.

Brief Guide to the Common Butterflies of the United States and Canada. Being an Introduction to the Knowledge of their Life-histories. By Samuel Hubbard Scudder. (New York: Henry Holt and Co., 1893.)

The Life of a Butterfly. A Chapter of Natural History for the General Reader. (Same author and publisher.)

IN the two small volumes before us Dr. Scudder, the author of the greatest monograph on any limited butterfly-fauna that has yet appeared ("The Butterflies of the United States and Canada"), has attempted the no less useful task of popularising the subject for the less advanced student.

Far more attention is paid in America than in Europe to the life-histories of insects, and the plan of Dr. Scudder's "Guide" is sufficiently indicated by the author in his preface. "I have accordingly selected the butterflies—less than a hundred of them—which would almost surely be met with by any industrious collector in the course of one or two years' work in the more populous Northern States and Canada . . . . As the earlier stages of these insects are just as varied, as interesting, and as important as the perfect stage, descriptions are given of these . . . . only such stages as would be more commonly met with being fully described, and the egg and earliest forms of caterpillar omitted as rarities, and also as too difficult for the beginner's study."

Those who know the thorough character of Dr. Scudder's work will not be surprised to learn that even within the narrow limits laid down, the book contains a far larger amount of general information than would be found in almost any popular European manual on a similar subject. Not that such information respecting our European butterflies does not exist, but it is scattered through thousands of volumes of periodical literature, and has hardly yet been properly systematised for the advanced student, much less for the beginner.

The introductory portion of Dr. Scudder's work consists of general information respecting butterflies in their various stages, separate keys to the American genera, both for the perfect insect and for the caterpillar and chrysalis, an explanation of neuration with a diagram, &c., &c.

In the body of the work each species occupies from one to two pages. It is first described as butterfly, caterpillar, and chrysalis, and then a full account of its life-history, habits, localities, times of appearance, &c., in all its stages, from egg-laying onwards, is given in larger type. An appendix contains instructions for collecting, rearing, preserving, and stuffing, extracted from one of Dr. Scudder's former works.

Dr. Scudder is rarely to be found tripping, but we think that the section on the senses of insects is hardly abreast of our present knowledge of the subject. On p. 23 he says, "The sounds made by butterflies are apparently due simply to the rustling of the wings." If he will refer to the work of an eccentric writer, but a good observer (Mr. Swinton's "Insect Variety," pp. 112-127), he will find a good deal of information about the stridulation of butterflies.

The second work which we have to notice, though smaller, is perhaps of greater interest to the European entomologist. It deals with *Anosia Plexippus*, the Monarch or Milk-weed Butterfly, one of the largest and most abundant of North American butterflies, a migratory insect which is rapidly extending its range over the warmer parts of the world.

It has been selected as a butterfly whose life-history presents more interesting points than that of most others (though other butterflies are, of course, referred to in the course of the work), and the following are some of the principal points which Dr. Scudder discusses in reference to it: the tongue, course of life, vagrancy, critical periods, mimicry, scent-scales, insect vision, the fore-legs, the position of the chrysalis, the proper name, &c.

It is now pretty well ascertained that this butterfly has as regular an annual migration as birds in North America from south to north and north to south. No lepidopterous insect probably possesses the habit to anything like the same extent; for the migrations of the day-flying moths of the genus *Urania*, though regular, are confined to comparatively narrow limits in the tropics.

We will now notice a few points that have struck us in glancing through the book. At p. 64, Dr. Scudder says: "There were certainly no butterflies here when the country was flooded with ice." Is not this too sweeping a statement? Have not our Arctic explorers found butterflies as far north as they have yet succeeded in penetrating?

It is pretty well known that newly-hatched caterpillars generally devour the shell from which they have just emerged. This has usually been regarded as merely an odd habit; but Dr. Scudder suggests that its real object may be to avoid betraying the proximity of the larva to its enemies by leaving the empty eggshell as an indication of its presence (p. 70). Scent is considered by Dr. Scudder to play an extremely important part in butterfly life. There are, of course, great differences in the structure of the eyes of different insects, but there is reason to believe that it is often very defective, and that its imperfect character is supplemented by a highly delicate sense of smell. A curious account of wasps chasing flies is given at p. 122, which seems to show that wasps at least are not the highly-endowed and intelligent creatures which some have been disposed to imagine. Yet the sense of smell in insects may be mistaken, as witness the well-known fact (which Dr. Scudder has forgotten to mention) that carrion-feeding flies will sometimes lay their eggs on foul-smelling plants. He finally sums up his remarks on the senses of butterflies as follows:—"It becomes clear that the exquisite beauty and variety in the butterfly world is not recognised by themselves, and form no element in their lives."

While agreeing with Dr. Scudder in the main as to his remarks on nomenclature, we are not quite sure that he is correct in applying Linné's name *Plexippus* to the butterfly in question. It is certain that Linné confounded two or three species under the name, among which was the Milk-weed Butterfly, and gave the locality as North America; but the words "Alæ primores fasciâ albâ, ut in seq. (*Chrysippus*) cui similis," seem to us to indicate that the name would be more correctly applied to an East Indian species; for no American species of the group agrees with the characters which we have quoted.

In reference to what Dr. Scudder says on p. 178 respecting the origin of the Pacific immigrants, we may mention that, to the best of our recollection, all the specimens of the butterfly which we have seen from any part of the Old World belong to the normal type of the United States.

The book is illustrated with four plain plates, representing the insect in its various stages, and numerous details.

In America, at least, entomologists are fast outgrowing the time when nothing was thought worthy of attention but the perfect insect. We imagine that the time is not far distant when no account of an insect will be regarded as *complete* which does not include its external and internal anatomy in all its stages as well as its life-history. W. F. KIRBY.

OUR BOOK SHELF.

Life with Trans-Siberian Savages. By E. Douglas Howard, M.A. (London: Longmans, Green, and Co., 1893.)

AWAY beyond Siberia proper, in the Okotsk Sea, lies the island of Saghalien, or Sakhalin. Acquired by Russia many years ago, it has been converted into a vast prison, in which to confine convicts, for whom transportation to the mines of Siberia is considered insufficient. To this island, even the name of which is whispered in fear in Russia, Mr. Howard was fortunate enough to gain access. Walking through the exile hospital one day, he saw a being unlike any he had met before, and which, it was afterwards explained to him, was a female of the race of Sakhalin Ainus—the aborigines of the island, and the progenitors of the Ainus of Japan. Mr. Howard was naturally fired with the desire to see more of the race, which possesses the distinction of being as simple in their savagery to-day as they were three thousand years ago. The book before us tells the tale of his journey to the Ainu country and his life among the people. The story is full of interest, and is told in an unaffected manner, without any straining after effect. As an example of the author's style the following account of the aboriginal method of procuring a light will suffice:—

"A rough little apparatus was produced, consisting of two little blocks of wood. Between these was placed a bit of very dry elm stick, one end, which we will call the lower end, being pointed so as to fit loosely into a hole in the lower block; the other end, also pointed, being in contact only with the flat under surface of the upper block. A bow was then unstrung at one end, the string was passed round the middle of the dry stick, and the free end was loosely re-attached. The bow was then worked with wonderful celerity, until the lower end of the stick first smoked, and then passed into a fitful blaze. This was communicated to some fine dry twigs, and in a few minutes we had as good a bivouac fire as I could wish."

Mr. Howard witnessed the manufacture of the poison used by the Ainu for tipping arrow-heads. His description brings to mind the witches' caldron in *Macbeth*. An infusion produced from dead spiders was mixed with inspissated gall of foxes, and a thick extract of the roots of *Aconitum napellus*, in order to procure the deadly paste. It has been said that the Ainus of Japan perform no religious ceremonies during the preparation of these ingredients, but Mr. Howard's observations show that the Ainus of Sakhalin certainly do sanctify them. After preparation the paste is pressed into a long and deep hollow in the arrow-head, and its poisonous properties are preserved by smearing the head with a resinous gum. The secret of manufacture is only known to the two chiefs of the village and two arrow artificers.

There are many other points of interest in Mr. Howard's narrative, especially to the student of ethnology. In fact the book appears to be a "plain, unvarnished tale" of personal observations, and on this account, if for no other reason, it is well worth reading.

Advanced Physiography. By R. A. Gregory and J. C. Christie. (London: Joseph Hughes and Co., 1893.)

TEACHERS have long felt the need of a good text-book on advanced physiography, and will no doubt fully appreciate the little book before us. Mr. Gregory's twelve chapters on the astronomical side of the subject form an admirable supplement to his now well-known "Elementary Physiography." This part of the book is treated in a very practical manner, and the text is at the same time remarkably free from errors; one mistake, however, is in placing β Cassiopeiæ amongst the bright-line stars instead of γ Cassiopeiæ. The various astronomical instruments are described in a clearly-written and well-illustrated chapter, which should prove extremely useful to students who have not the advantage of seeing and using the instruments for themselves. In all the most recent discoveries the book is well up to date; in the chapter on "Stars and Nebulæ" a racy account is given of the discovery, observations, and probable origin of the new star in Auriga. The author writes with a practical knowledge of his subject, and has done as much justice to it as the limitations of a text-book allow.

Mr. Christie is responsible for the three final chapters, dealing with the earth as a cooling globe in relation to Kant's hypothesis. The treatment adopted is more of the nature of an essay than that of a text-book; but, as pointed out by the author, this is chiefly due to the fact that the subject is to a great extent speculative. The table of the terrestrial elements known to occur in meteorites and other celestial bodies might have been of value if sufficient care had been taken to insure accuracy. As regards the elements in the sun it differs very widely from the table given by Mr. Gregory on p. 185, and several elements, such as bromine, are erroneously included.

The 107 illustrations form a noticeable feature of the book, many of them having been specially drawn for it. We confidently recommend the book to the notice of teachers, for it is certainly one of the most excellent expositions of the subject that we have yet seen.

Proceedings of the Edinburgh Mathematical Society. Vol. xi. (London: Williams and Norgate, 1893.)

THE practice recently adopted by this Society of issuing its volumes in complete form at the end of its session, whilst it has some advantages, has the great disadvantage which results to an author in the long delay of the publication of his results if he has made his communication early in the session. We believe, however, that the Society meets this objection by allowing authors to have copies of their papers as soon as they are printed.

There are twelve contributors to this volume of 170 pages. The historical notes are especially interesting. They are on the history of the Fourier series, by G. A. Gibson; history of the nine-point circle, early history of the symmedian point, and Adams's hexagons and circles, by Dr. J. S. Mackay. These last are written in Dr. Mackay's usual interesting style, with full references to early writings on the several points. It is a pity that he has not received sufficient encouragement to publish his large store of notes in a single volume instead of issuing them in the shape of detached notes. Prof. A. H. Anglin gives a paper on certain results involving areal and trilinear coordinates. Mr. C. Chree writes on action at a distance, and the transmission of stress by isotropic elastic solid media, and Mr. W. Peddie contributes notes on the use of dimensional equations in physics, on the fundamental principles of quaternions and other vector analyses, and on the elements of quaternions. This last subject is discussed at some length by Prof. Knott in the quaternion and its depreciators. His attitude is well known to the mathematical readers of NATURE (see vols. for 1891-2-3). The remaining notes appeal to the mathematical masters, who form the major part of the *clientèle* of 131 members.

LETTERS TO THE EDITOR.

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

The Publication of Scientific Papers.

THE discussion of this important subject has been started *à propos* of physical papers, but the publication of papers in all branches of science is in an equally unsatisfactory state.

Prof. Lodge, in his letter in your issue of July 27, after paying attention to the preparation of useful abstracts of all papers on physical subjects appearing both at home and abroad, calls attention to what has always appeared to me to be the most important matter for reform, namely, the means and methods of publication of English scientific papers.

There is no complaint more frequently heard abroad than that important papers of English scientific men are almost inaccessible to the foreigner, because it has been the fashion to communicate them to local societies and to rest content with such publication as is secured by their being printed in the Society's Proceedings or Transactions. If these societies distributed their publications liberally where there are students who ought to have the opportunity of reading them, and without taking account of whether they receive in exchange a publication of an equal number of pages, the evil would be much less. But this is not so. It is notorious—to take, for instance, the Royal Society of Edinburgh, with which I am best acquainted, and which is not by any means the least liberal in the matter of distribution—that unless the author distributes lavishly separate copies of his paper in every quarter where he considers it important that it should be read, it will pass unnoticed, and a worker in the same branch of science will not consider that he is open to any blame for not being acquainted with a paper published in an organ so difficult to procure. I believe that this applies in at least an equal degree to the other two societies mentioned by Prof. Lodge, namely, those of Dublin and Cambridge, and of course it is all the more applicable to societies of less importance. But even the Royal Society itself is open to exception in this respect, for although no fault can be found with the Proceedings or Transactions as a recognised organ of publication, they are, as a matter of fact, not more readily accessible abroad than the corresponding publications of the Edinburgh Society, and the majority of foreign students never see anything but abstracts of important English papers. The only independent scientific journal of importance is the *Philosophical Magazine*, and though widely known it is not extensively used, and has not grown with the times. The want of means of scientific publication which has been produced by the development of scientific activity in the last twenty or thirty years has been met by an increase in the number of societies, and by a greater development of society publication. The former is probably an advantage, the latter is certainly a disadvantage. The publication of scientific papers cannot be too much centralised in the interests of both authors and readers, and for this purpose a central organ such as indicated by Prof. Lodge is required.

What is at present inefficiently and extravagantly done by a multitude of amateur publishers scattered over the country could at much less cost be efficiently done by a central publishing officer issuing a central organ, in several series, each series appearing in monthly numbers, and the whole run on strictly business lines. Each series should be devoted to a particular science or branch of a science. Thus, there might be several series in chemistry as organic chemistry, inorganic chemistry, physical chemistry and technical chemistry. Physics also would fall into several series, as would other sciences. Each series of original papers would have a parallel one of abstracts of foreign papers on the same subject, and it would be useful to have a separate series, which might be issued weekly or fortnightly, devoted to printing a minute of the proceedings and papers read at the meetings of the various societies throughout the country, to be furnished by their secretaries.

The effect of the realisation of some such plan as this would be the immediate setting free of the large sum of money annually spent by the societies in printing, and the collection of all that is published in *one* organ, which would be an enormous assistance to the student.

Each series would have to be intelligently and liberally indexed, and a separate volume of the indices of all the series published each year. It would then be sufficient for the worker to take in the series devoted to his own branch of science and the yearly index volume, which would prevent his overlooking papers of importance appearing in other series.

This scheme of central publication has occupied my thoughts for some years, and I have from time to time discussed it with my friends, and it has even been brought before one publisher, but without any practical effect.

It is therefore with very great pleasure that I find Prof. Lodge advocating a similar scheme, and I hope that it may be the means of fixing public attention on the present unsatisfactory state of things and of forcing a remedy.

August 8. J. Y. BUCHANAN.

THE abstracts of physical science for the year 1886, published by the Berlin Physical Society, are contained in three stout octavo volumes, comprising over 2000 pages, while the somewhat less comprehensive supplements to the *Annalen* average about 1000 pages. A good index, on the other hand, can be prepared at little more than the cost of printing. An index entry, which contains the full title of the article, the name of the author, the correct reference, the number of pages covered by the article, and, where necessary, a brief indication of the scope of the article, is sufficient to inform the student where each advance in his particular branch of science is to be found reported, and is of permanent value to searchers of all sorts, provided a proper system of classification of the index entries is adhered to. The scheme of indexing carried out by the Association of Engineering Societies of America presents many features worthy of imitation. The index, which appears monthly in the journal, is printed on one side only (the reverse is available for advertisements) and possesses a separate pagination, so that a student can extract for himself any entries which he may require. At the end of the year the index is consolidated, so as to form a permanent record of the progress of the science during that period. The consolidation of the index can be cheaply effected by an arrangement with the printer to keep the type standing for twelve months, when, in addition to the reference to the source of the original paper, references to abstracts and reviews can be incorporated. If the Physical Society would undertake such a work, it is probable that the utility of the index would lead to an extension of the system to other sciences also. It is clear that by a cooperative arrangement between two or more societies various indexes could be issued at a relatively slightly increased cost. The economy is obvious: the same files have to be searched but once, the same staff would be competent to do the combined work at a cheaper rate, and minor economics could be effected in stationary salary of editor, &c.

It remains to be seen whether English physicists are disposed to abandon their present attitude of masterly inactivity—waiting until, in the fulness of time, International Bureaus shall step in and do the work for them. A simple scheme like the above requires no *deus ex machinâ* in the shape of British Association aid to set the ball rolling.

E. WYNDHAM HULME.

44, Blenheim Terrace, N.W., July 31.

The General Motions of the Atmosphere.

TWO cyclonic storms have occurred over the Indian region, the tracks of which appeared to be suggestive of the existence of very abnormal conditions in the general circulation of the currents of the atmosphere. The first storm appeared over the east of the Bay of Bengal, in about lat. 15° N., on May 20. The centre crossed the bay on a W.N.W. track during the 21st and 22nd, and appeared on the Orissa coast on the 23rd. Here it slowly recurved and followed a N., N.E., and E. course, finally passing away on May 29 or 30 into Assam and Manipur. The second storm appeared over the east of the bay, also in about lat. 15° N., on June 11, passed during the 12th, 13th, 14th, 15th, and 16th W.N.Westward across the bay, and to the centre of the Indian Peninsula. It there recurved, like its predecessor, through N. and N.E., and finally into E.

Combining the direction of movement of the two storms for each twenty-four hours after movement commenced we obtain the following figures:—

	Direction.		Direction.
1st day,	N. 80° W.	6th day,	N.
2nd ,,	N. 78° W.	7th ,,	N. 27° E.
3rd ,,	N. 52° W.	8th ,,	N. 50° E.
4th ,,	N. 36° W.	9th ,,	N. 70° E.
5th ,,	N. 13° W.		

The following is the normal movement of storms during the period May 20 and June 20, extracted from the "Handbook of Cyclonic Storms in the Bay of Bengal," by combining the directions of motion of each storm recorded within the period:—

	Direction.		Direction.
1st day,	N. 48° W.	5th day,	N. 48° W.
2nd ,,	N. 39° W.	6th ,,	N. 41° W.
3rd ,,	N. 40° W.	7th ,,	N. 22° W.
4th ,,	N. 55° W.		

It will be observed from this comparison that the direction of movement of the two storms of May–June, 1893, disagrees with the average movement of storms at this time of year. On the other hand, "recurving" from a N.W. translation, through a N. translation into a N.E. and E. translation is in the Indian region a marked feature of the progressive motion of storms in the spring and autumn months, and it hence follows that if the direction of movement of cyclones is controlled by the upper currents of the atmosphere, then the upper currents existing over the Indian region at the end of May and during the first half of June in the present year were analogous to those ordinarily prevailing over that region in the spring and autumn, and were not comparable with those normally prevailing at or about midsummer. Now, according to an hypothesis put forward by the writer, there exists over this thermal equator a current of westerly translation, and it is within this current, or on the margins thereof, that all the more important cyclones originate. On the north side of the current of westerly translation air currents exist, moving first to N.W., then to N., and finally towards N.E. and E., transferring the air raised over equatorial regions (or rather over the regions covered by the thermal equator) towards the temperate zone. In ordinary years nearly all the storms of the bay appearing between May 20 and June 20 appear to the north of lat. 18°, and the great majority of them to the north of lat. 20° N. At the same time the thermal equator and air-current of westerly translation at midsummer covers northern India, and its northern margin lies close to the Himalayan range of mountains. This range obstructs any northerly movement of cyclones, and hence the direction of motion of storms is controlled by the current of westerly translation, and is towards the west. In the spring and autumn, on the contrary, the thermal equator lies over southern India, and the motion of cyclones is—first westerly, within the equatorial current of westerly translation, and subsequently along the curved track described by the returning air. When, then, as in the present case, we have occurring nearly at midsummer a direction of movement of cyclones analogous to that prevailing in the spring and autumn, it may not be unfair to assume that the thermal equator, the return current of air from the torrid to the temperate zone and the massive current of easterly translation over the temperate zone, all lie to the southward of the positions occupied by them in normal years. If this be the case in the Indian region, it is conceivable that similarly anomalous conditions prevail in other parts of the world; and it is, perhaps, possible that the exceptional weather which has prevailed over the United Kingdom, and other portions of the north temperate zone, may be due to the fact that the United Kingdom, &c., relatively to that portion of the current of easterly translation which ordinarily transports cyclones eastward has been modified, and that this portion of the current, and consequently the path of cyclones, lie to the southward of their normal positions.

It is very difficult in India to accurately determine the lie of the thermal equator, as it is very doubtful if temperature observations at the earth's surface are in themselves sufficient to show the real atmospheric thermal conditions. Apparently, however, the centre of the thermal equator in May runs from about lat. 18° to 20° N. in long. 96° E. to lat. 25° N. in long. 68° E. The writer has extracted from the monthly weather review the temperature (day temperature) anomalies of three stations (Calcutta, Allahabad, and Lahore) lying to the north and of three stations (Nagpur, Madras, and Bombay) lying to the south of the line given above, and finds they are as follows:—

$$\text{Northern Stations.}\left\{\begin{array}{l}\text{Calcutta} = -4^{\circ}\!\cdot\!2\\ \text{Allahabad} = -3^{\circ}\!\cdot\!0\\ \text{Lahore} = -1^{\circ}\!\cdot\!9\end{array}\right\} = -3^{\circ}\!\cdot\!1$$

$$\text{Southern Stations.}\left\{\begin{array}{l}\text{Nagpur} = -2^{\circ}\!\cdot\!4\\ \text{Madras} = +1^{\circ}\!\cdot\!3\\ \text{Bombay} = -0^{\circ}\!\cdot\!8\end{array}\right\} = -0^{\circ}\!\cdot\!6$$

These observations show negative anomalies for both regions but they would also appear to show, from the largeness of the anomaly to the north and the smallness of the anomaly to the south, that the line of greatest heat over India in May had been thrown to the southward. According to the writer's views, however, the low latitude of the place of origin of the cyclones and the subsequent curved trajectories of the storms are stronger evidences of the southerly position of the tropical band of westerly translation than that afforded by temperature observations taken at the earth's surface.

W. L. DALLAS.

Simla, India, July 2.

Thunderbolt in Warwickshire.

ON Sunday evening, July 2, this part of Warwickshire was visited by a very severe storm of thunder and lightning, accompanied by torrents of rain. After the storm had subsided, about ten minutes before ten o'clock in the evening, a fireball seems to have fallen in the village of Dunchurch, an occurrence still rare enough to warrant its being placed on record.

On the afternoon of July 4 I visited the garden of A. H. Harrison, Esq., of Dunchurch Hall, in which an explosion occurred at the time indicated, breaking off at about seventeen feet from the ground a fine specimen of Wellingtonia growing on the lawn, which had been when intact about thirty feet high. The upper portion was shivered, fragments being scattered far and wide both over the lawn and an adjoining field, some fragments sticking in the grass lawn and showing that they must have been hurled with great force.

At the same time twenty-four panes of glass in front of the house were smashed by the violence of the explosion, at a distance from the tree of twenty-three to forty-three yards.

It was noticed that windows of plate glass, as well as windows which happened to be open at the time, escaped. The explosion is said to have been quite unlike thunder, and to have resembled the report of a heavy piece of ordnance. It is probable that the report was heard here in Rugby, as I find that two persons who happened to be in my house at the time remember hearing a double report at about the same hour, which they remarked upon to each other as being like the distant firing of a cannon.

As to the evidence of the agent of destruction being a fireball, I have, through the kind help of Mr. Harrison, been enabled to examine four witnesses, all of whom agree that during an interval of two minutes before the explosion a large fiery globe was seen travelling through the air, and emitting light of such dazzling brilliancy that the only one of them who was out of doors at the time was for a moment blinded and dazed, and felt for some short time afterwards a sensation of pain in the back of the head and the neck.

A fifth witness, whom I did not see, was at the time of the explosion in a room overlooking the lawn on which the tree grew, and states that she saw through the drawn blind the reflection of a fiery round ball at the instant of explosion.

The ball seems to have been larger than any hitherto observed, all speaking of it as appearing larger than the sun or moon, and one of them said it was as large as an ordinary fire-balloon when seen at a short distance. The colour is said to have been of an intense fiery red, but a person who did not see the ball was startled almost at the instant of the explosion by the lighting up of a long passage in Dunchurch Hall by an intense blue light.

The path taken by the fireball during the two minutes it was observed could hardly have been direct, as the direction taken when first seen makes an obtuse angle with the direction indicated by all who saw it immediately before the explosion.

14 Bilton Road, Rugby. L. CUMMING.

P.S.—I have submitted a draft of this letter to Mr. Harrison, who agrees with me in the accuracy of the report given above.

The Suicide of Rattlesnakes.

I NOTICE in NATURE for June 1, 1893, page 107, an inquiry by Mr. R. I. Pocock as to the suicidal habits of scorpions. His conclusion is that if scorpions sometimes kill themselves, the verdict must be "accidental suicide, or suicide while of unsound mind." I have no evidence to offer as to the habits of Californian scorpions, but I have myself witnessed the deliberate suicide of a rattlesnake, and think that a brief account of it may be worth recording. In the summer of 1888 Prof. Keeler saw a large rattlesnake (with seven rattles) crawl under the foundation of the dome of the six-inch equatorial. With the nice manipulation for which he is famous, Dr. Keeler fastened a pair of blacksmith's tongs about the animal's neck, and brought him into the large marble vestibule of the observatory. The snake was furious and was practically uninjured. After every one had seen him it became a question what to do next. It was resolved to put him into a gallon jar of water. Dr. Keeler had the task of getting the very lively animal (which was some three feet long) into the jar, and of letting go with the tongs; while I undertook to put in the stopper of the bottle at an auspicious moment. All this was accomplished very nicely, and the next step was to drown the snake by inverting the jar at intervals. After a little time it became obvious to every one, the snake included, that the animal must soon be drowned. At this moment the snake ceased any attempt to rise to the surface of the water in the jar, and in the most deliberate manner struck its fangs deep into its body. I have no doubt whatever that the blow was intentional, and with suicidal purpose. It was a single deliberate blow. There was no flurry. As far as one could see the animal was of sound and disposing mind and memory. It had been full of fury at first, but latterly had only sought to escape from the water to the air at the top. When this became hopeless the snake ended its own struggles. I had often heard that snakes (and scorpions) put an end to their own lives. Here is an instance which occurred before my eyes. The snake is now preserved in alcohol at the observatory, and the marks of the fangs are plainly to be seen.

Lick Observatory, July 19. EDWARD S. HOLDEN.

New Conclusions.

IN the last volume of the Proceedings of the Royal Society of Victoria, a paper appears by us entitled "Preliminary Account of the Glacial Deposits of Bacchus Marsh." In this paper we claimed to have shown that there were two distinct deposits of till separated by sandstones assigned to the Triassic age, and moreover that the upper till rested on the denuded surface of the latter.

Further examination has shown that we were mistaken as regards the last point. Our conclusion had been drawn mainly from a section which we have described and figured as occurring at a small quarry on the Korkuperrimul Creek. At this place we described till as overlying, and a granite boulder over a yard in diameter, together with smaller boulders, as being jammed into, the broken surface of the sandstone.

The real state of things is that the clay material containing the boulders is really a bed intercalated with the sandstone, the whole being inclined at about 35°–40°. What was described as till overlying these sandstones turns out to be a "wash" containing striated stones, and derived from an outcrop of a till like deposit a little above. Besides the larger clay bed containing the large boulders, there are several other thin bands of clay intercalated with the sandstone containing pebbles, several of which we found to be striated.

The real succession in this locality would now appear to be as follows:—

(1) Till, undoubtedly morainic, and probably resting on silurian rocks.

(2) Shales.

(3) Massive sandstones with intercalated bands of clay bearing transported boulders.

(4) A till-like deposit containing boulders.

(5) Shales and well-stratified fine argillaceous sandstones.

It would be unwise to assume that this succession represents the general order in Victoria, as stratified deposits associated with till may be of local significance only.

As the fossil evidence so far obtained points to the sandstone being of fresh-water origin, it seems reasonable to suppose that it was deposited in a glacial lake into which sub-glacial streams flowed, and in which floating ice wandered, dropping boulders here and there. At the quarry above-mentioned, the clay bed containing the large boulders, and the sandstone adjacent to it, are remarkably contorted as if an iceberg had grounded there.

As to the real nature of the till-like deposit referred to as overlying the sandstone, we do not yet care to speak definitely. It presents some strong points of resemblance to true till, but it may be of aqueous origin aided by floating ice.

It will be now seen that the sandstones known as the Bacchus Marsh Sandstones must be considered as part of the glacial series. Our friend Mr. Charles Brittlebank has also come to this conclusion quite independently of us. Of course the other sections given with our paper will have to be altered in accordance with the foregoing.

Having recently had an opportunity of seeing the glacial deposits near Heathcote, described by Mr. Dunn last year, we may say that there, as at Bacchus Marsh, the lowest member, at least, is a true till due to the action of land-ice. We cannot agree with Mr. Dunn in his opinion that these deposits are entirely an iceberg drift.

A notable point of difference between the till at Bacchus Marsh and that at Heathcote, lies in the immense quantity and variety as well as the great size of the rock-debris in the latter locality. Mr. Dunn well expresses it when he says that it looks as if the ruins of a continent were gathered here. It would almost seem as if Heathcote were in the region of a terminal moraine. The somewhat unsatisfactory evidence afforded by the "roche moutonnée," known as Dunn's rock, seems to indicate that the ice came from the south in this district.

GRAHAM OFFICER.
Melbourne University, July 4. LEWIS BALFOUR.

THE THIEVING OF ASSYRIAN ANTIQUITIES.

SO much interest is now taken in the archæological researches made in Egypt and Assyria that it behoves a journal of science to chronicle a case of considerable importance that has recently been before the law-courts. The case is noteworthy, because it is concerned with the excavation and disposal of the wonderful tablets, the decipherment of which has added so much to our knowledge of the early history of mankind.

We have not referred to the case earlier, as we had hoped that some action in the public interest would have been taken by the Trustees of the British Museum, which would have carried the matter a stage further. For this action however we have waited in vain.

Although the real question at issue is the spending of many thousands of public money, the case in the newspapers has taken the form of an action for libel. The plaintiff in the case was Mr. H. Rassam, formerly assistant-excavator to Sir Henry Layard in the works carried on for the trustees of the British Museum on the sites of the ancient cities of Nineveh and Calah in Assyria. His action was against Dr. Wallis Budge, acting Assistant-Keeper in the Department of Egyptian and Assyrian Antiquities in the British Museum. It was alleged that Dr. Budge had made certain reports concerning the way in which Mr. Rassam had disposed of some of the excavated antiquities, and that these statements were made to Sir H. Layard both at the British Museum and elsewhere. The statements were said to imply that Mr. Rassam had connived at depredations on the sites of the excavations made by him in Babylonia during the years 1876-82 for the trustees of the British Museum. Mr. Rassam estimated that his reputation had suffered by these charges to the extent of £1000, and after a hearing of four and a half days the jury decided in his favour, though there was a difference of opinion among them as to whether Dr. Budge's statements were actuated by *malice prepense*, and awarded him £50 to make up for the loss sustained by the defamations and to soothe his virtuous indignation. Such was the case before the public; the public interests behind it may be gathered from the following statement.

It will be remembered that so far back as 1846 Mr. Layard began to excavate at Kouyunjik for the trustees of the British Museum. These excavations had, we understand, been commenced at the expense of Sir Stratford Canning, on the spot where the eminent Frenchman, Botta, had begun to work, but were afterwards taken over by the trustees of the British Museum, who indemnified Sir Stratford Canning and paid Mr. Layard's expenses. When Mr. Layard came home, a year or two later, the excavations practically stopped, but were renewed at the expense of the trustees of the British Museum under the direction of a native, Mr. H. Rassam, the plaintiff in the present case. The funds spent by the trustees on these works were provided by the Treasury, and therefore all the results, without exception, belonged to the British Museum by right. In 1873 the late Mr. George Smith made an expedition to Assyria at the expense of the proprietors of the *Daily Telegraph*, with a view of discovering other fragments of the tablet containing the Assyrian account of the Flood. He subsequently made a second and a third expedition to the country (where, in 1876, he unfortunately died) at the expense of the trustees, with funds granted by the Treasury. In 1878 Mr. Rassam again appeared on the scene, and under the authority of a permit from Constantinople renewed diggings in Assyria, and began to open new sites near Babylon, at the expense of the British Museum. It will be seen then that, with very slight exceptions, the money has been found by the British Treasury. We now turn to the results of this expenditure. From the evidence elicited at the trial it appeared that soon after Mr. Rassam began to dig in Babylonia, collections of tablets found their way into the London market, and these were bought by the British Museum for considerable sums of money (*Times*, July 1). If we remember rightly Dr. Budge stated that between the years 1879 and 1882, while Mr. Rassam was excavating, a sum of at least £3000 of public money was spent in this manner. Now as no other excavations were being carried on except by the British Government, and as the internal evidence of the tablets indicated that those which they received from Mr. Rassam as the result of his works and those which they purchased had the same origin, it was natural that the public department should begin to grow uneasy. And this feeling became stronger when it was found that the tablets purchased were of much greater value archæologically and historically than those which arrived at the British Museum from Mr. Rassam. Speaking broadly, it seems from the evidence that Mr. Rassam sent home 134,000 pieces of inscribed clay from Babylonia, and of these more than 125,000 are what Sir Henry Rawlinson, Mr. Maunde Thompson, and Dr. Wallis Budge style "rubbish" (*Standard*, June 30, *Times*, July 3). This represented the direct return for the outlay. What did go wrong we cannot say, but the outsider will certainly think that something did go wrong in this matter. In 1882 Mr. Rassam came home, and in this and the following year collections of tablets and other antiquities of very great value were offered to the Museum for purchase; in fact the supply appears to have been so great that it was some three or four years before the British Museum had funds to buy what it was offered. In 1887 the British Museum despatched Dr. Budge to Mesopotamia with instructions to make investigations into the sources of the supply of tablets which were coming to London, and on many other points, to touch upon which does not concern us (*Times*, July 1; *Standard*, June 29). While in Bagdad Dr. Budge obtained a great deal of information upon the subject of the systematic trade in Babylonian antiquities which was being carried on, and he found that the agent who had been appointed at Mr. Rassam's instigation, and who represented himself as Mr. Rassam's "relation" (*Standard*, June 29), and who was paid by the British Museum to protect the sites, was himself actively engaged in the sale of antiquities. On visiting the sites of the excavations Dr. Budge found that clandestine diggings were going on, and he was also able to purchase many valuable tablets and other antiquities from the peasant diggers (*Times*, July 1). The information which he gathered on all these points he sent home to the British Museum in the form of reports, one of the results of which was the dismissal of the native agent. On two subsequent occasions Dr. Budge visited Assyria and Babylonia, and carried on excavations for the trustees, and he acquired some thousands of tablets.

It will easily be guessed that from first to last a very considerable sum of public money, amounting to tens of thousands of pounds, has thus been spent upon excavations in Assyria and Babylonia, and the question naturally arises, Has this money been spent judiciously, and has the nation obtained what it had a right to expect in return for its money? It seems pretty evident that people other than the trustees of the British Museum have obtained collections of Assyrian antiquities, and it appears to us that this subjeet should form the matter of a careful and searching investigation. Sales at auctions have revealed the fact that sundry gentlemen had been able to acquire Assyrian slabs from the palaces of Assyrian kings, and as the excavations were carried on by the Government, it is difficult to account for this fact. The public has a right to know how property of this nature came into private hands, and the question must be asked until it is satisfactorily answered. The matter cannot be allowed to rest where it is.

We have seen that it was stated at the trial that in consequence of Dr. Budge's reports the native agent has been dismissed for his pains. Dr. Budge has been mulcted by the verdict of the law-courts in a sum of something over, we hear, £1000. Hence arises another point of wide general interest regarding the treatment which should be accorded to confidential reports from subordinate officers by the higher officials. In the case with which we are at present concerned, Dr. Budge reported such things as he considered to be of importance for the information of his superior officers, and it was, one would think, their duty to sift such reports and to act upon them. For some reason or other, as we gather from the evidence at the trial, the trustees did not act upon them, from which fact Mr. Justice Cave inferred that Dr. Budge in repeating to Sir H. Layard part of the contents of his reports had repeated things which the trustees themselves had considered frivolous and trifling (*Times*, July 4). This, however, is no argument at all, for the reasons of the non-action of the trustees are unknown, and it does not follow that the trustees regarded them as vexatious and trifling. With the terror of the decision in this case before them, all members of the public service will be in duty bound to consider whether they are able to afford the expenses of an action at law, and the enormous costs which follow in its train, before they report unpleasant truths to their superiors. Who can complain if public servants, rather than incur the penalties of the law, hold back information they are in a position to give? Whether this will be good for the public service remains to be seen.

Mr. Justice Cave, referring to the depredations around the excavations, is reported to have said (*Standard*, July 4): "We all know that if you gave £300 for a cylinder like the one produced, it is an incentive for people to steal. It is like the poachers. They will take your own game if you will buy it of them, or they will take it anywhere they can get it." Mr. Justice Cave's facetious remark, however, is scarcely on all fours with the verdict of the jury. He owns that the excavating grounds in question are preserves belonging to the trustees of the British Museum; yet when a keeper reports in general terms that a large amount of poaching has been going on, he is heavily mulcted for his pains, because an individual chooses to assume that he was meant.

Here then are the facts; we believe that so far no action whatever has been taken by the Trustees; still we are glad to learn from the *Daily News* that Dr. Budge's *confrères* at all events have a sense of public duty. That paper states "that the keepers of departments and the assistants in the British Museum have combined to present Dr. Budge with a cheque in settlement of his damages in the recent libel action of 'Rassam *v.* Budge.' It is understood that this is not merely an expression of sympathy with a popular colleague, but that the action of the Museum officers was prompted by a strong feeling that as Dr. Budge has acted throughout in the interests of his department, it would be most unfair to allow him personally to suffer."

BRITISH ASSOCIATION MEETING IN NOTTINGHAM.

A FORTNIGHT ago some account was given of the local arrangements made for the entertainment of members of the British Association during their stay in Nottingham. The accommodation provided for the sections was also indicated. Fuller details on these matters will be found in the local programme now in course of preparation.

With regard to the more serious and useful functions of the Association, something of a preliminary and general character may now be stated.

It is with feelings of great satisfaction that members will welcome Dr. Burdon Sanderson as general president at Nottingham, and it will be unnecessary in a scientific periodical to refer to the eminent service which has been rendered to scientific progress by the president elect.

The acceptance of the following gentlemen of the positions of sectional presidents will also do much to ensure the success of the sections:—Mr. R. T. Glazebrook, Dr. Emerson Reynolds, Mr. J. J. H. Teall, Rev. Dr. H. B. Tristram, Mr. Henry Seebohm, Dr. J. S. Nicholson, Mr. Jeremiah Head, and Dr. H. Robert Munro.

In respect to these appointments universal regret will be felt at the inability of Prof. Clifton to fulfil the duties of the president's chair in Section A, which he had accepted, owing to serious family trouble. But the acceptance of the position by Mr. Glazebrook will beyond doubt cause general satisfaction.

The work of the sections will in part be connected with receiving the reports to be made by the various research committees. Amongst these the following subjects are included:—Electrical standards, meteorological observations on Ben Nevis, the application of photography to meteorology, calculation of tables of certain mathematical functions, recording direct intensity of solar radiation, wave-length tables of the spectra of the elements, an international standard for iron and steel analyses, the direct formation of haloids from pure materials, action of light on dyed colours, isomeric naphthalene derivatives, erratic blocks in England, the fossil phyllopoda of palæozoic rocks, the collection of geological photographs, the circulation of underground waters and their use as water-supplies, the zoology of the Sandwich Islands and of the West India Islands, exploration of the Irish Sea, the inhalation of oxygen in asphyxia, methods of economic training, exploration of ancient remains in Abyssinia, the characteristics of natives of Canada and of India, the recalescent points in metals, volcanic phenomena in Japan, the Pellian equation, the discharge of electricity from points, comparing and reducing magnetic observations, optical constants of lenses, ultra-violet rays of the spectrum, meteoric dust, rate of increase of underground temperature, the bibliography of solution and the properties of solutions, the bibliography of spectroscopy, the silent electrical discharge in gases, the action of light on the hydracids of the halogens in presence of oxygen, the proximate chemical constituents of various kinds of coal, the history of chemistry, the erosion of sea-coasts in England and Wales, the volcanic phenomena of Vesuvius, type-specimens of British fossils, investigation of the remains in Elbolton Cave, structure of a coral reef, the migration of birds, the protection of wild birds' eggs, the teaching of science in elementary schools, graphic methods in mechanical science, prehistoric and ancient British remains, the physical deviations from the normal among children in elementary and other schools.

Amongst the other subjects of general interest, which will probably be introduced and discussed, are the following:—

In Section A the question of the national physical laboratory, of the central publication of physical papers, of magnetic and other units, and of mechanical connection between ether and matter will probably be raised. It is expected that a discussion on the teaching of physics in schools will take place, as well as a joint discussion with Section C on "Earth Tremors."

Section B will receive communications raising discussion on explosions in coal mines, flame, bacteriology, recent progress in inorganic chemistry, and recent research in organic chemistry, especially in connection with colour and colouring matters. The papers on these subjects are to be classified, and each class will be considered on a special day, of which due notice will be given.

In Section C the presidential address will deal with "The Doctrine of Uniformitarianism as illustrated by recent petrographical research," a subject which Mr. Teall has almost made his own. Papers are expected on East Africa, the new red sandstone of the Midlands, the igneous rocks of Derbyshire, the boulder clays and drifts of the Midlands, the methods and need of teaching geology both as a branch of education and as a valuable training to engineers, miners, and others. Sections C and D will jointly discuss "Fossil and Recent Coral Reefs," both in respect to their origin and in relation to the part which corals have played in the formation of the earth's crust. Sections C and E will also hold a joint meeting for considering the mutual relations of geology and geography.

In Section D Prof. Bohr, of Copenhagen, is expected to communicate the results of researches of great importance on the chemical process of respiration. A discussion will also probably take place on the question how far the fundamental peculiarities of vital processes admit of being explained as merely resulting from the *complication* of the chemical and physical processes of which they consist. It is expected that other moot questions of fundamental importance in biology will also be brought under discussion.

The President of Section E will treat in his address of the Polar Basin, laying stress on some generally forgotten facts and summarising our knowledge of the margin of the Arctic Sea. Mr. W. M. Conway will give an account of his mountaineering experiences in the Karakorum Range. Messrs. Bruce, Burn-Murdoch, and Donald will describe with photographs and paintings the scientific results of a recent sealing expedition to Antarctic waters. Mr. Guy Boothby will describe his journey across Australia from north to south. There will also be papers on the influence of their geographical surroundings upon the people of Northern India, by Mr. E. Henwood, and a similar paper on the Congo Basin by Mr. Herbert Ward. Mr. H. R. Mill will describe the physical geography of the Clyde sea area, and the bathymetrical survey of the English lakes, and Mr. B. V. Darbishire will contribute a paper on some conditions of cartographic representation of distributions.

In Section F the subject of the presidential address will be "The Reaction in favour of the Classical Political Economy." Papers are expected to be read for discussion on the monetary situation by Profs. Foxwell and Cunningham, on agricultural depression by Messrs. H. H. Scott and L. L. Price, on corn averages by Mr. R. Hooker, on Australian banking by Dr. C. Gairdner, on Poor Laws by Dr. F. Wilkinson, on industrial arbitration by Mr. D. Schloss, on the employment of the unemployed, on local industries and the history of Nottingham lace by Mr. Frith and others.

The arrangements for Section G have not been received as yet, but the many promises received from eminent English and foreign engineers to attend the meeting leaves no doubt that the proceedings of this Section will be of unusual interest.

In Section H the subject of the presidential address will be one special phase of man's development. The papers and discussions in this section, always of a diversified and popular character, promise to be of more than usual interest this year. Dr. Hans Hildebrand, Royal Antiquary of Sweden, contributes a paper on "Anglo-Saxon remains, and the coeval ones in Scandinavia," and it is proposed to make his communication the basis of a general discussion, chiefly with the view of defining the special characteristics of Anglo-Saxon remains in this country as distinct from those of Celtic and Scandinavian origin. Another subject, also full of interest and even novelty to English archæologists, is the recently discovered prehistoric lake or marsh village near Glastonbury, which is to be brought before the section by its discoverer, Mr. Arthur Bulleid. As the buried ruins of this village are now being excavated on a larger scale than during the previous summer, it is expected that the amount of industrial remains, already of much archæological value, will be greatly enhanced before the meeting of the Association. It has therefore been suggested that the reading of Mr. Bulleid's report of these researches will be a good opportunity for the eminent archæologists, who have agreed to act as a committee of reference and advice, to discuss the more salient features of this remarkable discovery, and to describe from different standpoints its bearing on the early history of our country. This method of dealing with such a discovery is eminently well adapted both for furthering the objects of the Association and for communicating valuable information to the investigators themselves; and it is earnestly hoped that the committee of experts will find it convenient to be present. Nor do these interesting subjects by any means exhaust the list of the forthcoming materials. Anthropology proper will come largely to the front, and will receive special consideration in the president's opening address to the section, as has been stated above.

Among the more popular scientific communications, the presidential address and the popular evening lectures must take their place. The popular lecturers are Prof. Smithells, who will describe and illustrate his recent researches on "Flame;" Prof. Victor Horsley, who will treat of "The Discovery of the Physiology of the Nervous System;" and Prof. Vivian Lewis, who will lecture to the local working-men on "Spontaneous Ignition." In connection with the last announcement it may be noted that the introduction of the working-men's lecture dates from the last meeting of the Association in Nottingham.

It will probably be possible to make a further communication in our next issue, bringing forward the announcement of the principal arrangements for work and entertainment in a state more nearly approaching completeness and finality. FRANK CLOWES.

MAGNETO-OPTIC ROTATION.

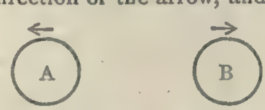
FARADAY'S famous discovery of the rotation of the plane of polarised light by passing the beam through a piece of his heavy glass placed along the lines of force of a magnetic field, was the starting point of the very important department of science now known as electro-optics. From this, as the first observed physical relation between optical and magnetic phenomena, has come the electromagnetic theory of light with all the magnificent researches and discoveries which have marked its experimental verification in recent years. I propose in the present article to give a short account mainly of magneto-optic rotation and the progress which has been made towards its dynamical explanation, followed by a brief discussion of some of the more intimately related phenomena which have been brought to light by recent investigations. It is no part of my plan however to discuss the experimental methods employed in the various researches referred to.

In the first place the magneto-optic relation which Faraday found is to be distinguished from the apparently similar effect which is produced by passing plane polarised light through a plate of quartz cut at right angles to the optic axis, or through a solution of sugar or tartaric acid. In the latter case the turning of the plane of polarisation depends only on the positions of the displaced particles of or in the elastic medium which forms the vehicle of the wave, and not on their motions; in the former the effect is a result of the motions of particles of other matter imbedded in or loading the surrounding ether.

The following illustration is I believe substantially what I have heard given by Lord Kelvin. Imagine two elastic jellies, one bored full of small helical cavities, either all right-handed or all left-handed, and having their axes all in one direction; the other having in it a number of particles endowed with a spinning motion and reacting in consequence of that spinning motion with centrifugal forces against elastic forces of the surrounding medium, and let the direction of axis and of spin be the same in the different cases. The former jelly will transmit circularly polarised waves travelling parallel to the axis of the helix with different velocities according as the helical arrangement of the displaced particles in the wave does or does not agree with the direction of the helical structure, the latter according as the direction of the motion of the particle caused by the wave is with or against the direction of the spin.

This illustration accounts for the essential difference between the results of observation in the two cases. The turning of the plane of polarisation produced by passing the beam through the quartz, or the solution, in one direction, is undone by sending the beam back again; that produced by passing the beam through a proper transparent medium placed along the lines of force in the magnetic field is doubled by reversing the ray after one passage, and returning the light to the side at which it entered.

To understand what takes place in each case we have to consider the nature of a plane polarised ray. According to the electromagnetic theory of light the disturbance in a plane polarized beam consists of an electric displacement in a direction at right angles to the plane of polarisation as defined in the ordinary way by reflection, and a magnetic displacement at right angles to the electric displacement and to the line of propagation, these two actions in a direct unreflected beam having the same phase. It is as yet impossible to say what it is in the ether that dynamically corresponds to these actions; but there can be no doubt that they are phenomena due to motion of some kind of or in the luminiferous ether. In the elastic solid theory of light, which must whether true or false have a certain correspondence with the facts, each part of the ether in a plane polarised beam was supposed to have a vibratory motion in a straight line at right angles to the direction of propagation, the direction of this line being the same along the whole length of the ray. Such a motion as this, it was first shown by Fresnel, may be regarded as the resultant of two oppositely directed circular motions, simultaneously possessed by each moving part of the ether. For consider a motion which would carry a particle round the circle A in a given time T in the direction of the arrow, and another which

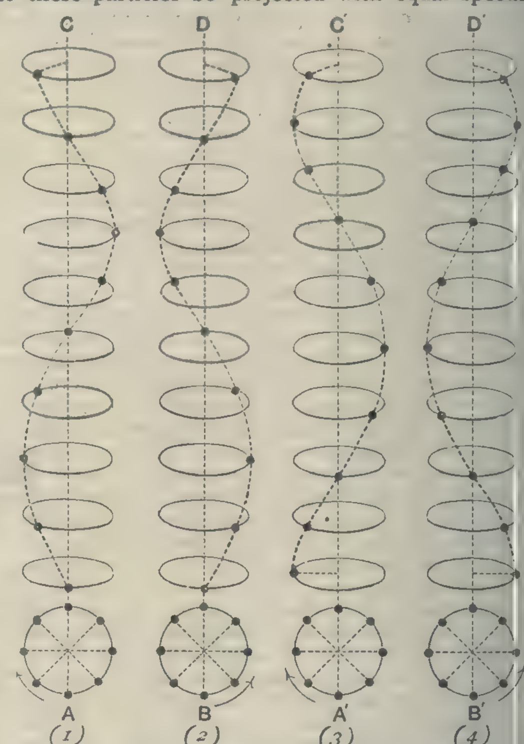


would carry a particle round the equal circle B in the same time in the opposite direction. Imagine two distinct particles to move with equal uniform speeds round the two circles, and suppose that both particles are at the top or at the bottom of their circular orbits at the same time. It is clear that at any given instant both are moving up or both moving down and at the same speed, while when one is moving from right to left the other is moving from left to right with the same speed, and *vice versâ*. Therefore if we conceive these motions united in one particle, the up and down velocities will be simply added together, the right and left motions will cancel one another. Thus the particle will have a simple vibratory motion in a vertical line in the period of the circular motions and with an amplitude of twice the radii of either circle.

Further it is to be noticed that the acceleration of the particle describing this rectilinear motion is the resultant of the accelerations of the particles in the two circular motions and that therefore the force required to maintain the simple harmonic motion is at each instant the resultant of the forces which would have acted on the particles in the circular motions when in the corresponding positions.

Thus the rectilinear vibration of a particle in the luminiferous medium may be regarded as compounded of two circular motions, and the particle as subject to a force compounded of the corresponding forces; and the same may be conceived of each moving particle in the wave.

Now to conceive of the motion in a beam of circularly polarised light and the relative positions of the disturbed particles, let a series of particles initially in a straight line along the direction of propagation be displaced into a helix along that line as represented in the diagram. Let these particles be projected with equal speeds in



the same direction tangential to the surface of the cylinder in which the helix lies, and at right angles to the axis; and further let them be constrained ever after to move with uniform speed in circles round the cylindrical surface. Clearly the helical arrangement will move onward along the cylinder—a circularly polarised wave will be propagated. The helical arrangement, that is the wave, is propagated in one direction or the other, for a given direction of the circular motions according as the helix is right or left-handed, or for the same direction of the helical arrangement according to the direction of the circular motion. Thus the direction of propagation is unchanged if both direction of helix and direction of motion is reversed. All this can be easily made out from diagrams (1), (2) of the figure above. Diagram (1) shows part of a left-handed helical arrangement of particles; (2) part of a right-handed one. Both illustrate the arrangement of particles, originally in a straight line, when disturbed by the passage of a circularly polarised beam. By supposing the particles to have the circular motions indicated below the diagrams, the propagation of the wave can be studied.

It follows therefore that if two such motions co-exist in the same particle both waves will travel in the same direction through the medium. If they travel with the same speed the resulting rectilinear motion of each particle will be the same all along the wave, but if they travel with unequal speeds the direction of this motion will turn round as the wave advances in the direction of the motion of the particles in the more quickly travelling wave, generating if the speeds are constant, the surface of a screw.

To constrain the particles to maintain the circular motions forces must be applied towards the centre of the orbit in each case. The reactions of the particles against these motions are what are properly called the centrifugal forces of the particles. But the different particles are connected by the elastic medium and the required centreward forces are supplied by its rigidity. Thus for given displacements produced by the beam entering the medium the forces due to the medium will be different if the rigidity is less for, say, a left-handed helical distortion than for a right-handed one, and the latter distortion will be propagated with the greater speed.

Now let the wave be reflected after passage, and let the direction of motion of each vibrating particle be reversed in the act of reflection. The direction of the helical arrangement will remain unchanged in each case. The wave which travelled the faster when direct will again do so, but the direction of motion being reversed the direction of motion in the plane polarised beam will turn round in the opposite direction as the wave moves forward, thus undoing the previous turning.

The same thing it is easy to see will take place if the reflection takes place without reversal of motion as at the surface of a rarer medium. In this case the helical arrangement which was left-handed becomes right-handed, and *vice versâ* after reflection. The arrangement which lagged behind before now that is reversed travels the faster and the line of resultant vibration again turns round, but in the direction of the circular motion in that circularly polarised wave which now moves the faster, that is in the opposite direction to that in which it moved before. Diagrams (3) and (4) of the figure show the configurations of parts of (1) and (2) after having been thus reflected.

Now consider the other case. It is observed, we shall suppose, that the right-handed circular ray travels faster than the other, and that whether direct or reversed. As before, the elastic action of the medium on the moving particles can depend only on the displacements of the particles in the helical displacement, and in the absence of any structural peculiarity to produce a difference must react in the same degree on the particles in both circular waves. Thus the centrifugal force reactions being the same for both waves, and the velocity of transmission being different, the luminiferous motions must be unequal, and such that compounded with a motion existing in the medium two motions are produced which exert equal centrifugal force reactions, balancing the equal elastic forces applied in consequence of the equal helical displacements.

According to this theory, which is due to Lord Kelvin, there exists in the medium a motion capable of being compounded with the luminiferous motion of either circularly polarised beam which is therefore a component only of the whole rotational motion. In the passage in which this dynamical explanation is put forward Lord Kelvin goes on to say,

"I think it is not only impossible to conceive any other than this dynamical explanation of the fact that circularly polarised light transmitted through magnetised glass parallel to the lines of magnetising force, with the same quality, right-handed always, or left-handed always, is propagated at different rates according as its course is in the direction or is contrary to the direction in which a north magnetic pole is drawn; but I believe it can be demonstrated that no other explanation of that fact is possible. Hence it appears that Faraday's optical discovery affords a demonstration of the reality of Ampère's explanation of the ultimate nature of magnetism."

A number of interesting conclusions seem to follow from this theory. In the first place the turning effect is not found to any sensible extent unless there is matter of some kind, magnetic or diamagnetic, present in the field. Hence the theory does not point to rotation of the parts of the ether but only to rotational motion of other matter imbedded in it and reacting on the ether in consequence of that motion.

Further, the explanation seems to decide against that view of diamagnetism which regards it as a differential effect due to the greater magnetisation of the surrounding medium. The rotation of the plane of polarisation is found in both paramagnetic and diamagnetic substances, but for the same direction of magnetic field is opposite in the two cases. This points to opposite rotations of the matter in the field according as it is paramagnetised or diamagnetised.

In all ordinary transparent substances which have been experimented on the effect has been found to be small. This of course was what was to be expected from the small amount of magnetisation (or diamagnetisation) produced in such substances even by very powerful fields. As a rule the substances are diamagnetic and give rotation of the plane of polarisation varying directly as the intensity of the magnetic field in which the substance is placed, and directly as the thickness of the medium through which the light is passed. It has been found however by Kundt that the turning produced by passing the light through a thin film of iron or cobalt is very great, a result which forcibly recalls the idea suggested by Lord Kelvin in the paper quoted above, that the moment of momentum of the matter in unit of volume of the magnetised substance might be the proper dynamical measure of the intensity of magnetisation.

Another result found both for magneto-optic rotation and for the turning produced by substances of helical structure is that the effect is greatest for the more refrangible rays of the spectrum, in fact is nearly inversely proportional to the square of the wave length of the light. This is of great importance in connection with the remarkable theory of the production of magneto-optic rotation in a medium having imbedded a large number of very small gyrostats which has been given by Lord Kelvin. In a continuation of the present article I shall endeavour to give a short account of the behaviour of such a medium when subjected to the disturbance due to the passage through it of a beam of plane polarised light. In connection with this theory the fact observed by H. Becquerel, Kundt and others that magneto-optic rotation is produced also in gases is of great interest.

Absolute measurements made by Lord Rayleigh give for bisulphide of carbon ·042 of a minute of angle for the turning of the plane of polarisation of sodium light in passing through a stratum 1 centimetre thick in a field of 1 C.G.S. unit of intensity the temperature being 18° C. A knowledge of this quantity (which is called Verdet's constant for bisulphide of carbon) enables the turning in other substances produced by a given field to be inferred by experiments of comparison. Further the intensities of magnetic fields can be inferred from observed amounts of turning produced by the passage of light through a column of measured length of any substance for which the constant has been determined.

In a succeeding article an attempt will be made to discuss with as little as possible of the aid of technical mathematics the propagation of plane polarised light in a gyrostatically loaded transparent medium, the "Hall effect" which, existing in a transparent dielectric, would there produce magneto-optic rotation, and to indicate shortly some of the bearings of magneto-optic phenomena generally on the electromagnetic theory of light.

ANDREW GRAY.

THE EARTHQUAKE IN BALÚCHISTÁN.

THE *Records of the Geological Survey of India*, May, 1893, contains some notes on the earthquake in Balúchistán on December 20, 1892, by Mr. C. L. Griesbach, one of the Superintendents of the Survey. The paper is illustrated by two photo-etchings, one of which is here reproduced with the description of the occurrence.

The following quotation is from the report of the Executive Engineer of the North-Western Railway at Shalabagh:

"On the 20th December, at 5.40 a.m. (Madras time),[1] this district was visited by a somewhat severe earthquake. It was followed by several lesser shocks, and at Shalabagh[2] they continued at frequent intervals during the day, and have occurred at frequent intervals up to the present date.[3] The exact time of the shock was shown by the stoppage of a pendulum clock in my office.

"*Effects at Sanzal.*[4]—The station building at this place has apparently suffered most, its close proximity to the line of fissure, which runs in a north-east and south-west line about half a mile below the station, being probably the cause. The water tower is standing, but most of the turrets are loose. . . . The oscillation of the ground caused the water to spill out of the iron tanks. . . . The station building, including the station-master's and signaller's quarters and out-houses, are very badly shaken, and will require rebuilding to a considerable extent. The whole of the chimneys have been thrown down.

"Lower down the line the only serious damage to the permanent-way occurred. There is visible at this spot to the eye, for a considerable distance, as far indeed as the eye can reach, a line of division in the soil, and where this intersects the railway at an angle of about 15° or 20°, the metals of the permanent-way were distorted in a most extraordinary way, the pairs of rails in each line immediately above the crack in the ground having suffered most. They were bent into a sinuous curve, which is represented approximately in the accompanying illustration.

View showing distortion of rails caused by earthquake between Sanzal and Old Chaman.

"I have followed the line of fissure in the surface of the ground for a considerable distance on each side of the line, and it extends beyond Old Chaman on the one side for several miles I am told; I myself followed it for one mile beyond Old Chaman, and could then see it extending far into the distance. In the other direction, I am informed by an Achakzai, who had just come from there, it cuts the line of the Khwája Amran range obliquely, and can be traced to the peak of that name, some eighteen miles off.

"There appears to have been a shearing action on the surface of the ground, the line of shear being tangential to the line of cleavage.

"The rails having resisted this motion were crumpled up in consequence. The joints in the rails on each side of the contortion have all been closed up, although of course, originally, clearance for expansion had been left.

"While tracing the crack in the ground through Old Chaman, I found that it crossed all the collecting pipes of the Military Works Department at Old Chaman. Most of these pipes crossed the crack at approximately a right angle and had not suffered, but one $1\frac{1}{2}$ inch pipe which cut it obliquely was pushed up and off the ground and formed a sort of arch over the crack. . . ."

"A week after the earthquake," says Mr. Griesbach, "I visited the Kójak range in company of Mr. Hodson. We first inspected the damage done by the earthquake to the houses and works in the neighbourhood of Shalabagh station at the eastern entrance of the Kójak tunnel. Though there was much mischief done to buildings, &c., not much could be learned from these effects of the earthquake. If the scene of destruction had been in a closely-built town, it might have been possible to detect some method, if I might use the expression, in the damage done, but at Shalabagh the houses are far apart, built on unequal hilly ground, and the workmanship in the buildings, mostly constructed of sun-dried bricks, is also very unequal, so that all one can say is that the shocks of earthquake have affected all the weak points of these buildings, many of which will have to be entirely reconstructed.

[1] At Quetta the shock was felt at 5.46 a.m., the distance from Shalabagh to Quetta being 53 miles in a straight line.

[2] Shalabagh is a station on the Sind-Peshin Railway at the eastern entrance to the Kójak tunnel.

[3] 22nd December.

[4] Sanzal is the first station on the western side of the Kójak tunnel.

"The Kójak tunnel fortunately escaped serious damage, though it is interesting to hear that the water-supply from some springs which issue inside the tunnel and which now escapes in a regular drain from the western (or Chaman side) of the tunnel, was considerably increased after the earthquake shocks.

"The block-house which defends that entrance to the tunnel received some slight damage in the shape of cracks which have appeared in the solid masonry.

"The effects of the earthquake shocks are visible almost all along the made banks on which the permanent-way is laid between the tunnel and Sanzal station. In their case the earthquake acted most beneficially, inasmuch as the artificially built-up material of these banks was well shaken down, and, though the latter had sunk here and there and cracks have appeared in places, their settling down and consolidating was equal to a season's rain, as the engineer of that section reports.

"The real interest of the earthquake, however, centred in the damage done between Sanzal station and Old Chaman.

"The line of railway descends to New Chaman from the Kójak tunnel in several great curves and in zigzag fashion. Sanzal station is situated near the upper margin of a great and rapidly descending glacis, which slopes down from the Kójak range to the great plain in which New Chaman is situated.

"About half a mile west of Sanzal station there is a path which runs from the Khwája Amran peak (8864 feet) in a north-northeast direction along this glacis. It appears that at the immediate foot of the Kójak range a great number of springs rise, close to which of course there is always a certain amount of grazing to be found, and thus this line of springs has been connected by a regular path, made by flocks passing along these patches of pasture-land. The water escaping from these springs has furrowed and denuded the glacis into an infinite number of small channels. Another feature is that the path with its springs and patches of grazing grounds all lie as it were in a natural depression, running parallel with the range of the Kójak itself, whilst immediately to the westward of it the ground of the glacis rises somewhat, before finally descending to the plains. This is well marked near Old Chaman, the foot of which is built on this rising ground.

"About seven to eight miles south of Old Chaman this insignificant rise of ground becomes an auxiliary range of hills, which runs west and parallel with the Kójak range towards the Khwája Amran peak itself.

"I expect to have further opportunities of geologically examining this ground when the weather will permit in the spring; until then I will only state my belief that the present path which connects the springs described indicates, as near as can be, the existence of an old fault-line. At the present time I have no further proof for it than this, that as far as I have been able to ascertain during this hurried visit, the line of path is, roughly speaking, also a geological boundary between the slaty formation of the Kójak and a grey earthy limestone, the latter of which is very probably of upper cretaceous or lower eocene age; this boundary being here suspiciously abnormal in appearance. The springs which rise along it tend further to the opinion that they appear along a line of dislocation, which view is further strengthened by the fact that in the neighbourhood of the springs not only a kind of travertine is visible, but a curious breccia, consisting of debris of both the limestone and the slates of the Kójak and cemented by calcareous rock, is *in situ* and in strong force all along the line of path, but not off it, which breccia I now look upon as a fault-rock. The glacis itself is chiefly made up of recent deposits, fans from the range above, but I hope to discover a more exposed section further south, where the structure of this dislocation, if it is one, will be clearly demonstrated. Finally, but not least, the fault seems to be proved by the earthquake itself, which has originated in a further, though slight, dislocation along a line which exactly and absolutely coincides with the present path connecting the numerous springs.

"In my theory explanatory of this earthquake, I therefore start with the assumption that an old line of fault exists, which runs more or less parallel with the Kójak range itself. In a mountain range entirely formed by flexures, which chiefly correspond to the strike of the range itself, such faults usually exist on a large scale. The lateral pressure which caused the folding of the strata in such cases frequently results in one or several systems of dislocations, as we may observe in numerous instances within folded mountain ranges. . . ."

"From the foregoing it would appear that the process of contracting and folding, with resultant dislocations, of this area in Balúchistán, is still proceeding. At some previous date in the history of the Khwája Amran Mountain range this process of compression, as it must have been, has led to the formation of the line of fault conjectured in these notes; the process, from whatever cause, is still active, and the tension having become too great has further resulted in a slight increase to the amount of dislocation already in existence. The two areas adjoining the fissure have moved about eight inches vertically and a couple or more feet horizontally from each other, which sudden establishment of a temporary equilibrium in this tension is no doubt quite sufficient to account for the vibration of the ground to a considerable distance, which vibration is commonly called an earthquake.

"I need scarcely say that there is no indication of any kind which would point to the existence of volcanic activity at, or anywhere near, the area affected by this earthquake; I mention this only, because it was also in this case, as in other instances elsewhere, the popular theory advanced by many of those who personally experienced the alarming symptoms of this perfectly natural phenomenon."

SCIENCE IN THE MAGAZINES.

OF the August magazines the strongest in articles of scientific interest is the *Fortnightly Review*. Under the somewhat misleading title "The Wanderings of the North Pole" Sir Robert Ball contributes a rather diffuse article descriptive of the variations of latitude; adopting Mr. Chandler's conclusion that the earth's instantaneous axis of rotation revolves about that of maximum moment of inertia, with a radius of thirty feet, measured at the earth's surface, in a period of 427 days. This result is expressed by Sir Robert Ball in the following language:—

In that palæocrystic ocean which Arctic travellers have described, where the masses of ice lie heaped together in the wildest confusion, lies this point which is the object of so much speculation. Let us think of this tract, or a portion of it, to be levelled to a plain, and at a particular centre let a circle be drawn, the radius of which is about thirty feet; it is in the circumference of this circle that the Pole of the earth is constantly to be found. In fact, if at different times, month after month and year after year, the position of the Pole was ascertained as the extremity of that tube from which an eye placed at the centre of the earth would be able to see the Pole of the heavens, and if the successive positions of this Pole were marked by pegs driven into the ground, then the several positions in which the Pole would be found must necessarily trace out the circumference of the circle that has been thus described. The period in which each revolution of the Pole around the circle takes place is about 427 days; the result, therefore, of these investigations shows, when the observations are accurate, that the North Pole of the earth is not, as has been so long supposed, a fixed point, but that it revolves around in the earth, accomplishing each revolution in about two months more than the period that the earth requires for the performanee of each revolution around the sun.

"What use has a serpent for its tongue?" is a question asked by Ruskin of 'scientific people,' "since it neither works it to talk with nor hiss with, nor, as far as I know, to lick with, and, least of all, to sting with, and yet, to the people who do not know the creatures, this little vibrating forked thread, flicked out of its mouth and back again as quick as lightning, is the most striking part of the beast." Mr. W. H. Hudson furnishes an answer to the question. He remarks: "So far from being silent on the subject, as Ruskin imagined, the 'scientific people' have found out or invented a variety of uses for the serpent's tongue. By turns it has been spoken of as an insect-catching organ, a decoy, a tactile organ, and, in some mysterious way, an organ of intelligence. And, after all, it is none of these things, and the way is still open for fresh speculation." Mr. Hudson puts forward the idea that the snake uses its tongue to concentrate the attention of an intended victim upon its head while its body is being trailed forward to effect the capture. We quote from his article:—

In most cases the movement probably would be detected but for the tongue, which attracts the eye by its eccentric motions, its sudden successive appearances and disappearances; watching the tongue, the long, sinuous body slowly gliding over the intervening space would not be observed; only the statuesque raised head and neck would be visible, and these would appear not to move. The snake's action in such a case would resemble the photographer's trick to make a restive child sit still, while its picture is being taken, by directing its attention to some curious object, or by causing a pocket-handkerchief to flutter above the camera.

Snakes have been observed to steal upon their victims in this quiet, subtle manner; the victim, bird or lizard, has been observed to continue motionless in a watchful attitude, as if ready to dart away, but still attentively regarding the gradually-approaching head and flickering tongue; and, in the end, by a sudden, quick-darting motion on the part of the snake, the capture has been effected. . . .

It is not here maintained that the tongue is everything, nor that it is the principal agent in fascination, but only that it is a necessary part of the creature, and of the creature's strangeness, which is able to produce so great and wonderful an effect. The long, limbless body, lithely and mysteriously gliding on the surface; the glittering scales and curious mottlings, bright or lurid; the statuesque, arrowy head, sharp-cut and immovable; the round lidless eyes, fixed and brilliant; and the long, bifurcated tongue, shining black or crimson, with its fantastic flickering play before the close-shut, lipless mouth—that is the serpent, and probably no single detail in the fateful creature's appearance could be omitted and the effect of its presence on other animals be the same.

In an article on "The Limits of Animal Intelligence," Prof. C. Lloyd Morgan gives an interesting account of some experiments and observations he has recently made on young chicks, with a view of determining the difference between intelligence and instinct. He expresses the distinction between the two as follows:—

Intelligence is the faculty by which, through experience and association, activities are adapted to, or, more strictly, moulded by, new ciccumstances; while reason is the faculty which has its inception in the true grasping of relationships as such. Intelligence is ever on the watch for fortunate variations of activity and happy hits of motor response; it feels that they are suitable, though it knows not how and why, and controls future activities in their direction. It proceeds by trial and error, and selects the successes from among the failures. Reason explains the suitability; it shows wherein lies the success or the error, and adapts conduct through a clear perception of the relationships involved. Individual experience, association, and imitation are the main factors of intelligence; explanation and intentional adaptation are the goal of reason.

Incidentally I have expressed my opinion that, in the activities of the higher animals, marvellously intelligent as they often are, there is no evidence of that true perception of relationships which is essential to reason. But this is merely an opinion, and nos a settled conviction. I shall not be the least ashamed of myself if I change this view before the close of the present year. And the distinction between intelligence and reason will remain precisely the same if animals are proved to be rational beings the day after to-morrow. For the distinction holds good between human intelligence and human reason, just as much as between animal intelligence and the possible reason of animals. It is no line of division which separates animals from men; but a distinction between faculties, one of which, at least (and perhaps both, though this I doubt), is common to animals and men.

The *New Review* contains an article by Prof. Ludwig Büchner on "The Brain of Women." It is well known that the average size of the female brain is considerably less than that of the male. Further, up to the present nothing has been found to justify the assumption that there is anything in the inner formation of the brain to make good its deficiency in size as compared to the male. This Prof. Büchner holds to be due to differences of development.

If we consider that for thousands of years woman, by reason of her subordinate social position, has received a different education from her male partner, and that her training has led her in quite another direction to his; that her horizon has been a more limited one, and moreover that every encouragement has been given to the play of her emotions at the expense of the activity of her intellect; and finally that this state of affairs has lasted from generation to generation, through mother to daughter, then, I say, that from a physiological standpoint there should be no cause for surprise that as a result woman should differ from man, that her brain should be inferior to his, or at any rate should have developed on different lines, or, as we have been saying, that the fore part of her brain should be found to be proportionately less and the hind part proportionately greater than that of man.

Mr. Thomas J. Mays writes in the *Century* on "Breathing Movements as a Cure." The evidence he offers indicates that "proper development and expansion of the lungs by means of well-regulated breathing must be regarded as of the greatest value in the prevention and in the treatment of pulmonary consumption."

"Fin de Siècle Medicine" is the title of an article by Dr. A. Simons Eccles in the *National Review*. After animadverting upon "the deficiency of muscular activity as a fruitful source of maladies resulting from the want of combustion and elimination of material used up or vitiated by the disproportionate action of other organs and tissues," Dr. Eccles describes the investigations that have recently been carried out in France and Russia as to the action of certain organic liquids in curing or modifying disease. Writing on "Electricity and Life" in the *Humanitarian*, Mr. H. Newman Lawrence comes to the following conclusions:—

(1) All the thousand and one changes which take place in the structure of the living body, be they due to the never-ceasing and involuntary process of metabolism, or to the exercise of function, or to the effort of will, partake of the nature of chemical change.

(2) All chemical changes are accompanied by electrical manifestations.

(3) Without chemical change and interchange, life does not appear to exist.

(4) Therefore, life is always accompanied by the generation of electricity.

Electrical energy, however, is not the immediate source of the vitality of the body.

Mr. C. T. Buckland contributes an excellent anecdotal article on "Leopards" to *Longman's Magazine*. Hitherto the beast has occupied only a comparatively small space in the popular literature of natural history, and this fact makes Mr. Buckland's experiences doubly interesting. Under the title "Birds of a Feather," Mr. F. A. Fulcher describes in the *Sunday Magazine* the flocking and migration of birds. Dr. J. G. McPherson gives a popular description in *Good Words* of Mr. John Aitken's fog-counter and the results that have been obtained with it. Finally, Miss Agnes Giberne expatiates upon celestial photography and spectroscopy in the *Monthly Packet*. The article is in continuation of an easily-worded series she is contributing under the title of "Sun-rays and Star-beams."

MARIÉ-DAVY.

DR. G. H. MARIÉ-DAVY, who died at Clamecy on July 16, distinguished himself in various branches of physical science. Astronomy, electricity, general physics, and meteorology, all occupied his attention from time to time, and to all of these branches of knowledge he made important contributions. Born at Clamecy in 1820, Marié-Davy entered the Higher Grade Normal School in 1840. Five years later he was appointed to the Chair of Physics at the Montpellier Faculty of Sciences, and also to the Professorship of Medicine. In 1862 Marié-Davy began his connection with the Paris Observatory. At first he had charge of the terrestrial magnetism service, but in 1863 he became the head of the international meteorological department that he had organised. While occupying this position he published a large number of meteorological memoirs and initiated the periodic distribution of reports and bulletins. He devoted himself chiefly to the study of the atmosphere and its changes, with special reference to the bearing of such matters upon agriculture and hygiene. In 1857 Marié-Davy invented a mercurous sulphate battery which was adopted by the French telegraph authorities, and also by some of the services in other countries. About this time he contributed numerous papers on statical, dynamical, and physiological electricity to various scientific societies and journals. During the revolution of 1870 he left the Paris Observatory and accepted a Professorship at the Polytechnic School—a post that he retained until the return of the Government to Paris. In 1887 he was nominated honorary director of Montsouris Observatory. Marié-Davy was a doctor of medicine and a doctor of physical and mathematical science. Among other honours he was a corresponding member of the Bureau des Longitudes, and an honorary president of the Société d'Hygiene. He was made a Chevalier of the Legion of Honour in 1877, and possessed the Brazilian Order of the Rose, as well as a number of other orders and dignities. The many and varied researches carried on by him, alone and in collaboration with other workers, testify to his greatness. He had a keen sense of right, and dared to give his opinion even when his material welfare was likely to be injuriously affected by so doing. A life so rich in results and void of dissimulation is one well worthy of being imitated.

NOTES.

M. PASTEUR has been elected an honorary member of the Vienna Academy of Sciences.

ON August 4, at about 6.45 in the evening, a distinct earthquake tremor was felt in Leicester and the neighbourhood. The wave passed from about south-west to north-east, and produced the maximum effect in Charnwood Forest. It is reported that the shaking lasted for about five seconds, during which a loud rumbling noise was heard.

A REUTER'S telegram from Vienna reports that a disastrous cloudburst occurred in Middle Styria on August 5. A number of houses were wrecked and several persons lost their lives. Two railway bridges were thrown down on the Grazkoeflach Railway. At about half-past ten in the morning of August 8 two shocks of earthquake were felt in the Mur Valley. The tremors travelled from north to south.

A SINGULAR occurrence has recently been reported from Gamlingay, Cambridgeshire. What appeared to be a dense cloud was observed, but to the astonishment of the villagers the cloud suddenly broke up and showered myriads of ants and flies upon them. So numerous were the insects that they almost covered the ground like a carpet.

THE southern counties are suffering from a plague of wasps. Judging from the correspondence in the newspapers, the insect has been unusually abundant, and has done a large amount of damage in certain districts. At Heathfield, Sussex, more than a thousand nests have been destroyed this summer, and the work of destruction is still going on.

A GOLD medal of the value of 1000 Italian lire is offered by the Royal Academy of Science of the Institute of Bologna, to the author of the best memoir describing a new and efficacious system, or a new apparatus, for preventing or extinguishing fires. The memoir may be written in Italian, Latin, or French, and must be sent in before May 7, 1894.

THE Report of the Postal and Telegraph Conference held in Brisbane in March last has just reached us. At one of the meetings Sir Charles Todd strongly urged the desirability of adopting a uniform method of reckoning time, and after a short discussion the following resolution was passed:—"That it is desirable in the public interests that the hour zone system should be adopted in a modified form, so that there should be one time throughout Australia, viz. that of the 135th meridian or nine hours east of Greenwich."

MR. EDWIN E. HOWELL describes in *Science* a meteorite observed to fall on May 26, 1893. The meteorite entered the ground to a depth of about three feet at an angle of 58° with the horizon. It is an aërolite of very pronounced chondritic structure, and has the usual black glazed appearance. The weight of the mass is 22½ pounds, and dimensions 6 × 7 × 9½ inches Mr. Howell proposes to give it the name of Beaver Creek, from the stream by the banks of which it fell.

THE *Reale Accademia dei Lincei* has issued a circular in which is given a list of the published papers of the late Prof. E. Betti. In honour of his memory it has been decided to collect and publish the whole of his scientific works, with an account of his life, written by the president of the Academy, Prof. F. Brioschi. In order that the collection may be as complete as possible, the circular asks all who have any unpublished letters of the famous geometrician, or a knowledge of works not included in the list, to communicate with Signore V. Cerruti, R. Accademia dei Lincei, Roma.

THE Society for Promoting Agricultural Science in Vienna will hold an international exhibition between April 20 and June 10, 1894. The exhibition will include specimens of economical food for the people, army supplies, appliances for saving life, means of transport, and sport in all its branches. This exhibition is being promoted by the Archduke Francis Ferdinand. Detailed information on the subject can be obtained from the Consul-General for Austria-Hungary, 11, Queen Victoria Street.

THE Board of Agriculture have been authorised by the Treasury to make arrangements, by way of experiment, for the transmission by telegraph of the weather forecasts, issued each afternoon by the Meteorological Council, to the telegraph offices in the rural districts of two typical counties, for exhibition in the office windows. The experiment will extend over the months of

August and September, should harvest operations continue so long, and Essex and Northumberland are the counties selected for the purpose. The measure of success which the forecasts now obtain is such as to lead the Board to the conclusion that the information thus made available will be of practicable value to agriculturists in making their arrangements for the following day.

SHARP thunderstorms occurred at several places in the south and east of England on Friday and Saturday last, accompanied by heavy rain or hail. In the eastern and northern parts of the kingdom the rainfall has been exceptionally heavy. At York the aggregate amount for the week ended the 5th inst. was 1·6 inch, while at Yarmouth it reached two inches, or nearly the average amount for the month of August.

THE question as to whether the term "perennial spring" is applicable to the climate of Quito, as it is claimed by many explorers of the equatorial city, is discussed by Dr. J. Hann in the *Zeitschrift der Gesellschaft für Erdkunde*. He comes to the conclusion that the term does indeed convey a fair idea of the climatic conditions of the place. Not only does the mean temperature and its range of diurnal variations resemble that of our May, but also the changeable weather, with its afternoon thunderstorms, rains and hailshowers, recalls our spring months. It is possible that the contrast between the cool mornings and evenings may be felt more severely in the capital of Ecuador than with us, on account of the greater power of the vertical rays of the sun, but the variability of the mean temperature is, on the other hand, much smaller than in our latitudes. The influence of the weather upon health is very much the same as that of our springs, attacking, as it does, all the mucous membranes of the unwary traveller. It is a question whether a perennial spring is as much of a blessing as the poets would have us believe. The charm of spring lies in the reawakening of life after the torpor of the winter, and where this contrast is wanting, the greatest part of the charm disappears.

A METEOROLOGICAL Society has recently been established at Zi-ka-Wei, near Shanghai, under the presidency of the Rev. S. Chevalier, S.J., and has issued its first report for the year 1892. A good stock of self-registering barometers has been purchased by the Zi-ka-Wei observatory, and distributed among the members of the Society who were able to make use of them. The report contains a brief account of the principal typhoons of the year 1892, accompanied by a map showing their paths, and also an interesting article upon the fogs along the northern coast of China, based upon the observations made at several stations of the Imperial Maritime Customs during the years 1889-91. The discussion shows that from September to November the coast is remarkably free from fog, but that from March to July fogs are very frequent either at the Shan-tung promontory or near the estuary of the Yang-tse-kiang. They are most frequent in the early morning, by far the greatest number being observed before 9 a.m. The conditions most favourable to their formation occur with a low and still falling barometer.

Science contains an interesting account by Mr. E. H. S. Bailey of the effects of a cyclone that passed near Williamston, Kansas, on June 21. At one point, where the track of the cyclone was about six hundred yards wide, elm and walnut trees two or three feet in diameter were torn up or wrenched off fifteen or twenty feet from the ground. The storm travelled eastward, and the debris was distributed round its centre in the manner that usually characterises cyclonic movements. Barbed wire fencing and telephone wires were lifted into tree-tops about fifty feet north of their original position. Heavy farm wagons were utterly destroyed, and spokes were broken off near the hub and carried to a distance of quite half a mile. But even these are comparatively unimportant items in Mr. Bailey's catalogue of casualties. We learn that gravestones (the size is not stated) were carried three hundred yards, and that chickens were stripped of their feathers and trees of their foliage. The west sides of the trees that stood the storm were much roughened, while the east sides were unchanged, owing doubtless to the fact that clouds of sand and dust accompanied the wind and assisted it in the work of destruction. Just before the storm left the earth's surface its fury was at the highest pitch and the width of its track was least. The length of the track, as shown by the devastation, was about five miles.

WE learn from the Kew *Bulletin* that the fine collection of *Stapelias* made by the late Mr. Thomas Westcombe, of Worcester, has been presented to the Royal Gardens, together with a number of notes, descriptions, and beautifully executed coloured drawings.

THE *Bulletin* of the Royal Gardens, Kew, Nos. 76, 77, contains an elaborate report on the preparation and export of Chinese white wax. The eggs of the *Coccus* which produces the excretions are invariably transported from the district where they are produced to that in which the wax is obtained. The industry appears to be a decaying one.

THE first three parts of vol. iii. of "Indian Museum Notes," published under the authority of the Agricultural department of the Government of India, contains a great mass of information on the causes of the various diseases which affect crops in India, descriptions of noxious insects, &c. It is edited by Mr. E. C. Cotes, Deputy Superintendent of the Indian Museum, who himself contributes a large number of notes. The third part is entirely occupied by a conspectus of the insects which affect crops in India, 240 in number.

IT would appear from researches made by Fromme and Stagnitta-Balistreri that no inconsiderable number of micro-organisms are capable of producing sulphuretted hydrogen. Fromme employed as culture media ordinary nutritive gelatine to which tartrate, acetate, or saccharate of iron had been added, the reaction being exhibited by the varying shades of brown to black produced by the organism's growth. Balistreri (*Archiv f. Hygiene*, vol. xvi.) used broth with and without peptone, and tested for the presence of this gas by the insertion of strips of lead paper. Amongst those organisms which produce sulphuretted hydrogen are the *B. proteus vulgaris*, the typhoid bacillus, *B. coli communis*, bacillus of rabbit septicæmia, the comma bacillus, whilst *B. subtilis*, the anthrax bacillus, *Micrococcus tetragenus*, the diphtheria bacillus yield a negative result. On substituting for beef broth that prepared from veal, horse-flesh, or haddocks, no difference in the behaviour of the organisms investigated was observed. When inoculated into raw eggs, which contain such a large proportion of loosely combined sulphur, the *Proteus vulgaris*, associated with so many processes of decomposition, failed, in spite of abundant growth, to produce any sulphuretted hydrogen. On boiled eggs, however, this microbe produces this gas. These interesting results suggest that the power of evolving sulphuretted hydrogen may be possessed in a latent state by certain bacteria, and that just as particular conditions may stimulate their activity in this direction, other circumstances may act as a deterrent.

THE power of gradually adapting themselves to their surroundings possessed in such a remarkable degree by many micro-organisms, has been studied as regards their susceptibility to various strengths of disinfectants by Kossiakoff, and still more recently by Trambusti (*Lo Sperimentale*, 1892, fasc. i.). Kossiakoff showed that a larger dose of a particular disinfectant was necessary to destroy an organism which had been trained by being subjected to gradually increasing doses of the disinfectant than was required when the organism was submitted to it without any such preparation. Trambusti examined the behaviour of various bacteria in the presence of corrosive sublimate, and found that they exhibited striking differences in their ability to withstand this material. Thus whereas the pneumococcus of Friedländer was trained to survive an addition of 1 : 2000 parts of the sublimate to the culture media, the bacillus of fowl cholera was not able to withstand more than 1 : 30,000. If, however, the pneumococcus were taken straight from a fresh culture without any previous experience of the disinfectant, it succumbed in a solution containing 1 : 15,000 parts. The bacillus of swine plague (Rouget des Porcs) was induced to resist an addition of 1 : 8000 parts, whereas without training 1 : 15,000 parts infallibly destroyed it. As regards the retention of their pathogenic properties amongst those organisms investigated, the bacillus of swine plague was the only instance in which the virulence was diminished during its treatment, an addition of 1 : 20,000 parts of corrosive sublimate rendering it innocuous, although its vitality was not destroyed in the presence of 1 : 8000 parts.

MESSRS. E. AND L. MACH have done a considerable amount of work in connection with the photography of flying bullets, air jets, and sound waves since their last publication on this subject. Some results gleaned from a series of about 1500 negatives have been recently communicated to the Vienna Academy. Sharp images of Mannlicher rifle bullets were obtained of 3·5 cm. diameter. The disturbing electric contacts in the field were dispensed with, as it was found possible to close the spark circuit mechanically by means of the sound wave produced by the bullet itself. A large number of experiments were conducted with the interference refractometer invented by Ludwig Mach, and constructed in a complete form with the aid of the Academy. After some trials they succeeded in producing homogeneous plane-parallel glass plates large enough to obtain an interference field 8 cm. in diameter. If one part of this field is occupied by a projectile, an air jet, or a sound wave passing one of the interfering pencils, the interference bands, usually rectilinear, appear bent in such a manner as to indicate the change of density of air at any point. For the purpose of instantaneous illumination the electric spark was usually employed, but sometimes, especially in cases where a longer illumination was admissible, as in the photography of air jets, blue monochromatic sunlight was substituted.

A SIMPLE instrument for trisecting any given angle, invented by Dr. E. Eckhardt, is described in the *Naturwissenschaftliche Wochenschrift*. A straight rule has a slot running along two-thirds of its length, with a pin capable of moving along it. A bar is attached to this pin, and another bar to a rivet at the inner end of the slot. Both these bars are equal in length to the remaining third of the rule, and their free ends are joined by means of another pin. When it is desired to trisect an angle, the pin moving in the slot is placed at the vertex, and the other pin in one of the sides, a parallel to the other side, being drawn through the point occupied by the pin. A curve is now drawn by means of a pencil attached to the unslotted end of the bar, and the intersection of this curve and the parallel referred to is the point of trisection required. The instrument also gives an easy construction for an angle of 36° and for the performance of the "golden section." It is exhibited at Chicago by "The Prussian Universities."

AT a recent meeting of the Société Française de Physique, M. E. Ducretet described a method he had employed for making high resistances without self-induction, and hence suitable for use with a telephone in Kohlrausch's method of measuring resistances. He uses a zigzag formed on platinised glass very like that, composed of fine platinum wire, used by M. Mergier, and finds that a piece of platinised glass 75 mm. by 110 mm., allows of the construction of resistances varying from 25 to 100,000 ohms. The glass plates are fixed in a glass vessel by means of an insulating cover, and this vessel is filled with purified petroleum, which M. Pellat has shown to be a very good insulator. In this manner all effects due to moisture in the air are removed, while it is easy to measure the temperature. A layer of mercury, of variable thickness, at the bottom of the vessel allows of the resistance being adjusted to any desired value.

WHILE engaged on some measurements on the electrical resistance of the human body M. Mergier was led to the construction of a simple instrument which, while being easily manipulated, should be capable of making such a measurement with accuracy. The instrument consists of two coils of insulated wire, fixed with their planes at right angles to each other, and placed within the field of a strong horse-shoe magnet. These two coils are connected in series with the resistances to be compared, and to the terminals of a battery. Under these circumstances, the position of equilibrium of the coils depends only on the ratio of the resistances of the two branches (coil and added resistance), and is independent of the value of the electromotive force of the battery. The current is led into the coils by three metallic points, placed one vertically above the other, and dipping into mercury cups. The coils are suspended by a silk fibre or from a steel point working in an agate cup. For use with alternating currents the magnet is replaced by two fixed coils, which are also connected to the circuits containing the resistances to be compared.

MESSRS. DEIGHTON, BELL AND CO. have published a second edition of Dr. W. H. Besant's excellent "Treatise on Dynamics."

MESSRS. J AND A. CHURCHILL have issued a little volume entitled "Homburg-Spa: an Introduction to its Waters and their Use," by Dr. Arnold Schetelig.

WE have received a report containing the results of observations made at Magdeburg meteorological observatory during 1891, under the direction of Herr A. W. Grützmacher.

DR. R. W. SHUFELDT, in *The Auk* of July, gives an account of an examination of the trunk skeleton of a hybrid grouse. His observations confirm an opinion expressed some years ago, that of all the North American grouse, the genera *Pediocaetes* and *Tympanuchus* are most nearly related to each other; in fact, so close is the relation, that the species are fertile *inter se*.

BULLETIN 42 of the Purdue University Agricultural Experiment Station contains a paper by Mr. J. C. Arthur on the relation of the number of eyes on the seed tuber of the potato to the crop obtained. The experimental data brought forward indicate that the proper way to cut potatoes for planting is to divide them into pieces of suitable size, without regard to the distribution of the eyes. In other words, the number of eyes per piece is immaterial, so that the weight or size of the piece should be the all-important factor in preparing seed material.

THE annual report of the Royal Botanic Garden, Calcutta, of which Lieut.-Col. G. King, F.R.S., is superintendent, has been issued. From it we learn that all the efforts to introduce the cultivation of the Japanese paper mulberry have failed. As the superintendent points out, this mulberry yields a beautiful fibre, which is naturally so white that it requires very little bleaching, hence it seems a pity that no wealthy landowner has taken up its cultivation on a large scale.

THE administration report of the Central Museum for 1892–93 has been prepared by Dr. H. Warth, officiating superintendent, and recently issued by the Government of Madras. It includes an account of corundum deposits in the Madras Presidency, and one on the phosphatic nodules of the Trichinopoly district. Dr. Warth says that the entire area covered by these nodules is about ten square miles, and that about four thousand tons of nodules are lying more or less loosely on the surface.

THE fourth volume of the Bulletin of the American Museum of Natural History contains a large number of important papers, among which we note one by Prof. H. F. Osborn and Mr. J. L. Wortman on "Fossil Mammals of the Wahsatch and Wind River Beds," and another by Mr. J. A. Allen on "The Geographical Distribution of North American Mammals." Mr. F. M. Chapman contributes an article on birds and mammals observed near Trinidad, Cuba, with some remarks upon the origin of West Indian bird life, and Mr. W. Beutenmüller gives several papers on Lepidoptera.

THE proceedings of the Bristol Naturalists Society for 1892 contains several interesting papers. Among others of general scientific interest we note a paper describing the fish-remains of the lower carboniferous rocks of the Bristol district, by Mr. A. J. Heath and Prof. C. Lloyd Morgan. Mr. Claud Druit gives an account of the Green Woodpecker, and Mr. H. J. Charbonnier contributes some notes on the habits of the larvæ of Gracillaria Syringella. Dr. J. A. Norton writes on the coloration of cuckoo's eggs. We regret to learn from the report that this once flourishing society is declining in numbers.

MESSRS. NEWTON AND CO., Fleet Street, have brought out a new kind of gyroscope top, which should be of interest to students of the dynamics of rotation. In it a shallow bell with heavy rim takes the place of the usual disc. At the inner apex is a point which rests on a steel cup in the top of a firm upright. By means of this support, freedom of motion in different planes is obtained without the use of gimbals. The top can be set spinning by twirling it between the fingers, and, owing to the fine workmanship, it will keep in motion for a considerable time. If any geometrical figure made by bending a piece of stout wire is fixed above the point of support, the upper end of the axis of the top follows the form so long as rotation is obtained, running continuously round it in a very remarkable manner. If the top were intended for a gyroscope, its axis should always remain parallel to itself unless guided in the way described. But this is not the case. The axis slowly gyrates and wobbles as it does so. These motions certainly imitate precession and nutation, but the mode of exemplification may lead beginners to a misconception. There is a possibility of being led away with the idea that the earth's axis changes its direction by itself, whereas it cannot be too strongly insisted upon that the effect is produced by external attraction.

AN important communication upon the production of ozone at high temperatures is contributed by Dr. Brunck, of Freiberg to the current number of the *Berichte*. The very title of the memoir is contrary to all our usually accepted ideas concerning the stability of ozone, but Dr. Brunck advances experimental evidence to show that polymeric oxygen is capable of formation and of subsequent existence for a short time even at temperatures of considerable elevation. It is quite true, as Andrews and Tait long ago pointed out, that at 300° ozone is converted into ordinary oxygen, indeed, Prof. Andrews gave 237° as the temperature of dissociation; but Dr. Brunck shows that the change is by no means instantaneous, and that if the gas is only allowed to remain for a short period of time in the heated vessel, a considerable proportion escapes decomposition. A quantity of oxygen was partially ozonised in the ordinary manner by means of a Siemens tube, and the gases, which contained about five per cent. of ozone, were led very slowly through a combustion tube heated to 350° in an air bath; the issuing gas was found to still contain twenty per cent. of the original quantity of ozone present. Filling the combustion tube with fragments of porcelain did not appear to materially diminish the quantity of ozone escaping dissociation. Dr. Brunck then proceeds to describe several high temperature reactions in which oxygen is liberated to a not inconsiderable extent in the condensed form of ozone. Schönbein some years ago made the remark that the oxygen evolved upon heating certain metallic oxides and peroxides appeared to contain ozone, inasmuch as it rapidly liberated iodine from potassium iodide. This statement, which appears to have been overlooked or mistrusted, is completely confirmed by Dr. Brunck, who shows that oxide of silver evolves as much as five per cent. of its oxygen in the form of ozone.

THE most interesting portion of Dr. Brunck's paper, however, is that in which he adduces experimental evidence that the strongly odourous gas hitherto considered to be chlorine, which is usually admixed to a slight extent with the oxygen prepared by heating a mixture of potassium chlorate and manganese dioxide, is in reality ozone. It is certainly singular that Marignac, on attempting to determine the amount of such admixed so-called chlorine in a strongly odourous specimen of the gas, only obtained three milligrams of silver chloride from fifty grams of potassium chlorate. Dr. Brunck now shows that an aqueous extract of the residue in the flask, after heating the mixture of potassium chlorate and manganese dioxide, always reacts neutral to litmus; whereas if free chlorine were evolved the residue must of necessity be alkaline. Moreover, even after repeated washing of the gas with concentrated solutions of caustic potash, sufficient to remove any free chlorine, the gas still maintains its strong odour, at once forms blue iodide of starch with a starch and potassium iodide paper, and bleaches a moistened litmus paper. Further, upon leading the gas through alcohol, aldehyde is produced, an oxidation which free oxygen alone is incapable of bringing about. The active properties and the odour are, however, completely lost after passage of the gas over a layer of manganese dioxide at the ordinary temperature, as would be the case if ozone were the energetic gas present in the oxygen. The above experiments concerning the comparative stability of ozone for a short time at high temperatures quite account for the formation of ozone when a mixture of potassium chlorate and manganese dioxide is heated. Dr. Brunck finally shows that the amount of ozone produced is considerably augmented by removing the escaping gases more rapidly from the heated mixture by means of a current of air or other inert gas. Pure potassium chlorate appears to yield no ozone upon heating, but a mere trace of impurity, such as potassium chloride or silica, causes more or less of the oxygen to be evolved in the form of ozone. Hence commercial chlorate always yields a small proportion of ozone.

NOTES from the Marine Biological Station, Plymouth.—The floating fauna has now begun to assume its distinctive autumn characters. During the past week there were taken, in addition to the larvæ of *Chætopterus*, *Amphioxus* larvæ, the *Tornaria* larva of *Balanoglossus*, numbers of *Plutei* and some *Bipinnariæ*, larvæ of the Polychæta *Magelona* (very young), *Pectinaria*, and *Polydora*, together with scores of *Pilidium*. Medusæ were very plentiful, especially the Leptomedusæ *Laodice cruciata*, *Obeliæ*, and an unidentified *Irene*-like Phialia, and, among Anthomedusæ, a small Margelid. There were also taken two specimens of a species of *Geryonia*, and several of the amethyst tentacled *Amphinenia Titania* (= *Saphenia dinema* of Forbes). *Noctiluca* has reappeared in small numbers. *Evadne Nordmanni* is extremely plentiful; *Podon* on the other hand is relatively scarce. The following animals are now breeding:—The Cladoceran *Evadne Nordmanni* (most carrying embryoes, some provided with the "winter egg"), and a few Lobsters (*Homarus vulgaris*).

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 the Rev. W. Meikleham; a Brown Capuchin (*Cebus fatuellus*) from Guiana, presented by Mr. T. Birks; a Rhesus Monkey (*Macacus rhesus*) from India, presented by Dr. G. Lindsay Johnson, F.Z.S.; a Leadbeater's Cockatoo (*Cacatua leadbeateri*) from Australia, presented by Capt. St. G. Ord; an Imperial Eagle (*Aquila imperialis*), two Great Eagle Owls (*Bubo maximus*) European, presented by Mr. Charles Clifton Dicconson, F.Z.S.; a Common Jay (*Garrulus glandarius*) British, two Alligators (*Alligator mississippiensis*) from the Mississippi, presented by Mr. Walter D. Marks; a Yellow-billed Sheathbill (*Chionis alba*) cap. at sea off Staten Island, presented by Capt. E. England; seventeen Guillemots (*Lomvia troile*), two Puffins (*Fratercula arctica*), twelve Kittawakes (*Rissa tridactyla*) British, presented by Mr. Thomas A. Cotton, F.Z.S.; a Cape Crowned Crane (*Balearica chrysopelargus*) from South Africa, presented by Mr. E. S. Spooner; two Peregrine Falcons (*Falco peregrinus*) from Ireland, presented by Capt. R. A. Ogilby, F.Z.S.; a Larger Hill Mynah *Gracula intermedia*) from Northern India, presented by Dr. Best; two Montagu's Harriers (*Circus cineraceus*) European, presented by Lord Lilford, F.Z.S.; ten Slowworms (*Anguis fragilis*) British, presented by Mr. F. A. Leach; a Black Rat (*Mus rattus*) British, presented by Mr. Arch. E. Scott, F.Z.S.; a Brown Capuchin (*Cebus fatuellus*) from Guiana, a Ring-tailed Lemur (*Lemur catta*) from Madagascar, a Ring-tailed Coati (*Nasua rufa*) from South America, deposited; a Yak (*Poephagus grunniens*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET 1893 (RORDAME-QUÉNISSET).—Herr E. Lamp gives a four-day ephemeris for this comet in *Astronomischen Nachrichten*, No. 3175, as obtained by using the elements he published in a previous number of the same journal:—

12h. Berlin M.T.

1893.	R.A. (app.) h. m. s.	Decl. (app.) ° ′
August 8	12 9 29	+12 28·8
12	12 12 51	11 7·2
16	12 15 38	9 58·7
20	12 18 2	8 59·8

This comet is now rapidly fading, and at the same time becoming very unfavourably situated on account of its rapid southerly motion.

COMET FINLAY 1893.—The following is the current ephemeris for Finlay's comet:—

12h. Paris M.T.

1893	R.A. (app.) h. m. s.	Decl. (app.) ° ′ ″
August 10	5 57 30·2	+23 7 14·3
11	6 1 16·4	9 53·9
12	5 0·6	12 12·3
13	8 42·6	14 10·0
14	12 22·5	15 47·6
15	16 0·3	17 5·8
16	19 35·9	18 5·1
17	6 23 9·3	23 18 46·0

TOTAL SOLAR ECLIPSES.—Under this heading Mr. Turner (*Observatory*, No. 204) says a few words about the results of the late eclipse and also the total eclipse that will occur on August 8, 1896. With regard to the former the observers who went out may be thoroughly congratulated on their performance. The photographs that were taken of the corona are, as Mr. Turner informs us, now in the hands of Mr. Wesley, who will make drawings of them, as he has done in the case of previous eclipses. During his recent visit to England Prof. W. H. Pickering compared the photographs he took with those already mentioned, with the result that many most interesting points have been revealed. Prof. Pickering, it may be remembered, employed one of Dr. Common's 20-inch reflectors of 45-inch focus, and, used slow plates, with the result that he "has got more detail in the inner corona than is shown on the English photographs." Referring to the eclipse of 1896 Mr. Turner points out the importance of making preparations a long time beforehand, in order to eliminate the possibility of hasty arrangements at the last moment. In the case of this eclipse it seems not a bit too early to commence, for, owing to the most favourable position of the central line of totality, it is probable that a host of observers, both professional and amateur, will be able to co-operate in the observations.

The central line cuts through Norway in the north, the east coast being the more favourable both for observation and comfort in travelling. Passing across Nova Zembla the line reaches Japan, and thus, as Mr. Turner says, "another delightful trip is open to any one with plenty of leisure."

The details of the eclipse are as follows:—

	At Varanger Fjord. d. h. m. s.	Nova Zembla. d. h. m. s.	Siberia. River Amur. d. h. m. s.	Japan. I. of Yezo. d. h. m. s.
Eclipse begins Aug.	8 16 59 43	8 18 30 1	9 1 16 13	9 1 55 8
Totality " "	8 17 55 37	8 19 28 59	9 2 27 31	9 3 5 26
Eclipse ends	8 18 55 31	8 20 31 54	9 3 36 54	9 4 13 10
Duration of totality	0 0 1 46	0 0 2 0	0 0 2 46	0 0 2 40
Sun's alt. at totality	15°	22°	46°	43°

THE OBSERVATION OF AURORÆ.—We have previously had occasion to refer to the movement for systematically recording the occurrence of auroræ which has been set on foot by Dr. M. A. Veeder. Public attention has lately been called to the matter by a long article in the *New York Sun* describing the plan of observation and the important results that must follow from its extended adoption. The method of observation is very simple, and requires but little time. Each observer indicates on the blanks supplied for the purpose the presence or absence of the aurora. Whenever the fact has been verified by observation the figures denoting the exact time at which the observation was made are entered in the proper space in the blank. The facts which it is especially desired to learn are the exact times of sudden changes in the brightness of the aurora, the extent of sky which it covers, and its position relative to the true north. In case observations are not made the spaces are simply to be left blank. Each blank sheet prepared in this way covers an entire month, and is arranged so as to enable comparisons to be made at a glance between the records from different stations. Only by the coordination of results uniformly recorded can any definite information be obtained as to the distribution, periodicity, and source of luminosity of auroræ. Dr. Veeder has employed his scheme of observation for some years, and finds that it works satisfactorily. Arrangements have been made for its introduction into the observatories of Archangel, Pawlosk, Ekatrainbourg on the Ural mountains, Irkutsk in Siberia, and at other points. The Director-General of the Italian Meteorological Service has also written expressing approval of the purposes of the research, and promising to aid it in every way possible. American observatories have also taken up the system, and other observations have been provided for on an extensive scale, so interesting and important results may be expected. Those who desire to take part in the work can obtain all information relating to it by application to Dr. Veeder, Lyons, New York.

NEW DETERMINATION OF THE CONSTANT OF UNIVERSAL ATTRACTION.—In a note under this heading on July 27 we gave a list of some of the different values obtained for the density of the earth. The following should be added to make it more complete:—

Jolly and Poynting, by the method of weighing, obtained 5·58 as the value for the mean density.

Wilsing's determinations in 1887 and 1888 gave 5·58 with a very small probable error.

"HIMMEL UND ERDE" FOR AUGUST.—In the current number of this periodical Prof. von Braunmühl contributes the discourse which he delivered before the Mathematical Society at München on "Galileo Galilei." Dr. Wilhelm Meyer continues his series of chapters on the planet Mars, and in this one he is able to reproduce some of the most interesting drawings of Prof. J. M. Schaeberle, made at the Lick Observatory. The discussion deals chiefly with the observations made and the suggestions put forward by such observers as Holden, Schaeberle, Barnard, Pickering, &c. Chapter v., on "The origin of the world according to opinions from the time of Kant up to the present," by Herr Guizel, deals with the process of development of the heavenly bodies, the case of comets receiving the writer's special attention.

Among the notes are found a few words about the sun and magnetic storms, with reference to Lord Kelvin's recent views, types of weather in Australia, driving ice in southern latitudes, and several others.

GEOGRAPHICAL NOTES.

THE question of the death of Emin Pasha is again under discussion. It is one of the most difficult problems associated with Africa to estimate the amount of credence due to native or Arab reports. The dictum that bad news travels fast in Africa has been repeatedly proved, but rumours of the death of every explorer of note who has buried himself for a time in the interior have been so persistent and so often falsified, that hesitation is justified in believing Emin dead. It may very well be that he was killed, as Arab report affirms, in October last, while on his great journey across Africa, by the very route which brought Stanley to his rescue five years ago. But on the other hand, it may very well be that he is pushing on leisurely towards Lake Chad and keeping his movements secret for political purposes.

A NEW field of discussion in geography appears to be about to open if we read literally the title "An Undiscovered Island off the northern coast of Alaska," in the last part of the *National Géographic Magazine*. The existence of an island in 73½° N. and 153½° W., north of Point Barrow, is inferred from some rather vague reports of whalers, and some still vaguer stories of the Alaskan Eskimo. Mr. Marcus Baker, who introduces the new land, believes in it sufficiently to propose the name Keenan Island for it; but General Greely contributes a note to the paper in which he shows good reason for believing that the whalers were mistaken, the Eskimo misunderstood, and the new land non-existent.

THE *Revue de Geographie* commences a series of articles on "Questions Géographiques," with a paper on the gaps in our knowledge regarding the vertical relief of France, by M. A. Thalamas. To fill these he urges the importance of supplementing the ordinary hypsometrical maps by sections, and by a complete series of perspective photographic views taken from characteristic points.

THE Rev. R. P. Ashe, author of the standard work on Uganda, and for many years resident there as a missionary, has returned to this country, bringing much valuable information regarding the geography of Eastern Equatorial Africa, which will doubtless soon be made public.

A NEW Geographical Society has been established at Tunis, having for its special aim the study of that protectorate. Not only geography but history, archæology, anthropology, colonisation, commerce, and "natural science" have places on its programme.

THE INSTITUTION OF MECHANICAL ENGINEERS.

THE Institution of Mechanical Engineers held their annual summer meeting at Middlesborough, under the presidency of Dr. William Anderson, F.R.S., during last week. The meeting commenced on Tuesday, August 1, and lasted until the following Friday. Two sittings were held for the reading of papers, four of which were read and discussed, as follows:—On recent developments in the Cleveland iron and steel industries, by Mr. Jeremiah Head, past president, chairman of the reception committee.—On the Middlesborough salt industry, by Mr. Richard Grigg, of Middlesborough. Communicated through Mr. E. Windsor Richards, vice-president.—On some engineering improvements in the River Tees, by Mr. George Clarke, of Stockton, engineer to the Tees Conservancy Commission. Communicated through Mr. Thomas Wrightson, M.P., chairman of the works committee of the Tees Conservancy Commission.—Description of the electric rock-drilling machinery at the Carlin How Mines in Cleveland, by Mr. A. L. Steavenson, of Durham. Communicated through Sir Lowthian Bell, Bart., F.R.S., past president.

Mr. Head's paper, as its title denotes, was of a very complex nature. The author traces the rise and progress of the iron industry in the Cleveland district, which, before the development of the ironstone in the Cleveland hills, was practically a purely agricultural country. The opening of the Stockton and Darlington Railway inaugurated a new era, which was to dawn over this part of the kingdom, and substituted for the calm frugality of a pastoral calling the grime, smoke, wealth and squalor of a manufacturing industry. John Vaughan was the man who made Middlesborough, and rightly his statue stands in the middle of that unlovely town. He was a typical pioneer, dogged of purpose, shrewd yet kindly. He probably did more towards advancing the commercial supremacy of this country than any six statesmen the century has produced. The first blast furnaces were erected in the Cleveland district by his firm, Bolckow, Vaughan and Co., at Middlesborough, in 1852. These were quickly followed by others at Port Clarence near by. They were erected by Bell Brothers, and Sir Isaac Lowthian Bell, the head of the firm, attended at the meeting and spoke in the discussions on the papers. Although advanced in years he is still a keen man of business and of vigorous intellect; the present Mayor of Middlesborough is his son. After the date we have mentioned Middlesborough grew like a gourd and flourished like a bay-tree. Her prosperity seemed as firmly founded as her gigantic blast furnaces, which were then the wonder of the whole iron-making world; but a greater man than either Vaughan or Bell arose, and with the invention of Henry Bessemer, the iron age gave place to the age of steel. Happily for Middlesborough it is difficult to divert the course of trade although the Cleveland ore is not suitable for steel making; or at any rate, was not until the basic process was introduced years afterwards. Middlesborough is well situated for communication by sea with the continent. The great deposits of hæmatite ore, from which by far the greater part of British steel is made, were discovered at Bilbao, in Spain, and Cleveland set vigorously to work to improve the naturally insignificant stream upon which she is situated. With characteristic northern energy the Tees was transformed from a creek with three and a half feet at low water, spring tides, to an estuary with twenty feet as a minimum depth and thirty-seven feet at high water. The ironmasters of the district, who had become numerous and influential, quickly laid down the necessary plant and machinery for making steel. Unfortunately, in a few instances, but those important ones, the vigorous parent stock was succeeded by a more debased growth and that for a time checked to some extent advance, or at any rate gave other districts an advantage; still the iron industry of Cleveland was so firmly established that it still remains the leading iron-producing district of England. At the present time Middlesborough is suffering, like all other parts of the kingdom, from the dulness of trade. There are more blast furnaces, more converters, more open hearth furnaces, and more steel and iron-producing machinery in the world than the world has call for. The engineer has so multiplied manufacturing facilities that we make more than we want, great as is the demand for iron and steel in modern economy. When process was cheapened by the ingenuity of inventors, those who first took advantage of the new means at their disposal became quickly rich. Investors and speculators crowded on to the field, and before the fact was known the producing power of man in the iron industry had been overdone. Sometimes in those strange fluctuations of trade which are the baneful characteristic of the present day, the demand more nearly reaches the power of supply; then for a few months, on the crest of this wave of inflated prosperity, works are busy and prices high. That lasts but a short time, and during the recent meeting the members of the Institution of Mechanical Engineers had the mournful spectacle presented to them of idle plant and unemployed workpeople, although each works manager put as bold a face as possible on his adversities, and strove to crowd as much work as his order book contained into the one day's visit of the institution.

To return, however, to Mr. Head's paper. We find that in 1872 there were thirty-seven iron works in the north-east district. Twenty-one have since disappeared or are now inoperative; whilst nineteen remain. The figures are delusive, for the size and power of production per works are now far beyond what they were at the earlier date. To show how steel has superseded iron, we find by the paper before us that the trade in iron rails has declined nearly 99% since 1872; whilst other kinds of finished iron have declined to the extent of 36% since the same date. Instead of finished iron absorbing 40% of the Cleveland pig-iron made as in 1872, in 1891 it absorbed only about 23%. The quantity of ore raised in Cleveland in 1872 was about 6,300,000 tons, and the quantity of pig-iron made in the north-east district about 1,920,000 tons. During the year 1891 there were produced in the north-east district 795,487 tons of steel ingots. In the latter year 2,260,000 tons of ores other than Cleveland were smelted and of these about 2,100,000 tons were imported chiefly from Spain. On the whole, there has been produced in this district about 36% more pig-iron than in 1871.

It is rash indeed to prophesy in industrial matters, which are influenced by many complex problems, but it would seem that the great change which is impending over Middlesborough is the adoption of a new process in steel making. To bring ore from Spain—the greater part of which is converted into slag, simply to encumber the ground; whilst a smaller percentage ultimately finds useful application—seems an artificial proceeding. At first it was forced upon English steel-makers, from the fact that our native ores, with few exceptions, are phosphoric and therefore unfit for the pneumatic process of steel-making. Later discoveries have removed this disability and by the basic process phosphorus can be eliminated, and good steel made. The Cleveland district is richer in iron ore of high quality than any other in England, but this ore is not suitable for steel-making by the old acid process. It is therefore the manifest duty of Cleveland to foster and perfect the basic system of steel-making, and so use the phosphoric ores of her native hills. The problem is chiefly a commercial one. Happily the stagnation of trade will quicken the ingenuity and enterprise of steel-makers, and we shall no longer depend so fully on a foreign source for the raw material of the most important industry in the kingdom.

The discussion on Mr. Head's paper turned chiefly on the respective merits of Yorkshire iron and mild steel. Mr. Windsor Richards said that best Yorkshire iron was better than the best mild steel made. The statement is too sweeping, and those who use this material will be more likely to agree with Dr. White, the Director of Naval Construction, who spoke in praise of mild steel, laying emphasis on the lower price it costs compared to Yorkshire iron. Mr. Aspinall, the chief Locomotive Engineer to the Sheffield, Manchester, and Lincoln Railway, and one of the best mechanical engineers in the country, also spoke strongly in favour of steel, traversing Mr. Windsor Richards's statement that the mildest descriptions could not be case-hardened. The subject, however, is somewhat antiquated, and were it not for the high authority of Mr. Windsor Richards, would hardly be worth reopening. The difficulties that stood in the way of steel for engineering purposes have been overcome years ago.

The next paper on the list was a contribution by Mr. Richard Grigg, and dealt with the newest industry of Middlesborough, namely, that of salt manufacture. The late John Vaughan, boring for water, came upon salt, and the result has been that quite a brisk industry has sprung up. At first the wells were made by the diamond drill, but the process was so expensive that the industry would have been strangled in its birth, had it not been that American ingenuity came to its aid. The salt in the Middlesborough district is at a considerable depth below the surface; in some places 1700 feet. The strata that have to be bored through are difficult, and it was thought at one time that the salt was too deep to win with profit. Some shrewd person, who had travelled in Pennsylvania, remembered how the Americans make their oil wells, and the system has been transplanted to Middlesborough, so that in some parts one might also fancy one's self in the neighbourhood of Pittsburg, so closely have the characteristic timber derricks been copied in this heart of the iron country. The chief point of interest raised by Mr. Griggs's paper was whether the brine-pumping is going to lead to subsidence or not. On the other side of our island, in the salt districts of Cheshire, brine-pumping has led to most curious and, to those on the surface, unpleasant results. The houses in Northwich bear evidence of this; the house-line presents most devious and irregular courses; the houses themselves are iron strapped or wooden bound, so that they may be "jacked" to lift them, as the earth upon which they stand subsides, and it is no uncommon thing for a Northwich landlord to be called on to the rescue of his buildings, which are in process of disappearing beneath the surface. In one place a house has so far settled down that what was the first-floor bed-room has become the basement, and the front door has been cut off between the two upstairs bed-room windows. Northwich Bridge has been lifted several times, or it would have been transformed into a dam; whilst large tracts of land have subsided bodily, and in one place there is, or used shortly ago to be, a line of rails which ended abruptly at the edge of a cliff, the remaining part being on a plain beneath. At one time these rails were continuous, and were only broken through subsidence caused by the abstraction of salt beneath. Probably, however, Middlesborough will not be served in this way. The salt there is deeper, and is surmounted by a stratum of rock. As the brine-pumping goes on, and large cavities are formed by the abstraction of salt, the roof of rock is left unsupported. The superincumbent mass of earth may, or may not, break this down. It is hoped that should a fall of the rock take place, the pieces descending will form themselves into a dome shape, and, therefore, be well calculated to resist the weight above. The hope appears too sanguine, for the rock would be more likely to give way over the centre of the cavity than at the sides, where it is nearer the supporting salt not dissolved; indeed, the dome would more likely be an inverted one. In the Cheshire district we believe the subsidences have invariably been of a gradual nature, so that inconvenience rather than danger has been the result. In Middlesborough the results may not be of the same gentle kind. It is true that the cavities are deeper in the earth, and that is an element of safety in one respect, but should the stratum of rock below give way suddenly serious results might follow, especially if some of Middlesborough's ponderous furnaces were above the spot affected. Near Nancy, in France, a subsidence of earth took place which was so sudden that it caused a report which was heard 12 miles away. Middlesborough is pumping salt close to the town, and what is, of course, worse, in the near neighbourhood of the docks. Authorities, however, differ as to what will be the result; time alone will prove; it may be in a manner more convincing than pleasant. Mr. Griggs's paper contains an excellent description of the machinery used, and illustrations of the same were exhibited on the walls of the Town Hall, where the meeting was held.

A paper by Mr. A. L. Steavenson, entitled, "Description of the Electric Rock-Drilling Machinery at the Carlin How Ironstone Mines in Cleveland," was next read. After briefly referring to the various means of drilling holes for blasting purposes, the author proceeded to describe the electric drill. We could not give a description of this without the illustrations which were exhibited on the walls. Mr. Steavenson, who is a mining engineer, has tried all kinds of drilling—hand, compressed air, hydraulic, and petroleum engine, but he gives preference to electricity as a means for transmission of power in this work, although he says that petroleum engines have done good work.

The last paper read at the meeting was a contribution by Mr. George J. Clarke, engineer to the Tees Conservancy. In this he describes briefly some of the works which have been done in making the harbour at Teesmouth and improving the navigation. Dredgers, training-walls, and breakwaters have been combined in this work which has proved of such signal value to the district; in fact they have made its large commerce possible.

During the meeting a number of excursions to various ironworks were made, and members had an opportunity of seeing the colossal proportions to which the machinery for the production of iron and steel has been carried in the present day.

THE WILLIAMS COLLECTION OF MINERALS.

A FEW words relative to the collection of minerals which has just been distributed among various museums by Mr. J. C. Williams, M.P. for the Truro Division of Cornwall, will be of general interest. This collection had been gradually brought together by the father and grandfather of Mr. Williams; it was removed nearly thirty years ago from Scorrier, where Mr. Michael Williams formerly lived, to Caerhays Castle, nine miles from the nearest railway station (St. Austell), and it has since been too remote from the ordinary line of travel to be of easy access to visitors. It was in this collection, while it was still at Scorrier, that my predecessor, Prof. Maskelyne, F.R.S., noticed in 1863 the specimen of connellite from which it seemed to him that the first crystallographic measurements might be obtained: the specimen was presented by Mr. Michael Williams to Mr. Maskelyne for the British Museum, and has ever since been on exhibition in the Gallery. As the crystals were only $\frac{1}{350}$th of an inch in thickness, the determination of their form was a noteworthy piece of scientific work; and it may be observed that the more recent discovery of larger crystals of the same beautiful mineral in another Cornish locality has only served to confirm the remarkable accuracy with which the form of those acicular crystals was then determined.

A short time ago, Mr. J. C. Williams, whose open-handed generosity is well known in Cornwall, perceiving that the continuance of the collection in so isolated a museum as that of Caerhays Castle prevented its utility both to students and the general public, decided to select some of the specimens for preservation in the family, and to present the remainder to public museums. Accordingly, in a courteous letter, he invited me to Caerhays to select any specimens which would be useful in completing the series preserved in the British Museum, and I immediately went down, accompanied by my colleague Mr. Miers, to examine the collection and remove the specimens which should be selected.

The collection, which amounted to about 10,000 specimens, was exhibited in numerous glazed wall-cases and table-cases in a large hall well lighted from the roof. The specimens were from various parts of the world, but as a rule only those of local origin could be of service for an old-established collection like that of London: the Cornish specimens, however, formed a series which, owing to the closing of so many mines and the change of mineral conditions in others, it would be quite impossible to reproduce in the present day: for the acquisition of such specimens the successive owners of the collection, by reason of their interest in Cornish mining enterprise and its products, have had excellent opportunities of which they have not failed to make use. In all, nearly 300 specimens were reserved by Mr. Williams for continued preservation at Caerhays; 510 specimens have been selected for the British Museum; the collection formed by the late Mr. John Taylor (to whom the British Museum was indebted for the donation of some excellent mineral specimens), and acquired at his decease by Mr. Michael Williams, has been given, with the exhibition-cases containing it, to the Camborne Museum; the remaining specimens and exhibition-cases have been divided between the museums of Redruth and Truro.

That the character and extent of the donation to the British Museum may be more readily appreciated by visitors, the selected specimens have been arranged in four window-cases of the Mineral Gallery, and will be exhibited together for a year or two before their distribution through the main collection. Special attention may be directed to two specimens of blende (sulphide of zinc) which for size and excellence are superior to any yet heard of, and in colour somewhat resemble those from Hungary. A remarkable specimen presenting crystals which are of an emerald-green colour and of unusual form, has been examined by Mr. Miers in conjunction with Mr. Prior, and will shortly be described by the former. He finds the crystals to be identical with spangolite (sulphate and chloride of copper and aluminium); of this species, described by Mr. Penfield three years ago, only one other specimen, found and preserved in the United States, is known to exist. There is a fine suite of crystallised specimens of cassiterite (oxide of tin). Special mention, too, should be made of the specimens of redruthite (sulphide of copper), the large series of specimens of chalcophyllite, clinoclase, and olivenite (arsenates of copper), libethenite (phosphate of copper), liroconite (phosphate of copper and aluminium), cupro-uranite (phosphate of copper and uranium), pyromorphite (phosphate and chloride of lead), cerussite (carbonate of lead), chalybite (carbonate of iron), and fluor.

The thanks of Cornish and London students are due to Mr. J. C. Williams for the generosity and self-denial he has shown in parting for their benefit with a valuable collection formed by the efforts of at least two preceding generations of his family.

L. FLETCHER.

PROPOSED NEW TELESCOPE FOR CAMBRIDGE OBSERVATORY.

IN order to complete the equipment of the Cambridge Observatory a public appeal has been made for funds. The appeal reads as follows:—

"It will be allowed that the Cambridge Observatory ought to be completely equipped for carrying on the most advanced work in modern astronomy. As celestial photography is the branch of astronomy in which the most important advance is now being made, it has been decided that a photographic telescope shall be obtained if the necessary funds be forthcoming. It is the opinion of those most competent to form a judgment that a photographic refractor of about 18 inches diameter would render it possible to attain results of the highest excellence. The new objective would be corrected for the photographic rays, and the present Northumberland telescope would serve as the guide when attached to the new tube. With such an exceptionally efficient instrument the director of the observatory would devote the attention of the staff (presently to be liberated by the termination of the international zone work on which it has been engaged for many years) to the investigation of stellar parallax. At the same time the telescope would be admirably adapted for other work. The twin instrument would be erected in the building at present occupied by the Northumberland equatorial, but a new dome, mounting, and driving clock would be required.

"The scheme sketched above has received the general sanction of the senate of the university, and the observatory syndicate are authorised to take the preliminary steps necessary to carry it out.

"The estimated cost for the new objective with the mounting, driving gear, and other adjuncts, is £2450. To this must be added £500 for the new dome, while the apparatus for measuring the photographs would cost £150. With the moderate allowance of £100 for extras, the total sum wanted is found to be £3200. The observatory syndicate have had under their consideration the means of providing this sum. There is a 'Special Sheepshanks Fund' available for the purchase of astronomical instruments for the Cambridge Observatory. This fund amounts at present to about £1500, of which about £1000 might be prudently expended. Accordingly about one-third of the money now required could be taken from the special Sheepshanks fund, whilst the remaining two-thirds would have to be raised otherwise. As the state of the university finances renders it hopeless to expect that any large sum could be forthcoming for this purpose from the university chest, it only remains to make an appeal to the public. The syndicate would therefore urge the friends of the University of Cambridge, and those interested in astronomical science, to render substantial aid in the furtherance of this project. They accordingly ask for donations towards the sum of £2200 which they have shown to be requisite for the full efficiency of the Cambridge Observatory.

Subscriptions will be received by Sir Robert Ball or by any of the following members of the observatory syndicate:—John Peile (vice-chancellor), G. G. Stokes, G. D. Liveing, G. H. Darwin, H. M. Taylor, and W. W. Rouse Ball. A list of subscriptions will be duly announced after replies to the appeal have been received.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE University Extension movement has hitherto received no assistance in the form of grants from the Government. But now that the movement is recognised as an educational power in the land it should be subsidised to a certain extent. As Prof. Stewart remarked in the course of a speech on the subject, delivered in connection with the summer meeting at Cambridge, "There was no sum of money that could be better spent by the State for educational purposes than a grant, say of £5,000 a year, to the university extension movement, because thereby they would render the £6,000,000 a year paid for elementary education so much more effective and productive, seeing that a very large proportion of university extension students were elementary school teachers." It was afterwards resolved: "That, in the opinion of this conference of university extension students, application should be made as early as possible to the Education Department for aid to university extension work, particularly for subjects not dealt with by the Technical Instruction Act."

UPRIGHT PENMANSHIP is rapidly becoming popular with the teachers and pupils in our schools, if we are to judge from the yearly growth in the number who send in copybooks to Mr. J. Jackson's annual competitions. The prize-list for 1893 just received contains four photographed specimens of prize-writing, and informs us that 1441 copybooks were sent in (as against 1121 in 1892). An eighth competition is announced for June 1894, when prizes to the amount of £60 will be awarded.

THE following is a complete list of the candidates to whom the University of London has awarded the degree of Doctor of Science this year:—Experimental Physics: Robert Wallace Stewart; Chemistry: Fredk. Daniel Chattaway and John Theodore Hewitt; Zoology: Henry Bargman Pollard; Animal Physiology: John William Pickering; Geology and Physical Geography: John Walter Gregory, William Fraser Hume, Maria Matilda Ogilvie.

SCIENTIFIC SERIALS.

Bulletin of the New York Mathematical Society, Vol. ii. No. 10. July 1893 (New York: Macmillan).—This young mathematical society crowns the previous good work of its *Bulletin*, in this, the concluding number of its second volume, by the translation and publication of Dr. Felix Klein's "programme on entering the philosophical faculty, and the senate of the University of Erlangen in 1872." It is entitled "A comparative review of recent researches in geometry" (pp. 215–249). The author prefixes a note in which he states that the programme had a limited circulation at first, with which he was then fairly well satisfied, but now that Lie's "Theorie der Transformationsgruppen" has appeared, and that an Italian translation has been published in the *Annali di Matematica*, it seems proper that a wider circulation should be given to his expositions. The translation, which is a literal one, has been admirably done by Dr. M. W. Haskell, and we feel sure that its publication will greatly extend Dr. Klein's *clientèle*. A few additional footnotes are supplied here and there. Dr. F. N. Cole continues his previous work with an article on "the transitive substitution-groups of nine letters" (pp. 250–258). He points out that Mr. Askwith (*Quar. Jour. of Mathematics*, vol. xxvi.) gives only 22 of the 34 actually existing types, and discusses the complete list of the transitive groups of this degree, with brief explanations of the processes by which he has obtained them. Prof. Ziwet gives a brief analysis (pp. 258, 9) of the "Index du répertoire bibliographique du Sciences Mathématiques, publié par la Commission permanente du répertoire" (Paris, 1893). Notes, lists of new publications, and the index complete the number.

IN the *Botanical Gazette* for July, Mr. D. M. Mottier has a paper on the embryo-sac and embryo of *Senecio aureus*; his results agree closely with those of Strasburger on *S. vulgaris*; Mr. P. Dietel describes a number of new specimens of Uredineæ and Ustilagineæ; Mr. G. F. Atkinson completes his account of the biology of the organism which causes tubercles in the roots of Leguminosæ; and Mr. C. Robertson contributes another to his series of articles on flowers and insects.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 15.—"On the Annual and Semi-annual Seismic Periods." By Charles Davison, M.A., Mathematical Master at King Edward's High School, Birmingham. Communicated by Prof. J. H. Poynting, F.R.S.

Method of Investigation.—The method adopted is similar to that employed by Dr. C. G. Knott in his paper on "Earthquake Frequency."

If $f(\theta)$ be a periodic function of θ, then

$$f(\theta) = a_0 + a_1 \cos(\theta + \alpha_1) + a_2 \cos(2\theta + \alpha_2) + \ldots a_n \cos(n\theta + \alpha_n) + \ldots,$$

from which it follows that

$$\frac{1}{\pi}\int_{\theta-\pi/2}^{\theta+\pi/2} f(\theta)d\theta = a_0 + \frac{2a_1}{\pi}\cos(\theta+\alpha_1) - \frac{2a_3}{3\pi}\cos(3\theta+\alpha_3) + \ldots + \frac{2a_n \sin\frac{n\pi}{2}}{n\pi}\cos(n\theta+\alpha_n) + \ldots.$$

This latter expression gives the mean value of $f(\theta)$ through an interval $\pi/2$ on either side of θ. From it, all terms involving even multiples of θ are eliminated, and the coefficients of all terms after the second are diminished to a greater extent than that of the second.

A definition of the unit earthquake having been adopted, the earthquakes of different districts are classified in half-monthly groups, the first half of February containing fourteen days, and of all the other months fifteen days; and the numbers so obtained are reduced to intervals of equal length (fifteen days). The numbers for the two halves of each month are added together. The mean of the numbers for the six months from November to April gives the six-monthly mean corresponding to the end of January. Six-monthly means are calculated in this way for the end of each month; each mean is divided by the average of all twelve, and the difference between each quotient and unity is multiplied by the augmenting factor 1·589, in order to obtain the correct value of the ratio $a_1 : a_0$. The curve obtained by plotting these reduced means thus gives special prominence to the annual period, by eliminating the semi-annual period and all those which are fractions of six months, and by diminishing the amplitudes of all other periods with respect to that of the annual period.

In investigating the semi-annual period, the numbers corresponding to the first halves of January and July are added together, and so on; the rest of the method being the same as for the annual period. The result gives special prominence to the semi-annual period by eliminating the annual period, and by eliminating or diminishing the amplitudes of all periods less than six months.

Seismic Periodicity in relation to Intensity.—This discussion is founded on: (1) lists compiled from Mallet's great catalogue, first, of shocks which were so slight as to be just perceptible, and, secondly, of those which were strong enough to damage buildings; (2) Prof. Milne's classification of the Japanese earthquakes of 1885 to 1889 according to the areas disturbed by them; and (3) different catalogues relating to the same district, it being obvious that two such catalogues for the same time can only differ by the omission or inclusion of slight shocks.

The following results are obtained:—(1) In both periods, the amplitude is greater for slight than for strong shocks; (2) there appear to be two classes of slight shocks with an annual period, the stronger having their maximum in winter, the weaker in summer; and (3) in the case of the semi-annual period, both strong and slight shocks, as a rule, have nearly the same maximum epochs.

Seismic Periodicity in relation to Geographical Position.—The number of records examined is 62, 45 belonging to the northern hemisphere, 14 to the southern, and 3 to equatorial countries.

1. *Annual Period.*—In every district, and in all but five records (which are obviously incomplete), there is a fairly well-marked annual period. As a rule, different records for the same district agree in giving the same, or nearly the same, maximun epoch. Excluding, however, those which disagree in this respect, we have left 34 records for the northern hemisphere, 9 for the southern, and 2 for equatorial countries. In the northern hemisphere, 4 records give the maximum in November, 16 in December, and 6 in January; in the southern hemisphere, 2 in April, 2 in May, 3 in July, and 2 in August; the end of the month being supposed in each case. As a rule, then, the maximum epoch occurs in winter in both hemispheres. The amplitude of the annual period ranges from 0·05 (New Zealand) to 0·67 (Sicily and Algeria), the average of 57 records being 0·33.

2. *Semi-Annual Period.*—Of the 62 records examined, only 3 fail to show a semi-annual period, the cause of the failure in these cases being no doubt the imperfection of the seismic record. In New Zealand and South-east Australia, the maximum epoch generally falls either in February or March and August or September; in North America, as a rule, in March or April and September or October. But for other regions it does not seem possible as yet to deduce any law. The amplitudes of the semi-annual period ranges from 0·06 (southern hemisphere) to 0·79 (Mexico), the average value being 0·24.

3. In fifteen cases, the amplitude of the semi-annual period exceeds that of the annual period. Eleven of these records include the following insular districts, which are among the most well-marked seismic regions in the world, namely, the Grecian Archipelago, Japan, the Malay Archipelago, New Zealand, and the West Indies. The average amplitude of the annual period in these eleven cases is 0·16, and that of the semi-annual period 0·24; *i.e.* the average amplitude of the annual period is just half that for all the districts examined, while in the case of the semi-annual period the average amplitudes are the same.

Origin of the Annual Period.—In this, the concluding, section of the paper, an attempt is made to show that the annual change in barometric pressure may be the cause of the annual change in seismic frequency. It would be difficult to prove that such a connection exists, but reasons are given which seem to render it in some degree probable.

1. The most probable cause of the origin of the majority of non-volcanic earthquakes is the impulsive friction, due to slipping, of the two rock-surfaces of a fault. Now, whatever be the causes of seismic periodicity, it seems probable that they are merely auxiliary, and determine the epoch when an earthquake shall take place, rather than there shall be an earthquake at all. Prof. G. H. Darwin has shown that the vertical displacement of the earth's surface by parallel waves of barometric elevation and depression is not inconsiderable, and that it diminishes at first very slowly as the depth increases. Since the fault-slip which produces even a moderately strong shock must be very small, and since the work to be done in such a case is, not the compression of solid rock, but the slight depression of a fractured mass whose support is nearly, but not quite, withdrawn, the annual range of barometric pressure does not seem incompetent to produce the effects observed.

2. Comparisons between the dates of the maximum epochs of the seismic and barometric annual periods are made in 31 of the districts treated in this paper. The seismic maximum approximately coincides with the barometric maximum in 10 districts, and follows it by about one month in 9, and by about two months in 4, districts; the other cases generally admitting of some explanation.

3. In several insular seismic districts, and especially in Japan and New Zealand, the amplitude of the annual period is very small; and, if many of the earthquakes of these districts originate beneath the sea, this should be the case; for, in the course of a year, as the barometric pressure changes, the sea will have time to take up its equilibrium position, and thus the total pressure on the sea-bottom will be unaltered.

PARIS.

Academy of Sciences, July 31.—M. de Lacaze-Duthiers in the chair.—Note on the work of M. D. Colladon, by M. Sarrau. M. J. D. Colladon, who died at Geneva on June 30, at the age of 91, was the first to transmit power to a distance by compressed air, and to utilise this power in boring tunnels. His system, proposed in 1852, was adopted in the working of the Cenis and Gothard tunnels. His name is also widely known in connection with improvements in paddle-wheels, and his celebrated investigation of the velocity of sound in the Lake of Geneva, in connection with Sturm.—Petroleum beds near Pechelbronn (Lower Alsace); exceptionally high temperatures observed there, by M. Daubrée. About twelve years ago the flooding of one of the petroleum mines of Pechelbronn by a sudden outbreak of the mineral oil suggested a substitution of boring and pumping for the laborious subterranean process, with the result that the yield was increased more than seventy times. The tertiary beds, which have an inclination of 7 or 8 per 100, are rich in gas, and the force with which the jets are projected when struck is sufficient to drench the men and produce a disturbance resembling an earthquake. It is calculated that all the sources together produce at present 80,000 kgr. of petroleum per day, and it is probable that many jets, if bored wide enough, would be capable of yielding 50,000 kgr. per day each. Some of the sources show a remarkable rise of temperature with increasing depth, reaching 1° for 7m. in one boring. This rise, contrary to the usual experience, becomes more rapid as the depth increases. M. Daubrée attributes both the occurrence of the oil and the extraordinary distribution of temperature to a particularly energetic internal activity, chemical or otherwise, of the globe at that point.—On the unequal resistance to drought exhibited by some largely cultivated plants, by M. P. P. Dehérain.—Observation of four simultaneous water-spouts at Antibes, by M. Naudin. These were observed on July 27, on the sea between Nice and Antibes. They were ranged very nearly in a straight line running east and west. The wind had suddenly veered from west to east and the water-spouts were produced at the junction of the two air-currents, and were observed to turn in a direction contrary to the hands of a watch. They lasted several minutes, gradually approaching the land, and broke on the hills near the shore.—Photography and physical observation of comet *b* 1893, made at the Juvisy Observatory, by M. F. Quénisset. A photograph was obtained by means of a Hermagis lens of 16 cm. aperture, the exposure being 40m., on July 19. The negative shows a double tail, one of them 1° long and pointing east, the other 30′ long and inclined towards the north.—An addition to the nomographic method recently described, allowing the introduction of another variable, by M. Maurice d'Ocagne.—On benzoylnicotine, by M. A. Étard.—On the fixation of iodine by starch, by M. G. Rouvier.—On the preparation of caproic and normal hexylic acids, by M. J. Tripier.—On gallate of mercury, a new antisyphilitic preparation, by MM. Brousse and Gay.—On virulent and epidemic cholera, by M. N. Gamaleia. The concentration of the nutrient medium, and the abundance of saline matter in the culture fluid gives rise to several slightly different variations of the cholera vibrio, which agree in being very much more virulent than the ordinary type. The author suspects an analogy between this fact and the observed dependance of the epidemic upon the conditions of desiccation of the soil and the level of subterranean waters.—On submarine photography, by M. Louis Boutan.—On the habits of *Blennius sphinx* and *Blennius montagui*, Fleming, by M. Frédéric Guitel.—On the cerebral nuclei of the myriapods, by M. Joannes Chatin.—Researches on the anatomy and development of the male genital apparatus of the orthopterous insects, by M. A. Peytoureau.—Anatomical characters of the stems of the Dioscoreæ, by M. C. Queva.—Development of the ground-nut, by M. A. Andouard.—On a trial of a screw for vertical propulsion, by M. Mallet. A Langlois air propeller of 2·5 m. diameter was attached to the car of a balloon of 800 m³. capacity, and worked by the muscular power of the aeronauts. During one minute the balloon was raised 100 m., sinking again to its former level on stopping the propeller.

CONTENTS.

THURSDAY, AUGUST 17, 1893.

OLD AND NEW ASTRONOMY.

Old and New Astronomy. By Richard A. Proctor, completed by A. Cowper Ranyard. (London: Longmans, Green and Co., 1892.)

As originally designed by Mr. Proctor, this work was to contain a complete account of the Old and New Astronomy, particular attention being paid to the latter portion, which he wished to make a special feature of the book. It was to be issued in twelve monthly parts, the first of which duly appeared in March 1888; but unfortunately Mr. Proctor did not live to complete what he intended to be his *magnum opus*, and at the time of his death in September 1888 only seven parts were in type and the manuscript of the chapters on the planets well advanced. Although a considerable proportion of the materials for the chapters on the new astronomy had been collected, nothing had been written for that portion of the book. Mr. Ranyard undertook to complete the work, and as we now have it five-sixths of the book deals with the ancient and old astronomy, and is due to Mr. Proctor; while the remaining portion by Mr. Ranyard deals with some of the work and problems of the new astronomy. Unfortunately the book had grown to such an enormous size that promised chapters on meteors and comets were omitted and we have the strange anomaly of a work on astronomy in which neither of these important phenomena are dealt with.

It is to be regretted that Mr. Ranyard, in finishing the book, did not attempt to draw up a list of the errata which "must inevitably occur in a work of this kind," and that he did not see fit to add in some places details of important points, the original omission of which was probably accidental. For instance, in the first chapter, which gives an account of ancient and modern methods of observing the heavenly bodies, we find it indicated that the reflecting telescope suffers from chromatic aberration (page 45); and although stress is laid on the "amazingly exact system of modern measurement" the two essential instruments, the filar micrometer and the chronograph, are not even mentioned. Later on, in dealing with spectroscopy, the diffraction grating is not dealt with, and there is no mention of the grating spectroscope. We venture to think that no work on astronomy can be considered complete in which such essentials to the proper comprehension of the subject are omitted.

In the chapters on the shape of the earth, the apparent motions of the sun, moon, and planets, the true mechanism of the solar system, and the measuring and weighing of the solar system, we find Mr. Proctor probably at his best, the subjects being treated in considerable detail, although there is very little that has not already appeared in his earlier works.

Two chapters are devoted to the sun and its surroundings, and here Mr. Proctor differs from most of the authorities on the subject. He assumes that the formation of a spot is usually preceded by the formation of a facula, although the subject is still under discussion and the weight of evidence at present is distinctly in favour of the opposite conclusion. Now that Prof. Hale has enabled us to supplement our photographic study of sun-spots by photographs of all the faculæ on the solar disc, we may shortly hope to be able to fully trace the life history of solar disturbances in particular regions of the sun, and so to obtain a firm basis for a definite conclusion in the matter. We are also told in this chapter that we are forced to the conclusion that sun-spots are produced in the main by uprushes of intensely heated vapours from below the photosphere, but the generally accepted view is that spots are due to downrushes of comparatively cool matter from the regions above the photosphere. The main objection to the view that sun-spots are due to uprushes of intensely heated matter is that the bright lines in sun-spot spectra are few, and are not those usually associated with extremely high temperature.

The interesting chapter on the sun's surroundings is marred by personalities which render it practically impossible to consider this portion of the book as dispassionate scientific work. We may mention, however one error of fact which Mr. Ranyard should have corrected. On page 408 we are told that the eclipse of 1860 is remarkable as the first in which photography was employed to secure views of the corona, whereas Majocchi, at Milan, in 1842, had unsuccessfully tried this method of observation; and Berkowski, July 28, 1851, had obtained a perfectly successful picture showing the prominences and corona.

The chapters on the planets are, as might have been expected, very full and complete, but contain little that is new or calls for special comment. The method of illustrating the seasons on the earth by a series of diagrams, showing our planet as seen from the sun at 6 a.m., midday, 6 p.m., and midnight at Greenwich, on one day in each month, may, however, be noticed as certainly an advance on the very unsatisfactory method usually found in works on astronomy. It is also interesting to note that the moon is properly considered as a planet.

In the discussion of the temperature of the lunar surface, we are told that merely theoretical considerations could be thoroughly relied upon as proving that the temperature during the lunar day exceeds that of boiling water; and Lord Rosse's measurements which indicate a temperature of fully 500° Fahrenheit, are accepted, while those of Prof. Langley, which assign a temperature below freezing point, are rejected as being affected by some unknown cause of error. Later researches by Mr. Boys have, however, confirmed Prof. Langley's results, and it would have been an advantage had Mr. Ranyard noted this in the completed volume.

In the chapters on stars and the new astronomy Mr. Ranyard gives in the beginning a full account of parallax, and presents an interesting diagram showing the distances of all stars whose parallaxes have been determined during the present century. The theories of the earlier astronomers with regard to the construction of the stellar universe are passed in rapid review, due credit being awarded to the work of Thomas Wright, of Durham, who really anticipated many of the speculations of Sir William Herschel. The various later disc, ring, and spiral theories of the Milky Way are carefully discussed and compared with the latest researches of Prof. E. C. Pickering and Dr. Gould, the whole object of the work being obviously to give a full and fair statement of fact, without regard to any preconceived ideas or theories. The distribution of nebulæ is then considered, and a careful analysis made of the many wonderful structures shown in Dr. Robert's photograph of the great nebula in Orion. The great similarity of these forms to those traceable in the Solar Corona is clearly demonstrated, and it is suggested that just as the coronal forms probably have their origin in enormous streams of gaseous matter ejected into a resisting medium, so these similar structures may be due to a similar cause. Mr. Ranyard then shows how these forms are reproduced in the arrangement of clouds of stars in the Milky Way, as shown by the marvellous photographs taken by Prof. E. E. Barnard of the Lick Observatory, excellent reproductions of which illustrate this portion of the book. A detailed examination of Prof. Barnard's plates seems to Mr. Ranyard to indicate the existence of dark-absorbing matter, "either like cold gas or fog of opaque particles in space, cutting out or dimming down the light of the region beyond." These dark patches assume the curved forms and tree-like structure already referred to, and thus seem to further confirm the idea of a resisting medium, which, as Mr. Ranyard is careful to point out, need not necessarily be a gas; dust moving in space, or meteors, or large masses would equally offer resistance.

By deliberately overprinting photographs of the Milky Way, long chains of stars and curving dark lanes have been brought into great prominence, and have materially assisted in the investigation. There is certainly much to recommend this startling suggestion of dark absorbing matter in space, and the wonderful details of Prof. Barnard's photographs, and the similarity to coronal and nebular forms, can scarcely be explained as due to accidental groupings of stars and dark spaces in the Milky Way. Although most authorities, including Prof. Barnard himself, prefer to suspend their judgment in the matter until still more photographic results are available, there can be little doubt that no more satisfactory hypothesis has as yet been advanced.

The connection between nebulæ and bright stars, and the connection of bright stars with faint ones by means of thin wisps of nebulous matter, undoubtedly indicate that differences in magnitude of stars are due to differences of physical condition and not to distance. As illustrating the far-reaching results of this conclusion Mr. Ranyard says:—

"If we assume a distance fifteen times as great as the distance of α Centauri, for a part of the Milky Way in which a first magnitude star is found to be associated with stars of the $17\frac{1}{2}$ magnitude, we must be prepared to assume a diameter for the large star twenty times as great as the solar diameter, unless its photosphere is brighter than the solar photosphere; while the smaller stars if their photospheres were as brilliant as the solar photosphere, would have diameters equal to about one-hundredth part of the solar diameter—that is, they would not much exceed the earth in magnitude."

The question of proper motion next receives attention, and this is followed by an account of binary and triple stars, most of the recent work being fully dealt with. In the discussion of stellar spectroscopy we find Secchi's classification of star spectra given to the exclusion of all others. Details of other systems might well have been introduced here, but it is evident that Mr. Ranyard considers the subject one in which very little advance towards a proper classification has been made. He is of opinion (p. 795) that the Sirian type are less condensed and are in an earlier stage than the solar type, and indicates that bright line stars must come somewhere between nebulæ and the Sirian type; but there is nothing to indicate whether he thinks this is the stage of rising or falling temperature, and the whole question is left in a vague and somewhat unsatisfactory manner.

In considering the supposed physical connection between the stars in the great nebula in Orion and the nebula itself, Mr. Ranyard relies on the fact that similar bright lines are found in the spectra of each, and quotes the photographs of Dr. Huggins as proving that these stars are physically bound up with the gaseous matter of the nebula. He himself seems inclined to the opinion that they are not condensations of the nebulæ, but are the centres from which the matter now forming the nebula was ejected; but whether condensations of the nebula or points of origin the spectra are supposed to be similar. It is important to remember, however, that it is nearly impossible to get a photograph of the spectrum of a star involved in a nebula without also obtaining a superposed spectrum of the nebula itself. Every tremor of the telescope sufficient to carry the star image off the slit will allow the nebula to imprint its spectrum on the plate, and if the star is allowed to trail along the slit it is clear that the nebula gets more exposure than the star at any particular point in the resulting photograph. There is at present no absolute photographic proof that the stars in the nebula in Orion contain the nebular lines as bright lines in their spectra, and consequently conclusions based on this assumption are untrustworthy.

Mr. Ranyard classes the nebulæ which give faint continuous spectra and do not show the characteristic green line, as white nebulæ, and places in this class the Andromeda nebula, the spiral in Canes Venatici, and the nebulous background of the Milky Way, but makes no suggestion as to the stage of development of these bodies.

On the question of "What is a nebula?" it is extremely difficult to understand the exact position assumed by Mr. Ranyard. He evidently considers nebulæ as containing solid or liquid matter and as increasing in temperature, but "the very great transparency" renders it probable that they either contain very little solid or liquid matter, or that the solid or liquid matter is aggregated into discrete masses with an average diameter of more than an inch; if the density of a nebula, leaving out of account its gaseous constituents, is as much as one one-thousand millionth of the density of atmospheric air at the sea level. These conclusions are practically an acceptance of the main idea of Lockyer's meteoritic hypothesis so far as it deals with nebulæ, although Mr. Ranyard rejects the spectroscopic evidence bearing on the point. The speculations as to the probable density of the Great Orion nebula, although extremely interesting, are vitiated by the fact that it is impossible to estimate the gravitational effect of the dark matter in interstellar space.

The book is well and copiously illustrated throughout, the plates and the photographic reproductions being of a very high-class character. Mr. Proctor's portion is written in his usual clear and popular manner, but the prevailing impression is decidedly that of disproportion. Too much space is occupied by the personalities which were unfortunately too frequently shown in his controversial methods, and by details of a comparatively unimportant character; while essentials are, as we have pointed out, frequently incompletely dealt with or even entirely omitted.

Mr. Ranyard's portion is admirably written, is very thoughtful and suggestive, and is a valuable contribution to our knowledge of the stellar universe and the condition and distribution of matter in external space. Indeed, the comparative brevity of this portion of the book is its chief fault, and a condensation of the earlier portion to allow of the expansion of this would greatly increase its value to the student, and would certainly not lessen its interest to the general reader. A. T.

EARTHQUAKES.

Erdbebenkunde. Die Erscheinungen und Ursachen der Erdbeben, die Methoden ihrer Beobachtungen. Von Dr. Rudolf Hoernes, o.ö. Professor der Geologie und Palæontologie an der Universität Graz. (Leipzig: Veit and Co., 1893.)

Étude sur les Tremblements de Terre. Par Léon Vinot. (Paris and Nancy: Berger-Levrault et Cie, 1893.)

IN a recent article in this journal, entitled "Seismology in Japan" (see NATURE, June 8, p. 136) attention was directed to the long series of memoirs which deal with the methods and results of earthquake-observation, and have appeared in the Transactions of the Seismological Society of Japan, or its successor, the *Seismological Journal of Japan.* Any advance in our knowledge of the phenomena or causes of earthquakes resulting from the study of the frequently occurring shocks in Japan is largely due to the untiring efforts of the editor of those journals, Prof. John Milne, and to those of the school of active seismologists, whom he has educated and inspired with some of his own enthusiasm. We can best judge, perhaps, how far advances of our knowledge on this difficult and obscure department of physics and geology have been real and of permanent value from the examination of text-books and general treatises, in which summaries are given of the latest and most important researches upon the subject.

The two works whose titles appear at the head of this article, and which have recently made their appearance in Germany and France respectively, may well serve the purpose of illustrating what is the high-water mark of our knowledge at the present time concerning these remarkable but little understood phenomena.

If we compare these two books with their numerous predecessors, the first peculiarity which strikes us is the classification of earthquake-phenomena, based on the supposed causes of the disturbance of equilibrium in the earth's solid crust, which have been adopted by the recent authors. While the older writers took for granted the close connexion between seismological and vulcanological phenomena, so that "earthquakes and volcanoes" were almost always discussed in the same treatise, the two works before us afford distinct evidence that this conviction has now been very seriously shaken. It is true that nearly all great volcanic outbursts have been attended by earth-tremblings; but it is equally true that some of the grandest displays of seismic energy have occurred in areas that have not at any recent period been the scenes of volcanic activity; and both the German and the French author admit the existence of great classes of seismic disturbances, which have no necessary connexion with any manifestations of volcanic energy.

Dr. Hoernes classifies earthquakes under the four headings: "Vulkanische Beben," "Einsturzbeben," "Dislocationsbeben," and "Relaisbeben." M. Vinot treats of them under the following heads:—"Tremblements de terre suivis, d'éruptions où liés directement à l'action volcanique;" "Tremblements de terre dus encore à l'action direct du feu central, mais sans manifestation consécutive du volcanisme;" and, lastly, "Tremblements de terre indépendent de l'action volcanique."

But with this recognition of the class of non-volcanic earthquakes the resemblance between these two books ceases. Dr. Hoernes commences his work with an admirable account of the speculations on the nature and causes of earthquake-phenomena which have appeared from the earliest times. His comprehensive sketch begins with extracts from the writings of Hebrew prophets and Greek philosophers, and ends with references to the Seismological Society of Japan. The two chapters which follow on earthquake-phenomena and earthquake-observation are clear and useful summaries of the most recent researches on the subject, and are well brought up to date. Supplied as they are with drawings and descriptions of seismographic apparatus, they afford one of the best guides with which we are acquainted to a general knowledge of the principles and methods of seismological investigation.

M. Vinot commences his work with a chapter on the nebular hypothesis and the proofs of the existence of central heat within the earth. He insists that, to explain the phenomena of earthquakes, it is necessary to assume the existence at a depth which certainly does not exceed "quelques centaines des kilomètres," of a mass of incandescent liquid materials, which he argues must consist of molten metals in which are dissolved certain gases. The subsequent chapters of his book are a series of deductions from these premises. It will thus be seen that the methods and plan of the German and French authors are about as diverse as can well be conceived. The German work abounds with references by means of which the student who is not satisfied with the summary statements in the text is enabled to put himself into communication with the memoirs of the original investigator whose views have been cited. The French work is simply a readable essay, in which we have none of these valuable aids to study. The illustrations of M. Vinot's book consist of several page plates, reproduced from photographs, and representing the now-destroyed terraces of Rotomahana in New Zealand and the country affected by the eruption of Tarawera but the connexion of these illustrations with the text is by no means obvious.

In two works so diverse in their plan and execution as are those before us, it is interesting to note yet another and somewhat unexpected feature which they present in common. That M. Vinot should commence his book with references to the Deluge, the destruction of Sodom and Gomorrah, and the giving of the law on Sinai, seems perfectly natural. But most readers will note with some surprise that the last chapter of Dr. Hoernes's book is one entitled "Die Sintfluth." We cannot but regard it as a remarkable testimony to the profound influence of that striking and suggestive book of Dr. Suess, "Das Antlitz der Erde," that this chapter should have been added by Dr. Hoernes to his systematic treatise on Earthquakes. It is scarcely necessary to point out that the flood to which the Austrian geologist devotes the final chapter of his treatise is the deluge, not of Sir Henry Howorth, but of Noah and Hasîs-Adra, and that the connexion between this final chapter and the preceding ones is of the very slenderest character. But the legends of our own childhood and of the childhood of our race have a fascination for us, which neither the brilliant French essayist nor the painstaking German professor seem to have been able to resist.

OUR BOOK SHELF.

The Points of the Horse. By M. Horace Hayes, F.R.C.V.S. (London: W. Thacker and Co., 1893.)

IT is certainly curious that although the English nation justly prides itself on its knowledge of horse flesh, and its success in producing the various equine breeds, it should possess no work dealing in an exact and scientific manner with the conformation of the animal that it has done so much to improve. That certain shapes are indicative of great speed, whilst others point to strength rather than speed, has, of course, always been insisted upon in a general way, but it has been left to Captain Hayes to imitate the example of several French authors, and deal with the subject in a scientific spirit. A soldier, a certificated veterinarian, a traveller, and a successful rider, the author is well qualified to treat of all that pertains to the subject before us. The work represents a painstaking endeavour to discover and explain the various principles which govern the make and shape of the horse.

Starting with a study of animals like the Indian black buck and cheetah, which possess terrific speed, he compares them with others such as the buffalo and rhinoceros, which are examples of great strength, a comparison which leads to the conclusion that animals of great strength are distinguished by a long body and short legs; those of great speed by a short body and long legs. This is an exemplification of Marey's law that muscles of speed are long and slender, and those of strength short and thick. Whether it was necessary to stray so far from home to find examples of this fact may be doubted. The thoroughbred racehorse on the one hand, and the massive carthorse on the other, are surely sufficiently contrasted types of speed and strength, whilst between the two extremes are numerous examples exhibiting the union of these two attributes in various degrees, the hunter, for example, uniting considerable strength with moderate speed.

The defects as well as many of the beauties of conformation are admirably depicted in a series of photographs, such defects as turned-in and turned-out toes, sickle-shaped hocks, and upright pasterns, being particularly good. The photographic plates, of which there are over seventy, certainly constitute an important feature in the work, embracing, in addition to the above, portraits of many celebrated racers, notably "Ormonde" and "St. Simon," as well as horses and ponies of various breeds found in different parts of the globe. A chapter is devoted to an examination of these photographs, the leading features and points of the animals represented being analysed and commented upon. It would be unfair in this connection to omit favourable mention of the 200 excellent drawings by the late J. H. Oswald Brown, which serve throughout the work to illustrate the letterpress.

Author, artist, and publisher have successfully united in producing a first-rate work, which may be cordially recommended to all lovers—and their name is legion—of the horse. W. F. G.

LETTERS TO THE EDITOR.

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

Quaternions and Vector Analysis.

IN a paper by Prof. C. G. Knott on "Recent Innovations in Vector Theory," of which an abstract has been given in NATURE (vol. xlvii. pp. 590–593; see also a minor abstract on p. 287), the doctrine that the quaternion affords the only sufficient and proper basis for vector analysis is maintained by arguments based so largely on the faults and deficiencies which the author has found in my pamphlet, "Elements of Vector Analysis," as to give to such faults an importance which they would not otherwise possess, and to make some reply from me necessary, if I would not discredit the cause of non-quaternionic vector analysis. Especially is this true in view of the warm commendation and endorsement of the paper, by Prof. Tait, which appeared in NATURE somewhat earlier (p. 225)

The charge which most requires a reply is expressed most distinctly in the minor abstract, viz. "that in the development of his dyadic notation, Prof. Gibbs, being forced to bring the quaternion in, logically condemned his own position." This was incomprehensible to me until I received the original paper, where I found the charge specified as follows: "Although Gibbs gets over a good deal of ground without the explicit recognition of the complete product, which is the difference of his 'skew' and 'direct' products, yet even he recognises in plain language the versorial character of a vector, brings in the quaternion whose vector is the difference of a linear vector function and its conjugate, and does not hesitate to use the accursed thing itself in certain line, surface, and volume integrals" (Proc. R.S.E., Session 1892-3, p. 236). These three specifications I shall consider in their inverse order, premising, however, that the *epitheta ornantia* are entirely my critic's.

The last charge is due entirely to an inadvertence. The integrals referred to are those given at the close of the major abstract in NATURE (p. 593). My critic, in his original paper, states quite correctly that, according to my definitions and notations, they should represent dyadics. He multiplies them into a vector, introducing the vector under the integral sign, as is perfectly proper, provided, of course, that the vector is constant. But failing to observe this restriction, evidently through inadvertence, and finding that the resulting equations (thus interpreted) would not be true, he concludes that I must have meant something else by the original equations. Now, these equations will hold if interpreted in the quaternionic sense, as is, indeed, a necessary consequence of their holding in the dyadic sense, although the converse would not be true. My critic was thus led, in consequence of the inadvertence mentioned, to suppose that I had departed from my ordinary usage and my express definitions, and had intended the products in these integrals to be taken in the quaternionic sense. This is the sole ground for the last charge.

The second charge evidently relates to the notations Φ_s and $\Phi_\times$ (see NATURE, vol. xlvii. p. 592). It is perfectly true that I have used a scalar and a vector connected with the linear vector operator, which, if combined, would form a quaternion. I have not thus combined them. Perhaps Prof. Knott will say that since I use both of them it matters little whether I combine them or not. If so I heartily agree with him.

The first charge is a little vague. I certainly admit that vectors may be used in connection with and to represent rotations. I have no objection to calling them in such cases *versorial*. In that sense Lagrange and Poinsot, for example, used versorial vectors. But what has this to do with quaternions? Certainly Lagrange and Poinsot were not quaternionists.

The passage in the major abstract in NATURE which most distinctly charges me with the use of the quaternion is that in which a certain expression which I use is said to represent the quaternion operator $q(\quad)q^{-1}$ (vol. xlvii. p. 592). It would be more accurate to say that my expression and the quaternionic expression represent the same operator. Does it follow that I have used a quaternion? Not at all. A quaternionic expression may represent a number. Does everyone who uses any expression for that number use quaternions? A quaternionic expression may represent a vector. Does everyone who uses any expression for that vector use quaternions? A quaternionic expression may represent a linear vector operator. If I use an expression for that linear vector operator do I therefore use quaternions? My critic is so anxious to prove that I use quaternions that he uses arguments which would prove that quaternions were in common use before Hamilton was born.

So much for the alleged use of the quaternion in my pamphlet. Let us now consider the faults and deficiencies which have been found therein and attributed to the want of the quaternion. The most serious criticism in this respect relates to certain integrating operators, which Prof. Tait unites with Prof. Knott in ridiculing. As definitions are wearisome, I will illustrate the use of the terms and notations which I have used by quoting a sentence addressed to the British Association a few years ago. The speaker was Lord Kelvin.

"Helmholtz first solved the problem—Given the spin in any case of liquid motion, to find the motion. His solution consists in finding the potentials of three ideal distributions of gravitational matter having densities respectively equal to $1/\pi$ of the rectangular components of the given spin; and, regarding for a moment these potentials as rectangular components of velocity in a case of liquid motion, taking the spin in this motion as the velocity in the required motion" (NATURE, vol. xxxviii. p. 569).

In the terms and notations of my pamphlet the problem and solution may be thus expressed:

Given the curl in any case of liquid motion—to find the motion.

The required velocity is $1/4\pi$ of the curl of the potential of the given curl.

Or, more briefly—The required velocity is $\frac{1}{4\pi}$ of the Laplacian of the given curl.

Or in purely analytical form—Required ω in terms of $\nabla \times \omega$, when $\nabla . \omega = 0$.

Solution—

$$\omega = 1/4\pi \nabla \times \text{Pot}\, \nabla \times \omega = 1/4\pi\, \text{Lap}\, \nabla \times \omega.$$

(The Laplacian expresses the result of an operation like that by which magnetic force is calculated from electric currents distributed in space. This corresponds to the second form in which Helmholtz expressed his result.)

To show the incredible rashness of my critics, I will remark that these equations are among those of which it is said in the original paper (Proc. R.S.E., Session 1892–93, p. 225), "Gibbs gives a good many equations—theorems I suppose they ape at being." I may add that others of the equations thus characterised are associated with names not less distinguished than that of Helmholtz. But that to which I wish especially to call attention is that the terms and notations in question express exactly the notions which physicists want to use.

But we are told (NATURE, vol. xlvii. p. 287) that these integrating operators (Pot, Lap) are best expressed as inverse functions of ∇. To see how utterly inadequate the Nabla would have been to express the idea, we have only to imagine the exclamation points which the members of the British Association would have looked at each other if the distinguished speaker had said:

Helmholtz first solved the problem—Given the Nabla of the velocity in any case of liquid motion, to find the velocity. His solution was that the velocity was the Nabla of the inverse square of Nabla of the Nabla of the velocity. Or, that the velocity was the inverse Nabla of the Nabla of the velocity.

Or, if the problem and solution had been written thus: Required ω in terms of $\nabla\omega$ when $S\nabla\omega = 0$.

Solution: $\omega = \nabla\nabla^{-2}\nabla\omega = \nabla^{-1}\nabla\omega.$

My critic has himself given more than one example of unfitness of the inverse Nabla for the exact expression of thought. For example, when he says that I have taken "eight distinct steps to prove two equations, which are special cases of

$$\nabla^{-2}\nabla^2 u = u,"$$

I do not quite know what he means. If he means that I have taken eight steps to prove Poisson's Equation (which certainly is not expressed by the equation cited, although it may perhaps be associated with it in some minds), I will only say that my proof is not very long, especially as I have aimed at greater rigour than is usually thought necessary. I cannot, however, compare my demonstration with that of quaternionic writers, as I have not been able (doubtless on account of insufficient search) to find any such.

To show how little foundation there is for the charge that the deficiencies of my system require to be pieced out by these integral operators, I need only say that if I wished to economise operators I might give up New, Lap, and Max, writing for them ∇ Pot, $\nabla \times$ Pot, and $\nabla .$ Pot, and if I wished further to economise in what costs so little, I could give up the potential also by using the notation $(\nabla . \nabla)^{-1}$ or ∇^{-2}. That is, I could have used this notation without greater sacrifice of precision than quaternionic writers seem to be willing to make. I much prefer, however, to avoid these inverse operators as essentially indefinite.

Nevertheless—although my critic has greatly obscured the subject by ridiculing operators, which I beg leave to maintain are not worthy of ridicule, and by thoughtlessly asserting that it was necessary for me to use them, whereas they are only necessary for me in the sense in which something of the kind is necessary for the quaternionist also, if he would use a notation irreproachable on the score of exactness—I desire to be perfectly candid. I do not wish to deny that the relations connected with these notations appear a little more simple in the quaternionic form. I had, indeed, this subject principally in mind when I said two years ago in NATURE (vol. xliii. p. 512): "There are a few formulæ in which there is a trifling gain in compactness in the use of the quaternion." Let us see exactly how much this advantage amounts to.

There is nothing which the most rigid quaternionist need object to in the notation for the potential, or indeed for the Newtonian. These represent respectively the operations by which the potential or the force of gravitation is calculated from the density of matter. A quaternionist would, however, apply the operator *New* not only to a scalar, as I have done, but to a vector also. The vector part of New ω (construed in the quaternionic sense) would be exactly what I have represented by Lap ω, and the scalar part, taken negatively, would be exactly what I have represented by Max ω. The quaternionist has here a slight economy in notations, which is of less importance, since all the operators—New, Lap, Max—may be expressed without ambiguity in terms of the potential, which is therefore the only one necessary for the exact expression of thought.

But what are the formulæ which it is necessary for one to remember who uses my notations? Evidently only those which contain the operator *Pot*. For all the others are derived from these by the simple substitutions

$$\text{New} = \nabla\, \text{Pot},$$
$$\text{Lap} = \nabla \times \text{Pot},$$
$$\text{Max} = \nabla .\, \text{Pot}.$$

Whether one is quaternionist or not, one must remember Poisson's Equation, which I write

$$\nabla . \nabla\, \text{Pot}\, \omega = -4\pi\omega,$$

and in quaternionic might be written

$$\nabla^2\, \text{Pot}\, \omega = 4\pi\omega.$$

If ω is a vector, in using my equations one has also to remember the general formulæ,

$$\nabla . \nabla\omega = \nabla\nabla . \omega - \nabla \times \nabla \times \omega$$

which as applied to the present case may be united with the preceding in the three-membered equation,

$$\nabla . \nabla\, \text{Pot}\, \omega = \nabla\nabla .\, \text{Pot}\, \omega - \nabla \times \nabla \times\, \text{Pot}\, \omega = -4\pi\omega.$$

This single equation is absolutely all that there is to burden the memory of the student, except that the symbols of differentiation (∇, $\nabla \times$, $\nabla .$) may be placed indifferently before or after the symbol for the potential, and that if we choose we may substitute as above *New* for ∇ Pot, &c. Of course this gives a good many equations, which on account of the importance of the subject (as they might almost be said to give the mathematics of the electro-magnetic field) I have written out more in detail than might seem necessary. I have also called the attention of the student to many things, which perhaps he might be left to himself to see. Prof. Knott says that the quaternionist obtains similar equations by the simplest transformations. He has failed to observe that the same is true in my *Vector Analysis*, when once I have proved Poisson's Equation. Perhaps he takes his model of brevity from Prof. Tait, who simplifies the subject, I believe, in his treatise on Quaternions, by taking this theorem for granted.

Nevertheless, since I am forced so often to disagree with Prof. Knott, I am glad to agree with him when I can. He says in his original paper (p. 226), "No finer argument in favour of the real quaternion vector analysis can be found than in the tangle and the jangle of sections 91 to 104 in the 'Elements of Vector Analysis.'" Now I am quite ready to plead guilty to the tangle. The sections mentioned, as is sufficiently evident to the reader, were written at two different times, sections 102–104 being an addition after a couple of years. The matter of these latter sections is not found in its natural place, and the result is well enough characterised as a *tangle*. It certainly does credit to the conscientious study which Prof. Knott has given to my pamphlet, that he has discovered that there is a violent dislocation of ideas just at this point. For such a fault of composition I have no sufficient excuse to offer, but I must protest against its being made the ground of any broad conclusions in regard to the fundamental importance of the quaternion.

Prof. Knott next proceeds to criticise—or, at least, to ridicule—my treatment of the linear vector function, with respect to which we read in the abstract:—"As developed in the pamphlet, the theory of the dyadic goes over much the same ground as is traversed in the last chapter of Kelland and Tait's 'Introduction to Quaternions.' With the exception of a few of those lexicon products, for which Prof. Gibbs has such an affection, there is nothing of real value added to our knowledge of the linear vector function." It would not, I think, be difficult to show some inaccuracy in my critic's characterisation of the real content of this part of my pamphlet. But as algebra is a formal science, and as the whole discussion is concerning the best form of representing certain kinds of relations, the important question would seem to be whether there is anything of *formal* value in my treatment of the linear vector function.

Now, Prof. Knott distinctly characterises in half a dozen words the difference in the spirit and method of my treatment of this subject from that which is traditional among quaternionists, when he says of what I have called dyadics—"these are not quantities, but operators" (NATURE, vol. xlvii. p. 592) I do not think that I applied the word quantity to the dyadics, but Prof. Knott recognised that I treated them as quantities—not, of course, as the quantities of arithmetic, or of ordinary algebra, but as quantities in the broader sense, in which, for example, quaternions are called quantities. The fact that they may be operators does not prevent this. Just as in grammar verbs may be taken as substantives, viz. in the infinitive mood, so in algebra operators—especially such as are capable of quantitative variation—may be regarded as quantities when they are made the subject of algebraic comparison or operation. Now I would not say that it is necessary to treat every kind of operator as quantity, but I certainly think that one so important as the linear vector operator, and one which lends itself so well to such broader treatment, is worthy of it. Of course, when vectors are treated by the methods of ordinary algebra, linear vector operators will naturally be treated by the same methods, but in an algebra formed for the sake of expressing the relations between vectors, and in which vectors are treated as multiple quantities, it would seem an incongruity not to apply the methods of multiple algebra also to the linear vector operator.

The dyadic is practically the linear vector operator regarded as quantity. More exactly it is the multiple quantity of the ninth order which affords various operators according to the way in which it is applied. I will not venture to say what ought to be included in a treatise on quaternions, in which, of course, a good many subjects would have claims prior to the linear vector operator; but for the purposes of my pamphlet, in which the linear vector operator is one of the most important topics, I cannot but regard a treatment like that in Hamilton's "Lectures," or "Elements," as wholly inadequate *on the formal side*. To show what I mean, I have only to compare Hamilton's treatment of the quaternion and of the linear vector operator with respect to notations. Since quaternions have been identified with matrices, while the linear vector operator evidently belongs to that class of multiple quantities, it seems unreasonable to refuse to the one those notations which we grant to the other. Thus, if the quaternionist has e_q, $\log q$, $\sin q$, $\cos q$, why should not the vector analyst have $e\Phi$, $\log \Phi$, $\sin \Phi$, $\cos \Phi$, where Φ represents a linear vector operator? I suppose the latter are at least as useful to the physicist. I mention these notations first, because here the analogy is most evident. But there are other cases far more important, because more elementary, in which the analogy is not so near the surface, and therefore the difference in Hamilton's treatment of the two kinds of multiple quantity not so evident. We have, for example, the tensor of the quaternion, which has the important property represented by the equation—$T(qr) = TqTr$.

There is a scalar quantity related to the linear vector operator, which I have represented by the notation $|\Phi|$ and called the *determinant* of Φ. It is in fact the determinant of the matrix by which Φ may be represented, just as the square of the tensor of q (sometimes called the *norm* of q) is the determinant of the matrix by which q may be represented. It may also be defined as the product of the latent roots of Φ, just as the square of the tensor of q might be defined as the product of the latent roots of q. Again, it has the property represented by the equation

$$|\Phi \cdot \Psi| = |\Phi||\Psi|$$

which corresponds exactly with the preceding equation with both sides squared.

There is another scalar quantity connected with the quaternion and represented by the notation Sq. It has the important property expressed by the equation,

$$S(qrs) = S(rsq) = S(sqr),$$

and so for products of any number of quaternions, in which the cyclic order remains unchanged. In the theory of the linear vector operator there is an important quantity which I have represented by the notation Φ_s, and which has the property represented by the equation

$$(\Phi \cdot \Psi \cdot \Omega)_s = (\Psi \cdot \Omega \cdot \Phi)_s = (\Omega \cdot \Phi \cdot \Psi)_s$$

where the number of the factors is as before immaterial. Φ_s may be defined as the sum of the latent roots of Φ, just as $2Sq$ may be defined as the sum of the latent roots of q.

The analogy of these notations may be further illustrated by comparing the equations

$$T(e_q) = e^{Sq}$$

and

$$|\epsilon\Phi| = e\Phi_s.$$

I do not see why it is not as reasonable for the vector analyst to have notations like $|\Phi|$ and Φ_s as for the quaternionist to have the notations Tq and Sq.

This is of course an *argumentum ad quaternionisten*. I do not pretend that it gives the reason why I used these notations, for the identification of the quaternion with a matrix was, I think, unknown to me when I wrote my pamphlet. The real justification of the notations $|\Phi|$ and Φ_s is that they express functions of the linear vector operator *quâ* quantity, which physicists and others have continually occasion to use. And this justification applies to other notations which may not have their analogues in quaternions. Thus I have used $\Phi_\times$ to express a vector so important in the theory of the linear vector operator, that it can hardly be neglected in any treatment of the subject. It is described, for example, in treatises as different as Thomson and Tait's *Natural Philosophy* and Kelland and Tait's *Quaternions*. In the former treatise the components of the vector are, of course, given in terms of the elements of the linear vector operator, which is in accordance with the method of the treatise. In the latter treatise the vector is expressed by

$$V\alpha\alpha' + V\beta\beta' + V\gamma\gamma'.$$

As this supposes the linear vector operator to be given not by a single letter, but by several vectors, it must be regarded as entirely inadequate by any one who wishes to treat the subject in the spirit of multiple algebra, *i.e.* to use a single letter to represent the linear vector operator.

But my critic does not like the notations $|\Phi|$, Φ_s, $\Phi_\times$. His ridicule, indeed, reaches high-water mark in the paragraphs in which he mentions them. Concerning another notation, $\Phi \overset{\times}{\underset{\times}{}} \Phi$ (defined in NATURE, vol. xliii. p. 513), he exclaims, "Thus burden after burden, in the form of new notation, is added apparently for the sole purpose of exercising the faculty of memory." He would vastly prefer, it would appear, to write with Hamilton $m\phi'^{-1}$, "when m represents what the unit volume becomes under the influence of the linear operator." But this notation is only apparently compact, since the m requires explanation. Moreover, if a strain were given in what Hamilton calls the standard trinomial form, to write out the formula for the operator on surfaces in that standard form by the use of the expression $m\phi'^{-1}$ would require, it seems to me, ten (if not fifty) times the effort of memory and of ingenuity, which would be required for the same purpose with the use of $\frac{1}{2}\Phi {}^{\times}_{\times} \Phi$.

I may here remark that Prof. Tait's letter of endorsement of Prof. Knott's paper affords a striking illustration of the convenience and flexibility of a notation entirely analogous to $\Phi {}^{\times}_{\times} \Phi$, viz. $\Phi : \Phi$. He gives the form $S\nabla\nabla_1 \, S\sigma\sigma_1$ to illustrate the advantage of quaternionic notations in point of brevity. If I understand his notation, this is what I should write $\nabla\sigma : \nabla\sigma$. (I take for granted that the suffixes indicate that ∇ applies as differential operator to σ, and ∇_1 to σ_1, σ and σ_1 being really identical in meaning, as also ∇ and ∇_1.) It will be observed that in my notation one dot unites in multiplication the two ∇'s, and the other the two σ's, and that I am able to leave each ∇ where it naturally belongs as differential operator. The quaternionist cannot do this, because the ∇ and σ cannot be left together without uniting to form a quaternion, which is not at all wanted. Moreover, I can write Φ for $\nabla\sigma$, and $\Phi : \Phi$ for $\nabla\sigma : \nabla\sigma$. The quaternionist also uses a ϕ, which is practically identical with my Φ (viz. the operator which expresses the relation between $d\sigma$ and $d\rho$), but I do not see how Prof. Knott, who I suppose dislikes $\Phi : \Phi$ as much as $\Phi {}^{\times}_{\times} \Phi$, would express $S\nabla\nabla_1 \, S\sigma\sigma_1$ in terms of this ϕ.

It is characteristic of Prof. Knott's view of the subject, that in translating into quaternionic from a dyadic, or operator, as he calls it, he adds in each case an operand. In many cases it would be difficult to make the translation without this. But it is often a distinct advantage to be able to give the operator without the operand. For example, in translating into quaternionic my dyadic or operator $\Phi \times \rho$, he adds an operand, and exclaims, "The old thing!" Certainly, when this expression is applied to an operand, there is no advantage (and no disadvantage) in my notation as compared with the quaternionic. But if the quaternionist wished to express what I would write in the form $(\Phi \times \rho)^{-1}$, or $|\Phi \times \rho|$, or $(\Phi \times \rho)_s$, or $(\Phi \times \rho)_\times$, he would, I think, find the operand very much in the way.

J. WILLARD GIBBS.

On Secular Variations of our Rainfall.

IN studying the rainfall of this country, it is instructive, I think, to compare a number of curves for different places, and a long series of years, all smoothed by means of five year averages. In the case of places not too far apart, one may then recognise a common type amid some diversity of detail. But it is not easy to trace such "family likeness" between *e.g.*, curves for the west of Scotland and the east of England.

The east of England curves seem to conform to the general law affirmed by Brückner for the greater part of the globe, viz. cold and wet periods alternating with warm and dry ones at intervals of about 35 years; so that, taking recent years, there was, in most places, a rainy period between 1841 and 1855, and again between 1871 and 1885, while a dry period occurred between 1856 and 1870.

In the accompanying diagram are shown two east of England curves, one for East Anglia, giving mainly the rainfall for Dickleburgh, in Norfolk, continued for about 17 years by that of Norwich (according to *British Rainfall*), the other for Boston (from the same work). These curves, it will be noted, dip down from a relative maximum in the early years, 1843 and 1847, and rise again to maxima in 1877 and 1881.

Some rainfall statistics for Oviedo were recently given in the *Meteorologische Zeitschrift* (Feb., 1892, p. 71). This is, it may be well to state, a university town in the north of Spain, capital of the province of Asturias, and about 20 miles from the coast of the Bay of Biscay. Now, the smoothed curve of this place, from 1853, has a form distinctly opposite to those just considered (as the diagram shows[1]). It rises to a maximum in 1864, goes down to a minimum in 1877, after which it rises again, reaching, perhaps, another maximum in 1887.

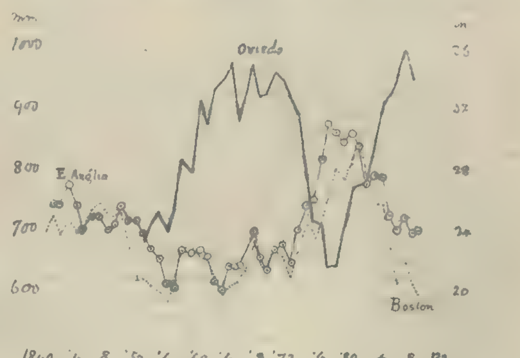
[1] The vertical scales, right and left, are not to be taken as equivalent.

This oppositeness in the variation of rainfall appears to merit attention. How is it to be explained?

One of the most interesting meteorological facts brought to light in recent years is, that the depressions which come over from the west do not take, as it were, a random course, but tend to follow, with more or less frequency, certain well-defined paths. The course of several of these paths has been indicated by Van Bebber, who has made a special study of the subject. Some of the paths are known to shift in the course of the year, having a different direction in midsummer from what they have in midwinter. And there can be little doubt, though the matter is still obscure, that the paths shift in successive years. The paths numbered IV and V by Van Bebber, are said to have shifted in the years 1879 to 1884-5 from a more maritime to a more Continental position, and Lang connects with this an observed variation in the rate of travel of thunderstorms in South Germany (see *Met. Zeits.*, Nov., 1891, p. [68], of *Literaturber*). Such shifting is very probably accompanied with variations of rainfall. Hellmann supposes this to be the reason why in Spain a year that is wet in the north-west is generally dry in the south-east, and *vice versâ*. We might, perhaps, roughly compare such variations to the case of a man watering a lawn with a garden hose, and directing the jet of spray now on one side, now on the other.

I do not know whether any suggestion of this nature is applicable to the case before us, or whether some other and better explanation may be forthcoming.

Oviedo is not, apparently, included in Brückner's data for estimating Spanish rainfall; and it is to be noted that he



regards the north of Spain as conforming to his thirty-five years law, while southern Spain is reckoned exceptional.

Brückner has two classes of exceptions: the "permanent," in which the curves are opposite to the normal (Ireland and the Atlantic islands being examples), and the "temporary," in which there is conformity to the rule, for a time; then, during some lustra, there come irregular variations. To this latter class are relegated south and middle Spain, Mediterranean France, West England, and Scotland. If Brückner's view regarding the north of Spain is correct, how comes it that the Oviedo curve has the character indicated, which is apparently that of the permanent exceptions?

In discussions on the subject of sunspot influence on weather one sometimes hears the opposite character of weather in different regions urged as a difficulty in the way of accepting such influence. Thus, in connection with a paper read by Mr. Scott to the Royal United Service Institution last year (*Journal*, May, p. 510) I find him remarking: "It is not possible to say whether or not the mere fact of our having very wet or dry weather is due to the sunspots, when our neighbours not very far off are having exactly the contrary. . . . Last summer everybody was abusing the weather because of its wetness. I myself was then living in the Black Forest, and we had four days' rain in eight weeks. Which of these conditions depended on the sunspots? Was it my fine weather or was it the rain here?"

With all deference to an excellent authority, and without offering an opinion upon the particular cases cited, it seems to me not impossible that the influence of the solar cycle might be manifested in an opposite succession of effects in different regions. Suppose, *e.g.* that in some region the rainfall in a long series of years varied, not as in the cases above considered, but in a certain regular correspondence with the sunspot curve; and in another region (perhaps further south) in opposite correspondence; also that these variations were traced to the shifting of a depression path. The opposite correspondence would obviously not be a good reason for denying sunspot influence, but rather corroborative evidence of such influence. Again, it will be admitted, I think, as conceivable that we might find certain great anticyclonic systems to vary in position or extent with the sunspot variations. Suppose, then, an anticyclone which lay over a region (*a*) at the time of minimum sunspots, were moved in a given direction, say northwards, so that it came to cover a region (*b*) at the maximum of sunspots and that it returned to *a* by the next minimum. In that case a place, *e.g.*, in the south part of region *a*, would have high barometer at minimum sunspots, while a place in the north part of region *b* would have low barometer. And at the maximum of sunspots, on the other hand, the two places would again have opposite conditions of pressure (to each other and to the first). These are some out of many aspects of the matter which seem to me to render doubtful the affirmation that if the solar cycle influences weather, it cannot produce an opposite succession of effects in different (even neighbouring) regions.

To revert, for a moment, to the shifting of depression-paths, might it not, in some cases, account for certain changes observed in the relative proportion of different wind directions? Suppose *e.g.* that, by the shifting of a path a little southwards, a place which has been for some years in its southern border comes to lie in the northern border, might it not thus come to have more easterly wind and less westerly? A. B. M.

The Non-Inheritance of Acquired Characters.

DR. WALLACE, in a letter which appeared in NATURE on July 20, asks for the opinion of naturalists as to the interpretation of certain facts bearing upon the question of the "Non-inheritance of Acquired Characters," and as I have given much thought to the subject I venture to offer my opinion.

In two papers published in *Natural Science*, vol. i. (1892), I set forth at some length a theory of heredity which has hitherto, so far as I am aware, met with no public criticism, and which I believe sets the question at rest, not by establishing the views of either of the rival schools associated with the names of Weismann and Lamarck respectively, but by showing that another interpretation is possible, and one which while fundamentally opposed to both of these makes it possible that there may be some truth hidden in the almost meaningless statements of the Weismannians and of the Lamarckians alike.

Till "heredity" is defined, and till we know exactly what we mean by "inheritance of characters" (be they "acquired" or "blastogenic"), it is useless to argue as to whether characters are "inherited" or not.

Is the word "heredity" an abstract noun, the name of a quality, a sort of magnified "family-likeness," or is it not? Those who write of heredity are too prone to speak of "heredity" as if it were a force or combination of forces producing an effect; as an "inherent tendency," to resemble parents or other ancestors which it is perhaps not unfair to compare to the "inherent tendency" of a watch to tell the time or of a weathercock to point to the south-west. There are those who even speak of it as being "latent" for a time and then, owing to some unknown cause, "springing into activity" anew and giving rise to what we call "atavism." Even "atavism" is not infrequently spoken of, as if it were of the nature of a force or combination of forces, comparable to a "latent tendency," which after lying "dormant" or "latent" for a time in a weathercock, suddenly springs into new activity and causes it to point as of old to the south-west.

It appears to me that if we once grasp the idea that "heredity" is the name of a quality, a particular kind of "likeness" or "similarity," and nothing else, we shall be saved from much useless discussion of propositions which are intrinsically almost, if not quite, meaningless.

Artemia salina is the collective name given to a large number of individuals which have certain characters in common. It would hardly seem to be necessary to suggest the probability that this possession of many characters in common is due to the action of Natural Selection; that each new individual possesses the characters in question solely by virtue of the fact that Natural Selection has led to the production of individuals possessing the power to produce, under given constant conditions, eggs, which by virtue of their constitution will develop under given conditions into adults possessing the characters which natural selection has *under those conditions* rendered nearly constant.

It has been found that this same constitution does not necessarily lead to the same series of developmental changes *under other conditions*, and that in strong brine the eggs develop into animals which, though capable of living and multiplying under those conditions, differ in form from the ancestral *A. salina*. This new form has no more right to rank as a species than has a "worker" bee whose adult form differs from that of its parent merely on account of certain conditions to which it is exposed during development.

It appears to me to be absurd to ask whether the "acquired characters" of the so-called *Artemia Milhausenii* are inheritable or not. Experiment has shown that the constitution of the species *A. salina* has so little changed that it still has the power to produce eggs which under one set of conditions develop into *A. salina* and under another set of conditions into *A. Milhausenii*. The average constitution of the species has not varied: it still produces ova which will develop into either *A. salina* or *A. Milhausenii*, according to the conditions to which it is exposed. If we look upon the species as a whole, it is not too much to say that it exhibits *no acquired characters*. If bred in strong brine the individuals of many generations are alike, having been moulded by like influences, intrinsic as well as extrinsic. If the extrinsic influences change, new individuals differ from the old ones, simply because the constitution of the individuals as well as that of the species is such that under the new conditions the developmental changes occurring differ from those which would have occurred under the old conditions.

Whether this is true of all species and under all conditions consistent with life and multiplication, or is not true of some, is a matter for experiment, and can never be decided by argument. The experiment has been made by nature, and also by man in the case of *Amblystoma*, and with a result in exact conformity with the result in the case of *Artemia*.

The experiment has also been made with *white mice* in Freiburg, and it has been conclusively shown that under constant conditions the characters of successive generations are constant. One element of the environment in one series of cases was Prof. Weismann armed with tools for amputation of the the tails of the young mice, *plus* a determination to amputate those tails. So long as this remained a constant factor in the environment, so long and no longer did the taillessness of the adult mice remain a constant character of the species.

The Texan species of *Saturnia*, so long as the exclusive supply of *Juglans regia* is a constant factor in the environment, may or may not have a constant group of characters. That is a matter for experiment; but innumerable experiments, called collectively "domestication," have shown that whatever effect changes of certain details of the environment—such as food—may have, the suspension of natural selection will in the long run lead to inconstancy of all those characters which are relieved from its restraining influence.

If anything has ever been rendered certain in biology by prolonged experiment and observation, it is the fact that specific characters are maintained constant *by selection and by that alone*. Long continued selection—natural or artificial—may produce a seeming constancy of characters (*which we call "heredity"* !), but in the long run this constancy will vanish when the particular selection which has induced it has been suspended for a sufficiently long period.

The discusssion upon the "Inheritance of Acquired Characters," though it has led to many valuable results, has been throughout little more than a quibble, for in the whole discussion, so far as I am aware, the meaning of the word "inheritance" has never been defined. Most of the disputants appear to use the term as the name for the action of a force or combination of forces, which some have called "heredity"—a force or influence—either simple or complex—of which it is perfectly safe to deny the existence. There is no such *thing* as heredity—heredity is only a quality, a likeness or similarity, and nothing more. That likeness of characters is simply and solely due to the likeness of the influences which have produced the like characters, and pre-eminent amongst those influences is natural selection, though *every* factor of the environment has also had its part to play. So long as those like influences—

extrinsic and intrinsic—remain like, so long and no longer do their effects remain constant. What effects a change in those influences may produce experiment and observation, and these alone can determine.

For thousands of generations certain characters, such as blindness and winglessness, and enormous size of head and of jaws, and complete absence of all power of multiplication either direct or indirect, either sexual or asexual, have remained constant in "soldier" termites. No soldier termite has any marked resemblance to any one of its ancestors. Yet each is like every other "soldier," and that likeness is "heredity." Its characters have not been "transmitted," for no ancestor ever possessed them. Like conditions in successive generations lead to like results, one of which is the production of a fairly constant proportion of neuter "soldiers" and "workers" devoid of any power of reproduction. Those "like conditions" include a constant, or nearly constant, structure of the males and females, albeit the polymorphism extends to these also. The recurrence of tho e like conditions has been determined by natural selection, and is still maintained by natural selection. To apply the term "transmission" in such a case would be not more absurd than in any other case, supposing the word to be used in its literal sense, for, though the soldier in every case derives its characters from a line of ancestors extending back to remote periods, not one ancestor in which line has possessed those characters; yet their geographical distribution at the present time shows that the characters of "soldiers" are of remote antiquity. This constancy of characters in many generations appears to be identical with the phenomenon called "inheritance."

Heredity then is a likeness of effects due to likeness in the causes producing them. The likeness of causes has been produced and maintained by natural selection acting under fairly constant conditions. "Inheritance" is a name given to the operation of an influence which has no existence in nature. The sooner we cease to use the word altogether the better it will be for our science.

"Inheritance of acquired characters" is a mere chain of words correlated with a chain of loose ideas, but not correlated with any natural objective phenomenon. To assert it as a fact is as futile as to deny it. C. HERBERT HURST.

Owens College, Manchester, July 26.

Echinocyamus Pusillus.

MAY I direct your attention to a rather serious error contained in the review of Théel's paper on *Echinocyamus pusillus*, which appeared in your number for August 3?

Your reviewer states that "not the least brilliant and far-reaching" of the advances in our knowledge of Echinoderm morphology, made in the year 1891, is the discovery by Brooks and Field of the primary bilateral symmetry "of the water-vascular system" of Asterias.

Had such a discovery been really made, it would no doubt have justified the epithet applied to it by your reviewer; but, in the first place it was not made, and in the second Metschnikoff long ago pointed out such a primary bilateral symmetry in the embryos of *Amphiura squamata*.

Field's paper, containing the results of his own and Brooks's work, appeared in the *Quarterly Journal of Microscopical Science* for 1892. In it he gives an account of the development of the larva of Asterias; but in the oldest stage which he describes *there is not as yet a trace of the water-vascular system.* He describes, it is true, in larvæ of a certain size a right as well as a left madreporic pore; but as all "echinologists," it is to be hoped, know by this time, the pore is primarily related to the cœlom, and only secondarily enters into connection with the water-vascular system. Further, Field distinctly states that cases of a double pore had been observed previously by continental zoologists, but regarded by them as pathological; and the chief point in Field's paper is the very probable theory put forward by him that such cases constitute a distinct stage in the ontogeny of the animal. E. W. MACBRIDE.

Zoological Laboratory, New Museums, Cambridge, August 5.

ON referring to my draft notes, which I happen to have kept, I find in place of the words "water-vascular system," quoted by your correspondent, "pore canal system"; and I do not deny that I should have done better had I transcribed them unchanged. I fail at the same time to see that the "error" complained of is, in its place, as serious as my critic would imply. No one who attempts to do his duty by the colossus of biological literature would fail to be familiar either with the work of the authors whom he cites, or with his own recent beginning in a kindred direction. Admitting the claims of one and all, the work of Field appeared to me to put the probability at stake upon a much firmer basis than that of his predecessors, and it was for that reason that I emphasised it. If I err not, a journalistic notice is not a thing to be hampered with names and details, especially when written with the dual object of directing attention to a really admirable monograph, and of endeavouring to promote an amicable spirit of brotherhood among workers in science, such as we to-day very much need. THE WRITER OF THE NOTICE.

The Supposed Suicide of Rattlesnakes.

THE letter of Mr. Edward S. Holden on this subject is extremely interesting. It appears that he, like other individuals who have imagined that they have witnessed the suicide of scorpions, has fallen into the error (so common in the interpretation of biological as distinguished from abiological phenomena) of stating his inferences and beliefs as though they were observations. The "instance which occurred before my eyes" (to quote his words, which remind one of the old herbalist, Gerard) was simply that of a snake biting itself when imprisoned in a jar of water. That the blow was "deliberate," "intentional," and of "suicidal purpose" is pure speculation—and nothing occurred before Mr. Holden's eyes to warrant his entertaining such a notion. Had Mr. Holden been aware that the poison of the rattlesnake has little or no effect upon another rattlesnake, nor upon the individual from which the poison is furnished, he would probably have been less ready to conclude that the bite was one of suicidal purpose. He would then perhaps have inquired as to the depth to which the bite penetrated into the tissues of the snake, and how far such a superficial bite as a snake can inflict upon a part of its own body is likely (in the absence of any poisonous action) to be seriously injurious to the snake.

In this case, as in that of the scorpion confined in a fiery circle (experimentally studied both by myself and by Prof. Bourne, of Madras, and reported on in the Proceedings of the Linnean Society and the Royal Society) the spasmodic struggles of an animal artificially confined and tortured, have been, as we clearly demonstrated, mistaken for efforts at self-destruction. The biting of its own body by the snake may be justly compared with the "biting the dust" attributed to men who die in hand-to-hand struggle, or to the biting of their own hand or arm by unhealthy children when suffering from a paroxysm of anger. E. RAY LANKESTER.

Oxford, August 11.

Imitation or "Instinct" by a Male Thrush?

ON the evening of July 19 a young thrush was caught in my conservatory and placed in a large outside aviary. The following morning I observed the parent birds feeding the young one through the bars with worms. In the same aviary there had been for more than ten years a male thrush which had been captured when quite young and had never been mated or troubled with family cares. On observing the parents of the young bird feeding their offspring he at once followed their example. On putting some bread and milk into the aviary he flew down, took up a piece and tried to induce the young bird to open its beak. At first the young thrush appeared to be afraid of accepting food from the foster-father, but after some persuasion it allowed itself to be fed with bread and milk, hemp seed, and other food. The parent birds were watching from the outside, and during the whole time occupied by the old male in feeding their progeny were also trying to introduce food through the bars The day after (July 21) the parent birds did not make any further attempt to introduce food, but contented themselves by watching their young one from a tree close at hand. If any of the house-cats approached the aviary the parents would at once give the alarm. In the course of another day or two they abandoned the young one entirely to the care of the old foster-father, who has proved quite worthy of his trust, as the young bird is now able to feed himself and is in a very thriving condition. The old male still insists, however, on giving it any delicate morsel he may find. This observation appeared to me to be of sufficient interest to record in your columns, as the old male bird certainly in this case learnt how to feed the young one by observing the proceedings of the parent birds. He had never reared any young ones of his own, and had never had any opportunity of seeing other families brought up in the aviary. E. BOSCHER.

Belle Vue, Twickenham, Aug. 1893.

Intrusive Masses of Boulder-clay.

THE letter of Messrs. Graham Officer and Lewis Balfour upon the glacial deposits of Bacchus Marsh suggests the desirability of uttering a word of caution against the assumption that boulder-clay intercalated between two beds of rock is necessarily of intermediate age. I have repeatedly observed *intrusions* of boulder-clay into the triassic sandstones of Lancashire and Cheshire, but never so striking an example as that described by Mr. Arthur R. Dwerryhouse in the current number of the *Glacialists' Magazine*. In his paper and the accompanying plate he shows how a series of glacial and triassic deposits were displayed in a trench in such a way as to give the impression that they were interbedded, sandstone being both below and above the glacial deposits. A minute examination established the fact that the drift deposits had been thrust in amongst the older rocks along a line of weakness due to the presence of a bed of marl. The intrusion had penetrated to a distance of *fifty yards* from the outcrop of the marl-bed.

I do not suggest that Messrs. Officer and Balfour have been misled by such an appearance, but merely warn geologists in general against falling into error.

We have heard much of late of floods and other catastrophes, even from geologists possessing a considerable intimacy with the phenomena of the British drift deposits. It would be interesting to learn in what way these injections of glacial sludge would be explained by the advocates of deluges.

PERCY F. KENDALL.

Yorkshire College, Leeds, August 14.

A Peculiar Discharge of Lightning.

I SHOULD like to add to the many recent accounts of lightning discharges the following particulars of which I have not yet seen any published account.

On the afternoon of Wednesday, July 26, during a storm at about 5.30, a blue flame was observed by some of the inhabitants of Epping to approach and shatter the chimney of a house upon the hill, occupied by Mrs. Brown and family at the time.

An examination of the interior of the house shows the discharge to have passed chiefly by the bell wires, which are fused, down one corner of a room upon the upper floor, breaking the back of a chest of drawers near, and setting the wall in the vicinity on fire.

On the ground-floor the discharge seems to have taken two paths to earth, viz. down the corner of a front room by means of some metallic damp-proof paper, and in the kitchen adjacent by means of some wooden cupboards, the doors of which were much broken and thrown across the room.

Mrs. Brown, who was seated in the front room, states that a few seconds before the house was struck she noticed what appeared to be a darkened space, surrounded by a crimson fringe of flame in the corner (perhaps a brush discharge), and her son in the kitchen at the time testifies to having seen a similar thing previous to what appeared to be the bursting of the luminous mass, which occurred with a loud report, filling the house with smoke and the usual accompanying smell of ozone. The walls are much damaged, and the polarity of a small compass in a drawer of a sideboard nearest the path of discharge was reversed. I considered the apparent forewarning of the brush discharge of sufficient interest to justify this letter.

WILLIAM BREW.

Electric Light Department, British Museum, August 8.

The Mean Density of the Earth.

IN a note in your issue of August 10, adding to the list of values for the mean density of the earth, which you gave on July 27, it is stated that Jolly and Poynting obtained the value 5·58. This is, I believe, the value obtained by von Jolly, but my final result, as published in the Philosophical Transactions for 1891, is 5·493.

In any account of recent work on this subject I think von Sterneck's experiments at Pribram and Freiberg deserve notice. These were made in the years 1882–5, and were pendulum experiments of the Harton Pit type. The method of comparing the times of swing of the pendulums below and at the surface was, I believe, quite new, and consisted in determining the coincidences with the same clock, which gave simultaneous half-second signals at the two stations by means of an electric circuit. The results unfortunately tend to confirm the conclusion which had, I think, been already drawn from Airy's work—that the mine method of experiment, though it may add to our knowledge of the constitution of the surface strata, is useless in determining the mean density of the earth.

Major von Sterneck's papers are published in the Proceedings of the Militär-Geographisches Institut of Vienna.

Pensarn, Abergele, August 12. J. H. POYNTING.

The Grouping of Stars into Constellations.

CAN you or some of your readers kindly give me an answer to the following questions, or tell me where I may obtain information on the subjects?

Did the Assyrians, Egyptians, Greeks, and Persians group the stars in the same manner into constellations? In cases where they did so were the constellations usually named by all the nations after the same animals?

How were the constellations, which we call after Greek heroes, named by Assyrians and Egyptians?

Do the different races of the present day, Chinese, Polynesians, Hindoos, Negroes, Americans, &c., each group the stars in a peculiar way?

If each race has its own plan of grouping the stars can we make use of this peculiarity in ascertaining the affinity of various races and nations? M. A. B.

Terriers Green, High Wycombe, August 11.

Numerous Insects Washed up by the Sea.

HAVE any of your correspondents mentioned the following fact? For the last two days, August 8 and 9, the shore at Dymchurch, Kent, and for more than two miles towards Hythe, was covered with countless quantities of winged ants washed to the shore by the waves. At low tide one sees three or four rims, so thick that each makes a black stripe, from two to three inches wide, running without interruption for more than three miles, and probably extending to a greater distance. We have had during these days winds from the north-east, very light on Tuesday morning, but strong since that.

Dymchurch, Kent, August 10. SOPHIE KROPOTKIN.

A Substitute for Ampère's Swimmer.

IN NATURE of July 27 Mr. Daniell gives a substitute for Ampère's swimmer. In Denmark we use the following simple rule given by Prof. Holten at least twenty years ago. The outstretched right hand is put in the current with the palm turned toward the magnet and the fingers in the direction of the current. Then the north-seeking pole will be moved in the direction of the thumb. HANNA ADLER.

Copenhagen, August 3.

A Correction.

IN my paper on "The Chatham Islands: their relation to a former Southern Continent," just issued among the Supplementary Papers of the Royal Geographical Society, vol. iii., there occurs a slip in the third and fourth lines from the foot of page 9, which I should feel obliged by your kindly allowing me to correct in your columns. My attention has been called to it by Prof. Newton, of Cambridge. In quoting from his and Sir Edward Newton's observations in the appendix to Captain Oliver's voyage of Leguat, as to the "now submerged Continent," of which Rodriguez, Mauritius, Bourbon, and Madagascar are, according to them, the existing fragments, I inserted the words "named *Lemuria*, by Dr. Sclater" after the word "continent." These words of mine should have occurred within square brackets, the absence of which was, I regret, overlooked in the proof. "Now the old land-connexion," writes Prof. Newton, "of the Mascarene Islands with Madagascar, of which we spoke as probable, is not at all necessarily the same thing as 'Lemuria,' which Mr. Sclater supposes to have reached some of the Malayan countries."

61, Glebe Place, Chelsea, S.W. HENRY O. FORBES.

THE ASTRONOMICAL HISTORY OF ON AND THEBES.

II.

IN relation to the extract from Brugsch, given in the last article, to the effect that there was one series of monuments with its starting point in the Delta, it must be emphatically stated that the results obtained from these monuments, studying them from the astronomical point of view, leads to a very different conclusion. Instead of one series there are distinctly two, absolutely dissimilar astronomically, and instead of one set of temple-builders going up the river there were two sets: one going up the river building temples to north stars, the other going down building temples to south stars; and the two streams practically met at Thebes, or at all events they were very fully represented there.

The double origin of the people thus suggested on astronomical grounds may be the reason of the name of "double country," used especially in the titles of kings, of the employment of two crowns, and finally of the supposed sovereignty of Set over the north, and of Horus over the south divisions of the kingdom.[1]

With regard to the start point of the temple-builders who came down the river, there is no orientation evidence, for the reason that there is little or no information from the regions south of Naga. At Naga (lat 16° 18′ N.), Meroë (lat. 16° 55′ N.), Gebel Barkal and Nuri (both in lat. 18° 30′ N.), there is information of the most important kind, but beyond Naga there is a gap; but since important structures were erected at the places named in, I think, early times (3-4000 B.C.), it is probable that the peoples who built them stretched further towards the equator.

With regard to the southern limits of Egypt in the time of Thotmes, it is supposed that the south frontier Kali of the inscriptions is probably connected with Koloë in 4° 15′ N. lat. according to Ptolemy.[2]

The authority for the general statement I have made rests upon the probable dates I have found for the first foundations of the temples of both series (N. and S. stars) which I have investigated, and here I must re-state that in almost every case that foundation precedes the generally-received date, which generally has reference to a stone building; while in all probability the first structure was a brick shrine merely, and in support of this view I may state that the looking after ruined shrines was recognised as one of the duties of kingship.

"I have caused monuments to be raised to the gods; I have embellished their sanctuaries that they may last to posterity; I have kept up their temples; I have restored again what was fallen down, and have taken care of that which was erected in former times."[3]

Not only did Thotmes III. find the original temple of Amen-Rā built in brick, but he found the temple at Semneh in brick also, and he rebuilt it in memory of Usertsen III.[4]

I have prepared a table which it is not necessary to give in this place. I bring together the foundation dates I have found most probable, bearing the above and many other considerations in mind. The dates are, of course, only provisional, since local data are in many cases wanting. Where no information is forthcoming as to the height of the horizon visible along the temple axis, I have assumed hills 1° high.

The following general conclusions may be drawn from the table:—

I. At the earlier periods there are well-marked epochs of temple-building revealed by the table.

II. The temples to the north stars, α Ursæ Majoris and γ Draconis, begin in the Delta.

III. The temples erected to the southern stars (α Centauri and Phact) begin at Gebel Barkal, Philæ, and Thebes almost simultaneously.

IV. The first north star temples for the worship of Set and Ptah were erected between 5400-4200 B.C. The series is then broken till about 3500.

V. The first south star temples (Phact at the summer solstice and α Centauri at the autumnal equinox), begin about 3700 B.C.

VI. γ Draconis replaces α Ursæ Majoris at Denderah, and north star temples are for the first time erected in the south at Karnak and Dakkeh in 3500 B.C.

VII. For the first time about 3200 B.C., N. and S. star temples are built simultaneously.

VIII. After this the building activity is chiefly limited to temples to southern stars.

If we take Brugsch's dates, we find that the foundations of the greatest number of temples were laid about the time of Seneferu, Pepi, and the twelfth dynasty. The more modern kings founded few temples, their function was that of expanding, restoring, and *annexing*. Even Thotmes III. seems to have laid no new foundations except perhaps that of the Ptah temple at Karnak, and that is doubtful.

This after all is not to be wondered at. Three thousand years of observations at least had shown that the stars were not to be trusted to fix a festival day, and the true astronomical user of the ancient temples had quite passed away. Still the ancient shrines were there, what more natural then, than to embellish them? The priests, by insisting upon the vague year had reserved to themselves a perfect means of hiding all festival difficulties for once in 1460 years; the old star would rise on the proper day of the Egyptian month, although it would be no longer visible in the temple. Indeed it is extremely probable that we have here the real reason of the priestly action. They were not fools, and they could, one would think, have had no better reason than this.

The wonderful Hall of Columns called Khu-mennu (splendid memorial), in the temple of Amen-Rā, was dedicated by Thotmes III. not only to Amen-Rā, but to his ancestors. It is interesting to note who these were in the present connection. I give them with Brugsch's dates.[1]

	B.C.
Seneferu	3766
Assa	3366
Pepi	3233
The Antefs	2500
The most famous sovereigns of the twelfth dynasty	2433—2300
30 princes of the thirteenth dynasty	2233

Of these ancestors, the first limited himself to southern temples, the majority, built near Pepi's time, were south temples. The twelfth dynasty was more catholic.

The more we continue it, the more interesting does this inquiry into the north star temples as opposed to the south star temples become.

These considerations are not limited to the temples, they apply also to pyramids.

At Gizeh we find both temples and pyramids oriented east and west.

At Gebel Barkal, Nuri, and Meroë in Upper Egypt, we find both temples and pyramids facing south-east, and at the former place, where both exist together, we find well-marked groups of pyramids connected by their orientations with each temple.

In the following tables I give the values for Meroë, Nuri, and Gebel Barkal:—

[1] Brugsch, "History," p. 6. [2] Brugsch, "Egypt," p. 184.
[3] Inscription of Thotmes III., translated by Brugsch, "Egypt," p. 188.
[4] Brugsch, "Egypt," p. 184.

[1] Brugsch, "Egypt," p. 180.

Meroë.[1]

Cult.	Magnetic Azimuth.	Astronomical Amplitude.	Decl.
Pyramid 16	N. 102° E.	3½° S. of E.	S. 3¼°
Pyramid 20	N. 103 E.	4½ S. of E.	S. 4¼
Temple near Wasser Becken	N. 112 E.	13½ S. of E.	S. 12¾
Pyramid 15	N. 112 E.	13½ S. of E.	S. 12¾
Pyramids 14, 37 ...	N. 113 E.	14½ S. of E.	S. 13¾
Pyramid 10	N. 116 E.	17½ S. of E.	S. 16¾
Pyramid 39	N. 118 E.	19½ S. of E.	S. 18¾
Pyramid 19	N. 83 E.	15½ N. of E.	N. 14¾

Nuri.[2]

Cult.	Magnetic Azimuth.	Astronomical Amplitude.	Decl.
Pyramids 10, 11, 12	N. 136° E.	37½° S. of E.	S. 35¼°
Pyramids 1, 4 ...	N. 137¼ E.	38¾ S. of E.	S. 36¼
Pyramids 13, 14, 15	N. 139 E.	40½ S. of E.	S. 38
Pyramids 2, 3, 16, 17	N. 145½ E.	47 S. of E.	S. 43¾
Pyramids 5, 6, 7, 8, 9	N. 146½ E.	48 S. of E.	S. 44¾

Gebel Barkal.[3]

Cult.	Magnetic Azimuth.	Astronomical Amplitude.	Decl.
Temple E	N. 132° E.	33½° S. of E.	S. 31½°
Pyramid 18	N. 132½ E.	34 S. of E.	S. 32
Temple L	N. 136½ E.	38 S. of E.	S. 35½
Pyramids 9, 13 ...	N. 136 E.	37½ S. of E.	S. 35¼
Pyramid 11	N. 140 E.	41½ S. of E.	S. 39
Pyramid 1, 2	N. 141 E.	42½ S. of E.	S. 39¾
Temples J and H ..	N. 145 E.	47½ S. of E.	S. 44¼
Pyramid 20	N. 146 E.	47½ S. of E.	S. 44¼
Pyramids 2, 15, 16, 17	N. 147 E.	48½ S. of E.	S. 45¼
Temple B...	N. 152 E.	53½ S. of E.	S. 49¾
Pyramids 5, 6, 7, 8, 10	N. 153 E.	54½ S. of E.	S. 50½
Pyramid 19	N. 156 E.	57½ S. of E.	S. 53
Temple A	N. 170 W.	88½ S. of W.	S. 71¼

It seems quite justifiable from the above facts to conclude that the pyramids and temples oriented S.E. and, as I hold, to α Centauri when it heralded the autumnal equinox, were not built by people having the same astronomical ideas, worships, and mythology as those who built at Gizeh due E. and W., and marked the autumnal equinox by the heliacal rising of Antares.[4] The only thing in common was noting an equinox, and so far as this goes we may infer that neither people dwelt originally in the Nile Valley, but came by devious ways from a country or countries where the equinoxes had been made out. J. NORMAN LOCKYER.

[1] For plans see "Lepsius," vol. ii. 133 and 134. A west variation of 8½° has been assumed.

[2] For plans see "Lepsius," vol. ii. 130. A west variation of 8½° has been assumed.

[3] For plans see "Lepsius," vol. ii. 125 and 127. A west variation of 8½° has been assumed.

[4] There is a point of great interest here It would seem from Captain Lyons' examination of the temples at Wady Halfa, which I make out to have been oriented to α Centauri, that when the two races were amalgamated in later times, both the stars to which I have referred as heralding the equinox were personified by the same goddess Selk

APPARATUS ILLUSTRATING MICHELSON'S METHOD OF OBTAINING INTERFERENCE BANDS.

IN the *American Journal of Science* for August, 1881, Captain Michelson described an ingenious method for producing interference bands, used by him in determining the relative motion of the earth and the luminiferous ether. Light from a lamp at a falls on a thinly silvered mirror b, where it divides into two rays—one, $b\,c$, reflected from the thinly silvered surface, is reflected back to b by the plane mirror c; the other ray traverses the glass plate b, and falls on the plane mirror d, whence it is reflected back to b. Here both rays reunite, and pass onward toward e. The mirrors d and c are silvered and polished on their front surfaces. By this means bands, similar to Newton's rings, are obtained between the mirror c and the reflection of d in b; the retardation of one ray with respect to the other being the length $bc-bd$; f is an unsilvered piece of plane glass, cut from the same piece as b, and placed in the ray $b\,c$, so as to compensate for the ray $b\,d$ passing twice through b; otherwise, owing to the dispersive power of the glass in b different wave-lengths of light in the ray $b\,d$ would be unequally retarded in comparison with the same wave-lengths in the ray $b\,c$. If the path $b\,c$ be now equalised in length with the path $b\,d$, and if, moreover, the piece of glass f be exactly equal and parallel with b, the central band will be black, owing to the ray

FIG. 1.

$d\,b$ being reflected from the rarer medium, whilst $a\,b$ is reflected from the denser medium.

Apparatus to show these bands can be easily and cheaply set up, and owing to the fact that an extended source of light may be used, they can easily be projected, and thus many interesting experiments shown to a large audience. The following is a description of a simple construction of the apparatus which I have found to work admirably.

All the parts are mounted on a piece of plate-glass ¼″ × 9″ × 12″. The two mirrors d and c, each two inches square, were silvered by the milk-sugar process, and afterwards polished with washleather and rouge in the ordinary manner. The mirror b was withdrawn from the silvering solution when only a thin layer had been deposited; no polishing was necessary. The layer of silver should reflect considerably more than half the light incident upon it, as thus the reflections from the unsilvered surface of b become relatively insignificant. Ordinary plate-glass was used in each instance.

Each mirror was attached vertically by pitch to a stand composed of two pieces of band brass soldered together at right angles, having three feet a, b, c (Fig. 2). In the case of the glasses b, f, and c (Fig. 1), a screw of pitch $\frac{1}{20}$″ was inserted in c (Fig. 2) as a rough adjustment for verticality of the mirror.

The mirrors b and f were maintained in position[1] by the conical foot a (Fig. 2) standing in a cylindrical hole in a blank which was stuck to the glass bed-plate by pitch, b resting simply on the surface of the glass, whilst the foot c stood in a V-groove in a brass blank, also stuck by pitch to the glass bed-plate. The fine adjustments required are for c (Fig. 1) a motion in the direction cf, and for d, adjustments in altitude and azimuth. These were respectively obtained by placing the two feet b and c (Fig. 2) (which should be rounded) of the mirror c (Fig. 1) in a long V-groove (a piece of angle brass was used),

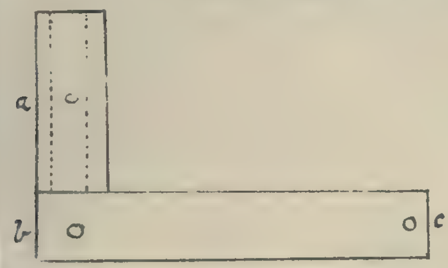


Fig. 2.—The dotted lines indicate the position of the mirror.

the third foot resting on the glass surface; the foot c was held against a screw passing, in the direction of the groove, through a brass blank soldered at the end thereof, which gave the longitudinal motion required for that mirror. By means of a lever of 18″ or so in length attached to it, a piece of steel wire, with a thread cut by means of stocks and dies of 40 to the inch, was found capable of adjusting to a quarter of a wave-length of light. The adjustments of the remaining mirror d (Fig. 1) were obtained by allowing the conical foot a (Fig. 2) to rest in a cylindrical hole, whilst the foot b rested on the glass as in the

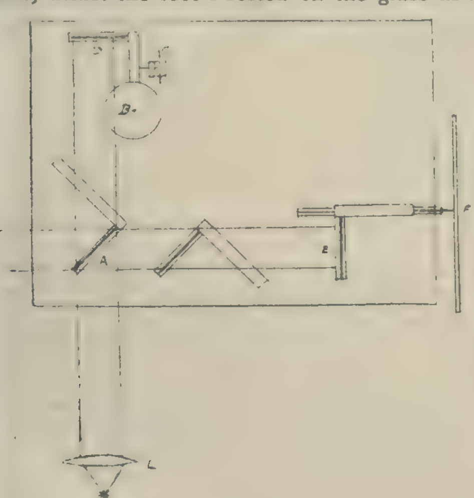


Fig. 3.

mirrors b and f (Fig. 1). The leg c (Fig. 2) was formed of a piece of steel wire with a screw thread cut as described above, with a large brass blank soldered to its upper end; this gave the adjustment in altitude. The adjustment in azimuth was obtained by holding the horizontal piece of band brass b c by means of a piece of elastic against the end of a screw of similar pitch to that last described, passing through a vertical pillar attached to the base-plate. The whole arrangement is shown in Fig. 3.

To avoid the effect of vibrations the whole may be supported on a block of stone, resting, in its turn, on hollow india-rubber balls; a plan adopted successfully by Dr. O. Lodge. When mounted in this manner the bands may be shown in a room possessing only an ordinary wooden flooring.

The bands are obtained as follows: A bat's-wing burner, or other source of white light, is placed at the focus of the lens L (Fig. 3) and arranged so as to illumine the mirror A. A card with a pinhole in it is then placed in front of the lens L, and, on looking in the direction M A, two images of this will be seen. By means of the screws B and C these two images are superimposed; and the distance A E having been adjusted by means of the screw and lever F and a steel scale, to be equal to A D, a sodium flame is placed in the focus of L and the pinhole card removed; the sodium bands will at once appear. By means of the screws B and C these are adjusted to a convenient width, and then, the bat's-wing burner having been replaced in the focus of L, the lever F is turned very slowly till the coloured bands appear. This can be done much more easily by placing a piece of platinum wire holding some sodium into the flame,

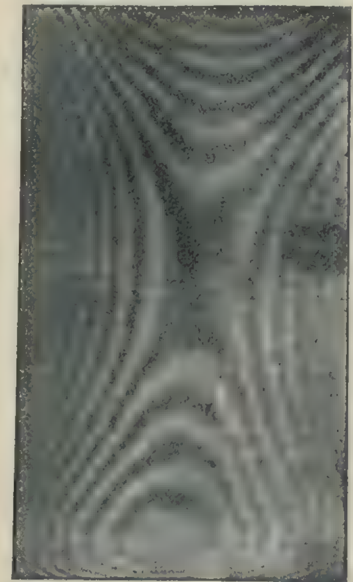


Fig. 4.—Photograph of interference band showing *cold* match.

when the bands due to the sodium will be faintly outlined on the white background, thus giving a guide as to whether or no you are turning the screw F too fast. The bands appear on the surface of the mirror E, and if an electric arc or a mixed gas limelight jet be substituted as the source of light, they can be projected on a screen so as to be visible to a large audience.

The forms of these interference bands, supposing each of the four pieces of glass to be perfectly plane and parallel, is given by Michelson (*Phil. Mag.* April 1882). The peculiar form of the bands obtained in my apparatus is shown in Fig. 4; this form is due to the curvature of the surfaces of the various glasses. A thin piece of glass or a soap film may be introduced into one of the paths and the displacement of the bands exhibited. But perhaps the prettiest experiment is to introduce the glowing end of a match into one of the rays. Suppose this ray to be A E (Fig. 3); then the appearance presented is exhibited in Fig. 5, where the bands are seen to curve round the end of the match as if it were pushing them inwards. A cold body, such as a piece of copper wire, cooled in a freezing mixture, has an opposite effect, attracting the bands into it. These effects are, of course, due to the heating or cooling of the air near the hot or cold body. Now it will be found on slowly turning the

[1] For some remarks on the general principles of these "geometrical slides" and "clamps," see Thomson and Tait's "Nat. Philosophy," part i. p. 150.

screw F (Fig. 3) so as to shorten the path A E that the bands at the side move in toward the centre, the opposite being the case on lengthening the path A E. Therefore heating the air (*i.e.* rendering it less dense) has the same effect as shortening the path (*i.e.* it accelerates the motion of the light passing along it), whilst

FIG. 5.—Photograph of interference bands sh wing effe:t of introducing glowing end of match.

cooling the air (rendering it denser) has the opposite effect; which demonstrates very simply the truth of the undulatory as opposed to the emission theory of light; for on the latter theory the exact reverse would be the case.

EDWIN EDSER.

THE AUGUST METEORS, 1893.

THE Perseid shower, though it cannot rival periodical displays such as the November Leonids and Andromedes when at their best, is certainly of equal interest, for it forms a tolerably rich display every year, and continues active during several weeks from a radiant which has a comet-like motion of about 1° R.A. per day eastwards. A vast number of observations have been made during the last half-century, but it must be confessed that we have by no means completed our investigation of this remarkable stream. Nor have we gained a thorough knowledge of the numerous and fairly prominent minor showers which contribute to render this epoch the most significant and the most interesting period of the year to the meteoric observer.

Either moonlight, or cloudy wet weather, prevented my obtaining any observations at the latter part of July this year, and it was not until August 4 that I commenced work. Moonlight was, however, pretty strong, and in a watch of about half an hour I only saw four meteors, including one typical Perseid from a radiant at about $36^\circ + 56^\circ$.

On the following night, August 5, the sky was much clouded, but between 10h. 15m. and 11h. 45m. I saw, in clear spaces, twelve meteors, of which four were Perseids, indicating a radiant at $39^\circ + 55^\circ$. The brightest meteor seen was at 11h. 3m., but it appeared behind thin cloud in the northern sky. It was fully equal to a 1st mag. star, and left a bright streak along its path from $17\frac{1}{2}^\circ + 76^\circ$ to $219^\circ + 78^\circ$. This was not a Perseid, the direction of flight being from near γ Andromedæ.

The nights of August 6 and 7 were cloudy and no observations could be secured.

On August 8 the sky cleared and I counted 36 meteors in the two hours from 10h. 50m. to 12h. 50m. There were 12 Perseids amongst them and the radiant was well defined at $41^\circ + 56^\circ$. At 11h. 25m. a fine Perseid about equal to Jupiter flashed out in the region of Polaris and left a streak of nearly 20 degrees along its course.

August 9 proved fine, but lightning was extremely frequent and vivid during the whole night, and considerably interfered with the observations. It proceeded from clouds low in the east and north quarters, but apart from that the firmament was very clear. The day had been one of excessive heat, the maximum shade temperature being 84°; the lightning which followed it may be said to have been in constant play during the night, one flash succeeding another with little intermission. The effect as it burst through the broken clouds and lit up their borders was very beautiful and so striking as to distract attention from the far less imposing features of the meteor shower then in progress. In the $2\frac{1}{2}$ hours' interval between 11h. 30m. and 14h. I managed, however, to observe 45 meteors, including 20 Perseids from a radiant which I determined as follows:—

h. m.	h. m.	°	
11 30	to 12 0 ...	42 + 56 ...	4 meteors.
12 0	to 13 0 ...	43 + 57 ...	9 ,,
13 0	to 14 0 ...	43 + 57 ...	7 ,,

Adopting the mean centre as at $43^\circ + 57^\circ$, I think the position may be considered a very accurate one for the date. I saw no exceptionally brilliant meteors during the night, though several of the 1st mag. were recorded, and the Perseids struck me as being fainter than usual. Most of them traversed swift short paths not very far from the radiant, so that the position of it could be determined very satisfactorily Mr. Booth of Leeds informs me that he found the Perseid radiant at $43^\circ + 57^\circ$ from 15 meteors of this shower observed on August 9. This positlon is identical with that found at Bristol on the same night.

On August 10 the sky proved variable, but it was pretty clear at times before midnight and overcast afterwards. Between 11h. and 12h. I noticed 21 meteors, of which 14, or two-thirds of the whole, were Perseids, but clouds interrupted work during a part of the time. After 12h. it was not found possible to continue the work with any further prospect of success, as clouds had obliterated all but a few 1st mag. stars. The Perseid radiant was now found at $45^\circ + 57^\circ$, which agrees with the usual position on the date of maximum. As to the character of the radiation on this and previous nights, it was fairly definite and exact, and limited to an area of 2° or 3°. In point of activity I regarded the shower as disappointing on the 5th, 8th, and 9th, but from what I saw on the 10th, and considering the unfavourable circumstances prevailing at the time, the display was a tolerably conspicuous one. I recorded several bright meteors on the 10th, and, as they may possibly have been seen elsewhere, the times of apparition and observed paths are given below:—

h. m.	Mag.	From α δ (° °)	To α δ (° °)	Radiant.	Notes.
11 0	1	1+11	26+19	304−14	Slow.
11 21	1	331+38½	317+23½	Perseid	Swift, streak.
11 24	1	325+29	314+15	Perseid	Swift, streak
11 43	♀	42+55	40+53½	Perseid	Slow, b. streak.
11 56	♃	140+84½	230+70	Perseid	Swift, streak.

On August 11 the sky was overcast.

On August 12 it was partly fine before 13h., but by no means favourable for this class of work. I counted 24 meteors, including 7 Perseids with radiant at $48^\circ + 57^\circ$.

On August 13 the conditions had greatly improved, and after midnight there was not a cloud in the sky. Watching for $3\frac{1}{2}$ hours I recorded 43 meteors and found the Perseid shower still visible from a radiant at $48^\circ + 57^\circ$ (8 meteors). No exceptionally bright meteors were seen, but at 13h. 5m. one about equal to Jupiter fell from

$338\frac{1}{2}^\circ+27^\circ$ to $347^\circ+19\frac{1}{2}^\circ$, its radiant being very probably at $271^\circ+48^\circ$ near the head of Draco.

On August 14 the atmosphere was unusually clear, and during the four hours from about 10h. 15m. to 14h. 15m. I observed fifty-six meteors. The Perseid shower was still distinctly visible, and the meteors pretty bright. From seven accurately observed paths a very good radiant was obtained at $49^\circ+57^\circ$. There was also a well-defined shower of streak-leaving meteors from Camelopardus at $61^\circ+59^\circ$, and these, if confused with the Perseids, would have given the latter radiant a very diffused appearance. On this and the preceding nights I saw many Cygnids and Cepheids from radiants at $292^\circ+53^\circ$ (sixteen meteors) and $311^\circ+62^\circ$ (fourteen meteors), and this pair of showers formed by far the most important of the minor displays of the epoch. I had in previous years detected the Cygnids, but never remember to have seen the shower of Cepheids on such activity.

On comparison of my Perseid radiants deduced, on August 5, 8, 9, 10, 12, 13 and 14 it will be seen that they exhibit an easterly movement in satisfactory agreement with my observations in preceding years. This remarkable displacement of the radiant may now almost be regarded as "an old story" but it will always remain a very significant and interesting feature of the shower both from an observational and theoretical standpoint. The motion of the radiant amongst the stars may be nearly as easily and certainly observed by an experienced and precise observer as the motion of a comet. The circumstances are different of course, for a radiant is simply an apparent position and not a visible object, but trustworthy observations define this position with considerable exactness, though it is impossible to eliminate all the sources of error.

Mr. Corder, at Bridgwater, informs me that on August 10, before 14h. he counted 129 meteors, but he regarded the display as rather a poor one. The mean position of the radiant was at $44^\circ+57\frac{1}{2}^\circ$, but he considers that it shifted from $40^\circ+56\frac{1}{2}^\circ$ to $47^\circ+58\frac{1}{2}^\circ$ during his observation.

Mr. Corder, watching until 15h. on August 13, counted 77 meteors, but he says the Perseids had almost ceased, and gave an uncertain radiant, but such as it was could be located near the stars B and C Camelopardi. He found a very active and well-defined shower of Cygnids from the point $293^\circ+50^\circ$. W. F. DENNING.

CHOLERA AND ARTICLES OF DIET.

ALTHOUGH in by far the larger number of cases the distribution of cholera has been traced to the use of impure water, yet there are a few authentic instances on record of its dissemination by means of various articles of diet, such as milk, fruit, salad, whilst Kossel and Steyerthal quite recently report two cases (*Deutsche med. Wochenschrift*, 1892) in which its communication was traced to bread and butter. It becomes, therefore, not only of interest but importance, to ascertain what is the vitality of the cholera organism when purposely brought in contact either superficially or incorporated with various articles of food. Researches in this direction have been undertaken from time to time by various investigators, Babes, Celli and others, whilst Dunham's experiments published in the *Medical Record* for 1892 are amongst the most recent and exhaustive on this subject. This author found that cholera organisms purposely introduced on to salad leaves and placed in a covered dish and kept at the ordinary temperature of a room, retained their vitality for five days, on cooked cauliflowers for from six to ten days, and on the same vegetable uncooked for thirteen days. On a sliced strawberry they did not survive more than twenty-four hours.

Some important contributions to our knowledge of this subject have been made by Friedrich, and are brought together in an elaborate memoir, "Beiträge zum Verhalten der Cholerabakterien auf Nahrungs und Genussmitteln" published in the *Arbeiten a. d. Kaiserlichen Gesundheitsamte*, vol. viii. 1893, p. 465.

The range of materials investigated is very extensive, upwards of fifty different articles being specially studied in this respect, including numerous kinds of fruit, several vegetables, besides milk, tea, coffee and cocoa, also particular descriptions of beer and wine, whilst amongst the miscellaneous materials examined may be mentioned caviar, biscuits, bonbons, tobacco, and snuff!

In the majority of cases the bacilli were not only rubbed on to the surface of the various fruits and vegetables, but were also inoculated on to slices, so that the effect on the bacillus of the *composition* of a particular fruit or vegetable could be ascertained. When simply exposed on the exterior of a given material, the vitality of the bacillus depends chiefly on the degree of moisture which is present in its environment, this organism being specially characterised by its rapid destruction in dry surroundings, but when brought in contact with the juices it is the proportion of fruit acid and sugar present which primarily determine its behaviour. The cholera bacilli are very sensitive to acid, and hence their destruction on most slices of fruit in from one to six hours.

Thus when inoculated on to slices of bright red very juicy and sour cherries, the bacilli were annihilated in three hours, whilst when simply rubbed on the surface and kept in a moist atmosphere they were still alive at the end of five days. On the other hand, when thus treated and exposed to the ordinary air of a room, the bacilli could not be found after twenty-four hours, whilst when placed in the direct sunshine their vitality was limited to one hour and a half.

But even on slices of fruit containing a much smaller amount of acid, such as pears, the vitality of the cholera organism was not much prolonged, and the reason for this must be sought in the fact that, when grown in solutions containing sugar, this organism produces acid, and the acid thus produced impedes its further development and destroys its vitality.

On vegetables such as cucumbers, cauliflowers, cabbages, the cholera bacillus maintains its existence for several days; thus on spinach leaves preserved in a damp atmosphere, the bacilli were still present after twelve days, and even when exposed to the ordinary air of a room they did not disappear until after six days.

As regards the behaviour of the cholera organisms in tea it is interesting to note that in a 3 per cent. infusion of black Chinese tea they are destroyed within twenty-four hours, whilst in a 4 per cent. infusion no trace of them could be found at the end of sixty minutes.

Friedrich has confirmed the results of other investigators on the bactericidal properties of coffee, finding two hours' immersion in a 6 per cent. infusion of this material sufficient for the destruction of these organisms.

In various kinds of beer, Munich, Pilsener, and Lager, they could not survive more than from one to three hours, but still more rapid was their extinction in white and red wine, for five minutes after their introduction they could no longer be found in the former, whilst in the latter their vitality did not exceed twenty minutes.

From the numerous investigations recorded it is obvious that during any epidemic of cholera the consumption of uncooked fruit and vegetables should be avoided, or that at any rate precautions should be taken to ensure their sterility by careful cleansing or by the removal of the rind or skin where possible.

G. C. FRANKLAND.

NOTES.

MEN of science throughout the world will be glad to know that the honour of knighthood has been conferred upon Dr. Joseph Henry Gilbert, F.R.S., who has been associated for more than fifty years with Sir J. B. Lawes in the agricultural experiments conducted at Rothamsted. British and foreign academies and learned societies have long recognised Dr. Gilbert's claims to distinction, and have bestowed upon him various marks of approval. We are glad now to be able to record that his scientific work has been officially recognised.

PROF. MAX MÜLLER has received from the Sultan of Turkey the gold medal of the Order of Merit, the highest honour in the Sultan's gift.

ZOOLOGISTS will learn with regret that Mr. George Brook, lecturer on embryology to the University of Edinburgh, died suddenly at Newcastle on Saturday night last. His death is a loss to zoology and to those who knew and appreciated him.

THE *Times* announces the death of Rear-Admiral T. A. Jenkins—one of the ablest officers of the U.S. Navy—at the age of eighty-two. In 1846 he prepared a report on the lighthouse systems of Great Britain and the continent. Shortly afterwards he assisted Prof. Bache in making some meteorological and hydrographical observations, and in determining deep-sea temperatures in the Gulf Stream, the vessel in which the investigations were carried on being built under his supervision. In 1852 he was appointed naval secretary of the Lighthouse Board, and from 1869 to 1871 was secretary of the Board. He was also for some time Chief of the Bureau of Navigation.

THE Franklin Institute has awarded a medal and a premium of twenty dollars, in accordance with the legacy of John Scott, of Edinburgh, to each of the following gentlemen:—Dr. Adolph Frank, Charlottenburg, Germany, for a composition of infusorial earth as adapted for filtering purposes; Frank Reddaway, Manchester, for his invention of camel-hair belting; Henry L. Bridgman, Blue Island, Illinois, for his invention of an ore sampling machine; and S. H. La Rue, Trenton, N.J., for his improvements in stoves. An Elliot Gresson medal has been awarded to Frederick E. Ives, Philadelphia, for his system of colour photography known as heliochromy. Any objections to these awards, or evidence of want of originality of the inventions named, should be lodged with the secretary of the Institute before October.

A REUTER'S telegram, dated August 11, reports that a violent shock of earthquake was felt on the previous evening in the small coast town of Mattinata. It was followed during the night by other shocks of less violence, which were felt also at Monte Sant', Angelo, Manfredonia, and Rodia—all towns on the shores of the Adriatic. Later information states that all the buildings in Mattinata were more or less seriously damaged by the earthquake, and great cracks were caused in the walls of the houses. Three persons were killed and four injured, while others were shaken or bruised. The island of Stromboli experienced a sharp shock, followed by an unusually violent eruption of the volcano.

THE Iron and Steel Institute will hold its twenty-fifth autumn meeting at Darlington, from September 26 to 28 inclusive, when several important papers will be read. Prof. Roberts-Austen, F.R.S., will contribute a paper on the influence of the rating of the rupee on the world's iron trade; Mr. H. Bauerman will discourse on the "Metallurgical Exhibits at the World's Fair"; and Mr. Kupelwieser will communicate a paper on the recent developments of the steel industry in Austria. A number of other subjects of technical interest will also be discussed. The members will have the advantage of visiting the numerous iron and steel works in the vicinity of Darlington, and arrangements have been made for excursions to Barnard Castle and Raby Castle.

THE Board of Agriculture have been requested to draw the attention of fruit growers to an international exhibition, to be held by the Russian Society of Fruit Culture, under the patronage of the Czar, at St. Petersburg, in the autumn of 1894, with the object of showing the present condition of the cultivation of fruit and vegetables, of viticulture, of the cultivation of various special plants, and the manufacture of their products. A congress of pomologists will be convened simultaneously with the exhibition. The exhibition will comprise sections dealing, among other matters, with horticulture implements and appliances, and technicality of production, and also literary, scientific, and educational accessories, collections, plans, &c. Detailed regulations of the exhibition and programmes of the various competitions will be published and distributed towards the end of this year. Persons interested in the progress of horticulture and pomology, both in Russia and other countries, are invited by the Russian Government to take part in this international exhibition and congress. Applications for further information should be addressed to the offices of the International Exhibition of Fruit Culture, Imperial Agricultural Museum, Fontanka 10, St. Petersburg.

SERIOUS floods have occurred in Galicia (says Reuter's agency) and they are exceeded in their gravity by disastrous inundations which have visited Saras and Ung, two northern countries of Hungary. The damage done in these districts is immense, and there has been serious loss of life. According to the latest accounts, the waters are now receding. Dispatches from Lemberg describe the havoc that has been wrought in the valleys beneath the Carpathians by the persistent rainfall. The rivers Dniester, Stryi, San, and Dunajec have overflowed their banks, causing great damage, especially in the districts of Zydaczow, Stryi, Przemysl, and Rimanow. At Turka twenty-two houses have been destroyed by the floods or struck by lightning, and many persons lost their lives.

DURING the past week the heat has been excessive in the midland and southern parts of England; it reached or exceeded 80° at Greenwich Observatory on eight successive days from the 8th instant, which is the longest period this summer during which such high temperatures have been recorded. On Wednesday, the 9th instant, and on Monday and Tuesday last, the temperature exceeded 85° in several places, and reached 89° in the neighbourhood of London on the latter day. On the 9th and 10th this exceptional heat culminated in severe thunderstorms in most parts of the country; in Ireland the storms and rainfall were very heavy, the amount of rain measured in the north of Ireland during the week ended the 12th instant being ·8 inch above the average. The heat on the continent has been much greater than in this country; the shade maximum at Rochefort in France reached 106° on Monday last.

DR. W. DOBERCK has communicated to *Hansa* of July 29 and August 5 an interesting article on the typhoons of the China Sea, a subject of which he has made a special study, and for the collection of the necessary materials his position as director of the Hong Kong observatory offers many advantages. So long ago as September, 1886, he communicated to the *Hong Kong Telegraph* a paper on the law of storms in the Eastern Seas. The present article embodies the facts there set forth so far as they relate to the subject in question, together with the results of the experience subsequently gained. The typhoons, like the hurricanes of the West Indies and other parts, generally give premonitory signs, such as the motions of cirrus clouds, the swell of the sea, and motion of the barometer, but there appears to be some difficulty in determining whether depressions will result in ordinary gales or in typhoons, and it is essential to determine quickly how a ship lies with respect to the advance of the centre of the disturbance. In these and other details which are of primary importance to the seaman navigating the China Seas, the information contained in the paper will be very useful.

THE report of the chief of the United States Weather Bureau for the year 1892 has recently been received, and shows that much attention has been given to the improvement of weather forecasts, the result being a success of 82·9 per cent. in the combined predictions of weather and temperature for twenty-four hours in advance. Until recently the issue of predictions was restricted to the Washington office, but now a number of competent observers make forecasts for their immediate vicinity. In order to render this service as efficient as possible, telegraphic reports are received when considered necessary from several of the West Indian islands. Various important investigations have recently been published, and at present the subject of the rainfall of the entire country is under discussion. The policy of the Bureau favours the establishment of high-level stations, and the observatory at Pike's Peak has been reopened; advantage has also been taken of one or two balloon ascents to obtain observations made in free air. Every effort is being made to advance the science of meteorology; the entire territory of the United States is now covered by local weather services with the exception of Alaska, and the weekly and monthly reports issued by them contain tables of meteorological data and discussions of great value to immigrants, invalids and to men of science generally. The *Monthly Weather Review*, issued by the Central Bureau, is a highly creditable work, prepared from the reports of upwards of 2600 observers. We also observe that frequent applications are made to the Bureau for climatological statistics, and that these are generally satisfied without expense to the applicants. The number of such applications during the year amounted to over 500; this fact alone is sufficient to show the liberal policy of the Bureau.

SOME elaborate investigations on the disinfecting powers of hypochloride of soda, chloride of lime, and peroxide of hydrogen have been recently published by Chamberland and Fernbach in the *Annales de l'Institut Pasteur*, June, 1893. When these materials were employed at a temperature of from 40–50° C. and higher, their action was invariably more rapid than when they were used at the ordinary temperature, thus affording a striking confirmation of Heider's experiments on the greater efficiency of disinfectants at higher temperatures, reference to which was made in NATURE for June 15. Micro-organisms in dry surroundings were found far more capable of resisting the action of these disinfectants than when exposed in a moist condition, that whereas in the latter case they were destroyed in a few minutes, in the former they defied an exposure of several hours, even to hot disinfectants. If, however, such dried germs be subjected to one hour's immersion in water they lose their power of resistance, for on the subsequent application of the disinfectant they succumb rapidly. These authors insist, therefore, on the importance of first spraying the walls of a room with water before commencing their disinfection. In conclusion a solution of chloride of lime (prepared by extracting one part of chloride of lime with ten parts of water and diluting the clear extract with ten times its volume of water) is recommended as an exceedingly efficient as well as economical disinfectant for practical purposes.

AN interesting example of the degree of resistance to high temperatures exhibited by some micro-organisms has lately been published in the *Centralblatt für Bakteriologie*, May 17, 1893. Whilst preparing nutritive gelatin-peptone in the usual manner, Heim found that, despite all precautions of sterilisation &c., numerous yellow or reddish-yellow centres subsequently appeared in the culture material. On isolating out these colonies and further studying them, these growths were ascertained to be derived from two spore-producing bacilli which had resisted the usual 10–20 minutes' exposure to steam on three successive days. On further studying these organisms it was found that one of them required three hours' continuous steaming before being destroyed, whilst the other was not annihilated until this had been prolonged for seven hours. These extremely hardy spores were traced to the leaf-gelatin employed, and as in many respects they resembled certain soil-microbes, Heim supposes that in some manner or other during its preparation the gelatin must have come in contact with soil. Still more recently a cladothrix has been found in water which, on account of its ability to resist high temperatures has been called *Cladothrix invulnerabilis* (*Centralblatt f. Bakteriologie*, vol. xiv. p. 14). It was still endowed with vitality after having undergone six successive exposures to ordinary intermittent sterilisation at 100° C.

M. LOUIS BOUTAN has succeeded in taking submarine photographs under various conditions, by a method described in the *Comptes Rendus*, No. 5. A camera constructed for several successive exposures was enclosed in a metal box provided with plane-parallel glass windows mounted in copper rings. The apparatus was mounted on a heavy stand provided with weights, so as to give it a steady footing on the sea bottom. Near the shore, in depths not exceeding 1 or 2 m., the camera could be placed in position without the necessity of the observer entering the water, and negatives were obtained by direct sunlight in about 10 minutes. With an exposure of 30 minutes negatives could be obtained at depths of 6 or 7 m., the apparatus being put up by a diver. The best images were obtained by placing a blue glass in front of the lens, but even the best showed a want of depth which could only be relieved by using a very small diaphragm. This difficulty would disappear if the lenses were adapted to submarine work to begin with. Pictures of the sea-bottom were also obtained instantaneously during a storm by means of a flash-light, consisting of an alcohol lamp fed by a reservoir of oxygen. Magnesium powder was projected into the flame by pressing a rubber ball. The depth at which these photographs can be taken is at present limited to that which can be attained by the diver.

THE absorption of light by platinum at different temperatures is discussed in a highly interesting paper recently communicated to the Accademia delle Scienze di Torino by Dr. G. B. Rizzo. He succeeded in obtaining transparent films of platinum produced under such conditions as to exclude the possibility of oxidation on raising the temperature. The apparatus employed consisted of two glass cylinders joined by a thin tube. Another tube was soldered to the middle of the latter, and connected with an air-pump and a reservoir containing nitrogen. The tubes were filled with nitrogen several times, and exhausted, so as finally to contain a rarefied atmosphere of nitrogen. One of the platinum electrodes was partly encased in glass, and connected with the negative pole of a Rhumkorff coil excited by six Bunsens, the other electrode being connected to the positive pole. Under these conditions the negative pole was volatilised and deposited as a thin film upon the walls of the glass cylinder containing the electrode. The glass cylinder was then disconnected by filling the apparatus with nitrogen to atmospheric pressure, melting the thin tube under the blowpipe, and drawing it out to a rod to be broken off. The platinum electrode was bent out of the way by melting its glass sheath, and the result was a cylinder of glass containing a fine deposit of platinum and filled with nitrogen. This cylinder was placed in an iron cylinder in a small gypsum furnace, and heated by a spiral tube of small gas jets. Light was transmitted through windows in the iron tube, and a Krüss universal spectroscope was used to compare the spectra transmitted through the glass and platinum, and through the glass only. The temperatures were measured by the calorimetric method. After allowing for the various reflections undergone by the light, it was found that as the temperature increased, the transparency of the film increased, especially in the more refrangible region. It may be added that this phenomenon, if found to hold generally, establishes a new correlation between light and electricity, the increase of electrical resistance of a conductor being accompanied by an increase of transparency.

THE alternate current supplied by the Innsbruck Central Station has been utilised by Dr. G. Benischke for the purpose of investigating the dielectric constants of some solids by the method of Gordon as improved by Lecher. This current charged the condenser positively and negatively at equal intervals, thus avoiding residual effects of all kinds. In order to obtain greater sensitiveness the alternate current was transformed to higher differences of potential by means of an induction coil. It was found that the dielectric constant is independent of the strength of the field in the condenser, and hence also that there exists no perceptible conductivity in the dielectric. The constant of paraffin was found to be 1·89, of ebonite 2·03, of sulphur 2·42, of common glass 4·17 to 4·52, of plate-glass 3·85.

WE have received the supplement to the calendar of the Royal University of Ireland for the year 1893. It contains the papers set at the University's examinations during 1892.

THE report of the fourth meeting of the Australasian Association for the Advancement of Science, held at Hobart Town, Tasmania, in January, 1892, has just reached us. It is edited by Mr. A. Morton.

THE *Midland Naturalist* contains an address delivered by Mr. W. H. Wilkinson, President of the Midland Union of Natural History Societies, on "The Life-History of the Diamond-Back Moth" (*Plutella cruciferarum*). We note that at the annual meeting of the Union on July 11 it was decided to discontinue the publication of the journal.

MESSRS. CROSBY LOCKWOOD AND SON will shortly publish "The Miner's Handbook," compiled by Prof. Milne, F.R.S., of the Imperial University of Japan. The volume is of especial interest on account of the fact that it is being printed under the author's direction at Tokio.

A CORRESPONDENT, "H. K. R.," writing from Victoria, Australia, with regard to a letter in our issue of March 30, refers us to another and in some respects simpler rule for finding the day of the week which corresponds to any given day of the year, to be found in Dr. Charles Hutton's "Mathematical Recreations," published in London in 1803.

THE U.S. Department of Agriculture has just issued a systematic and alphabetic index to new species of North American Phanerogams and Pteridophytes published in 1892, by Miss Josephine A. Clark. The index forms the seventh number of the third volume of contributions from the U.S. National Herbarium.

DR. MCALPINE has prepared a report for the Victoria Department of Agriculture on a poisonous species of Homeria found near Melbourne, causing the death of cattle feeding upon it. The species is *Homeria collina*, Vent.—var. *Miniata*, commonly known as Cape Tulip. There is evidence that it is fast spreading over the Colony, and strenuous measures will have to be taken to eradicate it.

WE have received the following excerpts from the Proceedings of the United States National Museum: Catalogue of the crabs of the family Maudæ in the U.S. National Museum; list of Diatomaceæ from a deep-sea dredging in the Atlantic Ocean off Delaware Bay, and scientific results of explorations, by the U.S. Fish Commission steamer *Albatross;* also notes on Erian (Devonian) plants from New York and Pennsylvania.

THE Memoirs and Proceedings of the Manchester Literary and Philosophical Society (vol. vii. No. 2) contains the second part of Prof. W. C. Williamson's General, Morphological, and Histological Index to his collective memoirs on the Fossil Plants of the Coal Measures. Prof. Harold B. Dixon, F.R.S., contributes a long paper on the "Rate of Explosions in Gases," and in collaboration with Mr. B. Lean, one on the "Length of Flame Produced by the Explosion of Gases in Tubes."

A COPY of Prof. C. V. Riley's presidential address on "Parasitism in Insects," delivered before the Entomological Society of Washington in 1892 has just reached us. It goes to show that "the parasitic forms and the parasitic habit have appeared late in the history of insect evolution on the globe." A number of papers by Prof. Riley on various entomological subjects have also been received. Among them is one on the habits and natural history of the Ox Bot-fly, *Hypoderma bovis*, in the United States. This has hitherto been supposed to be the common species of both America and Europe, but Prof. Riley finds that the species has not been observed and recorded in North America, hence he considers its presence as merely conjectural. The American species is *Hypoderma lineata*, Villiers, and it seems probable that when the life history of the European *H. bovis* has been worked out it will be found to coincide with the American Bot-fly as described by Prof. Riley.

A NEW mineral of exceptional interest, inasmuch as it contains about six and a half per cent. of the extremely rare element germanium, is described by Prof. Penfield, of the Sheffield Scientific School, U.S., in the August number of the *American Journal of Science*. Germanium was discovered in the year 1886 by Prof. Winkler in the Freiberg mineral *argyrodite*, a double sulphide of silver and germanium. The remarkable manner in which the new element was found to correspond with the *ekasilicon* predicted by Prof. Mendeleëff will be still fresh in the minds of chemists. Germanium thus belongs to the fourth or tetravalent vertical group of the periodic classification, occupying the space previously vacant between silicon and tin vertically and gallium and arsenic horizontally. Its atomic weight of 72·3 corresponds almost exactly with the number assigned to the missing *ekasilicon* by Prof. Mendeleëff. The occurrence of this interesting element appears, as far as the writer can gather, to have been noticed previously in only one other mineral specimen besides *argyrodite*, namely, in *euxenite* by Prof. Krüss, two years after its discovery in the former mineral. Since that time Prof. Winkler has prepared a large number of its compounds and from time to time described their properties, so that we now possess a considerable amount of information concerning germanium. The third mineral now announced was brought from Bolivia by Mr. Canfield as a new, rich, and very beautiful silver ore, and submitted to Prof. Penfield for examination. It has been termed *canfieldite* in honour of its finder. The presence of germanium was suspected from its behaviour when heated in closed and open tubes and on charcoal, inasmuch as it much resembled the behaviour of *argyrodite* under similar circumstances. Perhaps the most remarkable characteristic of germanium is that it forms a *white* sulphide, GeS_2. On heating *canfieldite* in a closed tube the sublimate of sulphide was observed to be white, and, moreover, when the mineral is heated on charcoal a white sublimate of oxide and sulphide is produced near the residual bead of metallic silver, together with a number of milk-white semi-transparent fused globules characteristic of germanic oxide, GeO_2. Eventually most of the compounds of germanium were prepared from the mineral and their properties found to correspond in all respects with those described by Prof. Winkler. A sulphosalt soluble in solutions of caustic alkalies like the sulphosalts of tin, antimony, and arsenic was obtained, and the alkaline solution yielded a precipitate of the white sulphide upon the addition of a dilute acid. When this sulphide, GeS_2, was heated in a current of hydrogen, small glittering scales of the lower sulphide, GeS, much resembling crystals of specular iron ore, were formed just beyond the heated portion of the tube; upon continued heating complete reduction occurred, metallic germanium itself being deposited upon the walls of the tube in small greyish-white octahedral crystals which exhibited a particularly brilliant metallic lustre.

Canfieldite, upon analysis, yields numbers which indicate that its composition is Ag_8GeS_6, or $4Ag_2S.GeS_2$. Prof. Penfield points out that the published analysis of Prof. Winkler's for *argyrodite* agrees much better with the same formula than with the formula $3Ag_2S.GeS_2$, which he ascribes to it in his memoir. Prof. Penfield confirms this by another analysis of *argyrodite* conducted with an excellent specimen in his possession. The two minerals would thus appear to possess the same composition. They are not identical, however, for *argyrodite* crystallises in the monoclinic system. *Canfieldite* crystallises in cubic octahedrons modified by dodecahedral faces; the crystals are black with a blue or purple sheen, they exhibit a magnificent metallic lustre and are extremely brittle. *Argyrodite* and *canfieldite* are therefore dimorphous forms of silver germanium sulphide.

NOTES from the Marine Biological Station, Plymouth.—Last week's captures include the Hydroid *Myriothela phrygia*, the semi-parasitic Rhabdocœle *Fecampia erythrocephala*, and the Mollusca *Favorinus albus* and *Rostanga coccinea*. The floating fauna has changed very slightly since last week, but several other autumn forms have made their appearance. Radiolaria have been present in fair numbers; the Anthomedusa *Podocoryne* (= *Dysmorphosa*) *carnea* has been plentiful, the majority possessing buds upon the manubrium; and the beautiful larvæ of the Prosobranch *Rissoa* and of the Opisthobranch *Ægirus punctilucens* have also been taken. The Turbellaria *Fecampia erythrocephala* and *Cycloporus papillosus*, and the Crustacean *Hyas coarctatus* are now breeding.

THE additions to the Zoological Society's Gardens during the past week include two Ruffed Lemurs (*Lemur varius*, ♂ ♀) from Madagascar, presented by Mrs. Brightwen; three Long-eared Owls (*Asio otus*) and one Tawny Owl (*Syrnium aluco*) from Europe, presented by Mr. Edmund Hart, F.Z.S.; a —— Falcon (*Falco* ——) from ——, presented by Lord Lilford, F.Z.S.; five shags (*Phalacrocorax graculus*) from Scotland, presented by the Maclaine of Lochbuie; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mr. E. Palmer; a Black-headed Caique (*Caica melanocephala*) from Demerara, deposited; a Regent Bird (*Sericulus melinus*) from Australia, purchased.

OUR ASTRONOMICAL COLUMN.

THE ORIGIN OF NEW STARS.—Prof. A. W. Bickerton writes to us from Christchurch, New Zealand, as follows:—"More than a year has elapsed since the first notice appeared of the new star in Aurigæ, and up to date no generally-accepted explanation of the special phenomena noted has been offered in any of the leading journals. May I beg to draw the attention of your readers to several articles bearing directly upon the mode of origin of new stars, published fifteen years ago in the Transactions of the N.Z. Institute? The explanation there offered appears to fit in almost exactly with the actual conditions as observed in this particular case. The papers referred to are contained in vols. 11, 12, and 13 of the Transactions of the N.Z. Institute. A summary of these papers also appears in the Proceedings of the Australasian Association for the Advancement of Science for the year 1891." Upon referring to the above references we find that Prof. Bickerton believes that new stars are caused by the "grazing" collision of stars like the sun. His researches show that "The temperature developed is independent of the amount of grazing. With similar substances it depends only on the velocity destroyed, so that the coalesced body produced by the merest graze must be as hot as though the whole sun collided. The molecular velocity of such a high temperature may be sufficient to carry away every particle entirely into space, the mass of the body not having sufficient attractive power to retain them. Hence an intensely brilliant body is produced in less than an hour; it then expands and increases in size and total luminosity for perhaps a few hours to a day or so; then the diffusion would be so great as to gradually lessen luminosity, until in a few months or a year the star would have disappeared into space. This represents all the peculiarities of temporary stars. If the graze be more considerable the attraction will be greater, yet the molecular velocity is the same: a hollow globe of gas may then result, giving us a planetary nebula. According to Lord Lindsay this is the condition of the temporary star in the Swan."

THE SPECTRUM OF THE RORDAME-QUÉNISSET COMET.—Prof. Campbell in *Astronomische Nachrichten*, No. 3177, gives a detailed account of the visual and photographic observations that he has made of the spectrum of this comet at the Lick Observatory. The following are the visual observations, and in the fourth column are given Kayser and Runge's wave-lengths for the edges of carbon bands.

July 11.	July 12.	July 17.	Carbon bands.	Description of bright lines and bands.
600	601	—	619·595	Maximum of red band, broad, faint.
562	—	—	563	Red edge of yellow band.
—	—	5633	5635	Very faint line terminating in yellow band.
—	—	558	5585	Bright line in yellow band.
5162·1	5161·8	5163·9	5165·2	Very bright line terminating in green band.
5124	5127	5128	5129	Very bright line terminating in green band.
—	—	509	—	Very bright line terminating in green band.
4734	—	—	4737	Red edge of blue band.
—	—	4734	4737	Bright line terminating blue band.
—	434	—	—	Bright region in continuous spectrum, faint.
—	421	—	—	Bright region in continuous spectrum, faint.

In addition Prof. Campbell has obtained two photographs of the comet-spectrum extending from wave-length 487 to 387. Twenty-eight bright lines have had their positions determined in the photographic spectrum, fourteen of which appear to correspond to lines and bands of carbon and cyanogen as given by Kayser and Runge. It is pointed out, however, that the wave-lengths of the comet-lines are systematically less than Kayser and Runge's by one or two tenth-metres. Prof. Campbell thinks this may in part be due to the fact that the cometary spectrum consists of unsymmetrical bands rather than lines, and partly to motion in the line of sight.

ATMOSPHERIC REFRACTION AND STAR PHOTOGRAPHS.—Now that stellar parallax is determined from photographic data, and a catalogue of stars is being prepared from the images impressed by celestial points upon sensitive films, it becomes necessary to investigate the effect of each and every cause tending to vitiate the results. Prof. A. A. Rambaut considers the most important of these disturbing causes in a paper on the distortion of photographic star images due to refraction read before the Royal Dublin Society on April 19, and just published in a separate form. Prof. Rambaut had previously published formulæ (*Astr. Nach.* 3125), by which the correction for refraction to the relative position of any two stars on a photographic plate can be computed in a convenient manner, and he has now followed these up by determining the distortion that takes place in the shape of a star-image during the exposure. His conclusion is that within the limits of an exposure of fifteen minutes' duration, "so long as the zenith distance does not exceed 60° no sensible error can arise through the distortion of a star by refraction if the measures are in all cases made from the centre of the image, and the coefficients in the formulæ of reduction are computed for the time corresponding to the middle of the exposure, but if photographs obtained with longer exposures are utilised for the determination of the relative position of stars, it will be necessary to know what star on the plate was used as guider, and the distortion by refraction must be investigated for all stars at any considerable distance from it." From this it will be seen that the photographs of stars obtained for the determination of parallax, or in connection with the star catalogue, are unaffected by the result, since the exposure in each case is usually less than the limit defined by Prof. Rambaut.

ASTRONOMY POPULARISED.—We have previously referred to a proposal to issue a new astronomical periodical, designed for amateurs, teachers, students of astronomy, and the public generally. The first number of this *Popular Astronomy* will be published about September 1, by Mr. W. W. Payne, Goodsell Observatory, Carleton College, Northfield, Minn., U.S. Messrs. William Wesley and Son, 28 Essex Street, Strand, London, are the agents for England. The periodical will be issued monthly, but no numbers will be published for July and August of each year. One of the features will be a scheme of work suitable for a small telescope, field glass, opera glass, and the naked eye. Those who wish to know their way about the sky will find their wants supplied, and home readers will be catered for by means of lists of best books and schemes of study. From these and other matters mentioned in the prospectus it seems probable that the periodical will possess the features that command success.

COMET APPEARANCES IN THE YEAR 1892.—Prof. H. Kreutz has collected together all the appearances of comets during the past year, this list appearing in the *Vierteljahrschrift der Astronomischen Gesellschaft*, 28 jahrgang, parts 1 and 2. In addition to short descriptions of the appearances put on by them at the times of discovery, and to the values of the elements of the new ones, he gives references to all the observations that have been made of them. Among those that receive more than usual attention are Comet 1892 I., discovered by Swift; Comet Holmes (1892 III.), Winneike's Comet (1892 IV.), and Comet 1892 V. (Barnard), since it was the first (excluding that photographed in the Solar Eclipse of May 17, 1882) discovered by photography.

GEOGRAPHICAL NOTES.

THE Society for the study of French Congo has organised a strongly-manned expedition to survey the valley of the Kuilu and Niadi rivers, in order to ascertain the feasibility of constructing a railway from the coast town of Loango to Brazzaville on Stanley Pool. A geological and botanical staff accompany the survey party, and the whole is under the command of M. A. Le Châtelier, who, with fifteen French members of the expedition, sailed from Marseilles last week.

RUSSIAN authorities are determined this year to test the capabilities of the Kara Sea route to Northern Siberia. A small fleet of three vessels, specially built on the Clyde for navigation on the Upper Yenesei, has recently set out in charge of Russian naval officers, who are confident of making a rapid journey. Capt. Wiggins is also in charge of some vessels laden with railway material for the great trans-Siberian line, which are now on their way to the Kara Sea. Dr. Nansen, in the *Fram*, must now be very near the entrance to the Kara Sea, and the nature of the ice there will determine which of the three routes into the sea will be attempted. The ultimate establishment of a commercial steamer service is only a matter of money.

IN a racy little pamphlet, *La Géographies dans les Chaires de l'Université*, Dr. Maurice Viguier makes a raid on a number of elementary text-books published by the leading geographical professors of Paris, and he succeeds in showing many errors of statement which should be set right. He goes on to argue that the inaccuracy of these popular schoolbooks, written to satisfy an arbitrary syllabus, proves the geographical incompetence of the authors. Few eminent men in any country could stand such a test, and in truth the faults cited and held up to ridicule so cleverly are faults of composition rather than of fact, and the worst are due to the ambiguity of words in common speech.

PRELIMINARY arrangements are being made for the meeting of the Sixth International Geographical Congress in London in 1895. This congress will be under the patronage of the Queen, and will bring together the geographers from all countries for the discussion of questions in which the international or universal side of geography will be kept to the front. The month of the proposed meeting has not yet been fixed.

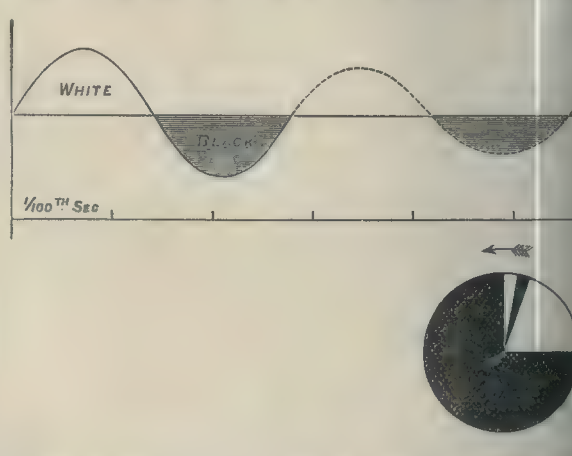
THE Central African telegraph line, projected by Mr. Cecil Rhodes, has been already commenced, and contracts have been signed for its construction from Fort Salisbury as far as Lake Nyasa. The wire will be carried on iron poles, and taken across the Zambesi (a distance of about half a mile) overhead at a height sufficient to allow the traffic on the river to pass entirely unimpeded. The advantage of this line in bringing the region of the great lakes into telegraphic touch with Europe will be very great.

CHARPENTIER'S EXPERIMENTS DEMONSTRATIVE OF AN OSCILLATORY PROCESS IN THE ORGAN OF VISION AND OF ITS DIMENSIONS.

ONE of the fundamental positions in Hering's physiological theory of visual sensation is that each sensificatory datum diffuses in the retino-cerebral organ beyond its precise locus of incidence, and thus directly modifies contiguous sensificatory data. A very elegant experimental substantiation of this position is contained in two simple optical observations by Charpentier[1] (of Nancy) giving not only the clearest possible demonstration of the fact itself, but an approximate measure of the physiological duration and velocity of the phenomenon.

These experiments are (1) that of the "black sector," demonstrative of a retino-cerebral oscillation; (2) that of the "fluted band," demonstrative of the propagation of that oscillation.

(1) *Charpentier's experiment of the Black Sector.*—A black disc with a white quadrant, revolving once in two seconds, illuminated by a very bright light (preferably direct sunlight). Observer's eye fixed upon centre of disc. A narrow black sector appears on the white quadrant near the receding edge of the black surface. This is interpretable as a rebound effect indicative of an oscillatory process in the retino-cerebral organ; the first effect at the arrival of the white border is the sensation of white, and this first effect is followed by an after-effect that is black. On closer examination it may be noticed that the angular breadth of the black sector is equal to the breadth of the white



interval between it and the receding black border, and that these breadths increase and diminish with increase and diminution in the speed of revolution; estimating from this speed and from the apparent extent and position of the black band, Charpentier finds that the white phase and the black phase have each a duration of ·014 to ·016 second, *i.e.* that a total oscillation of the two phases lasts ·028 to ·032 second, *i.e.* that the oscillation frequency is 36 to 31 per second.

Nothing can be clearer and more striking than this experiment; provided a strong light is used, it can be roughly demonstrated without any elaborate apparatus; it can be done by a black and white disc slowly turned round by hand, or by a

[1] *Comptes Rendus*, Soc. Biol., Mai 16, 23, 30, 1891. *Comptes Rendus*, Acad. Sc., Juillet 27, 1891. *Arch. de Physiol.*, Juillet et Octobre, 1892.

black and white card moved horizontally in front of the eyes. The estimates that I have made with proper apparatus very closely correspond with the value as originally determined by Charpentier. With a disc revolving once in two seconds, I find the apparent angular magnitudes of the two phases equal to about $2^\circ \cdot 5$; with a disc revolving twice as fast they are about 5°.

(2) *Charpentier's experiment of the Fluted Band* is somewhat more difficult of performance and of interpretation. A black disc, 45 cm. in diameter, revolving about twice per second, with a small white spot (1 cm. × ·5), 20 cm. from the centre. Observer's eye fixed upon a bead placed in front of the disc at that distance from the centre. Under these circumstances the white spot appears stretched out to a white band with indefinite beginning and end, which appears to be composed of several alternately lighter and darker portions of longer light internodes with shorter dark nodes. Whereas in the experiment of the black sector, the apparent angular magnitude *increases* with increased speed of revolution, in this experiment the angular magnitudes of the nodes and internodes *diminishes* with increased speed (or what amounts to the same thing, with approximation of the observer's eye to the disc) and *vice-versâ*.

Charpentier explains this at first sight very puzzling relation by the following hypothesis, which is at the same time an ingenious application of a well-known physical principle to a hypothetical physiological wave transmission *and a proof of the existence of the latter*. Upon the incidence of the stimulus white, an oscillation of sensation is produced, of which the first or positive phase is white, the second or negative phase black; each phase has a duration of about 0·015 sec.—*i.e.* the entire oscillation has a duration $t = 0{\cdot}03$ sec. and a frequency n of 33 per sec. This much is demonstrated by the experiment of the black sector. Let us now suppose that the oscillation spreads from its origin in the organ of vision[1] over the remainder of that organ, as an oscillation at one point of a pond spreads over the remainder of the pond. The problem is to determine the velocity of transmission v and the wave-length l of this presumably *propagated* oscillation. This is done by Charpentier by the following physiological application of Döppler's principle *re* the apparent modification of sound-waves according as the distance between origin and ear is increasing or diminishing.

In accordance with a familiar relation, wave-length l is equal to velocity v, multiplied by duration t, or $l = vt$. In accordance with Döppler's principle the apparent rise of tone or the apparent diminution of wave-length caused by the approximation of observer and wave origin, are such that $l' = (v - v')t$, where l' is the apparent wave-length, and v' the velocity of approximation.

If we were debarred from measuring tones proceeding from stationary origins, we might nevertheless determine their wave-length and velocity by calculation from measurements of the apparent wave-lengths of tones proceeding from origins moving at different known velocities. From two equations, $l' = (v - v')t$, $l'' = (v - v'')t$, we should have $t = \frac{l' - l''}{v'' - v'}$ and its reciprocal, $n = \frac{v'' - v'}{l' - l''}$ and (substituting $\frac{l}{v}$ for t) $v = \frac{l'v'' - l''v'}{l' - l''}$ and $l = \frac{l'v'' - l''v'}{v'' - v'}$.

These are, in fact, the data experimentally accessible in the retinal phenomenon. We cannot (as far as is known at present) measure the velocity and length of a retinal wave with stationary origin; we must determine these values from their apparent values with the wave-origin moving at different known velocities.

Practically the velocities v', v'', &c., of the wave origin on the retina are easily adjusted; the apparent wave-lengths l', l'', &c., more or less accurately observed. Given the dimensions of the disc, its distance from the eye and its rate of revolution, the experimental velocities are easily calculated; similarly if the apparent dimensions on the disc of the nodes and internodes are accurately observed, the retinal wave-lengths corresponding with them can be accurately calculated. It is in this second determination that the chief experimental error can arise; nevertheless, considering the original conditions of the problem and and that this is, in fact, the first time it has been approached and solved by any method, the results given by Charpentier are, within limits, sufficiently demonstrative of the propagation of a retinal oscillation and of its approximate velocity and wave-length. He finds from a large number of measurements a *velocity* between the limits of 53·8 and 90 mm. per sec. (mean value, 72); a frequency between 28 and 54 (mean value, 36); a calculated wave-length on the retina of 2 mm.; and a calculated wave-duration of 0·028 sec.

[1] It is essentially indifferent whether we take organ of vision to signify the retina or brain or retino-cerebral apparatus. It is convenient to refer measurements to the retina itself, and to determine retinal velocity and retinal wave-length.

Not the least satisfactory feature of these figures is that the value of the wave-duration derived by the indirect method of this more difficult experiment, practically coincides with that derived from the simple and easy experiment of the black sector.

A third experiment of Charpentier's, although not precisely confirmatory of these, seems to stand in some relation to the negative semi-vibration manifested as the black sector. A black disc with open sectors, revolving between the eye and a white sheet illuminated by direct sunlight, gives rise to the sensation of a magnificent purple colour, when the rate of revolution is such that the eye receives between 40 and 60 stimuli per second, *i.e.* when each stimulus occurs during the negative phase of the preceding stimulus. Above 70 and below 30 stimuli per second the sheet appears white. The effect is very striking and very easily obtained; in short, it is a "ladies' experiment"; its full explanation is a different matter, and far too uncertain for discussion in a short article.

A. D. W.

THE POSITION OF SCIENTIFIC EXPERTS.

FROM time to time it has been pointed out in these columns that the services rendered to litigators as such by so-called scientific experts is antagonistic to the pure spirit that should actuate men of science. For some years the position and character of the representative of science in courts of justice has been acquiring interest, not only in England but elsewhere. In fact, a few years ago a Committee of the American Association for the Advancement of Science was appointed to consider the whole matter, but no report of their proceedings has yet been published. An excellent discussion of the subject, however, comes from America in the form of a reprinted lecture on "The Scientific Expert in Foreign Procedure," by Prof. C. F. Himes, which appears in the June number of the *Journal of the Franklin Institute*. In order to direct the discussion, Prof. Himes first gives legal opinions as to the status of the expert. "Justice Miller," he says, "exhibited a plan of objection in a charge as follows:—'My own experience, both in local courts and in the Supreme Court of the United States is, that when the matter in contest involves an immense sum in value, there is no difficulty in introducing any amount of expert testimony on either side.' Another judge, in a lecture upon medical expertism, gives a similar opinion, that the ground of dissatisfaction in regard to medical testimony to both the professions of law and medicine, are reducible to one—that upon every conceivable issue expert opinions are procurable which sustain, or seem to sustain, the most contradictory views." But Prof. Himes does not take a pessimistic view of the scientific expert. He is inclined to believe that:—

"The scientific expert is simply a product, and an extreme product, of an advanced and rapidly advancing civilisation. He was recognised in the germ, to be sure, by the old Roman law, and we may assume in all systems of jurisprudence; but he has acquired an immensely increased importance, and a much wider field and a far greater frequency of employment by the recent, and very recent, marvellous advances in the applications of science—applications which have increased the sphere of things to be litigated about, which have introduced facts of an entirely new character to be adjudicated upon, to say nothing of the contribution that science has made, and is continually making, in many ordinary cases, of conclusive missing links of evidence which render decision previously uncertain, comfortably certain, and satisfactory.

"Now, one fact that seems latent in these expressions of the legal profession in regard to the scientific expert, and almost the first that impresses is that in many respects he seems to be a positive annoyance to lawyers, and even to judges at times—a sort of intractable, incompatible, inharmonious factor, disturbing the otherwise smooth current of legal procedure; too important or necessary to be ruled out, too intelligent and disciplined mentally to yield without reason to ordinary rules and regulations of the court, with which he may not be familiar, and, at the same time, possessing an undoubted influence with a jury, that it is difficult to restrict by the established rules and maxims of legal procedure."

After a consideration of the circumstances that shape the reputation of the scientific expert with the bar, bench, and laity we read :—"In considering some of the sources of dissatisfaction with the scientific experts, perhaps one of the first to suggest itself, and one of the most prolific, is the vagueness of the legal definition of the term 'scientific expert' before alluded to, but which on more careful consideration might rather be termed vagueness and variableness of the standard. Definitions of things are of ideals, and consequently definition is followed closely by the statement that the thing defined is non-existent. The ideal circle is defined, so the ideal solid, the ideal liquid; these definitions are only approached, never realised. Degrees of approach constitute the differences. Practically the courts are limited to the best experts extant in any field, though they may at times fall far short of the ideal. But it is to be feared that in many cases the experts fall below a reasonable and possible standard, and far below the standard that would be fixed by scientific men themselves, as well as below the exigencies of the case. This may easily be accounted for. A party presents a witness as an expert. The judge must pass upon his competency upon such examination as he can make. That decision, though not necessarily, nor even by unvarying practice, a matter of discretion, will not often be reviewed by a superior court. Often, then, the best solution, certainly the easiest, seems to be to admit, even where there may be grave doubt as to qualification, and to throw the burden upon the jury, already overburdened with questions, which the theory of trial by jury assigns them, questions which they are not qualified to deal with, although they may be fully up to the average in general intelligence. At a time when experts were not much beyond men in the ordinary avocations of life it may have been reasonable to require the jury to pass upon the 'weight and credit to be given to evidence viewed in connection with all the circumstances,' but under the changed circumstances of to-day, with experts of a character, and upon questions not dreamed of even a century ago, it seems to be straining a theory too far to put upon an average jury the decision of so grave a question, as to the character of the expert, which the court may not be able to settle satisfactorily. But for the theory it would not be thought of, if a system of jurisprudence were now being devised. Now among the results incidental to a liberal interpretation of the term by the courts are many that are regarded as the gravest evils of expert testimony. With doors wide open to incompetent persons, very slight pecuniary advantage, and still more frequently the incidental benefit attributed to notoriety and advertisement would cause them to seek entrance. As a result differences of opinion may be anticipated where knowledge is wanting as a basis. Then, too, the number of such experts in any case will be greater. The cross-examination absolutely necessary to test such evidence must be exhaustive and tedious. Trials are prolonged. The expense of the administration of justice is increased without furthering its ends, and withal often with incidental discredit not only of the testimony of experts, but in a measure of the whole judicial procedure which is responsible for them; and the jury are often left in such a state of mental confusion that the evidence can only be weighed by counting the experts. Now the rule should tend toward a greater strictness in regard to the qualifications of experts, since the progress of science tends towards a greater degree of specialisation in study, and consequently to more minute and extended evidence on the whole, with greater restrictions on the range of best evidence of any particular expert. If science stood still, or if forensic science was confined at all times to the same old ground, everything would be settled, but as it is, the new points at issue continually arising make new demands upon experts, which there may be few at first qualified to meet. The introduction of advanced scientific expert testimony is then hardly a matter of option. It is forced upon the courts by the fact that science is just as ready in the hands of the unscrupulous and dishonest to perpetrate the most flagrant wrongs as to aid in their detection, and that there is no advance in science that is not as accessible to the enemies of society as well as to society itself.

"But another, even more prolific source of complaint than laxity of rule in the admission of experts, lies in the anomalous position of the expert in many respects, and under the best circumstances. He is legally a witness, an ordinary witness, but practically with extraordinary functions and one loaded with extraordinary responsibilities, and one might add, frequently loaded with extraordinary, and even absurd, expectations. As a witness he is subpœnaed by the same form, obliged to respond under the same penalties, to take the same oath; is subject to the same rules and restrictions, and the same treatment in court. He has no higher claim upon the State, or upon the parties for his time or his private professional knowledge, which constitutes his livelihood. He receives, in most cases, to be sure, from the party calling him, a fee agreed upon between them, and certainly out of proportion to those of other witnesses, even if it is not professional in magnitude. He assists the side on which he is called in working up its case. He suggests the cross-examination of witnesses. He thus exhibits the character of a very willing witness, of a well-paid witness, combined with a great deal of the advocate. Now he cannot be held responsible for this position, but the system of jurisprudence, which not simply permits it, which has not simply taken him, but has forced him in, and which, apparently cognizant of all, seems only able to originate complaints, rather than to provide a different character for him; for there seems, indeed, in many of the adverse criticisms of experts, to be only a confession of weakness, rather than a disposition earnestly to consider the whole question with a view to the radical remedy of the evils. The human nature of the judge is recognised and provided against. Every safeguard is thrown around him to protect him from bias, or possible suspicion of bias, which would be almost as bad. The jury is selected so as to be free from bias, and is protected as well. Other witnesses are not expected to take the part the scientific expert is almost compelled to take. In fact, if deliberately planned, there could hardly be a network of conditions devised, calculated to produce so many of the evils of scientific expert testimony complained of, or to cloud this testimony of highest intrinsic value, having the highest degree of certainty, and in a field altogether its own."

"But in regard to the charge of bias," Prof. Himes afterwards goes on to say, "it may be admitted that the scientific expert may at times be biased, but that is only admitting that he is made of the same clay as other men. The bias, if not produced by the call, would certainly not be more of a reflection on his character than upon the system of jurisprudence which renders a call based upon bias not only possible, but almost necessary, and which provides no other method for the introduction of scientific testimony. But bias may be in nowise incidental to the call. It may be a purely scientific bias, due to some peculiar view or theory. No kind of training will fortify a man against bias at all points. In his laboratory, in conducting his investigations, the scientific expert may keep himself free from bias. The judge upon the bench is free from bias by habit, rather than by conscious effort. But even the judge, placed in some novel position of great responsibility, which this judicial habit does not fit exactly might lapse into a bias. . . .

"The criticism due to differences of opinion frequently exhibited by scientific experts can hardly be regarded as a serious matter by a profession characterised by differences of opinions on all conceivable points; the only settled opinions known to it being those of the court of last resort, which even claims the privilege occasionally of reversing itself. Differences of opinion among scientific experts are often doubtless due to differences in scientific character, resulting from the loose rule of admission. But there may still be honest differences between experts of highest character. I think such, however, it will be found, are rarely in regard to well-established facts, but oftener in regard to probable inferences from facts, whilst entire agreement would be marvellous in matters of theory and speculation. Courts and attorneys do not discriminate sufficiently between well-established scientific facts and scientific theories. Some of the most recent and far-reaching decisions of our highest tribunals have a basis of theory rather than of fact."

This leads to a point which we have always insisted upon, namely, that a scientific expert should not be called and subsidised by a particular side, but should be appointed by the judge or jury. To quote Prof. Himes :—

"Many of the most objectionable features of the expert witness originate in the mode of his entrance into court, and it is an allowable question, whether any modification could be made in the calling of the witness. Among the reports one judge expresses the opinion that, 'expert witnesses ought to be selected by the court, and should be impartial as well as learned and skilful. A contrary practice, however, is now probably too well established to allow the more salutary rule to be enforced.' Another judge suggests that the law should be so changed 'that this class of witnesses should be selected by the court, and that this should be done wholly independent of any nomination, recommendation, or interference of the parties, as much so to all intents as are the jurors.' This would not make experts *amici curiæ* any more than before, for all witnesses should be regarded in that light, but it would be a provision rather to preserve that character to them, coupled as it is with a recommendation as to compensation, so intimately connected with it. It is not the fact of extra compensation, or that the compensation is paid by the party benefited by his testimony, that creates the unfavourable impression. The other witnesses are friends of the court, by whatever party they may be called, they stand upon the same footing as to pay; but here is a witness who is paid according to a private agreement, by one of the parties; the amount is their own private arrangement on which the court is not consulted, over which the court has no control, a circumstance that imparts to him, in high degree, the character of a friend of one of the parties; and these facts as to compensation are often elicited at a time, and in a way, calculated to impair otherwise valuable testimony in the minds of the jury.

"By far the best plan seems to be that adopted in the Imperial Courts of Germany. For certain matters and lines of business permanent experts are appointed by the State, but they are not regarded as officers, but as *employés* for the time being. They have no official title, nor regular salary. The payment they receive is not enough to support them, but barely compensates them for their loss of time. For most cases the expert is appointed by the particular judge in the case, often on the demand of one or the other or both parties, but the choice of the expert lies within the discretion of the judge. He may appoint any man whom both parties suggested, or may also appoint a third man not suggested by either, but if both parties unite on one man he must listen to his testimony. If a question is involved for which regular legal experts are provided, these need only be or can be appointed. The qualifications for such a regular expert are that he should follow that particular profession or line of business habitually, and for the purpose of earning his living. The number of experts in a case is not limited by law, it rests with the discretion of the judge. The status of the expert in court is almost analogous to other witnesses, but it is not a civic duty, as with witnesses, to give evidence in court except where a profession is followed publicly and for a livelihood. The text of his oath before giving testimony is different from that of an ordinary witness; and he need not be sworn at all if both parties unite in dispensing with such qualification."

If a similar system were followed in England the testimony of scientific experts would be regarded with a little less suspicion than it is at present. Only by some such means can technical evidence of a wholly disinterested character be obtained.

SCIENCE CLASSES IN CONNECTION WITH THE LONDON COUNTY COUNCIL.

THE Technical Education Board of the London County Council has issued a series of Regulations with regard to the administration of grants to science classes. All the prescribed conditions tend to make the instruction efficient and develop technical education in the right direction. The following are those that refer to the manner in which various classes must be conducted:—

(1) That as a condition of aid being granted by the Board for the teaching of chemistry, physics, mechanics, and botany, it will be regarded as indispensable that provision should be made, to the satisfaction of the Board, not only for the experimental illustration of the lectures or class teaching, but for experimental work by the students themselves, either in laboratories belonging to the institution or, where this cannot be arranged, in the laboratories of some neighbouring institution with which the class should be associated; and every lecture must be followed by at least one hour's practical work on the same evening, or some other evening in the same week.

(2) That with regard to classes in the subjects comprised in the Science and Art Department Directory which are more strictly to be included under the head of technology, viz. building construction and drawing, machine construction and drawing, steam and the steam-engine, navigation and naval architecture, it be required, as a rule, that such classes be taught by teachers having a practical acquaintance with the industries to which they refer; provided that, in the case of teachers who have already successfully taught such classes, it shall be open to the Board, on being satisfied of the sufficiency of the qualifications, to make exceptions in particular cases. No grant will be given for classes in agriculture or mining.

(3) That for classes in geology and mineralogy suitable museum specimens be provided and examined by the pupils, and for classes in machine drawing a suitable collection of models and parts of actual machines be provided.

(4) That in the teaching of mathematics, practical geometry, building construction, machine drawing, naval architecture, navigation and nautical astronomy, "home work" be made an important feature, and that the students' work be examined and corrected by the teacher out of class hours.

(5) That in all practical laboratory classes, and in classes on mathematics, practical geometry, building construction, machine drawing, naval architecture, navigation and nautical astronomy, not more than twenty students shall be under the charge of one teacher at the same time, but where more than one teacher is present during the whole meeting of the class the number of students may be increased in proportion to the number of teachers.

(6) That in all subjects there be a sufficient supply of apparatus and materials for efficient teaching, and that such apparatus and materials be effectively used.

(7) That no payment be made on account of pupils who, in the opinion of the Board, may not reasonably be expected to profit by the teaching provided (*e.g.* pupils in navigation or nautical astronomy, or in the advanced stage of theoretical or applied mechanics who have insufficient knowledge of mathematics; those in building construction or machine drawing who have no knowledge of elementary mechanics, &c.).

The Board is prepared to consider applications for assistance to erect laboratories and provide the necessary equipment. It will also make grants in aid of the purchase of apparatus for science teaching. With so many advantages, technical education in the administrative county of London should grow apace.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE following is the list of candidates successful in the competition for the Whitworth Scholarships and Exhibitions, 1893:—Scholarships (tenable for three years, having an annual value of £125):—William Hamilton (Glasgow), John G. Longbottom (Keighley), Arthur E. Malpas (London), Richard J. Durley (London); Exhibitions (tenable for one year, having a value of £50):—Charles F. Smith (Glasgow), John Ball (Derby), William Buchan (Glasgow), John B. Chambers (London), Henry J. Loveridge (Southsea, Portsmouth), William F. Ireland (Glasgow), George W. Fearnley (Shipley), Oliver Styles (Edinburgh), George M. Russell (Portsmouth), Alexander A. Jude (Hull), Edward R. Amor (Devonport), Joseph Jeffery (Birmingham), Paul J. Reynolds (Plumstead, Kent), Thomas Pilkington (London), Richard Reynolds (Cardiff), George Wilson (Sheffield), Walter O. Hammant (Plumstead, Kent), John Orr (Airdrie), William I. Chubb (London), Henry Smith (Brighton), Frederick D. Green (Wanstead, Essex), John Powell (Crewe), James H. Hardy (Woodley, near Stockport), James H. Shepherd (Swindon), Herbert Thompson (Sheffield), Evan Stevens (Swindon), Henry E. Morrall (Wolverton), Herbert Bates (Manchester), Charles H. Hill (Stratford, London), William F. Massey (Newport, Salop).

The Scholarships Committee of the 1851 Exhibition Science Scholarships has issued a list of appointments for 1893. Four scholarships awarded in 1891 have been renewed for a third year in order to permit the holders to complete their investigations. These scholars are James H. Gray, John Joseph Sudborough, Harry Ingle, and Thomas Ewan. The following scholars of 1892 have had their scholarships renewed for a second year:—Andrew John Herbertson, James Blacklock Henderson, John Macdonald, Lionel Simeon Marks, George Lester Thomas, Harold Hart Mann, James Terence Conroy, Thornton Charles Lamb, Edward Arnold Medley, William Henry Oates, William Gannon, Frederick J. Smale, Samuel Henry Barraclough, David Hamilton Jackson, Edward Taylor Jones, James Bernard Allen. The list of science scholars of 1893 is as follows:—Herbert William Bolam, George Edwin Allan, James Wallace Walker, Arthur Lapworth, John Ellis Myers, Arthur Walsh Titherley, Edward Chester Cyril Baly, John Cannell Cain, Ella Mary Bryant, James Darnell Granger, Mary O'Brien, Frederick George Donnan, James Alexander MacPhail, Norman Ross Carmichael, Wm. Henry Ledger, George Wm. Macdonald. The institutions to be invited to nominate science scholars for 1894 are:—the University of Edinburgh, the University of Glasgow, the University of Aberdeen, Mason College, Birmingham, University College, Bristol, Yorkshire College, Leeds, University College, Liverpool, University College, London, Owens College, Manchester, Durham College of Science, Newcastle, University College, Nottingham, Firth College, Sheffield, University College of South Wales, Cardiff, Queen's College, Cork, Queen's College, Galway, the University of Toronto, Dalhousie University, Halifax, Nova Scotia, the University of Adelaide, and the University of New Zealand.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 7.—M. Lœwy in the chair.—On the periodic maxima of spectra, by M. Aymonet.—On the heat spectrum of fluorine, by M. E. Carvallo. A comparison between the results obtained by the author and simultaneously by Messrs. Rubens and Snow, of Berlin. In those portions which are common to all three observers, the agreement is perfect, although the results were arrived at by very different methods.—On the absorption of light by liquid bromine, by M. Charles Camichel. Liquid bromine absorbs luminous rays very energetically, especially the most refrangible ones. Thus, a thickness of bromine of a wave length and a half of D light exerts a considerable absorptive action upon the green ray of thallium, and a layer of six times that thickness absorbs the same radiation to such an extent that measurements become difficult. A drop of bromine was introduced between two pieces of glass constructed for observing Newton's rings. These glasses were mounted in a screw frame resting upon the carriage of a dividing engine, by means of which they could be moved in front of one of the collimators of a Gouy spectrophotometer. The thickness of the layer was measured by observing Newton's rings in monochromatic light. Two luminous pencils proceeded from the same source, one traversing the polarising collimator, the other the bromine glasses and then the ordinary collimator. Two patches were thus produced, which were equalised by the analyser when the bromine glasses were full and empty respectively. It was found that the absorption followed the exponential law between thicknesses of 0·5 and sixty times the principal wave length of sodium.—On the origin of atmospheric oxygen, by Mr. T. L. Phipson. Various plants, such as *Poa*, *Trifolium*, *Antirrhinum*, and *Convolvulus* were placed under glass shades with their roots immersed in water containing free carbonic acid and certain salts, shut off from the light, and their upper portions exposed to a north light in atmospheres of carbonic acid, hydrogen, and nitrogen respectively. It was found that in carbonic acid the plants were able to live for some time, but did not prosper. In hydrogen they fared better, but the gas gradually disappeared, probably combining with the oxygen evolved by the plants. *Convolvulus* throve very well in an atmosphere of nitrogen, especially if mixed with a third part of carbonic acid. After several weeks the composition of the gas began to approach that of our atmosphere, no change of volume having taken place. The bearing of these facts upon the history of the earth's atmosphere may prove important.—Of the isomorphism of anhydrous alums, by M. T. Klobb.—Influence of solar radiation upon plants, by M. G. Landel. Variations of intensity of solar radiation appear always to act in the same sense upon plants, as regards the quantity of flowers and the proportion of red pigment colouring the various parts. These variations differ much according to the species. In some the red pigment is well developed in the shade, whilst others remain perfectly green. The inflorescence in certain species does not seem to be sensibly modified by shade; in others the number of flowers is less.—The young bulbs of the *Dioscoreæ*, by M. C. Queva.

BOOKS AND PAMPHLETS RECEIVED.

BOOKS.—Mathématiques et Mathématiciens; Pensées et Curiosités deux edition: A. Rebière (Paris, Nony).—Solutions of the Exercises in Taylor's Euclid, Books 1 to 4: W. W. Taylor (Cambridge University Press).—A Treatise on the Mathematical Theory of Elasticity, Vol. 2: A. E. H. Love (Cambridge University Press).—A History of the Theory of Elasticity and of the Strength of Materials, Vol. 2, Parts 1 and 2: the late I. Todhunter, edited and completed by K. Pearson (Cambridge University Press).—British Rainfall, 1892: G. J. Symons and H. S. Wallis (Stanford).—Birds in a Village: W. H. Hudson (Chapman and Hall).—Pocket-book of Useful Formulæ and Memoranda for Civil and Mechanical Engineers, 23rd edition Sir G. L. Molesworth and R. B. Molesworth (Spon).—Report of the Fourth Meeting of the Australasian Association, held at Hobart in January, 1892 (Sydney).—Royal University, Ireland, Examination Papers, 1892 (Dublin, Thom).—Griffin's Electrical Engineer's Price Book: H. J. Dowsing (Griffin).—Les Turbines: G. Lavergne (Paris, Gauthier-Villars).—Fourth Report of the Department of Science and Art (Eyre and Spottiswoode).—Electric Lighting and Power Distribution: W. P. Maycock, Parts 2 and 3 (Whittaker).—Geology, an Elementary Hand-book: A. J. Jukes-Browne (Whittaker).—Electricity and Magnetism: S. R. Bottone (Whittaker).

PAMPHLETS.—U.S. Department of Agriculture, Report of the Chief of the Weather Bureau for 1892: M. W. Harrington (Washington).—Catalogue of the Crabs of the Family Maiidæ in the U.S. National Museum: M. J. Rathbun (Washington).—The Planet Venus: E. M. Clerke (Witherby).—Notes on the Trunk Skeleton of a Hybrid Grouse: R. W. Shufeldt.—Report upon the Scott-Moncrieff System for the Bacteriological Purification of Sewage: A. C. Houston (Waterlow).—On the Distortion of Photographic Star Images due to Refraction: Prof. Rambaut (Dublin).—A Preliminary Report on the Aquatic Invertebrate Fauna of the Yellowstone Natural Park, &c., &c.: S. A. Forbes (Washington).—Notes on a Few Fossil Plants from the Fort Union Group of Montana: F. H. Knowlton (Washington).

CONTENTS.

THURSDAY, AUGUST 24, 1893.

WATER AND ICE AS AGENTS OF EARTH SCULPTURE.

Fragments of Earth Lore: Sketches and Addresses, Geological and Geographical. By James Geikie, D.C.L., LL.D., F.R.S., &c., &c. (Edinburgh: John Bartholomew & Co. London: Simpkin Marshall, Hamilton, Kent & Co., Limited, 1893.)

THESE collected papers form a fairly connected work on the origin of the present surface features of the world at large, and of Scotland in particular. The first is a well-put plea for the more intelligent and far-sighted method of teaching geography, and is followed up by four articles on the geographical features of Scotland, which are of a somewhat advanced and special character, and lead directly to the exposition of the author's views on glacial action. That forms the subject matter of the next eight papers, supplemented by a geographical essay in which he discusses some aspects of the question of earth movements, which are obviously closely connected with the theoretical explanations of climatal change. On the whole, perhaps, another form would have been better; for the advice as to the teaching of geography will hardly be necessary for the same readers as those who, with their local field club, are prepared to follow the author through the Western Islands; while those who wish to examine once more the arguments for the special views on the ancient glaciation of the country which he advocates, would have found the information more usefully arranged for them, if worked into a manual. The style of the articles is sufficiently didactic to have readily lent itself to this form.

The book provides for the author an inventory of his own literary properties, and of some others, in which he has a joint claim, owing to his having independently arrived at the same conclusion as other observers. It provides for him also an opportunity of qualifying statements which further investigation has shown to require modification. In which respect the reader is equally benefited, as he would certainly prefer to receive the results of our author's mature judgment on the subject.

We appeal to him as a leader in geographical science, and one who has abundant facility of expression, not to encourage the absorption of too many words out of our current language for use as technical terms. Such names as *chain* and *range* should be simply descriptive of form, that is of actual continuity, or of contiguity with a linear arrangement, regardless of the origin of the features.

Among the most interesting geographical descriptions given is that of the "drowned lands," or areas which have been moulded into their present form by subærial action, and then submerged with all their hills and valleys (pp. 21, 367, and more fully in art. xiv). We shall know more about this as we get more soundings and the study of oceanography advances.

The feature of greatest importance in the study of geology and geography is the *plain of marine denudation*, the level at which the sea arrests the agents of subærial waste, and at which the wind waves carry on the work. This is the datum from which the amount of rock removed by denudation must be measured: this is the index that tells us how long the great forces of elevation and depression balanced one another: this marks the long drawn-out nodes in the undulations of the earth's crust.

Our author might have dwelt longer on this ground, when giving his views as to how the successive portions of the earth were brought within reach of the denuding agents to which he chiefly refers their sculpture.

Most of the papers are controversial, or they are written so as to strengthen those positions on which some disputed theory has been built up, and are so turned as to allow the author frequently to point the moral which he chiefly aims at inculcating.

We feel quite glad of the genial warmth of the volcanic fires which ushered in the Devonian, and are hardly willing to admit the existence of ice at this age in the Cheviot area. Yet there is no reason why the surrounding mountains may not have been high enough to nourish glaciers, but the shape and condition of the stones included in the conglomerates at the base of the red rocks are hardly sufficient to *prove* this, especially when the ghosts of scratches have in other cases been shown to be due to movements in the rock, which caused the included fragments to be crushed against one another.

After a long interval we read in the history of the Cheviots of Scandinavian ice which over-rode everything, and of the successive interglacial periods when that ice receded only to advance again with hardly less intensity, but we do not know how our author explains its apparently smaller eroding power, seeing that it failed to remove even the peat and silt which had accumulated in the interval.

As an example of the kind of evidence which is occasionally admitted in support of the former extension of land ice we may cite his reference of the implement-bearing gravels of East Anglia to the floods discharged at the foot of the melting ice-sheet.

The argument that the gravels are eighty feet above the sources of the *existing* streams after ages of denudation does not go for much where the level of the outburst of springs has varied within the memory of man; while the flint implement-bearing gravels creep up the hills in terraces with abundant material derived from the boulder clay which covers the tops of the hills all round, but never overlaps those gravels. The shells in the gravels are, with few exceptions, of the same species as those now inhabiting the neighbouring streams, and those exceptions belong to more southern forms. There very likely are marine gravels capping some hills, but they are certainly not correctly referred to as those "with ancient flint implements," &c., in East Anglia.

Although he frequently mentions "the now discredited iceberg theory," he does not often refer any of the drifts to their "random and eccentric action," but explains some of the difficulties of the distribution of erratics by the intercrossing of currents within the ice-mass. Whether or not any particular group of boulders or mass of drift was carried by icebergs or not, it is too much to say that there are no reasons for considering icebergs capable of polishing and striating rock surfaces (p. 219). If we allow that glacier-ice charged with stones and mud can erode its base, surely miles of the very same mass of ice, with the same mud and stones, when broken off and driven by wind and current on a shelving shore, must grind and polish the floor on which it is driven.

It is difficult to follow the explanation offered of the pushing up of shells belonging to temperate climates by the great ice sheet, or the wrenching off of large masses of rock underneath the ice, except on the supposition that all this was done during the *first* advance of the ice over the sea bottom, and over a surface irregularly fretted by subærial action. When once the sea-bed had been swept, no more such life would be there till the ice receded; and, when the crags had once been planed down, there could be no more jagged rock for the ice to break off and carry along. Moreover, it does not seem to have been observed that the flints so universally distributed through the marine gravels, such as those of Moel Tryfaen, are rusty gravel flints, and that there is no long interval without them all round the southern and central portions of the British Isles.

The point, however, to which our author seems to attach greatest importance is the occurrence of interglacial periods. He describes successive sheets of boulder clay, each of which is the accumulation of a separate and distinct ice flow. He points out that the fauna and flora found in beds interstratified in these clays are suggestive of alternations of cold and damp conditions with those indicative of a warm and genial climate. In Scotland and Scandinavia the gradual disappearance of the latest ice-sheets was, he says, marked by a partial submergence, but a great submergence he does not believe in, and, after describing the grand series of moraines which stretches across the northern states of America into the British possessions, says that "no one who has traversed the regions I refer to is at all likely to agree with Sir W. Dawson's view that the American mounds, &c., are the shore accumulations of an ice-laden sea."

We regret the somewhat assured manner in which the views of those who differ from our author are dismissed. Sir William Dawson traversed the regions referred to by him (p. 190) and arrived at a different conclusion; and there are some who have not confined themselves so exclusively to the subjects on which our author has made himself a name, who yet do not deserve to be excluded from the list of geologists because they do not agree with him on every point. It would be well also if he would strike out from any future edition all references to "the trained observer" and "the experienced eye," as his readers cannot help recalling many instances where trained observers have differed in interpretation, and where, the position having been shifted, even the experienced eye has seen things differently at different times.

Though our author could not in these essays discuss fully the various points which must be fixed before any theory can be considered as fairly established, he has indicated the lines of reasoning on which he would rely.

His position seems to be that there are known to recur such astronomical combinations as by a general lowering of the snow line would be sufficient to account for glacial conditions with such distribution of land and water as for instance prevail at present; that with unfavourable geographical arrangement no glaciation is possible; that the greater part of the results observed were produced by land ice, icebergs playing quite a subordinate part, and marine currents of any considerable volume and velocity being quite exceptional; that within each period of possible glaciation there were alternations of conditions of greater or less intensity corresponding to established astronomical cycles, and that the evidence of these were to be seen in certain beds intercalated in the drift. He admits, but explains away, the absence of evidence of the regular recurrence of such effects throughout the previous geological ages.

The geographical theory which he principally combats may be briefly summed up thus: There have been through all time terrestrial movements of wider or narrower extent which have carried portions of the earth's surface to depths below the lowest known abyss, and raised portions through distances greater than the highest mountain peak; the depression and elevation of extensive areas or ridges must, with sufficient precipitation, deflect ocean currents and produce such snowfields as would feed the largest glaciers or ice-sheets required in explanation of the drifts, boulders, and accompanying phenomena; there is evidence of movements on a grand scale since the period of great cold and similar movements have been going on up to a quite recent date, and these, if extended over a longer time, would produce all the effects required.

In the course of these addresses our author is frequently led to speculate upon the causes and some of the effects of earth-movements, and we find (*e.g.* pp. 129, 267, 342) such a good case made out every now and then for the geographical theory that we cannot help feeling that the difference between the two schools is not irreconcileable but this is a vast question which cannot be settled till many possibilities have been considered.

The various theories referred to have been built up on such a number of observations and hypothetical explanations that it is impossible to discuss them in one volume of essays, still less in a short review of that volume.

All the more, however, because the subject involves so many matters of controversy, do we welcome the publication of the latest views of one who is so skilled an observer as our author, and so competent to watch the progress of research in regions beyond that which he has especially studied.

WATER BACTERIA.

Diagnostik der Bakterien des Wassers. Von Dr. Alexander Lustig. Zweite sehr vermehrte Auflage. 128 pp. (Jena: Gustav Fischer, 1893.)

THIS is, we believe, the first attempt made to gather together in a compact form the various descriptions of bacteria which from time to time have been isolated from water by different observers. In those cases where the water investigator is concerned only with the number of microbes present in any given water, the task of mere enumeration is such that, however anxious to do so, it is almost impossible to take an intelligent interest in the nature of the microbes present, beyond a superficial glance at their more striking characteristics. But even this is sufficient to indicate what numbers of different kinds of microbes are present in water, whilst on a closer examination the list of varieties is very much more extended. Having regard to their superficial differences, then, Lustig, following the example set by Eisenberg in his "Bakteriologische Diagnostik," has mapped out two classes of microbes—those which liquefy and those which do not liquefy the gelatine—which are again divided up into micrococci and bacilli respectively. The tabulated account appended to each micro-organism includes its microscopic appearance, behaviour in gelatine-plate and tube-cultures, on agar-agar and potatoes, relationship to pathogenic properties, temperature, together with other special tests which have from time to time been employed, as well as the authority for its discovery in water.

In addition to the above classification, those bacteria which are known to be pathogenic to man and animals respectively are separately grouped, whilst those bacilli resembling the typhoid bacillus are brought together for purposes of comparison. The latter should prove a useful assistance in the separate diagnosis of the typhoid bacillus, for as it is by no means specially characteristic either in its macroscopic or microscopic appearances, there are many forms which may readily be mistaken for it on an ordinary water-plate.

We do not quite understand why Lustig has not rendered the cholera spirillum a similar service. There exist many spirilla in water which bear the most striking resemblance to Koch's comma spirillum, but which subsequent searching tests have proved to be distinct. Koch himself only a few weeks ago stated that no less than a dozen different vibrios had been isolated in his laboratory alone, from various waters which he examined last autumn during the cholera epidemic, none of which were the cholera spirillum, whilst other investigators have identified and described spirilla bearing the closest resemblance to the original comma spirillum.

Amongst the organisms pathogenic to man found in water we miss the tetanus bacillus. This organism was detected by Miquel in the rivers Seine snd Marne, and G. Roux states that he found it in large numbers in the sediment of the filter beds belonging to the water-works supplying Lyon with river Rhône water, whilst Lortet alleges that he discovered it in mud obtained from the bottom of the Dead Sea. In a future edition the anthrax bacillus must also be included, since it has recently been detected in the sediment at the bottom of a well, to the water of which an outbreak of anthrax amongst a flock of sheep was traced.

In the preface to the German edition Baumgarten writes: "Grössere Reihen von 'Wasserbakterien' sind schon früher von anderen Forschern (Frankland, Maschek, Adametz, W. Zimmermann, Tils) auf Grund eigener Beobachtungen und Untersuchungen beschrieben worden. Diese sowie *alle sonstigen*, verstreut in der Literatur . . . ist Lustig's Verdienst vereinigt zu haben." It is obvious that in a guide of this kind the list should be as complete as possible, and it is, therefore, surprising to find many important and quite unaccountable omissions. For example, none of the interesting phosphorescent bacilli obtained from sea-water by Forster, Fischer, and Katz are described, neither is any mention made of the organisms isolated by Russell from sea-water.

Amongst other organisms conspicuous by their absence may be mentioned the *bacillus thermophilus* originally found in large numbers in river Seine water by Miquel, the anærobic bacillus, *B. amylozyme* obtained by Perdrix from the same water, the *bacille rouge de Kiel* so carefully studied by Laurent, the "peach-coloured bacterium" of Lankester, whilst Roscoe and Lunt's sewage organisms, and Tataroff's large collection of bacteria isolated from the Dorpat water are entirely overlooked.

The descriptions appended are often provokingly incomplete, and this greatly militates against the value of the book in assisting in the identification of a particular organism, whilst in some cases the details are not always correct.

The book was originally written in Italian, so possibly during the translation into German errors and misprints may have crept in which were not present in the original, but it is none the less troublesome to find wrong references occasionally given, whilst the description of the same organism twice over, which occurs more than once, ought surely to have been guarded against. As an example of this we may mention a bacillus found by Claessen (mis-spelt Claesten) in unfiltered river Spree water, and described on p. 62 as the *Indigoblauer bacillus*, whilst on p. 70 we find it figuring again as bacillus, *Berolinensis indicus!*

In order to bring the descriptions up to a level with those in Eisenberg's "Bakteriologische Diagnostik," even (and as the volume before us deals solely with water-microbes, they might not unreasonably be expected to be fuller) careful revision will be required, and the evident signs of haste which at present characterise its pages conscientiously removed.

Such an array of different water microbes, to each of which is given a "local habitation and a name," might well make the reader say with the "Ancient Mariner," "Water, water, everywhere, Nor any drop to drink;" but it is reassuring to find that out of the 181 varieties found in water, only six are stated by Lustig to be pathogenic to man. P. FRANKLAND.

POPULAR METEOROLOGY.

Katechismus der Meteorologie. Dritte Auflage, gänzlich umgearbeitet. Von Prof. Dr. W. J. Van Bebber. (Leipzig: J. J. Weber, 1893.)

THE object of the author of this little book is to present as briefly and intelligently as possible the fundamental principles of meteorology, in a manner which will enable the public to form for themselves an independent judgment on the meteorological conditions prevalent at the moment, and to make the knowledge so obtained available for the purposes of daily life. The author, who is well and favourably known as a popular writer on meteorology by his *Lehrbuch*, thinks that this eminently practical object can be best effected by placing his information in a catechetical form; a method of conveying instruction which appears to find great favour in Germany. This particular work is already in its third edition, and is the sixtieth of a series which in its entirety probably comprises more than twice that number of works devoted to the culture of science, art, and industry, and all forming part of the "Illustrierte Katechismen." This form, however, is not one that commends itself generally to the writers of English text-books, at least in modern times. It is believed that the fascinating style of the ingenious Miss Mangnall endeared her writings to an earlier generation, but the peculiar form of which she was so admirable an exponent has not found many imitators. But the case seems to be different in Germany, to judge by the number of works and editions in this catechetical series, to which we have referred. The author contends that the form of the work is suitable, and in his recent revision he has preferred to retain it. But if the questions in a slightly altered shape were made to fill the place of marginal notes, and the information were presented in a continuous readable form, it would, to an English eye at least, be preferable to that adopted, which has all the appearance of a collection of conundrums without their interest. But apart from this question of form, there are two reasons why we are inclined to dissent from the judgment of the author. Meteorology has hardly crystallised into that definite shape in which a cut and dry answer can be given to every definite question. The author seems to take some praise to himself that every hypothesis has been most carefully excluded. But this is a very doubtful merit. It has the immediate effect of excluding much that gives a charm and interest to the study, and without a knowledge of which one can hardly be said to be instructed in meteorology. Working hypotheses, recognised as such, have a distinct value, especially in a science where much is, of necessity, tentative and experimental. The other objection which might be urged against the style arises from the fact that, in the present instance at least, it does not lend itself readily to the description of diagrams. Perhaps this explains why the book is not more profusely illustrated. It was doubtless felt that diagrams did not greatly add to the clearness of description.

The contents of the book are generally such as one would expect to meet in an elementary work on meteorology. There are, however, some exceptions, in which the author enters upon subjects which we are apt in this country to include under the wider title of physiography. After dealing with the temperature of the atmosphere, its daily and annual variations, the peculiarities of isotherms, &c., we have an account of barometric records and variations of atmospheric pressure with theories of the wind. Under this heading are treated such subjects as land and sea breezes, local winds, such as monsoons, and movements of the atmosphere affecting small areas. The transition to such subjects as the Gulf Stream and ocean currents is easy if a little unexpected, but the author soon returns to topics more immediately connected with meteorology properly so called. The subject of evaporation, and the deposition of moisture in its various forms, is sufficiently dealt with, and if there is nothing new in this chapter it is clear and satisfactory, and the same can be said for the few concluding questions on electrical and optical phenomena. A few remarks might have been added with advantage on the aurora, but possibly the author was afraid of hypotheses.

The most readable and the most interesting portion of the book is undoubtedly that connected with the behaviour of storms, and the formation of weather charts with a view to weather prediction. Here the catechist has practically to stand aside. In about twenty pages we meet with only eighteen distinct questions, and the tale is therefore practically told without that annoying form of interruption. And it is very well told. We feel that the author has shaken himself free from his self-imposed fetters, and is doing himself justice, and we can only regret that the earlier portion of the work is not marked by a similar freedom.

OUR BOOK SHELF.

The New Technical Educator: an Encyclopædia of Technical Education. Vol. I. (London, Paris, and Melbourne: Cassell and Co., Limited, 1893.)

THE subjects dealt with in vol. i. are as follows:—Drawing for Carpenters and Joiners, Cotton Spinning, Cutting Tools, Dyeing of Textile Fabrics, Electrical Engineering, Drawing for Engineers, Photography, Plumbing, Practical Mechanics, Projection, The Steam Engine, Steel and Iron, Technical Education, Watch and Clock Making, and Woollen and Worsted Spinning.

Taken as a whole, all these subjects are well written and illustrated copiously, several full-page plates being given. The frontispiece is coloured, and represents the scene in the Bessemer department of a steel works at night, during the process of a "blow." A very good idea is given of the wonderful pyrotechnic display.

The steam-engine is treated very much from the "heat" point of view.

Under the head of Plumbing much useful information is to be found, particularly the making of joints and bends in pipes of lead and other metals. It is usual, when making a bend in a wrought-iron lap-welded pipe, to endeavour to keep the weld on the inside of the bend, when possible, for obvious reasons. This is purely a practice which every gasfitter or plumber would naturally follow, and its omission from the paragraph is to be regretted.

The articles on electrical engineering are excellent as far as they go. The illustrations are clear and to the point; one or two of the earlier ones, however, would be improved by the addition of the lines of force.

Prof. R. H. Smith takes charge of the articles on "Cutting Tools"; needless to say they are well written, with examples taken from every-day practice in the works. The introduction of milling machinery into the engineering works of the country is comparatively of recent date, yet this method of machining work is rapidly coming to the front, and milling machinery is taking the place of the planing, slotting, and shaping machine for duplicate and general work. One great drawback to this method of working is the cost of the milling cutters; these are very expensive to make, and sometimes during the process of hardening and tempering they very often crack in the body or some of the teeth fly off. On the other hand, the quality of the work done by the milling machine is better than that from an average planing machine, less hand labour being required to finish the work.

The articles on technical education are most instructive; they cover a good deal of ground, generally taking a sensible and moderate view of the question. In the first article on this subject, the author, Mr. Henry Cunyngham, says that the object of technical education is to make good industrial workmen, and then goes on to name what are the qualities which go to make up a good workman. There is no possible doubt that apprentices to trades require facilities to study the technics of their trades, and that these facilities ought to be found in every manufacturing town, besides which, both parents and employers should make it a duty to see that the opportunities are not thrown away. On the other hand, the fact should not be lost sight of, that it is only possible to follow practice, *i.e.*, practical work, in the works.

The following chapters on this subject are by different authors, and deal with the progress of technical education in this country and abroad, then we have an elaborate description of polytechnics by Mr. Quintin Hogg, and the last chapter gives a fair idea of technical education in the colonies. All these chapters together give the reader much information about this all-important subject.

Although it has not been possible to note more of the contents of this volume, yet we can say that it is one of a series of most useful books, and if subsequent volumes are kept up to the standard of Vol. I. they will constitute a valuable Encyclopædia of Technical Education. N. J. L.

Wetterbüchlein. Von wahrer Erkenntniss des Wetters. By Leonhard Reynman. (Berlin: A. Asher & Co., 1893.)

THIS is the first number of a series of reprints of rare books relating to meteorology and terrestrial magnetism, edited by Prof. G. Hellmann, and, owing to the support of the German Meteorological Society and to a large amount of gratuitous labour on the part of Dr. Hellmann, the works, of which only a very limited number will be printed, are to be issued in a very cheap but elegant form, and will no doubt be much valued by students of those subjects and by persons interested in early literature. The *Wetterbüchlein* is the oldest purely meteorological work printed in the German language. The first edition was published in 1505, but inquiries made by Prof. Hellmann of 115 libraries in Europe have failed to discover a single copy, and of the second edition printed in 1510 only one copy can be found, viz. the one in Dr. Hellmann's library, of which a facsimile is now reprinted, together with an introduction of forty-two quarto pages, giving a most interesting and masterly account of this work and of all the other editions excepting two, of which no copy can be found. The *Wetterbüchlein*, which ran through seventeen editions in fourteen years, was exceedingly popular in its day, and contains in fourteen chapters a large number of weather prognostications, some of which are of an astrological character, but by far the greater part are based on optical and natural phenomena. The chapters are naturally of unequal value, but some of them contain results of importance deduced from a large number of actual observations. Many of the chapters have been traced by Dr. Hellmann to be based upon proverbs known to the old classical writers, and the author has also quoted freely from a work by Guido Bonatti, an Italian astrologer, which was printed in 1491, and from one by Firmin de Bellevall, a French writer, which appeared in 1485; but no clue can be found as to the origin of a chapter entitled "Das wetter zu wissen durch die vier quart des jars / als Liechtenperger setzt." If any of our readers can discover the origin of this section we shall be glad to hear of it. The *Wetterbüchlein* was, to a great extent, reprinted in various editions of the "Bauern-Practick," which appeared in the sixteenth century and had a much greater sale. It also found its way to this country, an almost literal translation appearing in "The Boke of Knowledge of Thynges Vnknown ...." published in London in 1585.

LETTERS TO THE EDITOR.

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

Prenatal Influences on Character.

THE popular belief that prenatal influences on the mother affect the offspring physically, producing moles and other birth-marks, and even malformations of a more or less serious character, is said to be entirely unsupported by any trustworthy facts, and is also rejected by physiologists on theoretical grounds. But I am not aware that the question of purely mental effects arising from prenatal mental influences on the mother has been separately studied. Our ignorance of the causes, or at least of the whole series of causes, that determine individual character is so great, that such transmission of mental influences will hardly be held to be impossible or even very improbable. It is one of those questions on which our minds should remain open, and on which we should be ready to receive and discuss whatever evidence is available; and should a *primâ facie* case be made out, seek for confirmation by some form of experiment or observation, which is perhaps less difficult than at first sight it may appear to be.

In one of the works of George or Andrew Combe, I remember a reference to a case in which the character of a child appeared to have been modified by the prenatal reading of its mother, and the author, if I mistake not, accepted the result as probable, if not demonstrated. I think, therefore, that it will be advisable to make public some interesting cases of such modification of character which have been sent me by an Australian lady in consequence of reading my recent articles on the question whether acquired characters are inherited. The value of these cases depends on their differential character. Two mothers state that in each of their children (three in one case and four in the other) the character of the child very distinctly indicated the prenatal occupations and mental interests of the mother, though at the time they were manifested in the child they had ceased to occupy the parent, so that the result cannot be explained by imitation. The second mother referred to by my correspondent only gives cases observed in other families which do not go beyond ordinary heredity.

"I can trace in the character of my first child, a girl now twenty-two years of age, a special aptitude for sewing, economical contriving, and cutting out, which came to me as a new experience when living in the country amongst new surroundings, and, strict economy being necessary, I began to try and sew for the coming baby and for myself. I also trace her great love of history to my study of Froude during that period, and to the breathless interest with which my husband and I followed the incidents of the Franco-German war. Yet her other tastes for art and literature are distinctly hereditary. In the case of my second child, also a daughter (I having interested myself prior to her birth in literary pursuits) the result has been a much acuter form of intelligence, which at six years old enabled her to read and enjoy the ballads which Tennyson was then giving to the world, and which at the age of barely twenty years allowed her to take her degree as B.A. of the Sydney University.

"Before the third child, a boy, was born, the current of our life had changed a little. Visits to my own family and a change of residence to a distant colony, which involved a long journey, as well as the work which such changes involve, together with the care of my two older children, absorbed all my time and thoughts, and left little or no leisure for studious pursuits. My occupations were more mechanical than at any other time previous. This boy does not inherit the studious tastes of his sisters at all. He is intelligent and possesses most of the qualifications which will probably conduce to success in life, but he prefers any kind of outdoor work or handicraft to study. Had I been as alive then as I am now to the importance of these theories, I should have endeavoured to guard against this possibility; as it is, I always feel that it is perhaps my fault that one of the greatest pleasures of life has been debarred to him.

"But I must not weary you by so many personal details, and I trust you will not suspect me of vanity in thus bringing my own children under your notice. Suffice it to say that in every instance I can and do constantly trace what others might term coincidences, but which to me appear nothing but cause and effect in their several developments.

"I will pass on to quote a few passages from letters written to me by two highly intelligent mothers, whom I asked to give me their experiences on this subject, if they had any.

"Mrs. B—— says: 'I can trace, nay, have traced (in secret amusement often), something in every child of mine. Before the birth of my eldest girl I took to ornithology, for work and amusement, and did a great deal in taxidermy too. At the age of three years I find this youngster taking such insects and little animals as she could find, and puzzling me with hard questions as to what was inside them. Later on she used to be seen with a small knife, working and dissecting cleverly and with much care and skill at their *insides*. One day she brought me the tiniest heart of the tiniest lizard you could imagine, so small that I had to examine it through a glass, though she saw it without any artificial aid. By some means she got a young wallaby and made an apron with a pocket inside which she used to call her "pouch." This study of natural history is still of interest to her, though she lacks time and opportunities. Still, she always does a little dissecting when she gets a chance.'

"I never noticed anything about P—— for some years. Three months before he was born a friend, whom I will call Smith, was badly hurt, and was brought to my house to be nursed. I turned out the nursery and he lay there for three months. I nursed him until I could do so no longer, and then took lodgings in town for my confinement. Now after all these years I have discovered how this surgical nursing has left its mark. This boy is in his element when he can be of use in cases of accident, &c. He said to me quite lately, 'How I wish you had made a surgeon of me.' Then all at once the light flashed in upon me, but, alas! it was too late to remedy the mistake.

"Before the birth of the third child I passed ten of the happiest months of my life. We had a nice house, one side of which was covered with cloth of gold roses and bougainvillea, a garden with plenty of flowers, and a vineyard. Here we led an idyllic life, and did nothing but fish, catch butterflies, and paint them. At least, my husband painted them after I had caught them and mixed his colours. At the end of this time L—— was born. This child excels in artistic talent of many kinds, nothing comes amiss to her, and she draws remarkably well. She is of a bright, gay disposition, finding much happiness in life, even though not always placed in the most fortunate surroundings. Before the birth of my next child, N——, a daughter, I had a bad time. My husband fell ill of fever, and I had to nurse him without help or assistance of any kind. We had also losses by floods. I don't know how I got through that year, but I had no time for reading. N—— is the most prudent, economical girl I know. She is a splendid housekeeper and a good cook, and will work till she drops, but has no taste for reading, but seems to gain knowledge by suction."

If the preceding cases are fully and accurately stated they seem to afford grounds for further investigation. Changes in mode of life and in intellectual occupation are so frequent among all classes, that materials must exist for determining whether such changes during the prenatal period have any influence on the character of the offspring. The present communication may perhaps induce ladies who have undergone such changes, and who have large families, to state whether they can trace any corresponding effect on the character of their children.

ALFRED R. WALLACE.

Habits of South African Animals.

THE following extracts from a letter just received from Mr. R. R. Mortimer, of Hanover Road, Cape Colony, contain some observations which will, I think, be of interest to naturalists, and therefore worth recording in the pages of NATURE.

ALFRED R. WALLACE.

"Since reading 'Darwinism,' powers of observation have unconsciously been gained by me. Day by day nature has some phenomena quite new to me, which phenomena would probably never have been observed by me if I had not had the good fortune to have digested the principles of the Darwinian Theory so obviously explained by you. From the time of reading the book till now I have observed peculiarities of organic beings in this part of the world. These observances I will relate: (1) The first observation I particularly remember was in regard to a peculiar action of a small bird, indefinitely termed by Colonials, snipe. What their specific or proper name is I cannot say, since the title of naturalist is not claimed by me. These snipe in question, or individuals of the variety, made their nests on mounds of dung which were practically the accumulated refuse of old sheep kraals. The shape of the nest was simply a hole scooped out on top of a mound. The colour of the refuse was a variegated dark brown and black. The eggs of such birds fully corresponded in colouration with the environment or surroundings. As a means of concealment, the colouration of the eggs was perfect. It required an extreme amount of careful inspection and search to detect the eggs in a nest on such mounds. When you came across the nest, you would find it was perfectly open and uncovered by any material; therefore you would presume the owners of the nest distinctly relied upon the colouration of their eggs to defy detection. But if by chance you detected a nest, and the owners *were* present, by holding yourself perfectly immovable and stationary, one bird would immediately approach its nest, and gradually cover it by scooping dust over the eggs with the action of its feet.

"This recourse to hiding its nest from view is only adopted on extreme occasions, when their sense-action gives them the knowledge that the enemy present has perceived its contents, or the nest itself. . . .

"There must be a double selective agency in this mode of concealment at work. . . .

"As far as my knowledge goes, our so defined snipe generally frequent localities where water is present. Now the *same* variety in question do make their habitat on banks of rivers, or where water is to be found; yet here have I noticed individuals of the same variety diverge from the specific character, take up a new area, if even only temporarily, where their eggs can be laid with more safety. It is an indisputable fact that the colouration of the snipe eggs is in union and harmony with the environment as a means of protection, yet here we find individuals of the same variety possessing the last possible resort of concealing its eggs—namely, covering them over with a material so as to defy any minute detective powers.

"Surely the struggle for existence must, in this case, be extremely severe, and the principle of natural selection in full activity. . . .

"(2) Having had practical experience in farming with ostriches, and their domestication, I may say a few words on them.

"Ostriches have, so to say, no means of indirectly concealing their eggs; but the only means of concealing their nest is by their personal presence. The hen does her share of sitting in the daytime, her drab-coloured plumage being in harmony with the surroundings. The cock replaces her on the nest at evening time, sitting throughout the night, and generally on to 8 a.m., his black plumage corresponding with the shades of night; therefore you have some difficulty, sometimes very great, in detecting the nest of an ostrich. . . .

"In addition to this remarkable adaptation of sexual colouration, the cock takes the *rôle* of a guard patrolling up and down some distance off the nest. When he perceives that mischief is bent upon the eggs by the approach of a person, he almost invariably charges him, and, woe betide if the person is destitute of some means of defence. To deliberately go up to a nest in the presence of its lord without some weapon or means of protection is considered by Colonials to be the height of foolishness and ignorance.

"But invariably again, on the other hand, when you have succeeded so far in reaching the nest, and handling its eggs, the cock quiets down.

"He loses all his viciousness, falls down alongside the nest, gives vent to, apparently, appeals for mercy, by continuously flapping his wings against the ground and giving forth sounds by means of his beak, of a peculiar dull clicking character.

"Domestication has made ostriches feel less fear for human beings, at the same time giving a more vigorous character to their viciousness. . . .

"Some two years ago, among a troop of ostriches that were brought down to the farm where I was gaining my experience, there was one ostrich, a male bird in every respect in its external character and colouration of plumage. It was to *all* possible appearance a cock, and yet it had been seen on two occasions to be paired by a true cock ostrich. This particular ostrich was a hen, although she had every appearance of being a cock. What explanation could you give as regards this incongruity?

"(3) About six months ago I found a peculiar bird's nest suspended from the root of a mimosa tree which overlapped a bank of ground. Before going further, I must first tell you that previous to the occasion in question I noticed the same peculiar form of nest, but it seemed so utterly impossible at the time that it could be a nest, since its structure and mode of suspension had the exact characteristics of a certain structural spider's web, that I passed it by. But on the second occasion, to make absolutely sure that I had not made a mistake, I went up and cut the nest off, with a certain length of the root to which it was attached. Imagine my surprise, when I saw that it was really a bird's nest with two eggs. Now this nest was a *perfect* facsimile of a common spider's web and home, found in the locality where I was at the time staying.

"Since it was a marvellous imitation of an insect's habitat, there must have been some corresponding necessity for such imitation. Either the nest must have been designed and constructed, so as to delude enemies by which the species was liable to be attacked, or, it was so imitated, that the materials of which the nest was made should serve as a bait, and allow the parent birds to be able to feed their young without the necessity of having to leave the nest, and so be unable to protect their young for the time being. The materials from which the nest was made were practically webs abandoned by their original owners. It was an instance of perfect imitation."

Astronomical Photography.

THE announcement (NATURE, August 10), that it is in contemplation to raise a sum exceeding £2000 for the establishment of a special photographic telescope at the Cambridge Observatory, leads me to ask whether astronomers have duly considered the facilities afforded by modern photography. At the time of my early experience of the art, thirty-five years ago, it would have been thought a great feat to photograph the Fraunhofer lines in the yellow or red regions of the spectrum, although even then the statement so commonly made that chemical activity was limited to the blue and ultra-blue rays was quite unwarranted. With the earlier photographic processes the distinction was necessary between telescopes to be used with the eye or for photography. In the former case the focal length had to be a minimum for the yellow rays, in the latter for the blue rays of the spectrum.

But the situation is entirely changed. There is now no difficulty in preparing plates sensitive to all parts of the spectrum, witness the beautiful photographs of Rowland and Higgs. I have myself used "orthochromatic" plates in experiments when it was desirable to work with the same rays as most influence the eye. The interference bands of sodium light may be photographed with the utmost facility on plates sensitised in a bath containing cyanin.

The question that I wish to ask is whether the time has not come to accommodate the photographic plates to the telescopes, rather than the telescopes to the plates. It is possible that plates already in the market may not exactly meet the requirements of the case, but I feel sure that a tithe of the sums lavished upon instruments would put us in possession of plates suitable for object glasses that have been designed for visual purposes. There would be no difficulty even in studying the requirements of a particular instrument, over or under corrected as the case might be.

A doubt may arise whether plates so adjusted would be as sensitive as those now in use. Probably Captain Abney, or some other authority, could give the required information. For some astronomical purposes a moderate loss of sensitiveness could hardly be of much consequence; for others doubtless it would be a serious matter. RAYLEIGH.

Terling Place, Witham, August 15.

The Discussion on Quaternions.

I HAVE followed with much interest the discussion on quaternions which has with more or less intermission been going on in NATURE for a long time.

It has always appeared to me that the student of physical science would better employ his time by studying the "Ausdehnungslehre" to which some of your correspondents have referred than by studying quaternions.

The wonderful work of Grassman is contained in a moderate-sized book in remarkable contrast to the two terrific volumes of Hamilton, which even Prof. Tait admits that he has not read entirely. The fact that the ausdehnungslehre could be mastered in a mere fraction of the time that would have to be devoted to the mastery of quaternions, is not however the important point.

The ausdehnungslehre seems to afford a symbolism more fitted for the expression of many recondite conceptions in physics, than anything which quaternions has to offer. Even the "Nabla" does not insinuate itself into Nature's secrets more cunningly than does the "Inneres Produkt."

Perhaps I may give an instance, which if elementary will at all events illustrate the extraordinary directness with which the different kinds of "product" reach the heart of a physical conception.

Think of a mechanical system of any kind which possesses but a single degree of freedom, think of any system of forces whatever applied to that system, and consider the question of equilibrium. The possible movements of the system form twists about one screw chain, the system of forces form a wrench upon another screw chain. Equilibrium will subsist if, and only if, the "Inneres Produkt" of the two screw chains is zero. Suppose any system whatever possessing n degrees of freedom. Dynamics teaches that mutually destructive twist velocities can be imparted to any $n+1$ screw chains about which the system can twist. Does any conceivable symbolism assign those twist velocities more beautifully than the ausdehnungslehre? Each twist velocity is the "Kombinatorisches Produkt" of all the screw chains to which it does *not* correspond.

The aptitude of other conceptions of this grand calculus for physical problems could be as readily exemplified. But I forbear. Why has not some one ere this translated into English "Die Ausdehnungslehre von Hermann Grassman" 8vo, pp. 388, Berlin 1862? ROBERT S. BALL.

Observatory, Cambridge, August 18.

A Curious Optical Phenomenon.

DR. LAUDER BRUNTON has asked me to give you an account of a very curious phenomenon witnessed from the top of Gausta mountain (height 6000 Norwegian feet) in Telemarken, south of Norway.

We were a party of two ladies and three gentlemen on the summit of this mountain on August 4.

On the morning of that day the sky was passably clear; at noon there was a thick fog. Between six and seven o'clock in the afternoon (the wind being south to south-west) the fog suddenly cleared in places so that we could see the surrounding country in sunshine through the rifts. We mounted to the flagstaff in order to obtain a better view of the scenery, and there we at once observed in the fog, in an easterly direction, a double rainbow forming a complete circle and seeming to be 20 to 30 feet distant from us. In the middle of this we all appeared as black, erect, and nearly life-size silhouettes. The outlines of the silhouettes were so sharp that we could easily recognise the figures of each other, and every movement was reproduced. The head of each individual appeared to occupy the centre of the circle, and each of us seemed to be standing on the inner periphery of the rainbow. We estimated the inner radius of the circle to be 6 feet.

This phenomenon lasted several minutes, disappearing with the fogbank, to be reproduced in new fog three or four times, but each time more indistinctly.

The sunshine during the phenomenon seemed to us to be unusually bright.

Mr. Kielland-Torkildsen, president of the Telemarken Tourist Club, writes to me that the builder of the hut on the top of Gausta has twice seen spectacles of this kind, but in each case it was only the outline of the mountain that was reflected on the fog. He had never seen his own image, and he does not mention circular or other rainbows. A. WILLE.

Christiania, August 15.

Supposed Suicide of a Rattlesnake.

THE letter of Mr. E. S. Holden, of the Lick Observatory, in your issue for August 10, describing how a rattlesnake struck its fangs into itself, when confined in a gallon jar containing water, which was inverted at intervals in order to drown it, is open to question as to its conclusion that it was a case of "deliberate suicide," for the following reasons:—

(1) That it was after "the snake ceased any attempt to rise to the surface of the water in the jar," that the blow was struck. The snake then being wholly beneath the water, would die from drowning, and not from the self-inflicted wounds caused by its poisoned fangs.

(2) That it has been proved by experiment by Dr. Weir Mitchell that the venom of the rattlesnake is of no effect upon itself, when introduced into any wound in its body. I speak from memory of an article which appeared in the *Atlantic Monthly* some few years ago. That self-insertion of the poison would make any difference is not likely.

Drowning (by the act of others) and not self-poisoning (or suicide) I take to be the cause of death in the case described.

Halifax, August 15. W. H. Wood.

Numerous Insects Washed up by the Sea.

The phenomenon referred to under the above heading in your issue of August 17 may be in part accounted for by the fact that on August 7, at many spots in the neighbourhood of Godalming (S.W. Surrey), the air was thick for several hours with swarms of winged ants. The direction of the wind was from the north-west, force moderate. Assuming the like to have taken place at other places, it is quite possible that large numbers of ants may have been carried out to sea and drowned from this region of Surrey and Hampshire.

Hunstanton, August 19. Oswald H. Latter.

THE FUNGUS GARDENS OF CERTAIN SOUTH AMERICAN ANTS.

One of the most interesting papers that has appeared during the present year, whether considered from the point of view of general biology or of mycology, is that which has recently been published by Herr Alfred Möller, nephew of Dr. Fritz Müller.[1] The work was carried out at Blumenau during the years 1890–92, and presents a clear and thorough investigation into the habits of the leaf-cutting ants and their remarkable custom of cultivating and feeding upon certain fungi. The work is introduced by a quotation from Thos. Belt's "Naturalist in Nicaragua," where the author, speaking of the leaf-cutting ants, states: "I believe . . . . that they are in reality mushroom growers and eaters." This statement Möller fully proves in the work before us. The first portion, forming the bulk of the work, is given up to the consideration of the fungus gardens of the leaf-cutting ants, and is divided into ten sections.

1. *The species of the leaf-cutting ants and their activity outside of the nest.*—Belt's description[2] of the Nicaraguan ants is quoted, and the differences between them and those of Blumenau are pointed out. The chief point of difference is that the latter form very narrow streets, travelling only in single file, and that their nests occur both in the forest and in the open. The commonest species is *Atta* (*Acromyrmex*) *discigera*, Mayr, whose workers are never more than 6·5 mm. long. Almost as common is *A. hystrix*, Latr., whose workers reach a length of 9 mm. Rarer than these are *A. coronata*, Fabr., and a doubtful form, which Möller terms *Atta IV.*

A minute description is given of a street of *A. discigera*, which was 26 metres long and about 1·5 cm. wide and high, roofed in in parts wherever possible. It led to a number of small Cupheas, whose leaves the ants were cutting. In the street could be seen a procession of loaded ants going towards the nest, and others empty-handed, going in the opposite direction. Some of the large workers run up and down the road unloaded, and act as road-menders if any accident happens to a part of the track. Other very small workers, which do not cut leaves, may also be seen carried upon the backs or even upon the loads of the actual leaf-cutters. An ant carrying a peculiarly shaped piece of leaf was watched from end to end of the track, and travelled the 26 m. in 70 minutes. The load was twice as heavy as itself.

The other species of the Atta have very similar streets. *A. hystrix* appears to work only at night.

The jaws of the ants are very strong, with serrated edges, and clash together laterally. The ant begins at the edge of a leaf, and cuts out a piece in about five minutes, revolving on one of its hind legs as a centre. When the piece is almost freed, the ant goes on to the main portion of the leaf, cuts through the last piece uniting it with the severed portion, drags up the latter, balances it on edge between its forelegs, and then, grasping it with its jaws, lifts it up above its head, so that the centre of gravity of the load is above the ant itself. It then marches off, down the stem, to the base, over the ground to the end of the street, and along this to the nest, travelling at a very uniform speed, and never letting go its load. The weight thus carried was found, on an average, to be twice that of the ant; but many were found carrying heavier loads, even as much as ten times their own weight! A street of *A. coronata* was watched for fifteen minutes, during which time 217 ants passed, carrying 3 grammes of leaves.

2. *The Nests of the Ants, and the Fungus Gardens.*—The nests of *A. hystrix* and *A. discigera* are usually below the surface of the soil, but covered, wherever necessary, with a thick mass of withered pieces of leaves and twigs, &c. They may be as much as 1½ metres in diameter. In the nests of all four species there is found, filling up the interior, a curious grey spongy mass, full of chambers, like a coarse sponge, in which the ants may be seen running about, and in which, here and there, occur eggs, larvæ, and pupæ. This is the fungus garden, termed by Belt "ant-food." It is separated from the roof and lateral walls of the nest by a clear space. The walls and roof are much thicker in winter than in summer; one nest examined had a roof 25 cm. thick and wall 40 cm. Photographs are given in the original paper, showing the appearance of the mushroom garden.

3. *Investigation of the Gardens. The Kohl-rabi clumps.*—The garden consists of two parts, differently coloured, but not very sharply marked off from one another. The older part is yellowish-red in colour; the newly-built portions, forming the surface of the garden, are of a blue-black colour. It is this part which is of the greater importance to the ants.

The garden is found, on examination, to consist of an immense conglomeration of small round particles of not more than ·5 mm. in diameter, of a dark green colour when quite fresh, then blue-black, and finally yellowish-red. They are penetrated by, and enveloped in, white fungus hyphæ, which hold the particles together. These hyphæ are similar throughout the nest.

Strewn thickly upon the surface of the garden are seen round white bodies about ·25 mm. in diameter; they always occur in the nests, except in the very young portion of the gardens. They consist of aggregations of peculiar swollen hyphæ, and are termed by Möller the "Kohl-rabi clumps." The hyphæ swell out at the ends into large spherical thickenings, about 10–24 μ in diameter (the ordinary hyphæ are 5–8 μ thick), filled with richly vacuolated protoplasm like the ordinary hyphæ. These clumps of "Kohl-rabi" are only found on the surface of the garden, and form the principal food of the ants. A microscopic examination of the particles of which the garden is composed shows that they contain remains of leaves; bits of epidermis, stomata, spiral vessels, &c., occur in them.

4. *The Importance of the Garden to the Ants.*—If a nest be broken into and the garden scattered the ants collect

[1] "Die Pilzgärten einiger südamerikanischer Ameisen." Heft 6 of Schimper's "Botanische Mittheilungen aus den Tropen." (Jena: G. Fischer, 1893.)

[2] "Naturalist in Nicaragua," p. 71.

it as quickly as possible, especially the younger parts, taking as much trouble over it as over the larvæ. They also cover it up again as soon as possible to protect it from the light. A nest, 1 metre × 50 cm. was opened, and in twenty-four hours the ants had put on a new roof 10 cm. deep. They also carry the nest with them upon their migrations

5. *The Use of the Garden: its Construction and its Tendance observed in Captivity.*—Some ants' nests were placed under a bell jar and supplied with leaves; they made no use of them and presently died. If they were supplied with a piece of "garden," they rebuilt it and covered it so far as they could. It was seen to shrink from day to day, the ants bringing out the old pieces and adding them to the wall; finally it was exhausted and the ants died. Others were starved for five days, and then supplied with a bit of garden; they at once began to eat the Kohl-rabi clumps. It was found by this means that each species of Atta will eat the Kohl-rabi of the other three as well as its own. Finally, by supplying the ants with bits of garden, a damp sandy floor, and fresh leaves, they were induced to build in captivity. The dish in which they worked was covered by a glass lid, and when this was covered with a dark cloth or otherwise kept dark, the ants built under it without covering the garden. In this way the whole process was observed. An ant bringing in a piece of leaf proceeds to cut it into halves, repeating the process till it has got a very small piece left, which it holds between its fore feet and turns round, crushing it in its jaws until the whole is reduced to a round ball of pulp about ·25 mm. thick. This it then takes and adds to the garden. So well is the kneading performed that no single cell remains uninjured, and it was observed that the hyphæ of the fungus grew through and round one of these particles within a few hours. Belt supposed that this process was performed by the small workers above-mentioned, but it is not so, as we have just seen. The small workers perform the function of weeding the garden, and this is so well done that a portion of it removed and grown in a nutrient solution gives a perfectly pure culture, not even containing bacteria!

6. *Development of the Fungus after removal of the ants; the conidia, "pearl-hyphæ," and strand-swellings. Result of the artificial culture of the Fungus.*—If a portion of garden be left to itself in darkness, the ants having been removed, aerial-hyphæ develop in a thick mass several centimetres high, with many anastomoses; the Kohl-rabi clumps are used up in the process, apparently supplying material for it. The formation of conidia now takes place all over the mass. From a hypha there buds out a lateral projection, which bears branches arranged roughly in whorls: upon these are again borne whorls of small club-shaped branches, from whose ends are abstricted rows of conidia, whose diameter is 2 μ; there are, as a rule, not more than ten in a row. Occasionally the formation of the strings of conidia occurs not only on the final branches, but also on those of the preceding order. After the conidia are formed the mass collapses (about the fifth day).

About the third day a careful search reveals among the ordinary hyphæ a few which are covered, as with rows of pearls, with small spherical lateral protuberances. These "pearl-hyphæ" arise from the ordinary ones. The cavity of the "pearl" is in direct communication with that of the hypha itself, and contains protoplasm. In connection with these there occurs a second type of conidia formation, distinguished by Möller as the "weak" formation. There is no preliminary branching, the conidia being abstricted from the ends of the pearl hyphæ, or plain hyphæ in connection with them. The end of the hypha swells up and bears the conidiophores. The chains generally consist of at least twenty conidia.

Still a third form of hypha is to be found. Sooner or later there are observed on the garden thick white strands, which on examination are found to consist of hyphæ, which look like rows of beads, or yeast-chains, and are much bent, branched, and twisted. From these there arise pearl hyphæ, or we may find pearls upon these hyphæ themselves. These peculiar hyphæ arise first of all as "pearls" on ordinary hyphæ, and then a process of budding goes on, just like that which gives rise to yeast chains. The "pearls" might be looked upon as homologous with these lateral swellings of hyphæ, but there is also another view, that they represent rudimentary conidiophores. It has been seen above that the conidiophores in the "strong" conidia formation are not always confined to the ends of the hyphæ, but may at times appear further back, and it is suggested that originally they were borne anywhere upon the hyphæ, and subsequently restricted to the tips, the "pearls" then representing rudimentary conidiophores. The "pearl" hyphæ and weak conidia formation are usually found in connection with these swollen strands, and on one or two occasions a connection was found with the strong conidia formation.

When a few ants were left with a large piece of garden, they did their utmost to prevent the formation of these aerial hyphæ, &c., biting them off as they appeared, but gradually the fungus gained the upper hand of them. Proceeding now to the results of culture in nutrient solutions, the strong conidia germinate and give rise to hyphæ which ultimately bear strong conidia again. Never did the "weak" form appear, but very often from the main hypha there were given off lateral branches, some of which developed into rows of beads, like the hyphæ described above, and others swelled up at the ends just like the Kohl-rabi. The cultures being pure, these formations could not be pathological, produced by bacteria, as is sometimes the case.

Similarly the weak conidia gave rise only to conidia like themselves. Pearl-hyphæ were occasionally formed, and rarely the peculiar hyphæ like rows of beads.

When one of these forms was grown in one culture drop, and bent over into another drop, in which the other form was, the two anastomosed freely, showing that they belonged to the same plant.

When a portion of Kohl-rabi is grown in the solution it gives rise to ordinary hyphæ, which ultimately produce a new crop of Kohl-rabi. On one occasion it gave rise to pearl-hyphæ and weak conidia.

To sum up, the fungus has two conidia forms, which develop upon the garden in the absence of the ants. The mycelium shows a strongly marked tendency to the formation of swellings and protuberances, which appear in a different form, more or less distinctly marked. One of these, which has probably reached its present form under the cultivation and selection of the ants, is the Kohl-rabi.

7. *Discovery of the Highest Fructification of the Fungus.*—It being evident that the fungus was either a Basidiomycete or Ascomycete, attempts were made to obtain its principal fructification by cultivation, but in vain. A fortunate discovery, however, was made of a nest which had a huge red Amanita-like fungus growing out of it. This was found to belong to the genus *Rozites*, and the species was named *R. gongylophora*. The development of the basidia, &c., is given in detail, but need not be gone into here. Cultivation of the spores showed that this was indeed the fructification of the Kohl-rabi-forming fungus.

10. *Plants attacked by Leaf-cutting Ants.*—These were found to be very numerous, and no rule could be formulated as to the operations of the ants. On one day they would strip one plant and the next day leave it untouched, or *vice versâ*. An interesting case was observed in the cold weather. An army of leaf-cutters was found stripping a Cecropia, though the latter was inhabited at the time by its protecting ants! The latter appeared to be too numbed by the cold to go out and fight.

THE GARDENS OF THE HAIRY ANTS.

While working at the preceding it was discovered that somewhat similar fungus gardens occur in the nests of *Apterostigma.* Four species were studied. All have the same fungus, belonging apparently, however, to a different genus from *Rozites.* These hairy ants live in decaying wood and have small gardens 4-8 cm. in diameter, built of bits of wood-fibre, beetle-dung, &c. The chief point of interest is that though all have the same fungus yet all have not cultivated and selected the Kohl-rabi to the same degree. *A. Wasmanni,* Forel, has a well-developed type with large spherical swellings on the ends of the hyphæ. The others have Kohl-rabi of a much lower type, the hyphæ being only slightly swollen into a club shape, and they are not aggregated into regular groups.

It was, as usual, found impossible to obtain by artificial culture the highest fructification of the fungus, so its systematic position is still undetermined.

THE GARDENS OF CYPHOMYRMEX.

This genus of ants is closely related to the two preceding, and the two species examined (*C. auritus,* Mayr, and *C. strigatus,* Mayr) are also fungus-growers. Both form nests like those of Apterostigma, and use similar material in the garden. The two species have the same fungus, but *C. strigatus* obtains far finer Kohl-rabi than *C. auritus,* just as we have seen to be the case with the species of Apterostigma. It is thus pretty evident that the large size of the best Kohl-rabi must be due to selection and cultivation on the part of the ants.

The concluding pages of the work are taken up by a discussion of the mycological results of these investigations, for which reference must be made to the original. The work is illustrated by beautiful plates, and forms as a whole one of the most fascinating contributions to botanical literature that have been made for many years.

JOHN C. WILLIS.

A FEW REMARKS ON INSECT PREVALENCE DURING THE SUMMER OF 1893.

WE are hearing a great deal just now of unusual amount of insect presence, and there appears no reason to doubt that such is very much the case, although for scientific use we need much more of reliable report than we possess as to what kinds of insects are noticeably more present than in seasons of ordinary meteorological conditions, and also we need observations as to what kinds may be unusually absent.

So far as my own acquaintance with the subject (which is mainly in reference to amount of presence of crop insects) allows me to judge, these unusually large amounts where they occur—for the superabundance does not affect all kinds—may be attributed to weather influence acting either directly on the development of the insects themselves, or so affecting the state of their crop-food-plants as to induce the conditions which we know well by the agricultural experience of many years are favourable to establishment of infestation.

The important preliminary as to there having been really such a definite deficiency in rainfall as to amount to what may be called "a drought" over England and Wales, we have stated shortly in the *Monthly Meteorological Magazine,* of Mr. G. J. Symons, F.R.S., No. cccxxxi., p. 98, as follows :—"Assuming that the twenty-four stations fairly represent England and Wales, we find that in March the rainfall was only one-third of the average, in April one-sixth, in May three-quarters, and in June two-thirds." Mr. Symons further points out that "this, of course, is taking the country as a whole ; at many individual stations the results would be much more striking, *e.g.* at Bodmin in the three months" (March to May) "only one fifth of the average fell."

Amongst insect attacks especially subject to increase by stunting of growth, or over-maturation of sap of thei food plants, are those of the Aphides or Plant Lice which have been—so far as my own contributors' report show—unusually early and prevalent this year. They were forwarded on mangolds from Devonshire almost a soon as there could be said to be good accommodation for attack on the leafage, and turnips and cabbage leafage damson early in the season, and larch later on the bor ders of England and Scotland, were some of the tree and food plant habitats which were exceptionally afflicted These prevalences agree with the rule of Aphis life laid down by Mr. G. B. Buckton, F.R.S., our great authority on Aphis life. In drawing attention to the abnormally rapid increase of Aphides under some circumstances, he accounts for it by maturity (*i.e.* power of reproduction taking place earlier in the life stage where from various causes inducing want of supply of nutriment, structura changes occur consequently on these in the larvæ of th Aphides subsequently born. (See "Brit. Aphides," b G. B. Buckton, F.R S., vol. i. p. 72).

Besides the above reasons for increase, we have als the negative reason of absence of destruction by goo drenching rains to wash off and often to drown th enemy. One of my correspondents wrote me that he ha been doing this or that, but the best help was the we come rain.

The above may be taken as a type of one way in whic weather influence acts ; in the case of wasps, which pop larly represent much of insect presence to the world a large, we have another set of influences.

Our recent drought began in March. In many year we have the most variable weather at this season and the queen wasps, the foundresses of the comm colonies, being tempted from their winter localities o hybernation by a day or two's warmth, are caught, it ma be, by heavy rain, or by snow, or by frost, and peris This year weather was more favourable to them, and w had not the drenching rains which in an ordinary ye put an end to many an embryo nest with its few grub whether in ground or hedge. The first commencemen formed of a tiny piece of paper, in shape like an um brella, with beneath it a pendant ending in a club forme of a few cells, each with its egg or young maggot tenan is delicate in the extreme. If the cavity in which it placed in the ground is flooded, its destruction is certai or if in storms the foundress cannot return to feed th young family they must perish.

In the case of wasps, probably weather influence which affect amount of any particular kind of food are a little troublesome as to any insect. All who at all stu their habits are aware that flesh, fish, insects to a larg amount, and fruit to utter rapacity of consumption, a constantly utilised by them for their own special suppo or that of the maggot family. To what extent the ad wasps may feed on other than vegetable matter I cann say, but dissection and examination of the undigeste food in the blind pouch of the food canal of the larv wasp has shown this to consist of remains both of anim and vegetable matter ; in the record before me chiefly insect *débris.* Their varied kind of food and their wo derful adaptability of instinct in making adverse c cumstances suitable for the household needs, make th wasp family when once established, most prolific pests

The great prevalence of what are called surface cat pillars, that is, the larvæ of various kinds of Agrotis the roots of various kinds of field crops, gives an examp of increase of presence of the Lepidoptera, under circu stances favourable to the development of the imago fr the chrysalis, and subsequently to the pairing of t moths and successful egg deposit. In wet and ch weather, when the moths hang about torpidly, a certa proportion of them get drenched, so that their wings a of little service ; the larvæ are injured in different wa or disease induced, much influencing amount of presen

In the past season such attacks as that of the great caterpillars (four inches or more in length) of the Lappet Moth, the *Gastropacha quercifolia* scientifically, to apple leafage; or again, the presence of caterpillars of the little *Pyralis glaucinalis* might reasonably be supposed to be influenced by weather. In the first case, the great size of the larva feeding on the leafy twig exposes it much to alternations of weather, and in the second, where, as in the samples sent me, the infestation was located in the outer part of fodder stacks, the penetration of wet which might soak the filmy cocoons with their developing contents, would cause conditions very different to the long-continued appearances of the present summer.

To go through the different orders of insects, specially represented, or the different dates and amounts of their appearance on the crops, would be too long here, but I can safely say that whilst the drought lasted I had constant applications regarding insect appearances, including a much greater variety than usual of kinds little observed in ordinary years, and in some cases unusual amount of presence of our common kinds.

Various representatives of the Acarina, as the currant, pear, and plum Phytopti were of course largely noticed, as also the Phytopti (or gall mites) of the hazel buds, of which the galls loaded the hazel boughs in this neighbourhood early in May to a degree I have never before seen. The kind of (so-called) "red spider" (*Bryobia prætiosa*) which ordinarily is chiefly found on ivy, extended its injurious presence so widely to gooseberry leafage as to necessitate careful, and happily successful, measures to get it under.

Why, with all this, various crop insect attacks were less reported than customarily remains uncertain. Corn Aphides as yet have not been complained of. Possibly this is by reason of the heat hardening the ears so that they were in a condition to withstand attack before the Aphides arrived on the heads to endeavour to pierce into them with their suckers. In countries where the climatal conditions can be counted on, this point (of arranging date of crop so as to protect itself from attack) is one of the regular methods of prevention. Another infestation which threatened to be very troublesome, but of which the second brood did not make any noteworthy appearance in various places, is that of the mustard beetle. Why this should be so I am as entirely at a loss to explain as the crop inspector who reported the state of things to me.

Various other absences of attack remain also unexplained, but are duly noted for possible future service in agricultural entomology.

So far as I can gather from contribution of my own correspondents, or other accessible sources of information, I should consider that such extra amount of insect presence as has occurred, has been owing to weather influence. We have had earlier and more numerous development of many kinds, and also in the case of various common crop insect pests, the hardness of the soil, and other conditions incident to drought, which made it totally impossible to bring either stimulating dressings, or mechanical measures to bear, necessitated our permitting increase to go on unchecked in some cases, and in some, though the caterpillars just below the surface of the ground necessarily did not themselves multiply, their unattainable legions swelled the numbers of observable pests, and probably will supply us a plentiful brood of moths for further continuation of species.

There does not appear to be any reason from previous circumstances, or from importations, to consider that we were suffering from other than the ordinary attacks, which, in a changeable climate like ours, must be changeable in their amounts; at least, so it appears to me from such an amount of report as I possess.

ELEANOR A. ORMEROD.

THE GREAT HEAT OF AUGUST 8 TO 18.

AN extraordinary wave of high temperature passed over this country between the 8th and 18th of this month, which has also been remarkable on account of the continuance of the heat during several consecutive days. High temperatures were experienced in all parts of the United Kingdom, but more especially in the southern and eastern portions of the country. The following table shows their distribution as represented by the stations included in the *Daily Weather Report*:—

Stations.	Days with temperature of 75° or more.	Days with temperature of 80° or more.	Days with temperature of 85° or more.	Days with temperature of 90° or more.	Days with temperature of 75°–90° or more.	Maximum temperature.	Date.
Leith	5	—	1	—	6	85°	15
North Shields ...	3	2	—	—	5	83	18
York	5	4	1	—	10	86	18
Loughborough ...	1	4	5	1	11	91	18
Liverpool	4	2	1	—	7	85	17
Parsonstown	5	2	—	—	7	82	14 and 16
London	—	4	4	3	11	93	18
Oxford	4	2	5	—	11	89	17 and 18
Cambridge	3	2	4	2	11	92	18
Jersey	4	4	3	—	11	89	17

A glance at this table shows that at Loughborough, Oxford, Cambridge, London, and the Channel Islands the temperature reached or exceeded 75° on every day of the period in question, the maxima reaching 91° at Loughborough on the 18th, 89° at Oxford on the 17th and 18th, 92° at Cambridge on the 18th, 93° in London on the 18th, and 89° at Jersey on the 17th.

At Greenwich the temperature exceeded 80° on each successive day from the 8th to the 18th inclusive, the highest readings being 93° on the 16th, 94°·2 on the 17th, and 95°·1 on the 18th. The last reading has only been exceeded twice at any time of the year during the last half-century, viz., 96°·6 on July 22, 1868, and 97°·1 on July 15, 1881. The highest reading in the sun during the eleven days in question was 146°·2 on the 18th, but this temperature was slightly exceeded in June last. Mr. Symons states that, on the 18th instant, the thermometer at his station at Camden Town registered 93°·6, which has only once been exceeded during thirty-six years (1858–93), viz., on July 15, 1881, when it read one degree higher; the present is the only year with a maximum shade temperature above 90° for three consecutive days. On the night of the 17th instant the minimum temperature in South London was as high as 72°, being rather above the average maximum temperature for the month of August, and the daily mean, as deduced from the maximum and minimum readings in the *Daily Weather Report* for the 18th, was 82°·5; this mean value is probably the highest on record since trustworthy observations have been taken. In a valuable paper recently read by Mr. Ellis before the Royal Meteorological Society, the average mean temperature at Greenwich for that day is given as 62°·5.

On the Continent the highest readings quoted in the *Daily Weather Report* were 102° and 106° at Rochefort in France on the 13th and 14th instant, while the maximum readings there reached or exceeded 90° on seven consecutive days. In the South of France the temperature exceeded 80° on each day of the period in question, 100° being recorded at Biarritz on the 17th.

The Weather Charts published by the Meteorological

Office during this period show that the conditions were mostly anti-cyclonic, both over this country and the Continent, with the exception of a depression in the south-west, which caused some sharp thunderstorms on the 9th and 10th. On the 18th another depression appeared off our north-west coasts, causing a gale in those parts, while strong winds and lightning occurred generally, with heavy rain in the west. These conditions checked the excessive heat; on the 19th the maximum temperature in London was 15°, and at Paris 25°, lower than on the previous day.

A SENSITIVE SPHEROMETER.

THE ordinary spherometer has three arms carrying three fixed points, with a point moved by a screw in the centre. This form is an improvement on the original spherometer invented by Andrew Ross, and for which the Society of Arts gave him a silver medal in 1841.

A description of Ross's instrument is given by Holtzapffel, vol. iii. p. 1271 of his work on "Turning and Mechanical Manipulation," extracted from vol. liii. of the Transactions of the Society of Arts. This instrument could measure to $\frac{1}{1000}$ of an inch, and by estimation half this amount. An ordinary spherometer, with a screw of $\frac{1}{100}$ of an inch pitch and head divided to hundredths, will measure to $\frac{1}{10000}$ of an inch.

I pointed out in vol. l. page 145, of the Memoirs of the Royal Astronomical Society that the sensitiveness of the ordinary spherometer was much increased by placing the screw not in the centre, but in one of the arms in place of one of the fixed points; this at once increased the sensitiveness of the screw in proportion to the distance of the screw from the nearest fixed point, and this fixed point from a line joining the other two fixed points.

The improvement I wish to bring before those interested in spherometers by this note, is the extension of this principle, for by carrying the middle point much nearer the line joining the other two, a proportionate increase of sensitiveness is obtained.

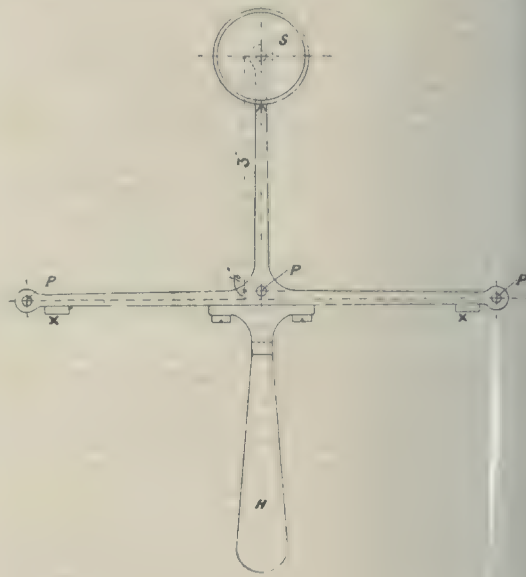
In the case of an instrument I have made on this plan I have increased the sensitiveness thirty times, the distance from the middle point to the screw being three inches, and the distance of the point from the line of the other two being $\frac{1}{10}$ of an inch; with a screw of one hundred threads to the inch and a head divided to hundredths, the ordinary form of instrument will read to $\frac{1}{10000}$, but on the plan I give, the same screw will measure $\frac{1}{300000}$ of an inch.

There is an additional advantage in this form, that the curvature of a part nearly in a line is measured, so that cross measures can be taken.

The form of the instrument is not symmetrical, and it requires to be balanced, so that when the screw is raised it will be possible to estimate the frictional contact of the outside points when the middle one is taking the weight. This balancing is easily done by adding a handle to the part opposite the arm carrying the screw; in practice it is found that this handle is of the greatest value in keeping the heat of the hand from the instrument, as even with the ordinary instrument, holding it for a short time in the hand alters the readings materially.

It is of great advantage to have on the arms carrying the two outer pins two pieces of wood or ivory projecting not quite as much as the measuring points, so that by tilting the instrument up these two pieces come first into contact with the surface to be measured, then by gradually raising the handle the points are brought gently into contact. The figure is a plan of this spherometer, and shows the position of the three fixed points P P P with reference to the measuring screw S, and the position of the balancing handle H with reference to the unsymmetrical arm carrying the measuring screw; X X are the projecting pieces already mentioned.

The movement of the screw being so large for a slight curvature, this instrument is more particularly useful for measuring the slight curvatures of so-called plane mirrors,



PLAN

for which, indeed, it was designed. To make it available for measuring differences between parts of a curved surface of considerable curvature the middle pin should be a screw capable of movement to, and clamping, in a position, that will allow the measuring screw to work.

A. A. COMMON.

JEAN DANIEL COLLADON.

DANIEL COLLADON, the celebrated physicist and engineer, died on June 30, at Cologny, near Geneva.

Colladon was born at Geneva, December 15, 1802. He belonged to a Protestant family from Berry, which removed from France, in the middle of the sixteenth century, on account of religious persecutions, and found refuge in Calvin's town. Many a distinguished magistrate came from this family, amongst others the learned juris-consult, Germain Colladon.

While still quite young Colladon proved to be wonderfully intelligent, and had a remarkably observant mind.

He went through the College and then the Academy of Geneva, which at that time had, among its professors, A. P. de Candolle, M. Aug. Pictet, Th. de Saussure and Prevost. His liking for science could not but develop itself in contact with these eminent men, whose esteem he soon gained.

At the age of ten years he made friends with Charles Sturm, who became a noted mathematician, and was on later occasions his fellow-worker. His inventive nature and talent for experimental inquiry turned itself above all to physics and its mechanical applications.

He was just twenty-two when he received from the Society of Science of Lille a first prize for the invention of a new photometer. At twenty-three he went to finish his studies at Paris. He lived there for about ten years, leading a simple life, almost entirely devoted to work.

He was received in a most flattering manner for such a young man by the pleiades of celebrated men, which the great town then possessed; Arago, Dulong, Fresnel, Fourier, Ampère. He made true friends with many of them, and had the honour of being a fellow-worker of the two last. At Paris he found the old friend of his childhood, Sturm, with whom, in 1826, he made the wonderful experiments on the Lake of Geneva, relating to "the velocity of sound in water," which united their two names so admirably in all treatises on physics, and which won for them the grand prize of the Institute of France.

By the side of these classical researches, Colladon's first works deal chiefly with electricity. In 1826 he published his experiments made at the College of France, with a galvanometer of his own invention, on the magnetic actions which ordinary electrical machines, Leyden batteries, and atmospheric electricity produce on the magnetic needle. He studied the electrodynamic actions with Ampère, and the conductivity of thin bodies for heat with Fourier.

The celebrity which he had acquired for himself at Paris by his works led to his being asked by the founders of the Central School of Art and Manufacture to join them, and to give a special course of lectures on the steam-engines and their use, which he did with much success from 1831 to 1834. He also made numerous researches and inventions relating to steam-engines. In 1844 the Lords of the English Admiralty adopted a dynamometer which he invented to measure the effective power of steam-engines for navigation, and which he was charged to make at the Royal Arsenal of Woolwich at the cost of the Admiralty.

In spite of the honourable place which he had attained at Paris in the world of science and industry, Colladon, was so attached to his country, that he gave up the many advantages which would accrue from a residence in France, and settled at Geneva in 1834. He proved himself on many occasions most useful in the debates of the little Republic, and was made Professor of the Academy in 1839.

In 1852 he rendered to the industry of his country the great service of representing it at the first Universal Exhibition in London, where he was delegated by the Federal Council as Commissioner for Switzerland.

He took part in two juries relating respectively to physical instruments and clocks. The most diverse branches of industry excited the interest and research of his fruitful mind. One to which he gave most of his attention was illumination by gas. In 1844 he was appointed engineer of the new gas company at Geneva. He invented a great number of improvements in gas-lighting, and the wonderful competence that he acquired has contributed largely to establishing a great number of enterprises of the same sort both in Switzerland and abroad. It was on this account that he was charged to superintend the installation of the Gas Society at Naples.

Hydraulics occupied him on many occasions; he studied the water supply of towns, and invented floating hydraulic wheels with the paddles below. It was he who discovered the ingenious way of lighting a liquid tube from within, by introducing, as it were, with the water a luminous ray, which remains imprisoned by the effects of totally multiple reflections, and illuminates the whole length of the liquid cylinder. The luminous fountain, or, as it is often called, "the Colladon fountain," originated from this delicate experiment. It formed one of the most beautiful ornaments at the Universal Exhibition at Paris, and was tried on a larger scale for the first time at the exhibition of Glasgow in 1884.

But these are not the inventions which render great the name of their inventor; the one which merits this honour, and to which the name of Colladon must ever be united, is that of the use of compressed air for the transference of energy. Profiting by the resources which he had at his disposal as engineer of the gas works at Geneva, from 1849 he made essays on the circulation of compressed gas in pipes, and he demonstrated the possibility of transmitting with economy a considerable energy for a long distance in narrow pipes. It is easy to understand the immense importance in the construction of long tunnels of transmitting energy by compressed air, for with the impulse given to the boring machine, fresh air is brought at the same time to the workmen at the end of the deep galleries. It is this idea, as simple as it is beautiful, which constitutes Colladon's claim to glory; this invention which must immortalise his name: it is this which makes it possible to construct the great subterranean passage which honour our generation, and which have made him one of the benefactors of our time. After the first studies for the tunnel of Mont Cenis, in December, 1852, he gave an excellent memoir on the subject to the Financial Minister of the Italian State, which was followed by a request for a patent for the new processes.

This important memoir, transmitted by the Italian Government to the Royal Academy of Science at Turin, was the object of a special report addressed to the Minister, and it concluded thus:

"The author does not limit his memoir to a simple description of the proposed scheme, but he shows the applicability by theoretical considerations. The commission recognises above all the vast importance the inventions of Monsieur Colladon could be in hastening the construction of the railways destined to cross the Alps." The splendid invention of Colladon was applied with much success by the Italian engineers at the construction of the Mont Cenis tunnel, and it made its reputation there, but all the honour belongs to the discoverer. If Colladon had not the pleasure of making the first applications of his invention, and if he had to leave to others the honour of making the first sub-alpine tunnel, he was able at least to give his ideas full development in the making of the St. Gothard tunnel, by the installation of the powerful compressors at Goeschenen and Airolo, which he executed for the enterprise directed by L. Favre.

Colladon was one of the first specialists in the art of constructing tunnels. It is owing to this that in 1878 he was made a member of the committee connected with the tunnel under the Channel. He was also very busily occupied studying out the boring of the Simplon.

We cannot in this short notice give a complete idea of the greatness, and fruitfulness of Colladon's career. Suffice it to mention his researches on the electricity of the torpedo, atmospheric electricity, the effect of lightning on trees, snow and hail, waterspouts, the use of steam for putting out fires, and on the terraces surrounding the Lake of Geneva.

Colladon had such a many-sided mind, that he could interest himself with the most diverse questions, and he studied them all with remarkable care and conscientiousness. Absolutely disinterested, he worked for the advancement of science, without pushing his inventions for his own profit. On the contrary, he was always at the service of others, and always ready to help them with his advice and assistance without any remuneration.

He was a great worker and was willing to assist others until the last years of his admirable life. He died at the age of ninety-one, preserving nearly to the last the use of his fine and noble faculties. His reputation had extended itself far and wide, and a great number of learned societies of all parts of the world counted him among the number of their members.

Ed. Sarasin.

NOTES.

We learn that Dr. J. W. Gregory arrived at Mombasa on August 19, after a successful expedition to Lake Baringo. He returned *via* Likipia and Mount Kenia, and ascended the latter to a height of more than 17000 feet. Dr. Gregory has explored the glaciers and the head-streams of the Tana, and the watersheds between the Tana and Athi rivers.

THE death is announced of Prof. G. W. Coakley, who for thirty-three years occupied the chair of mathematics and astronomy in New York University. He was born on the island of St. Bartholomew on February 22, 1814, entered Rutgers College in 1832, and graduated in 1836. In 1843 he was made professor of mathematics and astronomy in St. James's College, Indiana, where he remained until 1860, when he accepted the same professorship in New York University, filling the chair vacated by Prof. Loomis, who had gone to Yale University. He held this chair in New York University until his death, and was engaged in active teaching until his 77th year.

A REUTER'S telegram from Halifax, Nova Scotia, states that a terrific hurricane swept over the Maritime Provinces on August 21, and was the worst that has occurred since the great storm thirty years ago. In Halifax a vessel was sunk in dock, trees were uprooted, and the electrical systems were wrecked.

ON August 25 Prof. J. Victor Carus, the editor of the *Zoologische Anzeiger*, will celebrate his seventieth birthday. In honour of the occasion, the current number of that journal contains a remarkably fine portrait of the renowned zoologist.

THE Board of Agriculture notify that arrangements have recently been made by which the latest issues of the Ordnance Survey maps on the 1 in. and 6 in. scales have been made available for inspection by the public at the offices of the Board, at 3, St. James's Square. Changes in the boundaries of boroughs, of local government districts, and of parishes will be recorded on the 6 in. maps as soon as possible after they have been authorised, and a complete set of the index maps and indices of all Ordnance Survey maps and publications will be kept in hand for reference. It is believed that the facilities for inspection thus afforded will be found to be of general public utility.

THE *Times* gives some details received from Japan with regard to the recent volcanic eruptions in the Fukushima district, in the mountains of which Bandaisan, where there was a destructive eruption a few years ago, is the chief. The disturbances began with an earthquake early in the afternoon of June 4, which was followed by an eruption of Azuma-Yama the next morning. Other peaks in the neighbourhood became active, and the showers of stones and ash did much damage, especially to the mulberry trees of the district. It was decided to investigate the mountains, and two members of the geological bureau of the Agricultural Department were despatched from the capital for the purpose. They ascended Azuma-Yama very early on the morning of June 6 with the view of making observations in the immediate vicinity of the craters, and the same night reported to the authorities in the capital that, when they ascended, volcanic ash was falling and strong puffs of black cloud were escaping from time to time. They were able to make a circuit of the craters, from one of which dense volumes of vapour and ash were being emitted and from another heated air only. Whenever part of the sides gave way and fell in, the volume of vapour increased and a rumbling noise was heard. Heated fragments of rock were thrown out from time to time. On the morning of June 7 two students of the University of Japan and two engineers ascended the volcano. A violent eruption occurred while the party were approaching the crater. A dense column of gas arose, and was accompanied by a shower of rock fragments. After the explosion it was found that the two engineers had been overcome by the fumes. Attempts were made to rescue them, but they unfortunately failed. It was not until the following day that the neighbourhood of the crater could be searched and the bodies recovered.

THE *Journal* of the College of Science, Imperial University, Japan, Vol. V. Part IV., contains a paper by Prof. B. Koto "On the Cause of the Great Earthquake in Central Japan, 1891." Prof. Koto has examined a great line of fault which traverses a distance of 112 kilometres from the Kisogawa to the city of Fukui, through the Neo valley, cutting the hills, mountains, and plains alike with remarkable regularity and sharpness. He is of the opinion that the entire region on one side of the line of fault moved downwards in October, 1891, and was also shifted horizontally towards the north-west for from one to two metres along the plane of dislocation, thereby causing the earthquake.

MR. J. D. McGUIRE has, during the last two years, been endeavouring to reproduce aboriginal methods of work, chiefly in stone, with tools of stone, wood, and bone, such as are found in village sites in America and Europe, as well as with tools found in graves, and those used by races living in savagery. He describes his experiments in a paper "On the Evolution of Working in Stone," that appeared in the *American Anthropologist* for July. The experiments show that the art of grinding and battering stone must have preceded that of chipping, and that neolithic implements which are supposed to have taken years to fashion were really but the work of a few hours.

WRITING in the *Journal* of the Polynesian Society, Miss Teuira Henry, of Honolulu, says that a strange ceremony used to be practised by the heathen priests at Raiates, but can now only be performed by two descendants of priests, Tupua and Taero by name. This ceremony consisted in causing people to walk in procession over a hot earth-oven, without any preparation upon their feet, whether barefooted or shod, yet upon their emergence they did not even smell of fire. The ovens are frequently thirty feet in diameter, and are filled with roots of the *ti*-plant (*Dracaena terminalis*) and short pieces of *ape*-root (*Arum costatum*). It is hoped that some one will endeavour to solve the mystery of the feat while those men who practise it still live.

THE U.S. National Museum have published a report by Mr. Romyn Hitchcock on "The Ancient Burial Mounds of Japan," illustrated by ten excellent plates, mostly reproduced from original photographs. Mr. Hitchcock visited Japan with Mr. W. Gowland, who has spent several years in the study of the Japanese mounds. One of the earliest modes of burial in Japan was in artificial caves, hewn out of the solid rock on hillsides. It has been said that the early Japanese were cave-dwellers, but Mr. Hitchcock thinks this is very doubtful, for the reason that natural caves are not found where the history of the people begins, in Idzumo and Yamato. The examination of both natural and artificial caves indicates, at any rate, that the Japanese have not been cave-dwellers since their migration to Japan. Four distinct methods of burial have prevailed in Japan at different periods, which are distinguished by Mr. Hitchcock as follows:—(1) Burial in artificial caves. (2) Burial in simple mounds of earth. (3) Burial in mounds with rock chambers, or dolmens. (4) Burials in double mounds, or imperial tumuli. The chronological sequence of these different modes of burial is a matter of speculation, but, in all probability, the caves preceded in time the rock-built dolmens. No inscription remains, however, to enable ethnologists to solve the origin of the custom of cave-burial. A variety of articles were obtained from the mounds by Mr. Hitchcock, notably vessels of pottery of various shapes, illustrations of which accompany his report. The forms and style of decoration of these vessels are very rude; in fact it is pointed out that the decoration is much less elaborate than that found on the older pottery of the shell-heaps and pits of Yezo, and usually designated as Aino pottery. As Mr. Hitchcock remarks, it is difficult to explain the curious anomaly that the early pottery of a people who are famed at the present day for their productions in this kind of handiwork, should be inferior to the earlier productions of their predecessors, who have since absolutely lost the art of making pottery of any kind.

IT was Lœffler who most successfully exhibited in stained preparations the cilia or organs of locomotion attached to some micro-organisms. As is well known, these appendages will not stain in the usual manner, and special methods have to be adopted. Moreover, they are so delicate and easily broken or detached that the greatest care and skill have to be exercised in their demonstration. Lœffler's method consists in using a mordant, to which a certain proportion of either an acid or alkali is added, the nature as well as the proportion of the latter varying with the particular microbe under investigation. To ascertain the exact quantity required in each case is of course a very tedious process, but recent investigations have shown that the acid or alkaline reaction of the mordant may be neglected, and that equally successful specimens can be prepared when this precaution is altogether omitted. A very simple modification of Lœffler's method devised by Nicolle and Morax is published in the *Annales de l'Institut Pasteur*, July 1893, p. 554. These authors dilute a small quantity of a recent culture in water, and run a fraction of it on to cover-glasses and allow it to dry. Lœffler's fuchsin ink or mordant is then applied, heated over a small flame until it begins to steam, and then washed. This process is repeated three or four times, after which the preparation may be stained with an ordinary aqueous solution of violet and examined in the usual manner. It is stated that by thus substituting the application of the mordant three or four times for the once recommended by Lœffler, equally good results were obtained without the addition of either an acid or alkali.

AN elaborate investigation into the chemical and bacterial condition of the river Elbe at Magdeburg has been recently carried out, and the results are published in the part issued in July of the *Arbeiten a. d. Kaiserlichen Gesundheitsamte*, vol. viii. 1893. The Elbe at the intake of the Magdeburg waterworks contained on November 10, 1891, as much as 34·3 parts of chlorine per 100,000. This large proportion of chlorine sinks into insignificance when contrasted with the 130·3 parts per 100,000 present in the Saale one kilometre above its junction with the Elbe. The Saale receives the drainage from numerous potash and other works, and the waste water from one of these was found to contain as much as 656·4 parts of chlorine per 100,000, so that the brackish state of both these rivers is easily explained. Ohlmüller, who is responsible for the report, states that unless the intake of the Magdeburg water-works is removed to a more suitable spot there is every probability of the Elbe water becoming undrinkable, in spite of the exhaustive and careful filtration to which it is submitted before distribution, in consequence of its brackish taste. But another consideration also enters into the question of the desirability of this water for dietetic purposes, for the saline condition of a given water acquires a new significance since the important discovery that the cholera organism thrives luxuriantly and multiplies abundantly in water and other media containing a high percentage of salt. That the water of the Elbe remains brackish even when it reaches Hamburg was shown by chemical analyses made of this water during the cholera epidemic last year, and Percy Frankland states (*British Medical Journal*, July 29, 1893, p. 251) that he found 31·3 parts of chlorine per 100,000 in the sample which he examined. Hueppe, in his report on the Hamburg epidemic, mentions especially the salt taste which the water had. That other bacteria can also flourish in this brackish water is exhibited by the large numbers present in the Saale, there being as many as 40,440 in 1 c.c. of water abstracted about one kilometre above the point where this river joins the Elbe.

HERR A. HASEMANN suggests, in the current number of the *Zeitschrift für Instrumentenkunde*, a novel suspension for pendulums which appears to merit some further investigation. In the ordinary suspension of a knife-edge turning on a plane, a high magnification would show us a flattened cylinder working in a depression in the plane due to the elastic yielding of the material. This introduces friction and the sliding action discovered by Defforges. Herr Hasemann proposes to rest the knife-edge upon another, or rather to give both the knife-edge and its support a semi-cylindrical form. In that case the junction of the two surfaces is a plane, and for the same angle of swing the displacement of the surface of contact is much smaller. In the experiments undertaken to test this arrangement, the difficulty anticipated with regard to stability was found to be very much less than one might be led to suppose.

LORD KELVIN'S new series of electrical measuring instruments are described by Mr. Andrew Meikle in the *Electrician*. The chief representatives of this class of instruments are the recording electricity meter and the dial voltmeter. In the former, which is chiefly intended to measure the energy consumed in electric-lighting circuits, the whole current is sent through a stout coil consisting of a few turns of a copper spiral. Within this coil is suspended a vertical electromagnet made of a soft iron core wound with wire conveying a subsidiary current of $\frac{1}{10}$ ampere, which is 25 per cent. more than is sufficient for saturation. The position of this electro-magnet within the coil is recorded by an intermittent counting mechanism worked by a cam. The large dial voltmeter made for the Edison Electric Illuminating Company, of New York, depends upon the pull of a solenoid upon a suspended electromagnet as in the first instrument, but here the electromagnet is wound with 30,000 turns of fine copper wire, the current under investigation being conveyed to the coil by the spiral springs by which it is suspended. The resistance of the electromagnet coil is 1500 ohms, and the core is saturated by $\frac{1}{25}$ ampere. Electromotive forces of 60 volts and upwards are therefore measured free of residual errors. Attached to the electromagnet is a ratchet which is geared into a pinion wheel on the shaft carrying the pointer, thus giving the instrument a great resemblance with the aneroid barometer. A rod carrying two discs is screwed into the lower end of the electromagnet, and the discs, working in thick oil in a dash pot, serve to damp vibrations due to sudden changes of electromotive force. The diameter of the dial is about thirty inches.

M. D'ARSONVAL, we learn from *Électricité*, has been making experiments on the electric excitability of muscles after death, and recently sent some results of his observations to the Academy of Sciences. General opinion on this point agreed that the excitability disappeared very soon after the death of the animal, which is true only so long as one depends upon the shortening of the muscle for an indication of its sensibility. But this method is not sensitive enough to indicate disturbances of very small amplitude. For this purpose M. d'Arsonval has for many years used a special modification of the microphone, which he has named the *myophone*, and which, when it is connected with the muscle under experiment, gives a sound some time before any contraction is apparent, especially if the muscle is stretched by a spring. By this means it may be proved that nervous excitability may last for many hours after death. As an instance, the achilles tendon of a rabbit may be attached to the myophone, and the sciatic nerve excited by a current broken some 50 to 100 times per second. Besides proving that the death of a nerve is much less rapid than was hitherto supposed, these experiments also show that nerve may act on muscle without producing actual contraction, but only some simple molecular vibration.

We have received a catalogue of the library of the Akademie der Naturforscher, prepared by Dr. Oscar Grulich.

The City and Guilds of London Institute for the advancement of technical education has issued its programme of the technological examinations for the session 1893-94.

"Symons's British Rainfall" for 1892 has been published. It contains, in addition to the rainfall statistics gathered from more than three thousand observers in Great Britain and Ireland, several articles upon various branches of rainfall work.

A lecture on "Cholera Prospects and Prevention," recently delivered by Dr. Thorne Thorne, F.R.S., to the technical teachers of the National Health Society, has just been published by the Society. The teachers and the Society must benefit by putting themselves under such an excellent adviser as Dr. Thorne is upon hygienic matters.

The autumn session of popular science lectures at the Royal Victoria Hall, Waterloo Bridge-road, will open on Tuesday, September 5, with a lecture on "What I saw of New Zealand and the noble Maori," by Capt. Chas. Reade, R.N. The three other lectures of the month will be given by Prof. Malden, and will be as follows:—September 12, "Picturesque Ireland;" September 19, "Australia;" September 26, "The World's Fair and Chicago."

Three more volumes of the comprehensive Aide-Mémoire series, published by Gauthier-Villars and by Masson have been received. One, by M. Laurent Naudin, is on the manufacture of varnishes. It is divided into two parts, dealing respectively with the physical and chemical properties of the materials used, and with the actual processes involved, in varnish manufacture. M. G. Laverque is the author of a volume on turbines, which is also divided into theoretical and practical parts. The third volume is by M. A. Hébert, and deals with the means of detecting the adulteration of alcoholic drinks.

The Journal of the Marine Biological Association (vol. iii., No. 1) contains lists of the *Nemertines* of Plymouth Sound, by Mr. T. H. Riches, and the *Turbellaria* of Plymouth Sound and the neighbourhood, by Mr. F. W. Gamble. Dr. Benham contributes a paper on the post-larval stage of *Arenicola marina*, and Mr. E. W. L. Holt continues his description of the North Sea investigations carried on by him at the Marine Fisheries Society's laboratory at Cleethorpes. Mr. J. T. Cunningham contributes two interesting articles on the immature fish question, and the coloration of the skins of flat fishes.

The United States National Museum has issued in separate form the report of Dr. J. P. McMurrich on the Actiniæ collected by the U.S. Fish Commission steamer, *Albatross*, during the winter of 1887-88. The reports deals with the Edwardsiæ, Protactiniæ, Hexactiniæ, and Ceriantheæ. Dr. McMurrich will give the results of his studies of the Zoantheæ in a future report. Other recently-received excerpts from the Proceedings of the U.S. National Museum include a "Description of some Fossil Plants from the Great Falls Coal Field of Montana," by Mr. W. M. Fontaine, and a paper "On the Occurrence of the Spiny Boxfish (Genus Chilomycterus) on the Coast of California," by Prof. Carl H. Eigenmann.

An improved mode of preparing the ammonium salt of persulphuric acid, NH_4SO_4 or $(NH_4)_2S_2O_8$, is described by Dr. Elbs, of Freiburg, in the latest number of the *Journal für Praktische Chemie.* The potassium, ammonium and barium salts of persulphuric acid were obtained two years ago by Dr. Marshall, of Edinburgh, in large well-developed crystals as described in our note of Vol. 44, p. 577, and since the publication of Dr. Marshall's memoir M. Berthelot, who first pointed out the existence of the acid and its anhydride, has published an account of his further experiments upon the subject, fully confirming the results obtained by Dr. Marshall, and adding further details. M. Berthelot's latest form of electrolytical apparatus for the preparation of the persulphates by the electrolysis of solutions of the ordinary sulphates in sulphuric acid consisted of a double cell, the inner portion being constructed of porous porcelain. Into this inner porous cell of about 150 c.c. capacity was placed a concentrated solution of ammonium or potassium sulphate in dilute sulphuric acid, while the outer cell was filled with more of the dilute acid. M. Berthelot appears to have considered it essential to employ an anode of small surface in the inner cell, a piece of stout platinum wire being preferred; but a kathode of large surface was considered requisite in order to diminish the resistance of the arrangement, and a large plate of platinum was employed for this purpose. A current of three amperes was allowed to pass through the apparatus for fifteen to twenty hours, when a yield of about forty to forty-five grams of ammonium persulphate, corresponding to a yield of sixteen *per cent.* of the theoretically possible, was obtained. With the improved form of apparatus and under the conditions described by Dr. Elbs, it is possible to obtain an average yield of sixty-five *per cent.* of ammonium persulphate, the amount having even reached eighty-five *per cent.* in one experiment. As anode or positive pole a spiral of platinum wire is employed, and as kathode or negative pole a piece of sheet lead bent into a cylindrical form and surrounding the inner porous cell. The outer liquid consists of equal portions by volume of water and oil of vitriol, and the inner liquid is a saturated solution of ammonium sulphate in sulphuric acid diluted with eight times its volume of water. The apparatus is cooled during the passage of the current by a bath of pounded ice. If cold spring water is available, however, the cooling may conveniently be effected by substituting for the leaden cylinder in the outer vessel a worm of leaden tubing, through which the cold water is driven. The current of two to three amperes is only permitted to traverse the apparatus for three or four hours, when the contents of the inner cell are filtered through glass wool, which retains in the funnel the crystals of ammonium persulphate produced. The crystals are drained on porous plates, and the filtrate is again saturated with sulphate of ammonia, returned to the inner cell, and again electrolysed. There is no advantage in prolonging the experiment to twenty hours, inasmuch as the formation of persulphate occurs much more slowly after a time. After the first experiment, when a considerable quantity of ammonium persulphate remains in solution, one hundred parts of water at the ordinary temperature dissolving sixty-five parts of the salt, about forty grams of crystals are obtained in each operation of three to four hours. In order to recover the persulphate remaining dissolved after the conclusion of the preparations it is convenient to precipitate it as the potassium salt by the addition of a solution of carbonate or acetate of potassium. Potassium persulphate is much less soluble than the ammonium salt, one hundred parts of water, under the same circumstances as mentioned in the case of the latter salt, only dissolving two parts of the potassium salt. It would thus appear to be most advantageous to prepare the soluble ammonium salt as the starting-point for a study of the persulphates, and the method described by Dr. Elbs renders the operation both simple and cheap, and affords it in comparatively large quantities in a short period of time. The product may be purified from traces of admixed ordinary sulphate by first recrystallising a small portion, and subsequently washing the main quantity with the solution of the pure crystallised salt. Recrystallisation of the whole is attended with a considerable loss. The crystals are quite permanent, however, when stored in dry bottles with well-fitting stoppers.

NOTES from the Marine Biological Station, Plymouth.—Last week's captures include the Anthozoan *Gephyra Dohrnii*, the Æolid *Amphorina cœrulea*, the Cirrhipede *Scalpellum vulgare*, and the Brachyura *Ebalia tumefacta* and *Achæus Cranchii*. The floating fauna continues to be rich in trochophore larvæ of various types, as recently recorded; the larva of *Polygordius* was last week taken in addition. Among Protozoa, *Noctiluca* has become more plentiful; but the week has been especially marked by the presence of Radiolaria of several species in numbers altogether unprecedented in our experience. Other signs of an Atlantic element in the floating fauna of late are furnished by the continued abundance of the Siphonophore *Muggiæa atlantica*, both colonies, eudoxomes and larvæ, and by the capture of two specimens, sexually mature, of *Doliolum Tritonis*. The Hydroids *Aglaophenia pluma* and *myriophyllum* and the Nudibranch *Æolidiella Alderi* are now breeding.

THE additions to the Zoological Society's Gardens during the past week include a Mona Monkey (*Cercopithecus mona*) from West Africa, presented by the Misses Price; a Yellow-cheeked Lemur (*Lemur xanthromystax*) from Madagascar, presented by Miss Annie Gervers; a Bonnet Monkey (*Macacus sinicus*) from India, presented by Mr. J. W. Harris; a Short-toed Eagle (*Circaëtus gallicus*) from Morocco, and six Little Bitterns (*Ardetta minuta*) from Europe, presented by Lord Lilford; a Black-headed Gull (*Larus ridibundus*) from Brit. Isles, presented by Mrs. H. S. Wardrop; an Indian Kite (*Milvus govinda*) from Eastern Asia, presented by Mr. A. Savory; four Tortoises (——) from Formosa, presented by Mr. P. Aug. Holst; a Golden Cat (*Felis moormensis*) from Sumatra, a Slender-billed Cockatoo (*Licmetis tenuirostris*) from South Australia, and six Avocets (*Recurvirostra avocetta*) from Holland, deposited; six Avocets (*Recurvirostra avocetta*) from Holland, a Common Tern (*Sterna hirundo*) from Holland, a Japanese Ape (*Macacus speciosus*) from Japan, and a —— Hawk Eagle (*Spizaëtus* ——) from India, purchased.

OUR ASTRONOMICAL COLUMN.

THE CORDOBA DURCHMUSTERUNG.—Mr. John Thome, the Director of the National Argentine Observatory, is to be congratulated upon the publication of the Cordoba Durchmusterung Catalogue, containing the brightness and position of every fixed star down to the tenth magnitude comprised in the belt of the heavens between 22° and 32° of south declination. The results are a continuation of the Durchmusterungs of Argelander and Schönfeldt from their southern limit. In the present volume 179,800 stars are catalogued, but altogether the places of 340,380 stars have been determined down to − 42°. The observations for this great catalogue were begun in 1885 and ended early in 1891. They reach the enormous number of 1,108,600, and were made entirely by Mr. Thome and Mr. R. H. Tucker. The area over which the observations have extended is 6075 degrees of a great circle, hence the mean density of stars is 56·2 stars per square degree. The corresponding mean density for Argelander is 15·2, and for Schönfeldt 18·5. The density varies considerably, however, in different parts of the sky, and ranges from 70 to 160 stars per square degree in the Milky Way. Mr. Thome says that a series of twelve maps, each embracing two hours of right ascension and twenty degrees in declination, has been constructed upon the scale adopted by Argelander, and will be issued during next year with the second volume of the catalogue, containing stars within the belt from 32° to 42° south declination. The construction of these maps, and the preparation of a catalogue like that of which the first part has just reached us, involves an enormous amount of labour. Indeed, it is difficult to understand how, amidst the vicissitudes to which an observatory in the Argentine Republic must be subject, and with such a meagre staff as that under Mr. Thome's direction, it has been possible to do so much excellent work.

THE RORDAME-QUÉNISSET COMET.—On July 11 the Rordame-Quénisset comet (*b* 1893) was photographed at Goodsell Observatory, and a fine photogravure reproduction of one of the views forms the frontispiece to the August number of *Astronomy and Astro-Physics*. In a letter that appears in the same journal, Prof. J. E. Keeler describes the spectroscopic observations of the comet made at Allegharry Observatory. On July 10 the three usual carbon bands were seen, connected by a narrow continuous spectrum from the nucleus. Each band appeared to terminate sharply on its less refrangible side, where also the brightness was greatest. No direct comparison of spectra could then be made, so the positions of the bands were estimated. A photograph of the comet spectrum in juxtaposition with the solar spectrum obtained from the moon was procured on July 19. Upon the photograph could be seen a hazy band at λ 472 and another terminated by a line on the less refrangible side at λ 388, and fading away towards the more refrangible end of the spectrum. Between these two bands others were suspected, but could not be made out with sufficient accuracy for a determination of wave-length. A comparison of the spectrum of the comet with that of a spirit lamp on July 20 showed that the bands were coincident in the two spectra. The brightest comet band—that in the green—appeared to have a second maximum coincident with the second maximum of the corresponding carbon fluting

A SIMPLE EQUATORIAL MOUNTING.—M. J. Jarson describes in *L'Astronomie* for August a simple, if not new, means by which small telescopes can be moved equatorially, thus permitting an observer to keep objects in the field of view without constantly moving the telescope in altitude and azimuth. Applying this method, for instance, to a small telescope mounted on a small vertical tube, tripod fashion, such as those generally used at seaside resorts, the following account may show the simplicity of the arrangement. On the stand of the telescope a bar of wood or of iron is fixed horizontally, in which is a hole sufficiently large to pass a cord. The position of the hole is determined by the rule that the line joining the centre of motion of the telescope in declination to this hole makes an angle with the horizontal bar equal to the latitude of the place of observation. By connecting the object-glass end of the telescope to this hole, by means of a chain or cord, any celestial object can be followed in the heavens by simply keeping the cord tight and moving the telescope. A weight fastened to the eye end secures the tightness of the cord. The telescope will then describe an arc of a circle in the heavens, and not a straight line as formerly. For different objects it is obvious that one must vary the length of the cord; but for making prolonged studies of any particular one possessors of small instruments will find this a most useful arrangement.

A REMARKABLE SOURCE OF ERROR.—Dr. E. Von Rebeur-Paschwitz, in No. 3177 of the *Astronomische Nachrichten*, publishes some interesting curves traced by a horizontal pendulum during the prevalence of certain slight earth tremors occurring on different occasions and at different places. Traced photographically on sensitive plates moving with a velocity of twenty-four inches per minute, these tremors show a striking similarity to those observed by Prof. Milne in Japan. It appears that the surface of the earth is occasionally subjected to wave motions analogous to those disturbing a sheet of water, and often persisting with great regularity for several hours. Their connection with steep barometric gradients is probable, although that does not appear to be the only condition. In any case, the tremors appear in the presence of strong winds, at least in the neighbouring country, and they travel with at least the velocity of 2 km. per second. The influence of these tremors upon observations of polar distances, and upon spectro-photographic work, is sufficiently obvious to render it desirable that all observatories should be fitted with automatic instruments for registering these disturbances, and arrangements should be made for their study and comparison.

THE APEX OF THE SUN'S WAY.—In a letter to the editor of the *Bulletin Astronomique*, Prof. H. G. van de Sande Bakhuyzen says that he has determined the apex of the movement of our system from all Bradley's stars of which the distances from the pole of the Milky Way are less than 50°. In the calculation, he made use of the method employed by L. Struve in his memoir on the determination of the movement of the solar system, in order that the two results might be strictly comparable. Prof. Bakhuyzen has also repeated the calculations, using stars in the same part of the heavens as the above, but with proper motions not exceeding 0″·075. The first method gave, as the position of the apex,

R.A. = 264°, Decl. = 30°.

The result obtained by the second calculation was—

R.A. = 290°, Decl. = 24°.

The position found by L. Struve was—

R.A. = 273°·3, Decl. = 27°·3.

Prof. Bakhuyzen is at present occupied in determining the apex from stars of small proper motion in the Milky Way.

THE ORIGIN OF NEW STARS.—In the current number of *Die Natur* Prof. G. Hoffmann surveys the various new stars discovered since Tycho Brahe's Nova Cassiopeiæ, and the different theories advanced to account for their appearance. He is inclined to endorse the views of Prof. Seeliger, according to which the sudden brightness is produced by a heavenly body entering a "cosmic cloud" consisting of sparsely distributed matter. Prof. Hoffmann thinks that all new stars may be regarded as essentially of the same type as the variables of long period.

THE MINUTE STRUCTURE OF PLANT HYBRIDS.[1]

DR. MACFARLANE'S paper will not fail to impress biologists by the suggestiveness of some of his speculations and with the importance of his observations. Nor are his conclusions limited to the plant hybrids, which he discusses, but they apply, though with certain limitations, to all organisms resulting from sexual reproduction.

Of course, in the case of hybrids, the parental characters are often very different, and can therefore be easily recognised in the offspring, whence the examination of their characters, including, of course, their minute anatomy, becomes important to all who are interested in the problems of reproduction. For in the case of fusion of reproductive cells of the same species, where the parental characters differ often very slightly, it is difficult, and at times impossible, to distinguish whether the characteristics of the male or female parent predominate, or whether a complete blending has taken place. Theoretically perhaps we should expect this blending of characters, but our everyday experience brings to our mind so many instances of almost unadulterated inheritance of paternal or maternal characteristics, that we are somewhat prejudiced against a conclusion to which Dr. Macfarlane's observations on hybrids lead him, and which ought equally to apply to normal offspring.

The study no doubt presents many difficulties, which are, it is true, recognised by the author, but do not seem to him insuperable. First and foremost we have the variability of what are usually termed true species; and the author is careful to point out that "for hybrid investigation one should be acquainted with the parent individuals and the conditions under which they were grown, or try to choose an average specimen for study." But in either case errors may creep in. For if one of the parents has varied abnormally, though some of the offspring will inherit such a variation, others may revert to the more normal condition of their grandparents or great-grandparents. If, on the other hand, we choose the average specimen, we are entirely in the dark as to any special variation of the parental form. Nothing short of selecting normal individuals as parents and examining all or a large number of the hybrid offspring would afford sufficient basis for such conclusions, as the author deduces from his less complete observations. But Dr. Macfarlane does not even state in each case whether his observations are taken from the parents themselves, or only from average specimens.

The conditions of growth, too, enormously affect some of the characters which the author has chosen for comparison. The character of leaves for instance, especially as regards their tran[s]piratory functions, can be completely altered by the treatme[nt] of the young plant. If, therefore, the number of stomata p[er] unit of surface are to be of any value for comparison of form[s] both the parents and the offspring must be raised under simil[ar] conditions. If this is not the case we should expect the of[f]spring to resemble in this particular that parent which w[as] grown under conditions most similar to itself. Nor does th[e] author fail to find such a case. *Hedychium Sadlerianum* ap[]proaches very nearly in the number of stomata on the low[er] surface the condition of one of its parents, *H. coronarium*; bu[t] we are told nothing as to the condition under which the paren[ts] or offspring were reared, and the tendency to "sway toward[s] one parent" is explained by the assumption that it is "[a] morphological adaptation in the hybrid for physiological work[,] or in the truest sense a case of physiological selection."

Having thus briefly stated some of the difficulties besettin[g] the problem, we may state that all his observations and measure[]ments, down to the size of the plastids and starch grains, lea[d] the author to the conclusion that plant hybrids, at least se[ed] hybrids, are, both in their minute structure and in their genera[l] life-phenomena, intermediate between their parents.

This complete blending is, to say the least, very extra[]ordinary, and we are tempted to question whether the autho[r] has investigated a sufficient number of individuals of eac[h] hybrid. Surely the variability of hybrids would be sufficient to supply any investigator with numerous examples which wer[e] not intermediate. The unanimity of the observations publishe[d] make it imperative that some further investigations should b[e] undertaken with regard to the variability of hybrids, a facto[r] to which sufficient prominence is not given in the presen[t] paper.

Darwin insists both in his "Forms of Flowers" and al[so] in his "Cross and Self-fertilisation of Plants," upon th[e] correspondence between the crossing of distinct species an[d] legitimate unions of dimorphic and trimorphic heterostyle[d] plants. Yet from Dr. Macfarlane's paper we must conclude tha[t] in some respects at least there is no correspondence.

For Darwin states that though "the shape of the stigma an[d] the length of pistil both vary, especially in the short styled form[,] I have never met with any transitional states between the tw[o] forms in plants growing in a state of nature." Now the differ[]ence in these forms extends also to anatomical details, such a[s] the size of the pollen-grain and the size of the stigmatic hairs[,] and yet the offspring will all resemble either one or the othe[r] parent, and thus differ radically from all the hybrids which Dr[.] Macfarlane has examined, all of which represent forms inter[]mediate between the two parents. Dr. Macfarlane has of cours[e] come across some exceptions, but we are not told whether they are merely individual variations approaching one or other of the parents, such as we should expect to find, or whether in th[e] production of the hybrid there was always a tendency to approxi[]mate the male or female form. Whichever be the case, th[e] author is of the opinion that the number previously asserted to diverge towards one of the parents has been considerably over-estimated.

The author's contribution, however, to the investigation and discussion of graft hybrids is extremely valuable, and we cannot help wishing that he had found more similarity in the characters of graft and seed hybrids. We feel convinced, though we should not like to impugn the evidence brought forward, tha[t] the latter does not represent the average condition of the struc[]ture of plant hybrids, but that there must be more variation in their characters than the author has found in the specimens he was enabled to examine, especially more variation towards one or other of the parent forms, though we should not expect it to be so pronounced as in the case of graft hybrids. F. E. W.

[1] "A Comparison of the Minute Structure of Plant Hybrids, with that of their Parents, and its Bearing on Biological Problems." By Prof. J. Muirhead Macfarlane. (Transactions of the Royal Society of Edinburgh, vol. xxxvii. part i. no. 14.)

COMPULSORY LAWS OF ERROR IN DRAWING.

Digest of the Phenomena, with Examples.

THE object of the following paper is to present the facts in the briefest and, it is hoped, the plainest possible manner, for the purpose of calling attention to phenomena connected with the art of drawing, or depicting form in outline. It is to prove that error made in such drawing comes under the dominion o[f] natural law, or compulsion, and is not the result of individua[l] misconception of truth. The phenomena are altogether distinc[t] from intellectual aptitude, the intelligent and the dull being equally liable to commit the errors in the forms which will hereafter be specified.

Consideration will first be given to the existence of *general laws*, of which there appear to be three, so strongly marked as to stand clearly distinguishable as including in themselves the minor manifestations. These laws are as follows:—

(1) There is a general law making us fundamentally incapable of drawing in perspective. It is a radical condition—not of ignorance of the laws of perspective but of active negation of them. It is a natural necessity to show by the arrangement of lines the exact contrary to true perspective. It is persistent, and exists long after correct knowledge of the true arrangement of the lines is acquired, and the error is always liable to appear on any occasion of forgetfulness—that is to say, when drawing is not done with the true principles immediately in remembrance in the mind. It is perceivable in the form of direct *divergence* of lines (parallel in nature) which in perspective should *converge* to their vanishing point.

(2) Another general law is a natural incapacity to erect a proper perpendicular for an object unless the same occurs close on the line of direct sight (forward). If the perpendicular be situate laterally, and especially if it be short, it is liable to a deflection. This deflection occurs in the following manner:—If the same be on the right hand the line inclines from its top towards the central line of sight (forward); its foot is therefore nearer this central line than its top. On the left hand the phenomena are directly reversed. This error occurs whether the perpendicular be the obvious physical corner line of a solid or whether it be the integral (invisible) line of any such solid or of a drawn figure.

(3) The next general law is less distinct, but still abundantly provable on test. It affects those lines which, being in right angles to the observer, lie laterally to him; that is to say, if a line of the surface (horizontal) of a figure occur on the right or left hand, at a little distance, the line is not drawn with perspective inclination to the *vanishing point* in front of the observer, but is *drawn as a perpendicular*, or, as is evident, in such a manner as would be the true fact of its direction, void of the influence of perspective. Thus, if a square lie two or three feet to right or left of the draughtsman, those two sides of it which are the sides rectilinear, not sides parallel to the base of the picture-plane, are drawn as two perpendiculars, while they should be converging lines towards a point which leads them diagonal-wise across the paper.

These brief particulars are intended to give an account of the primary, or general, laws. All other manifestations are deducible from them—that is, in every case where a special aspect of a figure draws out its special error, this is seen to have its origin in one or other of these three primary laws. From this point I now proceed to illustrate with examples selected from three figures—the cube, the pyramid, and the hexagon—instances of special error. Other geometrical figures may at a future period be likewise illustrated, but the intention is in this paper only to broach the subject.

The Cube.

It is in all cases assumed the object lies on a table before the observer.

Position 1.—Let the cube be placed on the right or left, and with two planes parallel to the picture-plane, two in right angles.

Error 1.—The perpendiculars will be inclined as radiants upwardly.

Error 2.—The 3 perspectives visible will diverge.

Error 3.—Or these will be neutralised of perspective, and the true perpendiculars be inclined.

Position 2.—Let the cube be situate anglewise on the direct line of sight.

Error 1.—All 6 perspectives to right and left diverge.

Error 2.—Or the top is drawn as a *square*.

Position 3.—Poise the cube on an edge, so that one plane, resting exactly balanced on its corner, is in the direct front, and parallel to picture-plane.

Error 1.—The perspectives (3) will diverge.

Error 2.—The square of the front plane will be confused as rhomboidal.

Position 4.—Still having the cube poised on an edge, let it be turned so that three faces are seen at one time, and it presents perspectives in 9 lines.

Error 1.—All the perspectives, in groups of 3 each, for each plane, will diverge.

The Pyramid (Square).

Position 1.—Let the pyramid lie exactly in front, parallel to the picture-plane.

Error 1.—The two parallel edges of the square base, extending in right angles from the eye, will diverge.

Error 2.—The further side of the pyramid will thus be longer than the nearer side.

Position 2.—Let the pyramid lie on the same spot, but with an angle presented, so that the sides of the square extend in equal angles.

Error 1.—If the view of it should be isometrical, or the pyramid *flattish*, the perspectives will be shown diverging.

Position 3.—Place the pyramid point downwards towards the observer, in front, and with one side for a base.

Error 1.—The two parallel retiring lines of the inclined *real base* will show divergence.

Error 2.—Consequently, the further line of base will be longer than the nearer and upper of this sloping square.

Position 4.—Place the pyramid so that it still lies on a side for a base, but in front, and the apex and the central point of a side of the real base are on a line parallel to picture-plane.

Error 1.—The apex, which should thus lie horizontally *even* with the central point of that line of real base, which touches the ground, will be shown *below* that line. The true relation to central point given is never seen.

Error 2.—Such perspectives as occur will diverge.

The Hexagon.

Position 1.—Place a solid hexagon upright in the exact front of observer, with two planes parallel to picture-plane.

Error 1.—All perspectives of the parallel sides will diverge.

Error 2.—Consequently, the two parallel lines (integral) which connect opposite angles of the hexagon will lose *their* perspective.

Position 2.—Place the hexagon on a side, so that its lines, then horizontal, are parallel to picture-plane and the object is in a lateral situation, or not in front.

Error 1. The end, which is now a plane in right angles, will show the integral connecting lines between top and bottom angles *leaning*, because these are essentially perpendicular; therefore the perpendicularity is distorted. (General law 1.)

Error 2.—The line (integral) connecting the two angles midway between top and base line of this plane, and which should be of course *parallel* to these, and partaking of their perspective, will have a course diagonal to them, always deflected downwards.

Error 3.—The lines which indicate the further, or unseen plane of hexagon will show exact conformity to this error; also diverging perspective.

Position 4.—Place the hexagon again laterally, with its end as a front plane, and a side on the ground, the direction of the object being in a due rectilinear line.

Error 1.—The perspective bias will be lost (general law 3) and the lines traced as perpendiculars.

Error 2.—Or these will indicate divergence in place of convergence.

Error 3.—The plane parallel to picture-plane, and essentially void of distortion, will be nevertheless distorted.

Position 3.—Place the hexagon, still resting on a side, so that its lines take a diagonal line with regard to a line parallel to the picture-plane, and it must be in front.

Error 1.—The displacement of the integral perpendiculars will occur in the end planes, as in Error 1 of Position 2.

Error 2.—The Error 2, in Position 2, will be repeated.

Error 3.—The perspectives will diverge.

ARTHUR L. HADDON.

THE DEPARTMENT OF SCIENCE AND ART.

THE fortieth Report of the Department of Science and Art has just been issued, and is of a highly satisfactory character. From it we learn that in 1892 there was a very large increase, not only in the number of students and classes, but also in the number of schools or separate institutions in which science is taught. The number of classes in different branches of science in 1892 was 10,352, as against 8,568 in the preceding year, and the number of pupils under instruction showed the remarkable increase of 32,002, the totals for 1891 and 1892 being respectively 148,408 and 180,410. The number of examination papers worked was 203,347, and the number of individual examinees 108,858, so there was an average of nearly two papers for each student. The greatest number of papers, 29,051, was worked in mathematics. In physiography, 21,944 papers were written, and in theoretical inorganic chemistry, 21,578 papers. The lowest number of candidates were presented in mineralogy and nautical astronomy, the number of papers worked in these subjects being 119 and 141 respectively. With regard to the extent to which local authorities are devoting funds for the purposes of science, art, technical, and manual instruction, it is reported that "Of the forty-nine councils of counties in England (excepting Monmouth), forty-two are now giving the whole of the residue to technical education, while the remaining seven are giving a part of the amount; and of the sixty-one councils of county boroughs, fifty are devoting the whole of the residue to the same purpose, and ten are devoting a part of it, no decision having yet been arrived at in the case of Great Grimsby (which it may be mentioned was only constituted a county borough on April 1, 1891). Of the councils of the sixteen counties and county boroughs of Wales and Monmouth, to which the Welsh Intermediate Education Act, 1889, applies, fifteen are applying the whole of the residue to the purposes of intermediate and technical education, and one a part of it. Contributions are also made out of the rates under the Technical Instruction Act, 1889, in the case of seven counties and county boroughs in Wales and Monmouth. As regards Scotland, so far as returns have been received, the whole of the residue fund is being applied to technical education in the case of twenty counties (out of thirty-three) and sixteen burghs and police burghs (out of 187), while six counties and thirty-nine burghs and police burghs are giving part of it to the same purpose. Of the remainder, the majority of the local authorities are devoting the residue to the relief of rates, and a small proportion of them have under consideration the question of applying the money to technical education."

In conclusion, it is pointed out that "the opportunities afforded to people engaged in all branches of industry for acquiring a knowledge of much which is closely connected with their daily work, but which cannot be obtained in the factory or workshop, are constantly increasing. The municipal schools, which are steadily growing in number and efficiency in all parts of the country, must be of great service in this connection. Further, in proportion as local interest is developed, and employers show that they value sound scientific instruction and art teaching, the effectiveness of these schools will be promoted But whether the income of these schools be derived mainly from local or Imperial sources, it is essential that the course of instruction adopted shall be well adapted to the needs of the town or district. The more fully the educational welfare of the students takes the first place, and the mere earning of Government grants the second place in the new Municipal schools, the more certainly will they fulfil their object."

It is clear from this that the Department desires to stamp out the system whereby science classes are "farmed" by teachers. The acquisition of knowledge is rightly regarded as the proper goal, not the mere obtaining of a certificate. The technical instruction committees of some of the county councils would do well to bear this and the following admonition in mind: "Without a sound foundation of general education, the highest scientific training cannot be imparted; without a sufficient supply of teachers with adequate salaries, who are not overworked, and who not merely know their subject, but know how to teach it, a considerable part of the money expended on the encouragement of new forms of education must be wasted."

EUROPEAN LABORATORIES OF MARINE BIOLOGY.

MARINE laboratories are now recognised as essential to the progress of biology. The facilities they offer the collector and the investigator cannot be overrated, and it would be an excellent thing if institutions could be conducted on similar lines in every branch of science. Mr. Bashford Dean, in the *American Naturalist* of July, gives an illustrated description of marine laboratories in Europe, which is so interesting that a large portion of it is here reprinted. The description of the Marine Biological Station at Plymouth is omitted owing to the fact that a detailed account has already appeared in these columns (vol. xxxviii. p. 198, 1888). Mr. Dean prefaces his report as follows:—

"In every country the marine laboratory has become a need of the student of biology. During his winter studies in the university it serves to provide him with well-preserved material, often with living forms which he may himself prepare according to his wants; in summer it gives him opportunity to see and collect his study types, and utilise with profit and without physical discomfort abundant material relating to his studies. To the investigator the marine laboratory has become, in the broadest sense, a university. He may there meet the representative students of far and wide, fellow-workers, perhaps, in the very line of his own research, and must himself, unknowingly, teach and learn. He finds out gradually of recent work, of technical methods which often happen most pertinent to his present needs. He may carry on his work quietly and thoroughly; his works of reference are at hand; he has the most necessary comfort in working—the feeling of physical rest, untroubled by the rigid hours of demonstrations and lectures.

"The importance of the work of the marine laboratory has been keenly appreciated in foreign countries, and it is noteworthy how large a number of the original researches is at present conducted at, or upon material from, these distributing centres of biology. At the present day the entire coast line of Europe has become dotted with zoological stations great and small, grown out of the resources granted by societies, private individuals, or governments—perhaps by the combined efforts of all. It is a matter of great interest to note how thoroughly the marine laboratory system abroad had become a part of every grade of biological work. The student in a small university in the interior of France receives his first lessons from material sent regularly from Roscoff or Banyuls. He examines *living* sponges, hydroids, lucernarians, pennatulids, beroës, *Loxosoma*, *Comatula*, and *Amphioxus*. In Munich, hundreds of miles from the sea, is another example. Prof. Richard Hertwig, by the aid of material from Naples, demonstrates the larval character of ascidians, or the fertilisation of the egg of the sea urchin. Every group of European universities seems to have centralised its marine biological work in a convenient locality, and this branch of their needs is supported—and is well supported—even in countries whose financial resources are most limited. The importance of this work is felt to such a degree that it is not from reasons unselfish that universities have united in their support of a station like that of Naples. This has become literally an emporium cosmopolitan, bringing together side by side, perhaps not unnaturally, the best workers of many universities whose observations upon the best material, sharpened by discussion and criticism, are certainly tending to become the most accurate and the most fruitful in their direction and results.

"It is most singular that foreign countries are unquestioningly liberal in the support of *pure* biology, and in the work of marine stations the tendency is becoming less and less on the part of money-givers to ask how many fish will be hatched to become food material. Public interest has been gradually coming to be directed to the general laws and the problems of life and heredity. This has well been a hopeful sign, and the European biologists are not backward in emphasising the importance of their studies. Prof. de Lacaze-Duthiers does not hesitate even to propitiate the practical Cerberus, reminding him how often 'facts have been found at every step of science which were valueless at their discovery, but which, little by little, fell into line and led to applications of the highest importance—how the observation of the tarnishing of silver, or the twitching leg of the frog, was the origin of photography and telegraphy—how the purely abstract problem of spontaneous generation gave rise to the antiseptics of surgery.'"

Beginning with the marine laboratories of France, Mr. Dean says:—

"The extended sea-coast has ever been of the greatest aid to the French student—along the entire northern coast the channel is not unlike the Bay of Fundy in the way it sweeps the waters out at the lunar tides. The rocks on the coast of Brittany, massive boulders, swept and rounded by the rushing waters, will, at these times become exposed to a depth as great as 40 feet. This is the harvest-time of the collector; he is enabled to secure the animals of the deep with his own hand, to take them carefully from the rocky crevices where they would ever have avoided the collecting dredge. From earliest times this region has been the field of the naturalist. It was here that Cuvier, during the Reign of Terror, made his studies on marine invertebrates which were to precede his "Règne Animal." The extreme westernmost promontories of Brittany have, for the last half-century, been the summer homes of Quatrefages, Coste, Audouin, Milne-Edwards, and de Lacaze-Duthiers. Coste created a laboratory at Concarneau, but this has come to be devoted to practical fish culture, and is, at the present day, of little scientific interest. It is owing to the exertions of Prof. de Lacaze-Duthiers of the Sorbonne, that the two government stations of biology have since been founded. The first was established at Roscoff, in one of the most attractive and favourable collecting regions in Brittany, and has continued to grow in importance for the last twenty years. As this station, however, could be serviceable during summer only, it gave rise to a smaller dependency of the Sorbonne in the southernmost part of France, on the Mediterranean, at Banyuls, which had the additional advantage of a Mediterranean fauna.

"To these French stations should be added that of Prof. Giard, at Wimereaux near Boulogne, in the rich collecting funnel of the Straits of Dover; that of Prof. Sabatier at Cette, not far from Banyuls, a dependency of the University of Montpelier; that of Marseilles, and the Russian station at Ville-Franche, near the Italian frontier. An interesting station in addition, is that at Arcachon near Bordeaux, founded by a local scientific society, and having at its command the collecting resources of a small inland sea, famous for its oyster culture. Smaller stations are not wanting, as at the Sables d'Olonne.

"At Roscoff the laboratory building looks directly out upon the channel. In its main room on the ground floor, work-places are partitioned off for a dozen investigators; this on the one hand leads to a large glass-walled aquarium-room, while on the other opens directly to adjoining buildings which include lodging quarters, a well-furnished library, and a laboratory for elementary students. Surrounding the building is an attractive garden, which gives one anything but a just idea of the barrenness of the soil of Brittany. From the sea-wall of the laboratory one looks out over the rocks that are becoming exposed by the receding tide. A strong enclosure of masonry serves as a *vivier* to be used for experiments as well as to retain water for supplying the laboratory. The students are, in the main, those of the Sorbonne, and are under the direction of Dr. Prouho, their *maitre de conférences.* They are given every opportunity to take part in the collecting excursions, frequently made in the laboratory's small sailing vessels, among the rocky islands of the neighbouring coast. Strangers, too, are not infrequent and are generously granted every privilege of the French student. Liberality is one of the characteristic features of Roscoff. The stranger who writes to Prof. de Lacaze-Duthiers is accorded a work-place which entitles him gratuitously to every privilege of the laboratory—his microscope, his reagents, even his lodging-room should a place be vacant. It seems, in fact, to be a point of pride with Prof. Lacaze that the stranger shall be welcomed to Roscoff, and upon entering the laboratory for the first time, feel as much at home as if he had been there a week. He finds his table in order, his misroscope awaiting him, and the material for which he had written displayed in stately array in the glass jars and dishes of his work-place. So, too, he may have been assigned one of the large aquaria in the glass aquarium room—massive stone-base stands, aërated by a constant jet of sea water. He finds a surprising wealth of material at Roscoff, and his wants are plentifully and promptly supplied.

"At Banyuls, the second station of the Sorbonne, the buildings are less imposing than those of Roscoff. It is a plain, three-storey building facing the north, at the edge of the promontory which shelters the harbour of Banyuls. The vivier is in front of the station, behind is a reservoir cut in the solid rock—receiving the water of the Mediterranean, and distributing it throughout the building. On the first floor is a large aquarium-room lighted by electricity, well supplied with tanks, and decorated with statuary given by the Administration of the Beaux-Arts. The bust of Arago occupies an important place, as the laboratory has been named in his honour. The wealth of living forms in the aquaria shows at once by variety of bright colours the richness of southern fauna. Sea lillies are in profusion, and are gathered at the very steps of the laboratory. The work-rooms of the students are on the second floor, equipped in a manner similar to those of Roscoff. The director of this station is Dr. Fréderic Guitel. It is usual during the holidays at fall or winter, for the entire classes of the Sorbonne to spend several days in collecting trips in the neighbourhood. The region, with its little port, is famous for its fisheries, and one in especial is that of the Angler, *Lophius.*

"The station on the Straits of Dover, at Wimereaux, has earned a European reputation in the work of Prof. Giard. It is but a small frame building, scarcely large enough to include the advanced students selected from the Sorbonne. The laboratory is, in a way, a rival of Roscoff, and it is noteworthy that its workers seem to make a point of studying the laboratory methods of the German universities.

"The marine laboratory of Arcachon, one of the oldest of France, was built in 1867 by the local scientific society, and was carried on independently until the time of the losses of the Franco-Prussian War. Its management was then fused with that of the faculty of medicine of Bordeaux, with whose assistance, aided by that of a small subsidy from the government, the work of the institution is carried on. Arcachon, in itself, is a most interesting locality near Bordeaux. It has become a summering-place, noted for its pine-lands and the broad, sandy *plage,* picturesque in summer with swarms of quaintly-dressed children, the local head-dress of the peasant mingling with the latest toilets from Paris. Here and there is to be seen that accompaniment of every French watering-place, the goat boy in smock and berret, fluting to his dozen charges who walk in a stately way before him. The Bay of Arcachon is a small, tranquil, inland sea, long known for its rich fauna. In large part it is laid out in oyster parks which constitute to no small degree the source of wealth of the entire region. Shallow and warm waters seem to give the marine life the best conditions for growth and development. The laboratory is placed just at the margin of the water. It includes a dozen or more work-places for investigators, well supplied with aquaria, a library on the second floor, a small museum containing collections of local fauna, including the numerous relics of Cetaceans that have found their way into this inland sea. A small aquarium-room, opened to the public, is well provided with local forms of fishes, and like that of Naples, is eagerly visited. Those who are entitled freely to the use of the work-places are instructors in French colleges, members of the Society, and all the advanced students from the colleges of the State. For other students work-place is given upon the payment of a fee whose amount is regulated each year by the trustees. As at Roscoff, material is plentifully supplied.

"The zoological station at Cette is a direct annex of the University of Montpelier. The present temporary building is to be replaced by one of stone, which will enable Prof. Sabatier to add in no little way to the working facilities of his students. The region, in every essential regard, is similar to that of Banyuls.

"The station at Marseilles is devoted in great part to questions relating to the Mediterranean fisheries, and owes, in a measure, its financial support to this practical work.

"The station at Ville-Franche is essentially Russian. An account of this with figures has recently been published (Russian text) in Cracow. The station itself is well known through the work of Dr. Bolles Lee, and it is here that Prof. Carl Vogt has been a constant visitor."

After a description of the Plymouth laboratory, Mr. Dean mentions those of Liverpool and St. Andrews, north-east of Edinburgh concerning which he remarks: "The work of these stations is only in part purely biological; the practical matters of fisheries must be considered to insure financial support. In addition to these there are several stations, notably one south-east of Edinburgh, and another, recently equipped, on the Isle of Man.

"At St. Andrews, Prof. MacIntosh has studied the questions relating to the hatching and development of the North Sea fishes. Its situation upon the promontory leading into the Firth of Forth seems to have been especially favourable for the study of the North Sea fauna—the locality, moreover, is far enough northward to include a number of boreal forms. The importance of St. Andrews is at length better recognised, and a substantial grant from the Government will enable a large and permanent marine station to be here constructed. The facilities for work have, up to the present time, been somewhat primitive—a simple wooden building, single-storied, has been partitioned off into small rooms, a general laboratory, with work-places for half a dozen investigators, a director's room, aquarium, and a small outlying engine house with storage tanks. The laboratory owns a small sail-boat to assist in the work of collecting."

Passing to Holland, we read—"Holland, in the summer of 1890, opened its zoological station in the Helder, a locality which, for this purpose, had long been looked upon with the greatest favour. There is here an old town at the mouth of the Zuyder Zee, the naval stronghold of Holland, a station favourable for biological work on account of the rapid running current which renews the waters of the Zee. The station was founded by the support of the Zoological Society of the Netherlands, whose valuable work by the contributions of Hubrecht, Hoek, and Horst has long been known in connection with the development of the oyster industry of Holland. The work of the society had formerly been carried on by means of a portable zoological station which the investigators caused to be transplanted to different points along the East Schelde, favourable on account of their nearness to the supplies of spawning oysters. The present station at the Helder is situated directly adjoining the great Dyke, a small stone building of two storeys, surrounded by a small park. In itself the laboratory is a model one—the rooms are carefully finished and every arrangement has been made to secure working conveniences. A large vestibule leads directly into two laboratory rooms, and by a hallway communicates with the large, well-lighted library, and the rooms of the director. The aquarium-room has, for convenience, been placed in a small adjacent building. The director of this station is Prof. Hoek, and the president of the society is Prof. Hubrecht."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Stanford University of California (the *Times* says) is rapidly becoming the wealthiest institution of the kind in the world. Yet there are several American Universities and colleges which enjoy enormous wealth. For example, Columbia University has an invested capital of £2,600,000; Harvard, £2,200,000; Yale, £2,000,000; the California, £1,400,000; and the Johns Hopkins, £600,000. The endowment fund of the Stanford University cannot at present be stated, partly because the benefaction exists in the shape of property which is rapidly increasing in value. But estimates which appear to be well founded have been made at San Francisco showing that at no distant date the University will be worth £40,000,000, yielding an annual income of £2,200,000.

SCIENTIFIC SERIALS.

Wiedemann's Annalen der Physik und Chemie, No. 8 (1893).—Polarisation of undiffracted infra-red radiation by metal wire gratings, by H. E. J. G. du Bois and H. Rubens. Polarised light passing without diffraction through silver wire gratings experiences in general a rotation of its plane of polarisation. The transmitting power of the gratings for light polarised in a plane perpendicular to the length of the wires was found to be greater than that for light polarised in a plane parallel to them. The present experiments were conducted with finer gratings than before the smallest interval attained being 0·001 cm. and the measurements were taken in the infra-red region. The intensity of radiation transmitted was measured by the bolometer. It was found that as long as the wave length does not exceed a certain value, the grating transmits a larger fraction of the radiation when the electric vector is parallel to the wires; this value appears to be independent of the width of interval, but characteristic of the metal; for greater wave-lengths the transmittance is greater when the magnetic vector lies in the direction of the wires.—The superior limit of wave-lengths which may occur in the thermal radiation of solids; a conclusion from the second law of thermodynamics, by Willy Wien. Assuming the second law, and the existence of none but Maxwell's ponderomotor forces in the pressure exerted by a gas, the author shows that thermal radiation does not imply waves of all lengths, but that the curve of energy, when traced along the spectrum, falls continuously to infinitesimal values on the less refrangible side, and practically disappears in the region of Hertz's finite waves.—Electric oscillations of molecular structures, by H. Ebert. It is shown that the mechanism of luminescence may be fully explained by Maxwell's theory, regarding the luminous molecules as analogous to Hertz oscillators of very small dimensions.—A photometer, by E. W. Lehmann. This is constructed on the principle of Joly's photometer; it consists of two totally reflecting prisms placed side by side in a box. In each prism one of the adjoining faces is ground, and the two ground faces are turned in opposite directions so as to be illuminated by the two sources to be compared. The plain faces are turned towards the observer, with their edges touching. The observer looks at them through a tube containing a telescope; the box to which the tube is attached can be swung round through 180°, so as to exchange the ground faces. The sensitiveness is such that forty successive readings with amyl acetate burners at 120 cm. gave results not differing by more than 0·4 per cent.

Bulletin de l'Académie de Belgique, No. 6 (1893).—We notice the following among the scientific papers: Megamicros, or the sensible effects of a proportional reduction of the dimensions of the universe, by J. Delbœuf. According to Laplace, if the dimensions of all the bodies in the universe, their mutual distances and velocities were to increase or diminish in a constant proportion, these bodies would describe the same curves as they do now. The appearances presented to observers would be the same, and independent of the dimensions assumed. Hence the only facts we are able to appreciate are ratios. In opposition to this theorem, M. Delbœuf shows that if a system consisting of the sun and the earth were to be diminished in linear dimensions to one-half, all densities remaining the same at homologous points, and the orbital velocity of the earth were reduced to one-half its value, there would be certain changes in the relations of an observer to his surroundings which could not escape notice. The velocity of sound propagation will be the same as before, but the distance traversed during a certain number of vibrations will appear larger. If a metric system were to be determined on the reduced planet in a manner analogous to ours, the hectare will be a quarter, the litre one-eighth, and the kilogramme—owing to the reduction of gravitation—one-sixteenth of the corresponding actual measures. Hence the work done in lifting a kilogramme through one metre will be $\frac{1}{32}$ of an actual kilogramme-metre. Muscular power, on the other hand, being proportional to the volume or mass of muscle, will be only reduced to one-eighth, and the observer will be able to lift four times the previous maximum weight. All work necessary for life will proceed at four times the usual rate, and hence life itself will be more rapid. These considerations pursued by the author into the regions of building, thermometry, animal heat, respiration and circulation, go to show that real space is different from geometric space, and that the dimensions of the universe are absolute.—Note on the variations of temperatures of transformation below and above the critical temperature, by P. de Heen. The superior limit of pressure of superheated steam before the passage into the liquid state is the simple prolongation of the curve expressing the variation of the tension of saturated vapour.—On the production of ammonia in the soil by microbes, by Émile Marchal. Nitrification takes place in three principal stages, which may be described as ammonisation, nitrosation, and nitratation, resulting in the production of ammonia, nitrites, and nitrates respectively from the organic nitrogen. Ammonisation takes place essentially under the influence of microbes living in the upper layers of the soil. In arable land, the action of bacteria is predominant. The *Bacillus mycoides*, the most energetic of these, exerts a double activity in the production of ammonia, being ammonising in the presence of nitrogenous organic matter, denitrifying when embedded in easily reducible substances such as nitrates.

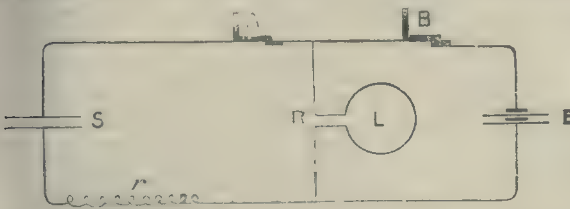
SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 1.—"On the Flow in Electric Circuits of Measurable Inductance and Capacity; and on the Dissipation of Energy in such Circuits." By Alfred W. Porter, B.Sc., Demonstrator of Physics in University College, London. Communicated by Prof. G. Carey Foster, F.R.S.

The arrangement of the apparatus in the experiments described was as follows:—

L is a coil possessing self-inductance; S, a condenser; R, an inductionless resistance; E, a battery; and A and B are two contact pieces of a pendulum interruptor. A and B are initially closed; B is first broken; A is then broken, and the charge remaining in the condenser is measured by discharging it through a galvanometer. The time interval between the two ruptures



can be varied one twenty-thousandth of a second at a time, and the manner of discharge of the condenser under the circumstances is thus determined. Curves were obtained showing (1) a merely leaking discharge; (2) the critical discharge that just fails to ever have negative values; (3) the critical discharge that just fails to be oscillatory; and (4) a thoroughly oscillatory discharge.

The differential equation to be satisfied by the discharge is—

$$\left(L\frac{d^2}{dt^2} + \rho\frac{d}{dt} + \frac{1}{S}\right) Q = 0,$$

where Q is the charge at any instant and ρ is the dissipation constant.

The solution of this for the case of oscillations is of the form—

$$Q = Q_0\epsilon^{-mt} \sec\phi \cos. (pt + \phi).$$

Experiment shows that the rate of damping is much greater than that calculated from the above, assuming that the wire circuit is the only seat of dissipation of energy. The explanation offered is that dissipation also takes place in the dielectric of the condenser. In accordance with this it is possible to reproduce the experimental curve by increasing the value of ρ from 28 ohms (the wire resistance in a particular case) to 59·4 ohms. The observed time period in this case is ·009147 seconds; the time period calculated on the above assumption is ·009154 seconds.

Experimental curves have also been obtained when iron rods are inserted in the coil. Their chief characteristics are—

(a) A decrease in time-period as the discharge progresses.

(β) Much more rapid decrement.

That (β) is only very partially due to eddy currents in the iron, was shown by repeating with a brass rod inserted in the place of iron.

Experiments are also in progress in connection with circuits of negligible capacity; a Wheatstone's bridge method being employed.

SYDNEY.

Linnean Society of New South Wales, June 28.—The following papers were read:—Notes on Australian Coleoptera, with descriptions of new species, part xiii., by the Rev. T. Blackburn.—Notes on the family Brachyscelidæ, with descriptions of new species, part ii., by W. W. Froggatt. This paper deals with Schrader's two genera Opisthoscelis and Ascelis; the two original species of Schrader are re-described, and two new species of Ascelis are added.—On the habit and use of nardoo (*Marsilea Drummondii*, R. Br.), together with observations on the influence of water-plants in retarding evaporation, by T. L. Bancroft. The author has visited the south-western corner of Queensland, journeying there *viâ* South Australia and eastward across Queensland. He first encountered nardoo in quantity near Lake Copperamana on Cooper's Creek, where, as over all the drainage-areas of the Cooper, Diamantina, and Georgina Rivers, the Blacks still make use of it as in the days of Burke and Wills. As originally stated, the plant thus utilised under the name of nardoo is a Marsilea; though doubt has been cast upon the statement under the idea that it would be impossible to obtain the involucres (sporocarps) in sufficient quantity to serve as food; and by those who took this view the seeds of *Sesbania aculeata*, Pers., were supposed to furnish the nardoo of Burke and Wills. In a day one could gather about a hundredweight of the dried rhizomes of the Marsilea with involucres attached, yielding perhaps about forty pounds weight of the latter. It was found also that the nardoo did not grow in permanent water nor in swamps, but in country subject to inundation; and from specimens brought home vigorous pot plants were reared without difficulty. As regards floating water-plants retarding evaporation, the author has made experiments with a series of gallon glass cells, some furnished with *Lemna*, *Azolla*, and *Nymphæa gigantea*, others without, and with some of each placed out of doors in the sun, and others in the shade and under cover, he found that evaporation was neither retarded nor hastened by the presence of the aquatic plants.

PARIS.

Academy of Sciences, August 14.—M. Lœwy in the chair.—On the Tubulane, a truffle of the Caucasus, by M. A. Chatin. This is a new variety of the *Tirfezia Boudieri*, which is so widely distributed in North Africa and Arabia. The roundness of the spores resembles that of the African variety, whilst the surface markings are those of *Tirfezia Boudieri Arabica*. The new variety, found about Tiflis and Baku, and sent from there by the French Consul, M. Auzepi, has been named *Tirfezia Boudieri Auzepii*. The natives call it Tubulane. It is the size of a large walnut, and its good quality and low price renders it fit for European export.—Study of the microbian origin of purulent surgical infection, by MM. S. Arloing and Ed. Chantre. Purulent surgical infection has for its essential agent the ordinary microbes of suppuration (streptococci in the cases examined). If microbes other than the preceding ones exist in the wounds, they complicate the purulent infection, but are not necessary to its development. To produce purulent infection, the streptococcus must assume the virulence which it possesses in the acute and grave forms of puerperal septicemia, and not that shown in erysipelas. There is a suspicion of etiological relations between surgical purulent infection, puerperal septicemia, and erysipelas, but it is not known as yet where and how the transformation of the pathogenic properties of the streptococcus take place which enables it to produce alternately these different clinical states.—On a product of incomplete oxidation of aluminium, by M. Pionchon. Submitted to the action of an oxy-hydrogen blow-pipe flame containing an excess of hydrogen, aluminium oxidises with vivid incandescence and is changed into a substance of a greyish-black colour, in which the ratio of the weight of oxygen to that of the aluminium has a value approaching 0·6, and therefore very different from 0·888, the value characteristic of alumina. A treatment of the substance with hydrochloric acid gave rise to a disengagement of hydrogen and the formation of aluminium chloride in solution, besides leaving an insoluble residue. A quantitative estimation of these various constituents leads to the conclusion that the grey substance contains small quantities of freer aluminium and alumina, and consists of a new oxide of aluminium, probably represented by the formula $Al_6O_7 = Al_2O, 2Al_2O_3$, which may be either a mixture or a compound.—On a new reaction of eserine, and a green colouring matter derived from the same alkaloid, by M. S. J. Ferreira da Silva.—Synthetic preparation of citric acid by the fermentation of glucose, by M. Charles Wehmer.—On the changes which have taken place in the glacier of the Tête Rousse since the catastrophe of Saint-Gervais, of 12th July, 1892, by MM. A. Delebecque and L. Duparc. Nearly all the water from the glacier escapes at present at the bottom, so that there is no immediate danger of its accumulation. But this state of things is only temporary. The valley of Montjoie appears to be exposed to a catastrophe similar to that of 1892, which must happen sooner or later. No preventive measures seem possible. A diligent watch, and an evacuation of the valley at the proper times seem to be the sole remedies.

BERLIN.

Physical Society, June 16.—Prof. von Helmholtz, President, in the chair.—Prof. Kœnig gave an account of the construction of the newest forms of artificial larynx, more especially the one described by Prof. Julius Wolff. The capabilities of the latter were demonstrated on a patient operated upon by Prof. Wolff, who could not only speak continuously so as to be audible throughout the whole lecture-room, but could also sing. The president pointed out that this case fully substantiated his theory as to the production of vowel-sounds, inasmuch as the tones being initially produced by a vibrating elastic membrane acquired their vowel quality solely by means of the varying shapes of the resonating buccal cavity. Prof. Fraenkel exhibited a man who without either a natural or artificial larynx could both speak and repeat the whole alphabet. It appeared that the patient while speaking swallowed at frequent intervals and ejected forcibly a considerable mass of air from the open end of the trachea. Careful investigation showed that there was no communication between the trachea and œsophagus; Prof. Fraenkel referred the power of speech to the existence of a fold of mucous membrane at the end of the widened pharyngeal cavity, at about the level of the former larynx, which was thrown into vibration during speech. It had not been possible to ascertain whence the patient obtained the air requisite to keep the fold in vibration; possibly the air which had been swallowed sufficed for this purpose. Dr. Krigar Menzel had, in conjunction with Dr. Raps, studied the motion of plucked strings by the method previously employed for stroked strings. The string is stretched across the long axis of a narrow brightly illuminated slit, and thereby casts a small punctiform shadow on a screen. When the string swings, a curve is traced on the moving screen, which admits of being fixed by photography. The speaker developed the theory of strings vibrating as above, and deduced formulæ which corresponded to the curves obtained. Dr. Wien spoke on the upper limits of wave length for radiant heat as based upon certain properties of Hertz's waves and the second law of thermodynamics.

Physiological Society, June 23.—Prof. du Bois Reymond, President, in the chair.—Prof. Koenig exhibited the two patients with extirpated larynx as described in the preceding report of the Physical Society.—Dr. Benda gave an account of his microscopical investigations on the development and function of the mammary gland. He had studied the development on five- and eight-month-old calves, and the functions on cows and bitches during lactation, and arrived at the conclusions that the mammary gland must be regarded as a tubular gland, and that there is no evidence of a new formation of cells during its activity. The idea that the secretion of milk depends on a breaking-down of the gland cells cannot apparently be supported by the results of microscopic investigation.

July 7.—Prof. Holowinsky, of Warsaw, spoke on a microphone he had constructed, by means of which it is possible to render audible rhythmic movements of long period, such as the cardiac impulse, the radial and carotid pulse, &c. The action of the instrument was demonstrated on several persons.—Dr. Baginsky had studied the relation of the nerves to the sensory end-organs in the case of the glossopharyngeal and olfactory nerves, by section of the nerves and subsequent investigation of the behaviour of the terminal sensory cells in each case. In the case of the tongue he found these cells unaltered after degeneration of their nerve; whereas in the case of the olfactory cells, both they and the whole mucous membrane degenerated after removal of the olfactory bulb. He, however, attributed the result in the latter case to injury of the ethmoid artery.

July 21.—Dr. Lilienfeld made a further communication on the clotting of blood arrived at by an examination of fibrine and of fibrinogen which he regarded as a nucleo-albumin. He came to the conclusion that some substance is present in normal blood which leads to clotting in presence of minimal amounts of calcium chloride. Dr. Paul Strassmann had studied the mechanism of the closing of the ductus Botalli in man, dogs, and cats, and found it dependent upon the anatomical arrangements of the entrance into the aortic arch, supporting his views by a series of preparations. Dr. Jacobs had investigated the action of extracts of a series of animal tissues on the number of the white corpuscles. He found that extracts of liver, kidney, pancreas, and thyroid had no effect on their number, while, on the other hand, extracts of spleen, thymus, and the marrow of bones, after producing a short fall, led to an increased production of leucocytes which continued for many hours, and was marked both in the peripheral as well as in the central blood-vessels and in the heart.

BOOKS, PAMPHLETS, and SERIALS RECEIVED

BOOKS.—Orchids of South Africa, Vol. 1, Part 1: H. Bolus (Wesley).—British Locomotives: C. J. B. Cooke (Whittaker).—Euclid, Books 1 to 6. D. Brent (Rivington).—Tables for the Determination of the Rock-forming Minerals: F. Lœwinson-Lessing, translated by J. W. Gregory (Macmillan).

City and Guilds of London Institute, Programme of the Technological Examinations, Session 1893-94 (London).—Catalogue of the Madreporarian Corals in the British Museum (Natural History). Vol. 1, the Genus Madrepora: G. Brook (London).—Transactions of the Sanitary Institute, Vol. xiii. (London).—Naturalist's Map of Scotland: J. A. Harvie Brown and J. G. Bartholomew (Edinburgh, Bartholomew).—Papers and Proceedings of the Royal Society of Tasmania for 1892 (Hobart).—Edelsteinkunde: Dr. C. Doelter (Leipzig, Veit).—Mineral Resources of the United States, 1891 (Washington).—Monographs of the U.S. Geological Survey, Vol. xvii., the Flora of the Dakota Group: L. Lesquereux (Washington).—Monographs of the U.S. Geological Survey. Vol. xviii.: Gasteropoda and Cephalopoda of the Raritan Clays and Greensand Marls of New Jersey: R. P. Whitfield (Washington).—General Report on the Operations of the Survey of India Department, 1891-2 (Calcutta).

PAMPHLETS.—The Yucca Moth and Yucca Pollination: C. V. Riley (Washington).—Parisitism in Insects: C. V. Riley (Washington).—Intorno all' Assorbimento della Luce nel Platino Diverse Temperature: G. B. Rizzo (Torino).—Wurde Bernstein von Hinterindien nach dem Westen Exportirt: A. B. Meyer (Dresden).—Some Ancient Relics in Japan: R. Hitchcock (Washington).—The Ancient Burial Mounds of Japan: R. Hitchcock (Washington).—Shinto, or the Mythology of the Japanese: R. Hitchcock (Washington).—The Ox Bot in the United States: C. V. Riley (Washington).—U.S. Department of Agriculture, Report of the Entomologist for 1892 (Washington).—Department of Agriculture, Victoria, Report on a Poisonous Species of Homeria: D. McAlpine (Melbourne)—Zi-Ka-Wei Observatory, the "Bokhara" Typhoon, October, 1892: Rev. S. Chevalier (Shanghai).—Guide to Ben Nevis (Edinburgh, Menzies). Description of some Fossil Plants from the Great Falls, Coal Field of Montana: W. M. Fontaine (Washington).—On the Occurrence of the Spiny Boxfish on the Coast of California: C. H. Eigenmann (Washington).—Report on the Actiniæ Collected by the U.S. Fish-Commission Steamer *Albatross*, during the winter 1887-88: J. P. McMurrich (Washington).—Massachusetts Institute of Technology, Boston, a brief Account of its Foundation, Character, and Equipment (Boston).—National Association for the Promotion of Technical Education, Sixth Annual Report, 1892-93.—Cholera Prospects and Prevention: R. Thorne Thorne (Allman).—L'Anthropologie aux Etats-Unis: Dr. P. Topinard (Paris, Masson).—Revised Report on the Copepoda of Liverpool Bay: I. C. Thompson (Liverpool).—On the Evolution of the Art of Working in Stone, J. D. McGuire (Washington).—Guide to Sowerby's Models of British Fungi in the Department of Botany, British Museum (Natural History). W. G. Smith (London).—Maupertuis, E. du Bois-Reymond (Leipzig, Veit.).

SERIALS.—Memoirs and Proceedings of the Manchester Literary and Philosophical Society. Vol. 7, Nos. 2 and 3 (Manchester).—Mittheilungen der Deutschen Gesellschaft für Natur und Völkerkunde Ostasiens in Tokio 51 Heft (Tokio). Aus dem Archiv der Deutschen Seewarte, xv. Jahrgang, 1892 (Hamburg).

CONTENTS.

THURSDAY, AUGUST 31, 1893.

BIRDS IN A VILLAGE.

Birds in a Village. By W. H. Hudson, C.M.Z.S., author of "Idle Days in Patagonia," "The Naturalist in La Plata," &c. (London: Chapman and Hall, Limited, 1893.)

MR. HUDSON would probably think it a doubtful compliment if we were to say that his last book is as good as either of the two which preceded it. But to say that "Birds in a Village" is not equal to "Idle Days in Patagonia," and not to be mentioned in the same breath as the charming "Naturalist in La Plata," by no means implies that it is other than a pleasantly readable book, with here and there—more particularly in the chapter which gives the title—graphic sketches of the habits of the birds he watched in his ideal country village, such as only a close and loving observer of Nature, and a practised writer, can give.

The unregenerate man may perhaps at first be a little inclined to rebel when he finds his insular ignorance of languages brought, he may think, rather too obtrusively home to him by untranslated Spanish poetry and a critical discussion on the superiority of Melendez to Tennyson in a chapter in which he had hoped to forget himself and his failings among blackbirds and thrushes. But any resentment he may have felt for the moment will be forgotten as he looks over the fence into the cottage garden and sees the hedge sparrow feeding the young cuckoo with caterpillars, "like dropping a bun into the monstrous red mouth of the hippopotamus at the Zoological Gardens," or lolls on the moss in the wood to watch through Mr. Hudson's binocular the jay, "high up amongst the topmost branches," as he "flirts wings and tail, and lifts and lowers his crest, glancing down with wild, bright eyes . . . inquisitive, perplexed, suspicious."

By the time he has wandered up the brook-side to the corner where "buttercups grew so thickly that the glazed petals of the flowers were touching, and the meadow was one broad expanse of yellow," and has caught sight of the kingfisher, "like a waif from some far tropical land," flying off "so low above the flowery level that the swiftly vibrating wings must have touched the yellow petals," he will have realised that he is in the company of one of the devoted worshippers of Nature, by whom "where'er they seek her she is found," and for whom every spot—country village, London park, or solitary South American plain—is "hallowed ground."

As might be expected of a man who has lived on such impartially friendly terms with living things of many kinds that, after lying helpless and alone miles away from any one, with a revolver bullet in his knee, he could find relief to his pain in the knowledge that the poisonous snake which had shared his rug with him through the night had got off in the morning without inhospitable treatment at the hands of his returning friend, Mr. Hudson rejects as "utterly erroneous" the "often quoted dictum of Darwin, that birds possess an instinctive fear of man," and quotes in support of his view—in which we entirely concur—the tameness of the moorhens in St. James's Park.

The wood-pigeons—in the country the wariest of birds, in London tamer if possible than the sparrows—are even stronger witnesses for him. It is said that the Paris wood-pigeons, which are as common and tame there as with us, and make frequent excursions to neighbouring country places, the moment they leave the precincts of the town assume their natural wildness, putting it off again the moment they return to the children and *bonnes* in the Tuileries Gardens.

By-the-bye, in connection with wood-pigeons we have a very small bone to pick with Mr. Hudson. Since Science has become a religion it was only to be expected that the religious parasite—*odium theologicum*—would develop new forms to suit. It has done so, and too many recent scientific works—notably one of the best modern bird books—are disfigured by sneers at other writers.

A charm of Mr. Hudson's writings hitherto has been, and we hope it always will be, that he has kept himself free from smallnesses of the kind. But there is "a little pitted speck" in this last fruit which we have never noticed in any of his earlier gatherings, and, microscopic though it is, we are sorry to see it. He is perfectly justified if he thinks it so in speaking of the wood-pigeon—the "deep, mellow crush" of whose note in Campbell's ears "made music that sweetened the calm" of the birchen glades he loved—as "*that dismal croaker.*" But having done so he ought not to fall foul of a brother ornithologist and his ancestry, and to throw Wordsworth at his head because he has ventured to write disrespectfully in *Blackwood* or *Macmillan* of the note of the greenfinch. We hope that Mr. Hudson will feel grateful to us for a friendly reminder that people who live in glass houses should not throw stones.

Mr. Hudson, as many another writer has done, protests in impassioned language against the practice of eating larks. The song of the "blythe spirit" of meadow and corn-land is as sweet to us as to him; and, being unfashionable enough not to appreciate, as every self-respecting diner should do, *mauviettes en surprise aux truffes*, or in any other dainty form, we may venture with a clear conscience to express a doubt whether the supply of larks to the markets affects appreciably, if at all, the numbers remaining to breed in England. Wherever they may come from, there can be no question the number of immigrants in winter is almost incredible. The most striking feature of a partridge drive at the headquarters of the sport, in the flat country round Thetford and Brandon, towards the end of the season, is the sight of the apparently interminable flocks which stream over the waiting guns. We have heard it said by a large landowner in the district, an ardent bird-lover, that it is no exaggeration to say that larks there are, when the early corn is first shooting, a nuisance to the farmers scarcely less serious than are the rats in more enclosed parts.

Space will not allow us to follow Mr. Hudson into the interesting questions touched upon in his later chapters. We fear that, whatever may lie before our children in good times to come, the dimming eyes of our own generation will not be refreshed by the sight of the glancing colours of exotic kingfishers reflected in English streams, nor can we ourselves look forward with any great confidence to an early realisation of Mr. Hudson's dream of artificial birds'-eggs of such magic perfection that schoolboys seeing them will rob birds'-nests no longer, though we agree with him in thinking that the volatile colours of most eggs when blown, make collections of but little lasting value.

There is in "Birds in a Village," unless we are mistaken, something which may possibly prove of more practical interest to lovers of good works of natural history than any such agreeable speculations.

"Travel fever" is a malady easily caught. It is recurrent, and when once caught, seldom completely shaken off until life energy begins to fail and a man nears the starting time for his last journey. There are touches—sometimes rather pathetic—in the book before us which suggests that it was written under the influence of an unusually sharp attack. A few words from a little girl in St. James's Park, "Oh, how I love the birds!" were enough to start the writer wandering "somewhat aimlessly" about the country till he stumbled on his nightingale-haunted village and stopped there. "I could not," he writes, "longer keep from the birds, which I, too, loved, for now all at once it seemed to me that life was not life without them, that I was grown sick, and all my senses dim; that only the wished-for sight of birds could medicine my vision; that only by drenching it in their melody could my tired brain recover its lost vigour."

The chapter headed "Chanticleer" is as symptomatic as the passage quoted above. Mr. Hudson tries seriously to persuade himself and his readers that he likes being awakened at three o'clock in the morning by his neighbours' cocks! When he believed himself listening to their crowings he was in a trance, having his eyes open. His body may have lain "on high ground in one of the pleasantest suburbs of London," but he was himself thousands of miles away—lying on the cliff-edge, dropping stones to startle the great coots of Patagonia, riding at a swinging gallop through rustling seas of giant thistles into the "mysterious, extra natural, low level plain, green and fresh and snaky, where horsehoofs made no sound," or gazing up at the starry skies of the Pampas. The sounds of which he was really conscious were the concerts of crested screamers, or the dance music of La Plata rails.

Mr. Hudson will not think we wish unduly to disparage his "Birds in a Village" if we express a hope that circumstances may allow him soon to let Nature have her way, and that before long he may be able again to show us, on larger canvas, other collections of sketches of scenes less easily accessible.

In these days of high pressure one of the most serviceable qualities that a man can possess is the power of self-abstraction—to be able to throw work and worries on one side and bury himself in other interests. In "Endymion," when the hero's father found money difficulties gathering round him, and his political hopes failed at what had seemed the very moment of realisation, he committed suicide "because," says the author, "he had no imagination." The power which could convey Lord Beaconsfield himself at the time of a crushing defeat back to the formal terraces and gardens of the Bradenham of his boyhood, and enable him there to forget himself in the hopes and fears of beings of his own creation, is a gift of the gods to the few. A love of Nature—its best substitute—is a possession scarcely less precious, and one to which every parent may do much to help his children.

For such an education many more ambitious works could be better spared than the transcripts from the less known pages of "God's great second volume" which Mr. Hudson so well knows how to write. T. D. P.

A MATHEMATICAL MISCELLANY.

Mathématiques et Mathématiciens, Pensées et Curiosités. By A. Rebière. Second edition. First edition, 1889. (Paris: Nony et Cie, 1893.)

THIS work, originally issued in 1889, contains quotations from various writers on the study or philosophy of mathematics, together with some anecdotes and problems on the subject. The first edition consisted of but 280 pages, but advantage has been taken of a new issue to make additions which have more than doubled its size. Save for a brief section on the history of mathematics, the work is almost entirely a compilation, and no attempt is made to connect together the extracts or draw any inferences therefrom. The reader thus has the advantage of being able to begin anywhere, but the effect of many hundreds of short and disconnected paragraphs is somewhat jerky. To form such a miscellaneous collection, drawn from writers of all ages, must have involved extensive preparation and years of reading. M. Rebière may be congratulated on the result of his labours, for the volume is undoubtedly interesting, though of somewhat unequal merit.

It is divided into four parts. The first is mainly devoted to remarks on the philosophy of mathematics—by far the greater portion being drawn from French sources. In our opinion this is the best section of the book, since many of the extracts here given would otherwise be practically inaccessible; moreover it is always instructive to read the opinions of writers like Condillac, Mdme. de Staël, Rousseau, and Comte, and not the less so when their knowledge of the subject discussed is rather superficial. At the same time we think that a reader may reasonably expect detailed references to the sources of the quotations, and certainly the value of the collection would be increased thereby.

The section on the history of mathematics, which is placed at the close of this part, is a mere travesty of the subject. We cannot suppose that M. Rebière, when writing his work, seriously thought that Galileo, Kepler, Newton, and Leibnitz were the only mathematicians outside France who should be mentioned as having been eminent in the last five hundred years; that among over forty names given as representing contemporary mathematicians not a single foreigner should find a place; or that five French papers were the only current periodicals of any importance (had not M. Rebière ever heard of *Crelle's Journal?*). In the second edition the names of Huygens, Euler, Gauss, and Jacobi, together with those of a few European contemporaries are added, but though M. Rebière in his preface specifically calls attention to these additions, we consider he would have been better advised to have omitted this section rather than give a sketch which is so unsatisfactory.

The second division of the work is of a very miscellaneous character, ranging from quotations and anecdotes to a note on the superstition that thirteen is an unlucky number, and a remark that Newton's fluxions is not, as might be inferred from the title, a medical work. Any citation involving a geometrical term or a number seems to be regarded as worthy of a place here: thus the observation of a diplomatist that the straight course is not always the shortest way is regarded as a geometrical anecdote. Such examples abound, but it is an unusual stretch of langunge to call them mathematical.

The third division commences with some quotations which might have been equally well placed in the first part of the book. Most of it is, however, devoted to what are called paradoxes and singularities; such as a mnemonic verse for recollecting the approximate value of π, that the number six hundred and sixty-six is supposed to be connected with Antichrist, that a map of the heavens is now being prepared by photography, that two and two do not truly make four because the units used can never be exactly alike, that since it is very cold at the North Pole it might be thought that it was very hot at the South Pole, that Cardan's solution of a cubic equation is useless for determining real roots, and so on. Such a collection of assertions and extracts—mostly unaccompanied by comment or reference — will probably be less attractive to the mathematician than to the general reader.

The book concludes with some problems, classified according to subjects. In general, only the enunciations are given. Thus, in arithmetic, we have the question how many digits are used in paging a volume of one thousand six hundred and forty-five pages; in algebra, the question of finding the number of rabbits and pheasants when altogether among them there are thirty-five heads and ninety-four feet; in optics, the determination of a point equally illuminated by two given luminous points; in mechanics, the curve of pursuit, and in higher (!) mathematics, the question of finding the sum to which a centime would amount in eighteen hundred and eighty-nine years at compound interest at the rate of five per cent. a year. Some "recreations" and celebrated problems are also included: historical notes on these or references are either absent or so incomplete as to be practically useless, though they would add greatly to the interest of the questions. Moreover, it seems desirable to add a warning that questions of this kind—such as the inscription in a circle of a regular polygon of seventeen sides, the theory of the knight's tour on a chess-board, and the formation of perfect numbers—are of a totally different character to the common catch of the time occupied in reaching the top of a pole twenty metres high by a snail which each day crawls up three metres and each night slips down two metres. Here, however, conundrums and problems of all degrees of difficulty are indiscriminately mixed up together. In spite of this obvious criticism the collection is a good one, and well adapted to stimulate interest.

The printing and get-up of the book are admirable, while the foregoing sketch will, we think, enable the reader to form a general idea of its contents. We have already stated that, in our opinion, its chief value lies in the citations on the philosophy of the subject; the scientific worth of the rest is more questionable, but it forms an amusing collection of assertions and notes concerning mathematics which may be commended to those interested in such matters.

OUR BOOK SHELF.

Grasses of the Pacific Slope, including Alaska and the Adjacent Islands. Part II. By Dr. George Vasey, Botanist to the U.S. Department of Agriculture. Issued June 1, 1893. (Washington: Government Printing Office, 1893.)

THIS is the fourth part of a series of plates and descriptions of the rarer American grasses which has been issued by the United States Department of Agriculture. The first volume was devoted to the species of Texas and the south-west, and the present volume, which is now finished, contains plates and descriptions of the grasses of California, Oregon, Washington, and the north-western coast, including Alaska. Dr. Vasey, who for many years was head of the department at Washington, died before the present volume was issued. He was a native of Yorkshire, who emigrated to the Western States in early life. For many years Dr. Vasey lived in Illinois, and was one of the leading authorities on the plants of the Western States. He was already advanced in years when he became a government servant, and made a special study of the grasses.

The number of grasses of the Pacific Slope reaches nearly two hundred species. They are nearly all specifically distinct from the species east of the Mississippi River. A considerable number of the grasses of the mountain regions of California, Oregon, and Washington reappear in the mountains of Idaho, Montana, and the interior Rockies.

The interior of California is a dry region, verging in the extreme south into desert country, and is very deficient in grasses. In the present part there are descriptions and plates of 1 Schimdtia, 1 Phippsia, 1 Arctagrostis, 2 species of Agrostis, 3 of Calamagrostis, 2 of Deschampsia, 1 Trisetum, 1 Danthonia, 6 of Melica, 2 of Pleuropogon, 1 Uniola, 15 of Poa, 1 Colpodium, 2 of Dupontia, 1 Glycera, 1 Atropis, 3 of Festuca, 2 of Bromus, 1 Agropyrum, 3 of Elymus, and 1 Gymnostichum. Only two of the species are British, *Calamagrostis neglecta* and *Elymus arenarius*. The descriptions are mainly drawn up by Mr. L. H. Dewey. We wish the department could see its way next to issue a complete synopsis of all the grasses of thé United States. J. G. B.

Reveries of World History, from Earth's Nebulous Origin to its Final Ruin; or, the Romance of a Star. By T. Mullett Ellis. (London: Swan Sonnenschein and Co., 1893.)

IT is difficult to estimate the place of this book in scientific literature. The object of its publication is apparently to give the world the benefit of moralisings very similar in style to those indulged in by Mr. Richard Swiveller of *Old Curiosity Shop* fame. But there is no substance in the book whatever. From the first to the last page the author meanders on with wearisome platitudes expressed in high-flaunting style, obscuring a line of fact in a page of padding. This is the manner in which he is carried away on the subject of the origin of man.

"He came like an apparition. Whence? Who shall say? Who shall dare, out of his absolute knowledge, to declare his origin, his ancestry?

"What hopes had he in that dreary desolation? What thoughts? What ambitions?

"What a being! What a nature, his! How noble his form! Between the mammoth and himself, between the animals that he chased and he, what a chasm in the scale of creation!"

So the rhapsody continues, without backbone or argument of any kind. Mr. Millett Ellis probably means well. Indeed, his literary effort may be highly appreciated by people who mistake verbiage for eloquence. To us, however, the contents appear to be in a nebulous condition like that which existed when, to use Mr. Ellis's words, "The chaos of earth circled in the vastness."

LETTERS TO THE EDITOR.

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

The Publication of Physical Papers.

THE discussion started by Mr. J. Swinburne in NATURE of June 29, seems to have wandered from its original purpose, and from the points suggested in your article of July 13. It is the duty of an investigator in any branch of Natural Science to publish the results of his research if they appear to be both new and of sufficient interest. He has three courses open to him. He can write a book, relying on the advertisements of his publisher and on reviews to inform other workers that such a book exists. His space is unlimited, but he cannot make sure of a circulation unless by presentation copies. He may communicate his results to a scientific society. His space is somewhat limited, but he secures a definite circulation, and an opportunity for discussion. Or he can communicate them to some technical journal, securing generally the maximum circulation, but with considerable restriction as to space.

The publication of books needs no comment, and was alluded to by Mr. Swinburne. Mr. Buchanan thinks that the publication of papers in all branches of science is in as unsatisfactory a state as that of physics, and advocates the central organ suggested by Dr. Oliver Lodge, and referred to by Mr. Swinburne as a last resort. But the real question seems to be one of facilities for the publication of original communications, not of abstracts or reprints; and these not of general science, but of physics. Mr. Swinburne has given reasons which render a purely physical journal impossible, unless it be endowed or subsidised, as in the case of the excellent *Physical Review* of the Cornell University. Nothing could be more complete than the publication of chemical researches; and geology, astronomy, biology, and physiology, though untainted by the patentee, and treated often as a hobby rather than as a study, seem to be well provided for.

Exhaustive and important physical researches, such as those of Ewing on Magnetism, should undoubtedly be communicated to the Royal Society. The Transactions, it is true, are very expensive, and the circulation appears to depend largely on presentation copies, unless an abstract or reprint appears elsewhere. Work done at University laboratories is in many cases appropriately communicated to local societies, the circulation is almost negligible, and the majority of the papers are never heard of by outsiders. The Physical Society appears to offer the greatest facilities, and to publish its proceedings in the best possible manner—first through its own Proceedings, secondly by a recent arrangement with the *Philosophical Magazine*, thirdly by a number of reprints issued to the author, and last, but not least, by the admirable report which is sent to and printed by a number of technical journals, and which appear regularly in NATURE. Dr. Lodge thinks that "the method of publication invented, or at any rate adopted, by the Physical Society of London" is "well worthy of imitation." Not of imitation surely, for to multiply societies will hinder rather than facilitate reference to the published papers. The valuable work of the Physical Society needs extension. The double publication in the *Philosophical Magazine* and in the Proceedings seems to be somewhat wasteful. A selection of its heavy mathematical papers might be offered by the Society to the *Philosophical Magazine*; and thus leave room in its Proceedings for publication, in addition to its present contents, of papers accepted for printing, but not necessarily for reading and discussion; and for abstracts or for full publication of the more important physical papers of the societies of Cambridge, Oxford, Dublin, Edinburgh, and Glasgow. The Institution of Civil Engineers publishes a number of "selected papers"; these are either unsuitable for reading and discussion at a meeting, or are of minor importance. They receive perhaps less attention from London members who frequently attend the meetings, and who rarely read the Proceedings, but they secure as wide a circulation as those which are accepted for reading. A very successful departure was made by the Institution of Electrical Engineers in the publication, early in August, 1892, of a paper by Mr. J. Swinburne on "Problems of Commercial Electrolysis." At the meeting on November 10, this paper was taken as read, and a useful and vigorous discussion followed, occupying two evenings.

By the brief but careful and always accurate abstract of the papers, and by the no less excellent though much more care-demanding report of the discussion, an unusually wide circulation of the chief points of all communications to the Physical Society is secured. The lithographed reports are sent gratuitously to any technical journal that cares to publish them. Abstracts of "selected papers" could be sent out in the same way, and could be made with far less trouble, since, unlike the report which is issued a few days after each meeting, they could be dealt with at leisure; the abstract might indeed be furnished by the author, though I am not sure that this is advisable. The Physical Society seems in every way admirably fitted for the publication of physical papers, and no greater facilities for experimental demonstration could be desired than those which are so freely afforded to the authors of papers read before it.

Mr. Basset suggests that the London Mathematical Society would be a good medium for the publication of physical papers. May I protest against confusion between the two sciences, and I am sure that many pure mathematicians, though from a different point of view, will agree with me? There was once and I believe still exists, a "science" called Microscopy. It was divided into two factions, strongly opposed to each other. These were named, reciprocally I suppose, "The Glass and Brass School," and "The Slug and Bug School." The one regarded the *navicula* and the *grammatophora* as having been specially created to afford test objects for showing off the performance of favourite instruments; the other considered immersion objectives and correcting adjustments as mere tools, the use of which must be learned; and regarded polariscope attachments and mechanical stages as toys. The problem worker, it would be ambiguous to call him a mixed mathematician, finds in physics an unlimited material for problem-setting. In many cases he accidentally makes an original contribution to physical science, he frequently gives most valuable finishing touches to the experimental work of others, and occasionally actually retards progress, as in alternate current electrical engineering, by introducing complications on insufficient data, to the discouragement and confusion of the experimental worker. Good tools are in themselves a delight to a good workman; no true physicist can disregard mathematics, even in those branches which are to him useless. But the aims differ, and the sciences should be distinct.

There need be no rivalry whatever with the Royal Society. Elaborate memoirs do not admit of discussion, and it would be a pity to burden the Physical Society with the expense of printing them, when the Royal Society can so well afford to give them place in its Transactions. The strict rules of the Institution of Civil Engineers against the publication of its papers in technical journals before they have appeared in its own proceedings, and the similar rule of the Royal Society, so far as its Transactions are concerned, may perhaps be in keeping with the unapproached prestige of these institutions. But the Royal Society issues proofs of its Proceedings after the papers have been read, and the Institution of Mechanical Engineers and other societies send out proofs of their papers with the simple condition that they are not to be reprinted until the communications have been actually read. The Physical Society tacitly adopts the latter course, sending proofs before the meeting to those who are likely to take part in the discussion. The only objection to the free publication of a paper *before* it is read and discussed, is that a discussion may take place prematurely in the technical journals; but with the exception of NATURE, these are in touch with so few branches of physics, that but little harm would be done.

I venture to think that the publication of physical papers can be carried out most efficiently by means of the present procedure of the Physical Society; that with a few modifications it could deal with all the more important physical papers annually published in this country; and that such centralisation is very desirable. Such modifications I beg to suggest are the following:—(1) Let mathematical papers, *i.e.*, those which consist of problems in mixed mathematics rather than pure physics, be offered to the *Phil. Mag.*, publishing the conclusions, with a reproduction of any resulting diagram, in brief abstract in the journal. (2) Let papers be invited not only for reading during the winter season, but for publication at intervals throughout the year, whenever enough matter has been collected to fill a number, as is done in many other publications. (3) Let selections be made from these for reading, on the grounds [*a*] of scientific importance, [*b*] suitability for discussion, [*c*] experimental demonstration. (4) Reprint in abstract, or occasionally in full, papers read before other societies (excepting, of course, the Royal Society).

I feel that some apology is due for making these suggestions elsewhere than at an annual general meeting of the Physical Society, but the attendance at the meetings is no measure of the important work which this society does in the publication of physical papers, and as these suggestions arise directly out of the discussion which has arisen in your columns, they may perhaps not be out of place there. ALEX. P. TROTTER.

28, Victoria Street, Westminster.

The Definition of "Heredity."

WHEN all the world is ringing with the words "heredity" and "inheritance," it is natural to feel some surprise and amazement on hearing from even so high an authority as Dr. Hurst that they are expressive of nothing but the incoherence of ideas emanating from confused brains. Perhaps as a student of Darwinism I may be allowed a little space in your columns to suggest that there is an alternative view to that held by Dr. Hurst.

His position I understand to be this: No force of any kind except natural selection is at work to preserve the form of organisms from alteration. Does he mean to confine the application of this statement to organisms existing under stable conditions, or would it have equal force in the probably numerous cases where temporary changes in circumstances occur? Now it cannot be denied that there is some factor of considerable power controlling the variations of species from the normal type; but that it is a natural selection, as ordinarily understood, seems to me to be at least open to discussion. If, without the action of natural selection all species are liable to react to any change in their environment, there is no reason against and very great probability in favour of many species having been destroyed by the advent of new conditions followed by the substitution of new forms quite ill-adapted to the old conditions. What would then be likely to happen should the original circumstances return? Two alternatives are possible under Dr. Hurst's view. Either the form resulting from the first change must be lost, or it must again become modified; but the chances are infinite against any approximation to the original organism being reached unless there be some tendency towards a return to former types.

If we adhere to the opinion that "heredity is something more than mere family likeness," and not quite comparable to the "tendency of all weathercocks to point to the south-west," we are at once freed from the difficulty, and can see how a species might outlive many temporary changes in the form of influences to which it might be subjected. In order that species may be modified to suit new permanent surroundings it is obviously unnecessary that the variations arising among the individuals shall be very frequent, and, when organisation and environment are in agreement, it is equally obvious that the fewer the departures from the normal type the better will it be for the species. If, then, the tendency is strong in all organisms to conform to an ancestral type, whenever there is a merely temporary change of environment the chances of some at least of the individuals leaving unmodified descendants, when the old conditions reassert themselves, is vastly increased; and if meanwhile some other individual families have become somewhat modified, then the number of species in existence may also have been increased. Of course I am supposing that the period during which abnormal conditions of life remain in force shall not extend sufficiently to allow all the unmodified individuals to be eliminated by the action of natural selection.

If I have been successful in my argument, I think it will be clear that the force which I should designate by the term "heredity" cannot be described as a tendency fostered by natural selection; for, while any influence it may exert antagonistic to the development and continuance of species will be counteracted by natural selection, the benefits it may confer are almost entirely prospective, and therefore do not fall within the range of the force which tends to preserve favourable variations.

I conceive that the definition of the word "heredity" should be—the tendency, more or less strong according to the age of the species, to follow certain types, exhibited by all organisms, and that it is no mere abstract idea devoid of objective existence, but a force the importance of which we are not yet able to fully grasp.

In conclusion I should like to mention a point with regard to the case of Saturnia which has, I think, been overlooked. What has really been proved is simply the fact that the insect is extremely susceptible to modification by change of food. If some entirely new food-plant, if possible chosen from an entirely different order, could be found as a substitute for either species of Inglans, and the result were carefully watched, the experiment could not fail to be instructive, I will not say conclusive.

Rochdale, August 19. J. SPENCER SMITHSON.

Sexual Colouration of Birds.

THE recent controversy in your columns with regard to the non-inheritance of acquired characters opens up the question whether the principle of natural selection operates universally in the animal kingdom, or whether we must involve other causes to supplement it. In Dr. Hurst's letter of August 17 (p. 368) is a sentence which seems to embody what has generally been understood as Darwinism: "If anything has ever been rendered certain in biology by prolonged experiment and observation, it is the fact that specific characters are maintained constant by selection, and that alone." But how does this agree with Dr. Wallace's theory of accessory plumes? This theory he himself thus expresses ("Darwinism," p. 293): "The fact that they have been developed to such an extent in a few species is an indication of such perfect adaptation to the conditions of existence, such complete success in the battle for life, that there is in the adult male, at all events, a surplus of strength, vitality, and growth-power which is able to expand itself in this way without injury." Here we have two entirely different views of what is meant by the struggle for existence. According to Dr. Hurst it is incessant; let its operation cease, and the characters of the species become speedily obliterated. According to Dr. Wallace a victorious species may leave the arena, and rest upon its laurels. But if natural selection ceases to work in this field, why not in others? The colours, it is true, may be due merely to waste products turned to account, but the annual growth of the peacock's plumes—often nearly five feet in length—must require a great expenditure of vital force.

In Brown's "Thier-reich" it is stated that even in ordinary cases moulting is not unaccompanied with danger to the bird. And this is not all: the secondary wing feathers of the argus pheasant are developed to such an extent that they are said "almost entirely to deprive the bird of flight" ("Descent of Man," vol. ii. p. 97). The theory by which Darwin himself accounted for these phenomena, viz. that the female selected the most brilliantly coloured male as her partner, explained the facts, but failed for want of sufficient evidence that any such selection took place. I cannot think that the two forms of sexual selection, by battle and by female preference, conflict, since the hen bird might well admire the combination of fine plumes and warlike prowess.

There is, besides, Mr. Stolzmann's theory that it is to the advantage of the species that the number of males should be kept down, since bachelor males persecute the hen bird upon the nest. This assumes what is not well proved, that males largely outnumber females. But a very large proportion of the species in which the cock-bird is highly decorated are polygamous, and in these cases the number of males is obviously excessive. Mr. Stolzmann's theory in no way conflicts with Darwin's, but rather supplements it. Moreover, it is hardly more than an extension of Dr. Wallace's view that the dullness of the female's plumage is due to her need of protection, which in the case of the male is less necessary. Both Darwin's theory and Mr. Stolzmann's require further evidence, but they each have the merit of suggesting a cause for the constancy of the same plumage through successive generations.

Scourie, Lavig, N.B., August 24. F. C. HEADLEY.

Bird's Steering Methods.

MR. HEADLEY'S suggestion (NATURE for July 27) that gulls sometimes steer by dropping one foot, is, it seems to me, hardly tenable, for so small a rudder acting on so thin a medium as air would be of little effect. And although I have seen many gulls under very varying circumstances, I have never seen them even appearing to direct their course in such a manner.

That birds, to a great extent, steer by changing the position of their centre of gravity is undoubtedly correct, and it is especially true of birds with long narrow wings, such as the petrels and sheerwaters. The albatross exhibits this method to perfection, and anyone who has watched this bird circling far and wide, will have noticed what an angle the outstretched, almost motionless, wings make with the level of the water, an angle frequently as great as 45°

The flexion of the body is, I take it, of comparative little help, difference in force or direction of wing stroke being the main method by which birds direct their course.

The wings may act synchronously, a change in the direction of one wing causing it to act with more or less force than the other, while such change might be so slight as to elude the eye, or even a camera. A humming-bird will hover about a cluster of blossoms, now hanging motionless, now circling right or left around the flowers, and as there is no turn of the head or swaying of the body, it is evident that the directed force lies in the wings, although their presence is indicated by a mere hazy blur. The body is usually held at an angle of from 30° to 45° with the vertical, and the tail is kept closed, being indeed rarely spread, except when the bird is darting about in the air.

The use of wings is well shown by the crows, which in fall and winter roost in great numbers on the other side of the Potomac, and may be seen towards sunset winging their way homeward from their feeding places. When the wind is light, the crows fly high and steadily, but in windy weather they may be seen beating back, just skirting the tree-tops, apparently to take advantage of any favouring eddy that may exist near the earth. As the birds dart up and down, and from side to side, one can clearly see the wings open and close, and unless my eyes are very deceptive, the two wings are by no means always opened to the same extent.

The principal use of a bird's tail seems to be to effect vertical changes in direction, and while birds with moderately long tails usually have a more graceful, gliding flight than their abbreviated relatives, they are no more expert on the wing. The flight of the forked-tailed swallow is more pleasing than that of the short-tailed chimney swift, but the swift is quite as much at home in the air as is the swallow.

Birds with unusually long tails, such as the hornbills, are apt to be but indifferent flyers.

Washington, D.C., U.S.A., August 14. F. A. LUCAS.

The Early Spring of 1893.

THE exceptional character of the spring of this year has already been described in these columns. It seems worth the while to inquire to what extent the warm weather commencing in March affected the times of flowering of our native flora. The Botanical Section of the Halifax Scientific Society has now for seven years, since 1887, kept a record of all plants observed by its members growing within the limits of the Halifax parish. This, it may be mentioned, is of considerable extent, perhaps measuring six miles by twelve or more. Thus, the record affords a means of comparing the dates of flowering this spring with those of previous years. Of course these will not coincide with records from other districts, as the South of England, but they will satisfy the necessary condition of such an inquiry, viz. that the district should be of limited extent so that the time of flowering of any species in one year is practically the same throughout it. In addition there is the advantage that the drought was not so great as to retard or kill the vegetation. On the other hand, such a record must necessarily be open to error; a plant may have been in bloom some time before it was met with; only a comparatively few species have been recorded *every* year without a break; some days often intervene between a flower being in bud and in bloom, and the record may possibly, without saying so, refer to the former. However, these errors are partly constant, and may be partly eliminated by neglecting the rarer species, which have only been noted two or three times.

In February almost the only plant to flower was the hazel, seen this year on the 15th, and last year fourteen days later.

In March twenty different species were observed in flower; of these only half had been previously recorded in March, the other half being equally divided between April and May. Coltsfoot (*Tussilago Farfara*) and *Salix Caprea* appeared at the usual time within the first week; the daisy was not noticed till the 31st, whereas it had previously been found on the 29th; but almost all the others were very much earlier than usual. The average was more than eighteen days before the earliest previous record. This is borne out by the fact that the same elm (*Ulmus montana*) was in flower this year (on March 9) twenty days earlier than last year. In some cases, *e.g. Stellaria Holostea*, *Ranunculus acris*, and *Alchemilla vulgaris*, the period was increased to as much as five weeks.

There were a few apparent exceptions, but they may certainly be put down to accident or rather neglect. The chickweeds, *Cerastium triviale* and *Stellaria media* escaped notice till April, groundsel had previously been noted earlier than April 9, and shepherd's purse was no doubt in flower early in April, but was ignored till May came in.

The effect of the weather became more pronounced throughout April. Excluding the common "weeds" just mentioned, every flower was at least a fortnight before its earliest previous record, and the list of twenty-five species is composed almost entirely of May flowers; in fact the only exceptions were the wood sorrel and the marsh marigold, in flower on the 5th and 8th, or antedated fourteen and twenty days respectively. On an average the flowers of April were 25·5 days earlier than in any of the previous years. The exact dates of a few of the commonest are appended.

Cardamine pratensis	April 8, 1893;	May 10–15,	1887–92
Scilla nutans	,, 13, ,,	,, 1,	1887
Lychnis diurna ...	,, 13, ,,	,, 10,	,,
Veronica Chamaedrys	,, 13, ,,	,, 15,	1888
Allium ursinum ..	,, 16, ,,	,, 5,	,,

Thirty-five fresh species were added in May, twelve of which are usually June flowers. By this time, however, it became difficult to keep a complete record, so that about half-a-dozen appear to flower later this year than in one or other of the previous years. Again excluding these, the remainder flowered seventeen days earlier than before. From a consideration of those given below it would appear that the season was about three weeks earlier at the beginning of the month, and a fortnight at the end.

Cytisus Scoparius ...	May 6, 1893;	May 13, 1890
Orchis mascula ...	,, 6, ,,	,, 14, 1892
Geranium Robertianum	,, 6, ,,	,, 17, 1887
Trifolium pratense ...	,, 6, ,,	,, 28, 1892
Quercus Robur ...	,, 6, ,,	,, 29, 1887
Crataegus Oxyacantha	,, 7, ,,	,, 29, 1888 (But usually June 3–9.)
Rhinanthus Crista-galli	,, 27, ,,	June 9, 1890
Chrysanthemum Leucanthemum ...	,, 27, ,,	,, 9, ,,

In June the advance still remained about a fortnight, taking twenty seven species into consideration, but an increasing number have to be left out owing to the impossibility of recording all as soon as they appeared. Ten out of the twenty-seven had previously belonged to the catalogue of flowers appearing in July.

Lychnis Flos cuculi ...	June 10, 1893;	June 17–26,	1887–92
Silene Cucubalus ...	,, 10, ,,	,, 26,	1888
Rosa canina	,, 10, ,,	,, 28,	1887
Centaurea nigra ...	,, 10, ,,	July 2,	1889
Lonicera Periclymenum	,, 15, ,,	,, 2,	1892
Spiræa Ulmaria ...	,, 15, ,,	,, 2,	1889
Digitalis purpurea ..	,, 15, ,,	June 24,	1890
Valeriana officinalis...	,, 17, ,,	,, 24,	,,
Achillea millefolium..	,, 26, ,,	,, 27,	1892

In July there seems to be no evidence for the maintenance of the advance; the flowers were then appearing at their normal season, *e.g.*—

Campanula rotundifolia	July 8, 1893;	July 2–15, 1887–92
Calluna Erica	,, 22, ,,	,, 19, 1887
Jasione montana ...	,, 1, ,,	,, 2, 1892
Cnicus arvensis ...	,, 1, ,,	,, 2, 1889
Scabiosa succisa ...	,, 22, ,,	,, 23, ,,
Galeopsis Tetrahit ...	,, 15, ,,	,, 16, 1892

The general result is, then, that the season was three weeks early in March, but that by the first of April the advance had increased to four weeks; this was maintained through most of the month, but May day was only some three weeks in advance; the fall continued slowly through May and June with an average advance of a fortnight. In July, however, the effects of the early spring had ceased to have any effect. These conclusions are more likely to err on the side of moderation, for it must be remembered that the flowering time this year has been contrasted not with the average, but with the earliest record of previous years.

W. B. CRUMP.

Mr. Love's Treatise on Elasticity.

THE second volume of Mr. Love's treatise will doubtless be reviewed in NATURE in due course; but in the meantime I desire to make some observations upon certain criticisms, which this work contains, on my own papers on thin elastic shells, plates, and wires.

The theory of thin plates, and shells in the form given by Mr. Love, is based upon those of Kirchhoff, Saint-Venant and Clebsch. All these theories are incomplete and defective, and depend upon certain assumptions and approximations which have been called in question, and are by no means free from difficulty. An attempt has been made—see pp. 92 and 207—to remove these objections by classifying the different cases which arise, but whatever may be thought of the success of this explanation, it requires the reader to wade through a long and complicated analytical investigation before he is in a position to apply the theory.

On the other hand, the method of expansion originally employed by Poisson, and afterwards by myself, coupled with the hypothesis that the stresses R, S, T may be *treated* as zero, is one of great power, and, as I showed a few years ago, enables an approximate theory to be *completely* worked out as far as terms involving the cube of the thickness of the plate or shell, and Mr. Love is forced to admit on p. 236 that his own theory is incapable of doing this. It is true that Clebsch and Saint-Venant have raised objections against the method of expansion which I cannot regard otherwise than as frivolous ones; but although an account of the first class of theories is no doubt desirable, it is much to be regretted that Mr. Love has allowed his bias against the second class of theories to lead him to adopt a mode of treatment which greatly increases the difficulties of the subject, is less perfect, and which, I fear, will retard its further progress by throwing unnecessary obstacles in the way of students.

On pp. 238 and 262, Mr. Love imagines that he has detected an error in my own work as regards the values of T_1, T_2 (in his notation P_1, P_2), but this conclusion is not warranted. His investigation in § 353 expressly supposes the vibrations to be non-extensional, whereas in the investigation by which I have calculated, T_1, T_2 by means of the variational equation, extension is expressly supposed to take place. If it were desired to calculate the values of T_1, T_2 by the variational method in the case of inextensibility, it would be necessary to start with the corresponding form of the potential energy, and to take account of the fact that δu, δv, δw are not independent, either by means of indeterminate multipliers or by elimination. The two cases are therefore not parallel, and the so-called test is nugatory. If a direct test were desired, it could be supplied by means of the theory of the radial vibrations of a cylinder worked out to a second approximation.

The only other point to be noticed is that in the case of a bent wire the values of the three couples given by Mr. Love on p. 169 disagree with those obtained by myself. Mr. Love *assumes* these couples to be respectively proportional to the changes of curvature and twist, and he then proceeds to calculate the latter quantities in terms of the displacements by a method which leaves nothing to be desired as regards elegance and conciseness and comprehensiveness. But he can scarcely be said to have given anything which can be called a proof that these couples are *actually* proportional to the above-mentioned quantities; and a new and independent investigation is much to be desired.

A. B. BASSET.

Hotel de Russie, Bad-Ems, Nassau, Germany, August 23.

An Appeal to Mathematicians.

SINCE I have commenced the study of the "Ramayana" (the great Sanskrit epic) in original Sanskrit, and its translations, epitomes, and commentaries by renowned European scholars, I have been struck with the inadequacy the western scholars of Indian chronology have shown in fixing the date of Rama.

I cannot but admire the method used by our modern Egyptologists in computing the dates of Egyptian chronology, and correcting the discoveries of some of the earlier researches in that interesting branch of knowledge. Having discovered it written in some old MSS. that in the reign of a certain king some remarkable comet or eclipse was observed, or a building was erected pointing to a certain star in the heavens, which has since changed position, &c., &c., our scholars have obtained sufficient data to compute with tolerable correctness a more or less trustworthy date for that king.

There is no doubt that such refined discoveries could never have been made if this branch of knowledge were left alone with simple historians or simple chronologists—I mean, no light would have been thrown over the pages of the dark history of Egypt had not astronomical methods been employed to solve the vital questions of Egyptian history.

I am very much grieved to see that the chronology of India has not at all been touched by any scientific investigator whose conclusions could be relied on, though Indian chronology is now proving to be far more interesting than the chronology of any other country or nation of the world. India has now the honour of being under the benign rule of the British nation, so forward in scientific matters; then does it not give grief to the lover of India to see this important branch of past history so much being neglected?

The second half of the eighteenth century and the first quarter of this nineteenth century had seen a few benefactors of India, like Profs. Colebrooke, Muir, Wilson, &c., whose discoveries brought to light much interesting information about ancient India. It was a misfortune for India of to-day that among those benefactors they were few who could bring in mathematical astronomy to solve some vital points of Indian chronology. Prof. Colebrooke wrote some valuable essays on the Hindu system of astronomy, but it was our misfortune that his attention was not drawn towards the Indian chronology; otherwise he was a man who could have done much to settle the dates of Hindu chronology.

Rama has been a personage of Indian history whose existence has not yet been denied by any scholar, yet see what conflicting dates have been given to this mighty king of ancient India: Sir William Jones places Rama in the year 2029 B.C., Tod in 1100 B.C., and Bentley in 950 B.C. Govvesio would place him about the thirteenth century before the Christian era!

Govvesio computes his date thus:—"From Rama to Sumitra, the contemporary, as it appears, of Vikramaditya (B.C. 57), fifty-six kings ruled in succession. By allowing on a reasonable computation an average of a little more than twenty years to each reign, we arrive at the thirteenth century before the Christian era." ("Ramagana," vol. i. Introduction.) While it is questionable whether any king by name of Sumitra ever reigned in India, or was a contemporary with Vikramaditya, Govvesio confesses—"But to this opinion I do not intend to attribute more weight than that of a probable conjecture." And so it is; and a ridiculous one, too; for Sumitra[1] was not a king contemporary with Vikramaditya, but *she* was one of the queens of the king Dasaratha, the father of Rama.

I now come to the point of my appeal. Here is the position of the seven primary planets at the birth of Rama plainly written in Canto xix. of the first book of the Ramagana: Moon in Cancer, Sun in Aries, Mercury in Taurus, Venus in Pisces, Mars in Capricornus, Jupiter in Cancer, and Saturn in Libra. The problem to be solved is this: Taking January 1, 1894, as starting-point, compute when the planets occupied the positions respectively referred to above, and when again they will occupy the same positions in the future? Though the problem appears to be a simple one of permutation and combination, but I must confess with regret that none

[1] "Sumitra" is a Sanskrit word of feminine gender. As Sanskrit was a living language at the time of Vikramaditya, though perhaps only within higher circles of society, yet it could not be believed that this word might have been so degenerated as to be used in opposite gender at that time.

of the professors of mathematics here with whom I have come in contact have taken the trouble of solving it, and therefore it is that I am appealing in this strain to the mathematicians who have any interest in the chronology of India.

Many interested scholars have expressed their desire for the solution of this problem. Thus says Prof. Schlegel: "I leave to astronomers to examine whether the parts of the description agree with one another, and if this be the case, thence to deduce the date. The Indians place the nativity of Rama in the confines of the second age (Treta) and the third (Dwapara); but it seems that this should be taken in an allegorical sense. . . . . We may consider that the poet had an eye to the time in which, immediately before his own age, the aspects of the heavenly bodies were such as he has described."

Besides the positions of the planets at the birth of Rama, I have a few more data concerning the Hindu system of the division of heavens, which I shall be glad to communicate to any gentleman who is acquainted with that system, and expresses a desire for the same.

KANHAIYALAL.

Lahore, August 8.

Arrangements for Work of Chemical Section of the British Association.

MANY of your readers will be interested to know that M. Moissan has kindly arranged for a demonstration of the properties of fluorine, and his method of isolating the element, at a meeting of the Chemical Section of the British Association at Nottingham, in September. M. Moissan will also exhibit some specimens of the diamonds he has artifically produced.

We also hope to have at least two discussions, one on Bacteriology and its related chemical problems, which Prof. Percy Frankland has been so good as to promise to open, and another on explosions in coal mines, with special reference to the "dust theory." This, Prof. Harold Dixon has kindly consented to introduce.

Permit me to remind authors that they will greatly facilitate the arrangements for the satisfactory grouping of papers at the sectional meeting, if they will communicate as early as possible with the Secretaries, Burlington House.

J. EMERSON REYNOLDS.

University of Dublin, Trinity College, August 21.

The Bacchus Marsh Boulder Beds.

YOUR issue of August 10 contains an interesting communication by Messrs. Officer and Balfour on the glacial boulder beds of Bacchus Marsh in Victoria, in which they are referred to as triassic. May I be permitted to point out that this is erroneous? It is true that the late Dr. O. Feistmantel in his earlier descriptions of, and references to, the flora of these beds, regarded them as triassic, but this was the natural consequence of their correlation with the Talchir group of India, which he then ascribed to the trias. In 1886 it was shown by Dr. Wagner and myself sumultaneously that the true correlation of the Talchir group was with the marine beds below the Newcastle coal measures of New South Wales; the Bacchus Marsh boulder beds are consequently upper carboniferous, and form part of the traces of the upper carboniferous glacial period which have been recognised in Australia, Africa and Asia. The matter will be found fully dealt with in pages 120–123 and 191–214 of the second edition of the "Manual of the Geology of India," just published by the Indian Geological Survey.

S.S. *Rena*, August 19. R. D. OLDHAM.

Old and New Astronomy.

WHILE thanking you and your reviewer for your very courteous and appreciative notice of the "Old and New Astronomy," I should like to be permitted to point out that the chapter on the sun's surroundings was printed and was in the hands of the public before my connection with the work commenced. Your reviewer suggests that I ought to have corrected certain statements in this earlier part of the volume, but I felt that it was sufficient to mention in the preface that I did not agree with *all* Mr. Proctor's conclusions, and it must be obvious that it would neither have been an easy nor a gracious task to have attempted in the latter part of a book to criticise the statements and theories of the deceased author of the earlier chapters.

Your reviewer suggests that the proof I give of the very small density of the Orion Nebula is "vitiated by the fact that it is impossible to estimate the gravitational effect of the dark matter in interstellar space." I conclude that he does not refer to dark matter within the area of the nebula, for this would only add to the mass of the nebula and to the observed velocities of the stars in its neighbourhood. That dark matter evenly distributed in space around would not interfere with the gravitational effect of the nebula will be evident to those who remember that the attraction of a hollow spherical shell on a body within it may be neglected, since the attractions in all directions balance whatever is the position of the body within the spherical shell. The stars around the nebula seem to be distributed in all directions, and it cannot be supposed that in each case there is a gravitating dark mass on the side away from the nebula which counterbalances the attraction of nebulous matter.

Your reviewer cannot, I think, have seen Dr. Huggins's photograph of the spectrum of the Orion Nebula and the stars involved in it, or he would not suggest that the bright lines in the spectra of the stars could be due to the overlapping by tremors and atmospheric disturbances of the spectrum of the nebular matter. The bright nebula lines distinctly widen and brighten in the neighbourhood of the stars. One is therefore forced to conclude that the bright lines when they cross the stellar spectra belong to the stars.

A. C. RANYARD.

August 19.

THERE is nothing in my review that implies the desirability of Mr. Ranyard having modified any of Mr. Proctor's *conclusions* in the chapter on the sun's surroundings; I simply pointed out an *error of date* that should have been corrected.

I do not see any reason for supposing that the quantity of matter in the area we call the Orion Nebula is greater than that in any other arbitrarily selected equal area in space, and the evidence seems conclusive that the whole of interstellar space is a meteoric *plenum*. This being so, there is no reason why stars in the neighbourhood of the nebula should have their velocities in any way affected by it. Mr. Ranyard proves that there is no great difference in density, but does not touch the question of the absolute quantity of matter involved.

I have not seen Dr. Huggins's original photographs of the spectrum of the Orion Nebula, and the stars involved, nor have I seen direct copies of them, but I have examined other photographs in which the star and nebula spectra appear, and have also visually examined the spectra, and am by no means convinced that the nebula lines are brighter and wider in the stars.

THE REVIEWER.

An Old Device Resuscitated.

IN the Astronomical Column of the current number of NATURE a description is given from *L'Astronomie*, of M. Jarson's method of giving equatorial motion to a telescope mounted on an ordinary altazimuth stand. This method will be found figured and described by Lord Lindsay, now Earl Crawford, in the *Monthly Notices* of the Royal Astronomical Society, xxxvii. 1, Nov. 10, 1876. Moreover, in a note appended to the paper, Lord Lindsay says that since writing it his attention had been drawn to the fact that this principle of mounting had been described by Sir George Airy in *Monthly Notices*, xv.

F. W. LEVANDER.

30, North Villas, Camden Square, N.W., August 28.

Laws of Error in Drawing.

I SHOULD be obliged if you allow me to state in the next issue of NATURE, to prevent any misconception of the extent of those "compulsory errors" alluded to in my article printed in the current number, that I am able to specify such, with equal particularity, as they occur in the following additional figures, viz.:—The cylinder, the ringed cylinder, the oblong, the octagon, cone, hexagonal pyramid, octagonal pyramid, triangle (solid). Also in those figures framed of square-sectioned woodwork that have the following shapes, viz. square, cross, triangle, arch, hexagon, pentagon, circle. Again, that they are observable in all forms which are complexities of the primal forms above given; and, moreover, I have traced them clearly in the draughtsmanship of Orientals, and even in the drawing of the greatest painters.

ARTHUR L. HADDON.

Glenavon, Cornwallis Avenue, Clifton Vale, Bristol, August 25.

THE INFLUENCE OF EGYPT UPON TEMPLE-ORIENTATION IN GREECE.

I HAVE shown in former articles that in our own days and in our own land the idea of orientation which I have endeavoured to work out to the best of my ability for Egypt still holds its own. It is more than probable, therefore, that we shall find the intermediate stages in those lands whither by universal consent Egyptian ideas percolated.

Among these lands Greece holds the first place. It is perhaps proper that I should state here that the view as to the possibility of temple orientation being dominated by astronomical ideas first struck me at Athens and Eleusis, and that I endeavoured to settle the question by studying the Egyptian monuments, because they were the only monuments I could study as a stay-at-home, thanks to the labours of the French Commission and of Lepsius.

When I found that the same idea had been held by Nissen, and that the validity of it seemed to be beyond all question, I consulted my friend, Mr. F. C. Penrose, particularly with regard to Greece, as I knew he had made a special study of some of the temples, and that, being an astronomer as well as an archæologist (for, alas, they are not as I think they should be, convertible terms) it was possible that his observations with regard to them included the requisite data.

I was fortunate enough to find that he had already determined the orientation of the Parthenon with sufficient accuracy to enable him to agree in my conclusion that that temple had been directed to the rising of the Pleiades. He has subsequently taken up the whole subject with regard to Greece in a most admirable and complete way,[1] and has communicated papers to the Society of Antiquaries, February 18, 1892, and more recently to the Royal Society, April 27, 1893, on his results.[2]

The problem in Greece was slightly different to that in Egypt; we had not such a great antiquity almost without records to deal with, and moreover the feast calendars of the various temples presented less difficulty.

There was no vague year to contend with, and in some cases the actual dates of building were known within a very few years. Mr. Penrose has been convinced that in Greece, as in Egypt, the stars were used for heralding sunrise. He writes :—

"The object the ancients had in using the stars was to employ their rising and setting as a clock to give warning of the sunrise, so that on the special feast days the priests should have timely notice for preparing the sacrifice or ceremonial, whatever it may have been :

> "Spectans orientia solis
> Lumina *rite* cavis undam de flumine palmis
> Sustulit," &c.

In Greece, not dominated by the rise of the Nile, we should not expect the year to begin at a solstice but rather at the vernal equinox. I have shown that even in pyramid times in Egypt the risings of the Pleiades and Antares were watched to herald the equinoctial sun; it is not surprising, therefore, to find the earliest temples in Greece to be so oriented. Mr. Penrose has found the following :—

η Tauri (The Pleiades)	Archaic temple of Minerva	Athens[3]	R	1530
	Asclepieion	Epidaurus	R	1275
	The Hecatompedon site of Parthenon	Athens	R	1150
	Temple of Bacchus	Athens	R	1030
	Temple of Minerva	Sunium	S	845

[1] In the lists of temples which follow all the orientations were obtained from azimuths taken with a theodolite, either from the Sun or from the planet Venus. In almost every case two or more sights were observed, and occasionally also the performance of the instrument was tested by stars at night. The heights subtended by the visible horizon opposite to the axes of the temples were also observed.

[2] See NATURE, February 25, 1892, and May 4, 1893.

[3] R indicates a rising, and S a setting observation.

				B.C.
Antares	Heræum	Argos	R	1760
	Earlier Erechtheum	Athens	S	1070
	Temple at	Corinth	S	770
	Temple on the mountain .. .. Jupiter Panhellenius	Ægina	S	630

Here we find the oldest temple in a spot which by common consent is the very cradle of Greek civilisation.

It has also been shown that in Khu-en-Aten's time the new sun-temple at Tell el-Amarna was oriented to Spica, Spica too, we find, so used in Greece in the following temples.

				B.C.	
Spica	The Heræum at	Olympia	R	1445	
	Nike Apteros	Athens	S	1130	
	Themis ...	Rhamnus	R	1092	
	Nemesis ...	Rhamnus	R	747	
	Apollo	Bassæ	R	728	Eastern doorway
	Diana	Ephesus	R	715	

When owing to precession the sun's spring equinox place had receded from Taurus and entered Aries, in Egypt the equinoxes were no longer in question, since the solstitial year was thoroughly established, and consequently we find no temples to the new warning star α Arietis.

In Greece, however, where the vernal equinox had now been established as the beginning of the year, we find a different state of things, no less than 7 temples oriented to α Arietis are already known.

α Arietis	Minerva	Tegea ...	R	1580	
	Jupiter Olympius	Athens ...	R	1202	
	Jupiter	Olympia ...	R	790	
	Temple (perhaps Juno)	Platea ...	S	650	
	Jupiter	Megalopolis	S	605	
	Temple at the harbour ...	Ægina ...	S	580	
	Temple on Acropolis of Mycenæ	...	R	540	Eastern doorway
	The Metroum ...	Olympia ...	S	360	

The above are all intra-solstitial temples, that is, the sunlight as well as the light of the star can enter them, and this enables us to note a certain change of thought brought about in all probability by the artistic spirit of the Greeks. The Egyptian temples were all dark, often with the statue of a god or a reptile obscure in the naos, and many were oriented so that sunlight never entered them. Mr. Penrose points out that almost all the Greek temples are oriented so that sunlight can enter them, of such temples we have the following 27.

7 examples from		Athens.	1 example from		Sunium.
3	,,	Olympia.	1	,,	Corinth.
2	,,	Epidaurus.	1	,,	Bassæ.
2	,,	Rhamnus.	1	,,	Ephesus.
2	,,	Ægina.	1	,,	Platæa.
2	,,	Tegea.	1	,,	Lycosura.
1	,,	Nemea.	1	,,	Megalopolis
1	,,	Corcyra.	2	,,	Argos.

Now in all these Greek temples, instead of the dark naos of the Egyptian building, we find the cella fully illumined and facing the entrance. Frequently, too, there was a chryselephantine statue to be rendered glorious by the coloured morning sunlight falling upon it, or if any temple had the westerly aspect by the sunset glow.

It was perhaps this, combined with the later invention of water clocks for telling the hours of the night, which led to the non-building of temples resembling those at Thebes and Denderah facing nearly north. Still there are scattered examples; one of very remarkable importance, as it is a temple oriented to γ Draconis 1130 B.C., built therefore not very long after the temple M at Karnak, and this temple is at Bœotian Thebes! A better proof of the influence exerted by the Egyptians over the temple building in Greece could scarcely be imagined. As Mr. Penrose remarks:—

"Thebes was called the City of the Dragon, and tradition records that Cadmus introduced both Phœnician and Egyptian worship."

It would be very surprising if we assume, as we are bound to do, that these temples to stars were built under Egyptian influence, that Sirius should not be represented among them, that being the paramount star in Egypt at a time when we should expect to find her influence most important in Greece. Still, I have shown already that as the Greek year ignored the solstice, the use of Sirius as a warning star for all purposes of utility would not come in. Mr. Penrose finds, however, that in spite of this Sirius was used for temple worship.

"Leaving the solar temples, we find that the star which was observed at the great Temple of Ceres must have been Sirius, not used, however, heliacally—although this temple is not extra solstitial—but for its own refulgence at midnight. The date so determined is quite consistent with the probable time of the foundation of the Eleusinian Mysteries and the time of year when at its rising it would have crossed the axis at midnight agrees exactly with that of the celebration of the Great Mysteries.

"It is reasonable to suppose that when, as in the case of Sirius at Eleusis, brilliant stars were observed at night, the effect was enhanced by the priests by means of polished surfaces."

Another question. Does the star follow the cult in Greece as it does in Egypt?

In Greece we find the following:—

"The star α Arietis is the brightest star of the *first sign of the Zodiac*, and would therefore be peculiarly appropriate to a temple of Jupiter. The heliacal rising of this star agrees both with the Olympieium at Athens and that at Olympia. There is a considerable difference in the deviation of the axes of these two temples from the true east; but this is exactly accounted for by the greater apparent altitude of Hymettus over the more distant mountain at Olympia.[1]

"The Pleiades are common to the following temples of Minerva, viz. the Archaic temple on the Acropolis, the Hecatompedon, and Sunium. In the two former it is the rising, the latter the setting star.

"There must have been something in common between the temples at Corinth, Ægina, and Nemea. The two last, at any rate, are reputed temples of Jupiter."

The Greek side of the inquiry becomes more interesting when the connection between the orientation of the intra-solstitial temples and the local festivals are inquired into; in Egypt this is all but impossible at present.

A temple oriented to either solstice can only be associated with the longest or with the shortest day; if the temple points to the sunrise or sunset at any other period of the year the sunlight will enter the temple twice whether it points to the sunrise or sunset place.

Now Mr. Penrose finds that in Greece as in Egypt the initial orientation of each intra-solstitial temple was to a star, and this would, of course, secure observations of the star and the holding of an associated festival at the same time of the year for a long time. But when the precessional movement carried the star away they would only have the sun to depend on, and this they might use twice a year. It is possible, as Mr. Penrose remarks, there would have been no reason for preferring one of these solar coincidences to the other, and the feast could have been shifted to a different date if it had been thought more convenient." He goes on to add, "It would appear that something of this sort may have taken place at Athens, for we find on the Acropolis the Archaic temple, which seems to have been intended originally for a vernal festival, offering its axis to the autumnal sunrise on the very day of the great Panathenaia in August.

"The Chryselephantine statue of the Parthenon, which temple followed on the same lines as the earlier Hecatompedon (originally founded to follow the rising of the Pleiades after that constellation had deserted the Archaic temple alongside), was lighted up by the sunrise on the feast to the same goddess in August, the Synæcia, instead of some spring festival, for which both these temples seem at first to have been founded.

"The temple at Sunium, already quoted for its October star-heralded festival to Minerva, was oriented also axially to the sun on February 21, the feast of the lesser mysteries."

I have had to insist again and again that in the case of the Egyptian temples the stated date of foundation of a temple is almost always long after that in which its lines were laid down in accordance with the ritual. No wonder then that the same thing is noticed in Greece.

"In about two-thirds of the cases which I have investigated the dates deduced from the orientations are clearly earlier than the architectural remains now visible above the ground. This is explained by the temples having been rebuilt upon old foundations, as may be seen in several cases which have been excavated, of which the archaic Temple of Minerva on the Acropolis of Athens and the Temple of Jupiter Olympius on a lower site are instances. There are temples also of the middle epoch, such as the examples at Corinth, Ægina, and the later temples at Argos and at Olympia (the Metroum at the last named), of which the orientation dates are not inconsistent with what may be gathered from other sources."

The problem is, moreover, helped in Greece by architectural considerations, which are frequently lacking in Egypt, of two temples it can be shown, on this evidence alone, that one is older than the other. Such an appeal strengthens my suggestion that two of the temples of the Acropolis Hill were oriented to the Pleiades, by showing the older temple to point to an earlier position of the star group. To these Mr. Penrose adds another pair at Rhamnus, where he has found that there are two temples almost touching one another, both following (and with accordant dates) the shifting places of Spica, and still another at Tegea.

J. NORMAN LOCKYER.

[In a letter received from Mr. Penrose, giving me permission to use the above quotations from his preliminary account, he makes the following interesting statements:—

"In my paper sent to the Royal Society there was a passage which seems to make it practically *certain* that heliacal stars were connected with the intrasolstitial temples as derived from Greek examples alone, independent of the powerful aid of the Egyptian cases.

"That the first beam of sunrise should fall upon the statue centrally placed in the adytum of a temple or on the incense altar in front of it on a particular day, it would be requisite that the orientation of the temple should coincide with the amplitude of the sun as it rose above the visible horizon, be it mountain or plain.

"That a star should act as time-warner it was necessary that it should have so nearly the same amplitude as the sun that it could be seen from the adytum through the eastern door, if it was to give warning at its rising, or to have a similar but reversed amplitude towards the west, if its heliacal setting was to be observed; and it follows that in the choice of the festival day and the corresponding orientation, on these principles, both the amplitude of the sun at its rising and that of the star

[1] With regard to a temple of Minerva using α Arietis at Tegea, Mr. Penrose writes:—"Minerva is allowed by the poets to have been able to use Jupiter's thunder, so this is no misappropriation of the star. Juno also seems to have claimed the use of α Arietis as at Samos, and at Girgenti it suits the orientation of the temple of Juno better than Spica. But Spica seems to have been connected with the worship of Juno and Diana in their more strictly female capacity."

eastwards or westwards as the case might be would have to be considered in connection with one another.

"From what has been said it is obvious that in the intrasolstitial temples the list of available bright stars and constellations is in the first instance limited to those which lie within a few degrees of the ecliptic, and it will be found that in the list above given and those which follow, if we omit Eleusis, where the conditions were exceptional, all but one of the stars are found in the zodiacal constellations. A very great limit is imposed in the second place by one of the conditions being the heliacal rising or setting of those stars from which the selection has to be made. So that when both these combined limitations are taken into account it becomes improbable to the greatest degree that in every instance of intrasolstitial temples of early foundation of which I have accurate particulars, being twenty-eight in number and varying in their orientation from 21° N. to 18° 25′ S. of the true east. There should be found a bright heliacal star or constellation in the right position at dates not in themselves improbable unless the temples had been so oriented as to secure this combination.

"I have just been looking into the number of possible stars which could have been used, *i.e.* within the limits of the greatest distance from the ecliptic that could have been utilised.

"The stars which could have been utilised in addition to the seven which serve for nearly thirty temples are ten only, viz.:—

Aldebaran.	β Libræ.
Pollux.	α Libræ.
β Arietis.	α Leonis.
β Tauri.	γ Leonis.
α and β Capricorni as a group.	β Leonis.

"If the orientations had been placed at random would not our thirty temples have made many misses in aiming at these seventeen stars, it being necessary also to hit exactly the heliacal margin? And would they have secured anything like a due archæological sequence?

"Another point is this:—

"Whenever a star less than first magnitude is used (Pleiades only excepted) it has been necessary to secure coincidence to give it several more degrees of sun depression than in the cases of Spica and Antares."]

BRITISH ASSOCIATION MEETING.

FURTHER information is now to hand as to the scientific work which has been arranged for the approaching meeting of the Association at Nottingham.

In Section A two papers have been received on "Physics Teaching in Schools." G. H. Bryan contributes an interesting paper on "The Moon's Atmosphere and the Kinetic Theory of Gases," showing that every planet must be throwing off some of its atmosphere on the kinetic theory, though at an exceedingly slow rate in the case of the larger bodies. Prof. J. J. Thomson will exhibit and explain a new form of air-pump, which will be of interest to sections A and B. Prof. Viriamu Jones is sending a paper on "Standards of Low Electrical Resistance."

As reported by Prof. Emerson Reynolds on p. 416, Section B has been most fortunate in securing a promise from M. Moissan to describe and demonstrate the preparation and properties of fluorine. This will probably have the effect of inducing chemists from all parts of this country to visit Nottingham, as the demonstration has never yet been made in this country, and is of almost unique importance and interest. It is anticipated that M. Moissan's communication will be put down for Monday, September 18, and will probably include the exhibition of his artificial diamonds. Prof. Percy Frankland will introduce the discussion on "Bacteriology in its Chemical Aspects" on Friday, 15, and amongst other papers will be one by J. T. Wood, on "A New Bran Bacterium." Tuesday, 19, will probably be mainly devoted to the discussion of "Colliery Explosions," introduced by Prof. H. B. Dixon, one of H.M. Commissioners. On this day further communications on flame researches are also expected. The President's address is put down for twelve o'clock on Thursday, September 14; it will deal essentially with "The Comparative Chemistry of the Elements," specially treating of carbon and silicon, and of silico-organic researches; showing further that it is possible in the light of recent knowledge to fill in some details of the chemical history of the earth. Dr. Phookan has promised a description of his recent researches on the "Rate of Evaporation of Bodies in Different Atmospheres."

In Section C Prof. Hull will read a paper "On the Water-supply of Nottingham"; Mr. Walcot Gibson, one on "The Geology of British East Africa"; Prof. Brögger will describe "The Eruptive Rocks of the Christiania District"; E. T. Newton, "The Trias Reptiles"; Prof. Sollas, "The Carlingford Rocks" and "Glendalough Amphibolite"; R. M. Deeley, "The Drifts of the Trent Valley"; and Prof. Iddings, of Chicago, "The Petrology of a Dissected Volcano." Amongst other papers already promised are the following:—"The Gypsum Deposits of Nottinghamshire," by A. T. Metcalfe"; "Derbyshire Toadstone," by H. A. Bemrose; "Mollusca from the English Trias," by R. B. Newton; "Transported Mass of Chalk in Boulder-clay of Culworth, in Huntingdonshire," by A. and C. Cameron; "Some Volcanic Rocks of South Pembrokeshire," by F. T. Howard and E. W. Small; "Midland Trias," by Dr. A. Irving; "Limestone Inclusions in the White Sill," by E. T. Garwood.

Two further papers are sent in for Section D—one by Prof. Gilson, of Louvain, on "Cytological Difference in Homologous Organs," and one by G. B. Rothera, on "Some Vegetal Galls and their Inhabitants."

In connection with Section E the exhibition of the 120 pictures painted on an Antarctic sealing expedition by Mr. Burn-Murdoch has been referred to. The discussion on the "Limits between Geography and Geology" will be introduced by Mr. Clements R. Markham, Pres.R.G.S. Mr. Delmar Morgan will summarise our knowledge of Thibet, and Miss Taylor will describe her recent journey in that country. Mrs. Grove will read a paper on the "Islands of Chiloë." Mr. E. G. Ravenstein will give an account of recent African travel; and a large number of other papers are promised, many of which are of more than ordinary interest. The illustration of many of these papers by lantern photographs will be a special feature.

With respect to Sections F and G there is at present nothing further to add to the original statement made a few weeks since.

In Section H Mrs. Grove promises a paper, "The Ethnographic Aspects of Dancing." Prof. Boyd Dawkins, who is now on a visit to Glastonbury, intimates his intention to discuss the scientific bearings of the discoveries made at the lake village in that neighbourhood; and, in order that the members may be better able to understand the structural details of the woodwork exposed in the course of the excavations, Dr. Munro proposes to give an illustrative sketch of the different methods adopted in the construction of lake-dwellings. Hitherto lake-dwelling researches have furnished little evidence of the kind of houses erected on the artificial islands, but during last autumn a crannog was investigated in Argyllshire which has disclosed some remarkable information on this point. The discussion on lake-dwellings is fixed for Sept. 19, and as this important subject has formerly only incidentally come before the Association, the occasion promises to be most instructive to all interested in the early history of Britain. Among the other papers sent to the section is one by Mr. Romilly Allen on the "Origin and Development of Early Christian Art in Great Britain and Ireland." This paper is to be well illustrated. Indeed, this is the case with most of the archæological papers. Dr. Hildebrand is arranging illustrations of the Swedish antiquities he wishes to compare with our Anglo-Saxon ones, in groups, which are to be printed on sheets and distributed among the audience when he reads his communication.

The information contained in the above paragraphs has been furnished by request by presidents and recorders of sections; possibly further details may be forwarded in time for publication before the meeting.

The promises of exhibits of scientific apparatus, models, diagrams, and photographs in the laboratories of the University College, Nottingham, are now coming in. Scientific novelties are promised for the conversazione at the Castle.

Visitors can obtain on application the usual lists of hotels and lodgings. FRANK CLOWES.

GEORGE BROOK.

GEORGE BROOK, whose untimely decease on August 12 we have already chronicled, was born on March 17, 1857. He died, therefore, in his thirty-sixth year, apparently from the effects of heat-apoplexy, while on a visit to his wife's family near Newcastle-on-Tyne. On the fatal day he joined a shooting party on the adjacent moor; after a successful expedition and a repast in the shooting-box, he was complaining laughingly of the necessity for early rising on such occasions, when his head fell back and he expired without uttering a sound. He was buried at Benwell Church, Newcastle, where, six years previously, he was married to Fanny, second daughter of Mr. Walter Scott, of Riding Mill. He was educated at the Friends' School, Alderley Edge, and, although he afterwards studied for a couple of years under Prof. Williamson and others at the Owens College, Manchester, he may be said to have been, as a naturalist, mostly self-taught. His earlier years of active life were spent in his father's business at Huddersfield, and he turned the experience thus gained to good account in his after career. His first definite association with scientific work dates from his connection with the recently deceased Mr. J. W. Davis, of Halifax, and others, in the prosecution of biological investigation in the West Riding of Yorkshire. He was in 1884 appointed scientific assistant to the Scottish Fishery Board and lecturer on comparative embryology to the University of Edinburgh. He retired from the first-named office in 1887, leaving as a legacy a series of valuable notes and reports upon the food fishes, but the last-named one he held till death. As an embryologist, he is himself best known for his work upon the origin of the endoderm from the periblast in teleostean fishes, and although not the first to have suggested this, it must be said, in justice to his memory, that certain recent investigators have reverted to his views without according him befitting recognition. His love of experimental marine zoology, and his personal munificence in the interests of pure science, reasserted themselves in 1889, in his attempt to found a lobster hatchery and marine observatory at Loch Buie, Isle of Mull, duly noted in our pages (NATURE, vol. xlii. p. 399), and which we know to have involved him in a not inconsiderable loss. He was secretary to the Huddersfield Naturalists' Society, and to the Scottish Microscopical Society, of which he was a founder; he was for three years a vice-president of the Royal Physical Society of Edinburgh, and a member of council of the same, the Linnean Society of London, and the Royal Society of Edinburgh. He had recently joined the Zoological Society, and was but a few months ago appointed an examiner in Biology to the Royal College of Physicians, Edinburgh. In the year 1889 he rose suddenly into fame as the author of the *Challenger* Report on the Antipatharia. His preliminary paper, dealing (*Proc. R. Soc. Edin.*, vol. xvi. p. 35) with the homologies of the mesenteries in the Antipatharia and the Anthozoa, had apprised the world of the breadth of his inquiry into, and the extent of his knowledge of, this difficult and little understood group; but the preparation, within approximately a year, of that which came to be termed "one of the most praiseworthy" of all the *Challenger* reports, set a seal to his reputation, and exalted him to a foremost position among living Actinologists. In this work he elaborated his important discovery of dimorphism (in Schizopathinæ) by division of a single primitive zooid into three, instead of by specialisation of individual polypes; and at the time of his death he had well-nigh completed an important paper dealing with this and kindred subjects, for which his talented assistant, Mr. Binnie, had prepared a large series of beautiful sections and some elaborate drawings. The thorough and conscientious manner in which he had worked out the Antipatharians of the *Challenger* collection led, in 1890, to his engagement by the Trustees of the British Museum for the arrangement and cataloguing of their very large collection of stony corals; and the present month marks the publication of that which will perhaps rank as his *magnum opus*, viz., the "Catalogue of the Genus Madrepora," a quarto volume of 212 pages, with 35 beautiful plates, mostly from photographs taken by himself. This welcome treatise, which was the first of a projected series dealing with the stony corals, like most of the set to which it belongs that have appeared under Dr. Günther's direction, is, in reality, no catalogue at all, but rather a revisionary monograph, founded upon the study of rich material from world-wide localities, which must furnish a basis for succeeding inquiry into the group with which it deals. None but those who enjoyed the deceased author's personal friendship can form an adequate idea of the labour and expenditure, both of time and capital, which he bestowed upon this volume. It is the practical outcome of the last three years of his life's work. The success with which he dealt with the bewildering difficulties before him may be perhaps sufficiently gauged from its "Introduction," and to what important lines of structural investigation and conclusions the task was leading him, it is obvious from this and his last published paper "On the Affinities of the Genus Madrepora" (*Jour. Linn. Soc. Zool.* xxiv. p. 353).

The most striking features in George Brook's personality were his right living and his manly independence, his moral attributes being in every way worthy his mental ones. There can be no question that his capacity to form an independent judgment, and his great powers of organisation, under the influence of his indomitable will, formed the keystone of his successes, and placed him in a position to rise supreme above petty jealousy and the evils begotten of narrow cliquism and over-ambition. His natural inclinations were towards solid work, as will be obvious from his having originally settled down to the study of the Crustacea, but to relinquish it for that of the Corals—a choice which makes his loss a well-nigh irreparable one to British zoologists of the present generation. In addition to the many unfinished works to which we have alluded, he has left behind him at least the material for a reconsideration of the morphology of certain great veins in the Amniota, and for a detailed report upon some of the corals collected by Prof. Haddon in the Torres Strait, which had been placed in his hands. Indeed, almost his last words to the writer of this notice were expressive of a desire to "get on" with the latter. His final act, as a zoologist, was the determination of a Collemboloid (upon which group he was an authority) for his friend Prof. W. A. Herdman, with whose pioneer's work in British marine zoology he was in active sympathy. A devoted husband, an exemplary parent, a true friend, whose advice was always sound, and whose criticism was as well founded as it was frank, he passes from us in the heyday of life. His life furnishes a noble example of independent manliness, and of enthusiasm for the spread of truth and the cause of scientific advancement.

NOTES.

We learn from the *Revue Générale des Sciences* that M. d' Abbadie, late President of the Paris Academy of Sciences, has asked the Academy to accept a considerable gift in the name of his wife and himself. The donation consists of the Abbadia estate (Basses-Pyrénées), having an annual revenue o twenty thousand francs, and one hundred shares in the Bank of France, representing a capital of four hundred thousand francs and an annual income of fifteen thousand. By the deed of gift, these properties will not fall to the Academy until after the decease of the donors. Two of the principal clauses and charges of the legacy are as follows:—(1) The Academy may establish on the Abbadia estate any researches or laboratories, except those devoted to vivisection. (2) An observatory must be established at Abbadia, in which a catalogue of five hundred thousand stars can be made, the work to be completed in 1950. In order to reduce the expenses which this stipulation carries with it, the work may be confided to some religious order. The Academy has nominated a commission to examine the conditions of this munificent donation, and has expressed its deep gratitude to M. and Mme. d'Abbadia. It is not too much to say that this feeling is shared by all men of science.

The following men of science have been elected Fellows of the Reale Accademia dei Lincei:—In mathematics, Prof. L. Bianchi and Dr. G. D'Ovidio; chemistry, Dr. G. Ciamician and Prof. D. Mendelejeff; botany, Profs. E. Strassburger and N. Pringsheim; agriculture, Dr. F. Cohn. Dr. E. Bertini has been elected a correspondent in mathematics; E. Millosevich in astronomy; A. Abetti in mathematical and physical geography; and O. Mattirolo in botany.

The *Times* announces the death of Prof. M'Fadden A. Newell, Superintendent of Public Instruction of the State of Maryland, U.S.A. He was educated at Trinity College, Dublin, and the Royal College of Belfast, and went to the United States in 1848. He was Professor of Natural Science in the Baltimore City College from 1850 to 1854, and occupied the same chair in Lafayette College, Pennsylvania, from 1854 to 1864. In 1865 he was appointed President of the Normal School of the State of Maryland, succeeding, three years later, to the position of State Superintendent of Public Instruction, a post he held for a quarter of a century. In connection with Prof. Crury he published a series of text-books entitled the "Maryland Series," and his Annual Reports, in twenty-five volumes, are held in high esteem.

We regret to record the death of Father R. P. Vines, Director of Belen Observatory, Havannah.

A disastrous cyclone swept northwards along the Atlantic seaboard of the United States on August 29. At Savannah, Georgia, property to the value of millions of dollars has been destroyed, and news of great loss of life and property is reported from Brunswick, Georgia, and further south, while the town of Tybee has been completely wrecked. It is reported that the storm traced out a path marked by devastation across Georgia and South Carolina to Charlotte, in North Carolina, and thence to the east coast again to Petersburg, Virginia. The city of Savannah presents a scene of wreck and ruin surpassing even the effects of the great storm of August, 1881. For eight hours the wind rushed through the city with terrific force and swept down houses as if they were packs of cards. Nearly every house in the city has suffered some damage, and the streets have been rendered quite impassable by the wreckage.

A Reuter's telegram from New York states that a cyclone passed over that part of the Atlantic coast on August 23, in the direction of the New England States, and left its marks over a region around New York extending over an area of fully a thousand miles. A rainfall of 3·82 inches in twelve hours was measured, and is said to be the highest ever recorded by the local signal service.

The next meeting of the French Association for the Advancemence of Science will be held at Caen, with M. Mascart as president. M. E. Trélat will preside over the meeting to be held at Bordeaux in 1895.

It has been finally arranged that the Congress of the Photographic Society and Affiliated Societies shall be held on October 10, 11, and 12. All the arrangements will be completed in a few days, and a full programme will be circulated as soon as possible.

An International Exhibition of Photographic Art has been organised by the Paris Photo Club, and will be held from December 10 to the end of this year. The address of the Secretary is 40 Rue des Mathurins, Paris. An international exhibition of amateur photography will be held in the Museum of Fine Arts, Kunsthalle, Hamburg, on October 1–31.

The annual general meeting of the members of the Federated Institution of Mining Engineers will be opened on Wednesday, September 6th, in the rooms of the Philosophical Society of Glasgow. A number of papers on mining subjects will then be read, and on the two following days excursions will be made to collieries, iron and steel works, and other places of interest.

The Indiana Academy of Science has decided to make a biological survey of the State of Indiana, and Profs. L. M. Underwood, C. H. Eigenmann, and V. F. Marsters have been appointed as organisers and directors of it. The first work will be the preparation of a complete bibliography of materials bearing on the botany, zoology, and palæontology of Indiana, to be published by the Academy. When this has been done, it will be possible to discuss the fauna and flora, its extent, distribution, biological relations, and economic importance, and thus accomplish the main purpose of the survey.

Mr. J. F. James gives in *Science* a description of the "Scientific Alliance of New York," instituted at the end of last year, and having for its chief object the establishment of a centre where knowledge of what is being done in one society is conveyed to all the rest. Much is to be gained by this kind of cooperation, both by science and individual workers. Already the Alliance has been joined by the New York Academy of Science, Torrey Botanical Club, New York Microscopical Society, Linnean Society of New York, New York Mineralogical Club, New York Mathematical Society, and the New York Section of the American Chemical Society, each of these societies being represented by its president and two members upon the council of the Alliance. At the opening meeting the president deprecated the views of so-called practical men in whose eyes science "is worth only what it will bring when offered in the form of dynamos, telephones, electric-lights, dye-stuffs, mining machinery, and other merchantable wares." The need of endowment for research in the region of pure science was pointed out, reference being made to the German Universities, where the professors are expected to do original work, leaving the teaching to instructors. The second meeting was held in March, 1893, when the report of a committee, recommending the establishment of an endowment fund of 25,000 dollars for the purpose of encouraging original research, was adopted. The fund is to be known as the "John Strong Newberry Fund," and will be used for furthering researches in geology, palæontology, botany, and zoology. All information relating to it or to the Alliance can be obtained from Dr. N. L. Britton, Columbia College, New York.

THE question as to whether amber was exported from the far east to Europe is discussed by Herr A. B. Meyer in a paper read before the Isis Society of Dresden. There seems to be little doubt that some specimens now sold at Rangoon are of Baltic origin, as proved by the amount of succinic acid contained in them. But there are, on the other hand, many authorities for the early derivation of amber from India and especially Burma. There are four passages in Pliny giving India as the native country of amber, and ancient Greek authors, especially Sophocles, testify to its origin in eastern India. It would be very strange if the Phœnicians, while shipping ivory, peacock feathers, tin, jewels, and spices from "Ophir," had left behind a highly valued, abundant, striking, and easily transportable article like amber. A specimen of Burmite, as the Indian amber is now usually called, from the Indian Museum, Calcutta, gave 2 per cent. of succinic acid; another specimen, analysed by Dr. Helm, gave off none. The specimens examined by the latter "had frequently embedded in them small particles of decayed wood and bark," which recalls a passage in Archelaos, who says that the Indian amber often has pieces of pine bark adhering to it. The Indian origin of much of the amber acquired by the Mediterranean nations in ancient times appears, therefore, to be placed beyond doubt. It is, indeed, probable that Baltic amber did not become a regular article of commerce before the first century of the Christian era.

WHILST our knowledge concerning the behaviour of bacteria in animal tissues is daily receiving fresh additions, but little is known on the relatively unimportant although interesting question of their deportment in vegetable tissues. Much uncertainty exists as to whether bacteria are or are not normally present in healthy vegetable tissues, but the most recent investigations appear to show that they are absent, although they may obtain easy access through minute abrasures, and retain their vitality for a considerable time, and in some cases even multiply. This view is supported by Russell, who has recently presented an interesting dissertation to the John Hopkins University on "Bacteria in their Relation to Vegetable Tissue." A large number of examinations were made of healthy plant tissues, but in no case were bacteria isolated from them, although in wounded tissues they were frequently found. Ordinary saprophytic bacterial forms were inoculated into the healthy tissues of various plants, and were identified after several days, thus the *B. luteus* was found in large numbers in the stem of a geranium after forty days from the date of its introduction. Moreover, nearly as many bacilli were obtained 10 millimetres above the point as at the seat of inoculation, 1850 being found at the latter place, and 1764 above. In all the experiments, although the distance at which bacteria were found varied from 30-50 mm. above, in no case were they identified at more than 2-3mm. below the point of inoculation. Russell suggests that this upward distribution of the germs may be due to food materials being more abundant in the rapidly growing apex, whilst smaller resistance is offered to their passage in the less developed cellulose walls than in the more matured cell-membrane of the older tissue. Moreover, as the bacteria were definitely located in the interior of the cells, and no opening of any kind could be determined, he suggests that they have the power, by means of a ferment excreted, to work their way from cell to cell without causing a permanent rupture.

THE August number of the Journal of the Royal Horticultural Society contains several interesting papers, among which is Prof. F. W. Oliver's second report on the effects of urban fog upon cultivated plants. The report deals especially with the physiological aspect of the question, the action of fog upon plants, both by reduction of light and atmospheric impurities, being described in detail. The Rev. G. Henslow gives the results of experiments made with a view of determining the effects of growing plants under glasses of various colours. His observations show that during germination it is generally immaterial whether the seeds are subjected to light or not. In the case of a variety of larkspur, however, light was found to be positively injurious. No coloured light, or combination of lights, which was not of the quality of pure colourless daylight, gave such good results as ordinary daylight. A comparison made between plants growing under ordinary window-glass and in the open showed that the glass exercises a deletereous effect, due possibly to an excess of heat by which respiration is stimulated and assimilation reduced. It is suggested that in order to reduce "scorching" some means must be used which reduces the heat rays without lessening the whole amount of white light.

WE have received from Dr. P. Bergholz the results of the meteorological observations at Bremen for the year 1892. This station is one of considerable importance, both on account of its outfit with self-recording instruments, and even with duplicate recording instruments for some of the elements, so as to avoid any possible gap in the continuity of the records, and also on account of the long continuance of observations. The first volume of this series, for the year 1890, contained the results of observations taken since the year 1803, and we see from Dr. Hellmann's *Repertorium* that observations were taken at Bremen as early as 1795. The work contains hourly readings, and, in addition, observations arranged for three hours daily, in accordance with the international scheme, together with curves showing the diurnal range for each month and for the year; it also comprises rainfall values for four other stations, and phenological observations for eleven years; the whole forming a very complete and creditable compilation.

IN *Wiedemann's Annalen*, No. 8, Herr W. Voigt gives a further account of the progress of his attempt to determine the greatest possible number of physical constants of the same pieces of metal subjected to the least mechanical manipulation. The pieces were carefully cast and sawed into shape where necessary. It is not surprising that the constants thus obtained differ in many cases from those found in the case of drawn and rolled metals, but it seems that the object of discovering the laws of the numerical relations between the various constants render it highly desirable that the substances should be investigated in what may be called their most natural state. The constants recently dealt with are thermal dilatation, thermal pressure, and specific heats at constant pressure and volume respectively. The determination of the specific heat by the method of mixtures has led to some ingenious contrivances for minimising the errors which are apt to influence this somewhat delicate operation. The outer vessel of the Neumann "cock" for heating the body under examination was made movable instead of the inner, thus enabling it to be refilled without removing it from the stand. The loss of liquid due to the splashing produced by the metal falling into the calorimeter was avoided by throwing it into a metal cage just in contact with the liquid, which was then lowered about halfway towards the bottom. The liquid was stirred by a small turbine, and the thermometer was so arranged that it only came into contact with liquid which had ascended from the metal, and then had been drawn down through the turbine tube, thus giving a very rapid rise and gradual fall of temperature, as indicated by the thermometer. The scale was read by a small microscope provided with two wires touching the scale, the meniscus being brought midway between the two. This simple arrangemen has the effect of eliminating all parallactic errors.

THE Comité International des Poids et Mesures has issued a volume containing the proceedings of meetings held during 1892. M. L. Chappuis contributes to the volume a report of an investigation of the thermal expansion of water by the weight-thermometer method. He has made two complete determinations, one between 0° and 42°·4 C., and the other between 0° and 36°·6 C. The results show that the expansion of water from 0° to 40° is very closely given by the following expression $-0·84 - 66·573253t - 8·798939t^2 - 7·892005 \times 10^{-2}t^3, + 5·155549 \times 10^{-4}t^4$. M. C. E. Guillaume has prepared a report on the metals employed in the construction of standard scales, in which he recommends nickel as the best substance.

COLONEL WATERHOUSE has been making experiments upon the electrical action of light upon silver and its haloid compounds, and communicated his results to the Asiatic Society of Bengal in May last. His arrangement was such that one plate could be exposed to light while another with which it was in electrical connection was screened from actinic rays. From the experiments it appears that, as a general rule, sunlight has an oxidising or dissolving effect on silver, whether in acid or alkaline solutions, the exposed plates being nearly always positive, and consequently forming the anode of the voltaic couple. With solutions decomposed by silver, and forming sensitive compounds with it, the action is variable.

MR. P. JANET, in the current number of the *Journal de Physique*, describes the methods he has adopted for experiments on electric oscillations of comparatively long period, $\frac{1}{10000}$ second and thereabouts. His object more particularly is to obtain the actual form of the curves of intensity and electro-motive force, rather than to find the period and logarithmic decrement. With a modified form of interruptor of M. Mouton's he is able to read accurately to $\frac{1}{30000}$ second, or even less. A mica-condenser forms part of his arrangement, and he was incidentally led to make experiments on the "hysteresis and dielectric viscosity" of the mica, from the study of certain variations which he found in the capacity of the condenser. He sums up his results on this point thus:—"In a condenser with solid dielectrics, under the influence of rapid [electric] oscillations, there is a lagging of the charges behind the differences of potential; or, in other words, for equal differences of potential, the charges are smaller with increasing than with decreasing potentials." A new and apparently accurate method for the determination of the coefficient of self-induction is also given as a secondary result of the experiments.

IN the same journal M. R. Malagoli gives a summary of his theoretical investigations on electrolysis by alternating currents, the results of which agree with the experimental determinations of M. Mengarini. He concludes that the necessary and sufficient condition under which electrolysis by alternating currents is possible, is that the quantity of electricity passing through the voltameter during a single alternation of the current must be at least twice that which is necessary for the production of the maximum polarisation of the voltameter. Electrolytic production ceases when these two quantities become equal, and the amount of the electrolyte decomposed is proportional to their difference.

AT the meeting of the Paris Academy of Sciences on August 14, MM. Delahaye and Boutille showed an ingenious fire-alarm. A hollow ball of aluminium, 15 to 20 mm. in diameter, is supported at one end of an arm, with a counterpoise at the other end, the whole being in equilibrium at the ordinary temperature and pressure of the air. The apparatus is purposely made not sensitive enough to show the ordinary natural changes of pressure, but if the specific gravity of the air becomes diminished considerably, either from a rise of temperature or an admixture of coal gas in sufficient quantity to become explosive, the balance is destroyed, and the ball in falling completes an electric circuit by which an alarm bell is set ringing until the normal state of affairs is again established.

SIR CHARLES TODD has issued a report on the rainfall in South Australia and the northern territory during 1892, with the weather characteristics of each month.

GUSTAV FISCHER, of Jena, has recently published second and revised editions of two well-known books—Prof. E. Strasburger's "Kleine Botanische Practicum," and Prof. Richard Hertwig's "Lehrbuch der Zoologie."

MESSRS. CROSBY LOCKWOOD AND SON will publish in September a comprehensive handbook on "Practical Building Construction," by Mr. J. P. Allen, lecturer at the Durham College of Science, Newcastle-on-Tyne. The work will be illustrated by about 1,000 diagrams.

WITH reference to the article on the "Position of Scientific Experts" in our issue of the 17th inst. a correspondent informs us that for some years it has been legal for a judge to select an expert to report to the Court upon a particular matter in dispute, and this practice is occasionally followed. The mode of selection and of appointment, and the status of the official English expert, are therefore almost identical with those of his German equivalent.

THE Isle of Man Natural History and Antiquarian Society visited the Marine Biological Station at Port Erin on August 14, and Prof. Herdman, F.R.S., the director of the station, gave the members an address upon the objects and methods of marine biology. We understand that it is intended to construct fish hatcheries at Port Erin, and to wall in several of the creeks round the coast for the preservation of young fish until they reach maturity.

AN "Electrical Engineer's Price-Book," edited by Mr. H. J. Dowsing, has been published by Messrs. Charles Griffin and Co. It contains a large amount of information on the commercial aspect of electrical work, and should be of great assistance, not only to electrical engineers, but also to borough engineers, architects, railway contractors, and local authorities who desire to be informed upon matters connected with electrical installations.

BRAZIL produces, on the average, about 360,000 tons of coffee per annum, that is, about four-fifths of the whole amount consumed in the world. Since the State of Sao Paulo alone produces one-half of this quantity, an illustrated pamphlet by Señor Adolpho A. Pinto, one of the Commissioners of the State at the World's Columbian Exposition, would be expected to contain an accurate account of coffee cultivation. The little pamphlet justifies the expectation. Every one interested in coffee-growing in general, and in Sao Paulo in particular, will find it well worth reading.

IT was generally admitted by those competent to judge that the display of scientific instruments at the Paris Exposition of 1889 was inferior to that of 1878. There were, however, a few striking exhibits scattered in different classes in an unaccountable manner. Mr. A. Lawrence Rotch was appointed to report upon the meteorological instruments at the exhibition, and though there was a difficulty in comparing objects in the same class, owing to their being distributed over an immense area, it was satisfactorily overcome. Meteorologists will be glad to know that Mr. Rotch's report has been extracted from the second volume of the Reports of the U.S. Commissioners to the Universal Exposition at Paris, and is now issued separately.

THE report on the operations of the Department of Land Records and Agriculture, Madras Presidency, for the official year 1891–92 has been received. From it we learn that experiments made by the Madras railway companies in the use of eucalyptus leaves to prevent incrustation in locomotive boilers have turned out very satisfactory, and are therefore being continued. The chief feature of the year was the comparative immunity from serious disease which the cattle enjoyed. The total reported losses (87,000) were only fifty-eight per cent. of the average losses, and fifteen per cent. less than in 1890–91. The losses from snake-bite decreased from 2,698 to 1,751, and the decrease was spread over the whole Presidency, except Ganjam and Vizagapatam. Losses by wild animals also decreased by 345 head. No reason is given to account for this singular reduction.

THE Royal Society of Tasmania issued in June last the reports of its proceedings in 1892, and the volume has just reached us. Among other papers printed in full occurs one by Mr. G. M. Thomson on Tasmanian crustacea, with descriptions of new species, and another on new species of Tasmanian araneæ, by Mr. A. T. Urquhart. The Rev. F. R. M. Wilson contributes a paper on the climate of Eastern Tasmania, indicated by its lichen flora, in which he gives facts which "suggest to the medical faculty what probably their experience has already proved, that the climate of East Gippsland and the eastern coast of Tasmania must be pre-eminently beneficial to invalids. Lichenological observations indicate that both of these places are favoured by a much milder winter, as well as a cooler summer, than the other parts of their respective colonies." Mr. Wilson also gives a description of Tasmanian lichens, and Mr. John Shirley a list of those now known.

DR. D. S. JORDAN showed in 1889 that, in every case where the waters of Yellowstone Park were destitute of fish, the cause was topographical, that is to say, there was some physical barrier to the entrance of fishes from below. This being so, it seemed possible to stock these waters permanently with game-fish, so the U.S. Commissioner of Fish and Fisheries sent Prof. S. A. Forbes to Yellowstone Park in 1890 to investigate the variety and abundance of the lower animal life of the fishless waters, since upon this the fishes introduced would chiefly have to depend for food. Prof. Forbes has prepared his "Preliminary Report on the Aquatic Invertebrata Fauna of the Yellowstone National Park, Wyoming, and of the Flathead Region of Montana." In it he presents a summary review of the invertebrate life of the waters of Wyoming and Montana in the mid-summer season, with descriptions and determinations of such new or particularly abundant kinds as have thus far been made out. A detailed discussion of the results will be published as soon as the mass of material collected during the expeditions has been examined.

THE organo-metallic compounds of magnesium form the subject of a communication to the current number of *Liebig's Annalen* by Dr. Fleck of Tübingen. The di-methyl, di-ethyl and di-propyl compounds of magnesium were obtained by Dr. Löhr in the same laboratory in 1890. Dr. Fleck has continued the work, and now describes the di-phenyl compound and gives further details concerning the mode of preparation and properties of the fatty alkyls above mentioned. The magnesium alkyls are of a somewhat similar nature to the well-known zinc methide and ethide. They differ, however, in the nature of certain of their reactions, and their chemical activity is considerably superior to that of the zinc alkyls, which have hitherto been regarded as exceptionally active substances. Not only are the magnesium compounds spontaneously inflammable in the air, but the methyl compound was described by Dr. Löhr as igniting spontaneously and burning in a very beautiful manner in carbon dioxide gas, being capable of extracting the oxygen from its combination with carbon. The three fatty alkyls are best prepared by the action of the alkyl iodides upon magnesium amalgam. When an attempt, however, is made to prepare the diphenyl compound by heating in a closed and previously exhausted tube a quantity of magnesium amalgam and brombenzene, instead of obtaining magnesium diphenyl decomposition occurs, and the resulting product is merely a mixture of bromides of magnesium and mercury with diphenyl itself $(C_6H_5)_2$. Dr. Fleck has at last succeeded in preparing magnesium diphenyl by heating a mixture of magnesium filings and mercury diphenyl, $Hg(C_6H_5)_2$, within a narrow range of temperature. About ten grams of mercury diphenyl and a little more than the calculated quantity of magnesium in fine powder are placed in a tube of soft glass, which is then exhausted by means of the air pump and sealed. Upon heating the tube and contents to 200 a violent reaction suddenly occurs, with production of a voluminous white mass occupying at least three times the space of the original mixture. Above 210° this white substance commences to carbonise, so that the tube is maintained for four or five hours at a temperature of 200—210°, not exceeding the latter limit. The product is spontaneously inflammable in air, so that it is necessary to open the tube under benzene. Any excess of mercury diphenyl is dissolved out by warming with benzene over a water bath, the residue is then treated with a mixture of ether and benzene, in which alone of all the organic solvents tested magnesium diphenyl is soluble; upon decantation from the residual amalgam and evaporation of the clear liquid in a stream of nitrogen, pure magnesium diphenyl is obtained as a grayish-white solid. Analyses of the product agree with the formula $Mg(C_6H_5)_2$.

MAGNESIUM diphenyl, like the dimethyl, diethyl and dipropyl compounds, reacts in a most violent manner with water. Even when the substance is first covered with ether, and then small pieces of ice are slowly added, the reaction still occurs almost explosively. Magnesium hydrate and benzene are the products of the reaction as indicated by the equation

$$Mg(C_6H_5)_2 + 2H_2O = Mg(OH)_2 + 2C_6H_6.$$

Magnesium diphenyl is consequently extremely hygroscopic, attracting moisture from the air with great rapidity when covered with a layer of benzene. When freely exposed to the air it at once burns to magnesium oxide and a carbonaceous mass. If, however, the compound is covered with benzene and exposed to perfectly dry air for some days, an oxy-compound, $Mg(OC_6H_5)_2$ is formed as a brown solid. Bromine reacts with great energy to form bromides of magnesium and phenyl, even when largely diluted with ether, and so does not form an intermediate compound,

$$\mathrm{Mg}\Big\langle{}^{\mathrm{Br}}_{\mathrm{C_6H_5}}$$

corresponding to the well-known zinc iodo-ethide,

$$\mathrm{Zn}\Big\langle{}^{\mathrm{I}}_{\mathrm{C_2H_5}}$$

Indeed, this incapability of forming mixed halogen alkyls, owing to greater activity, is one of the most characteristic distinctions between the magnesium and the zinc alkyls generally. Benzal chloride, $C_6H_5.CHCl_2$, reacts with magnesium diphenyl in an interesting manner, forming without extraneous application of heat triphenylmethane, $(C_6H_5)_3CH$, and magnesium chloride.

Notes from the Marine Biological Station, Plymouth.—The *Actinotrocha* larva of *Phoronis* has now made its appearance in the floating fauna. The Radiolaria mentioned last week, though still present, have become much less numerous; the tow-nets have this week been crowded with *Rhizoselenia.* The Siphonophore *Muggiæa atlantica* is abundant, and the medusæ *Saphenia mirabilis* and *Amphinema Titania*, with swarms of small *Obeliæ*, have also been observed. The Nauplii of *Sacculina* are plentiful, and among Mollusca the larvæ of *Ægirus punctilucens* and the larva *Cirropteron semilunare* of M. Sars (possessing a four-lobed velum) have been observed. The Polyclad *Leptoplana tremellaris* is now breeding; and young metamorphosed specimens of the Opisthobranch *Oscanius membranaceus* have been taken with the dredge on the bottom.

The additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus*) from India, presented by Mrs. H. Leavitt: a Blau-bok (*Cephalophus pygmæus*) from South Africa, presented by Mr. J. E. Matcham; a Yellow Baboon (*Cynocephalus babouin*) from West Africa, a Banded Gymnogene (*Polyboroides typicus*) from East Africa, a White-necked Stork (*Dissura episcopus*) from East Africa, presented by Mr. Thomas E. Remington; a European Tree Frog (*Hyla. arborea*) from Europe, two Fire-bellied Toads (*Bombinator igneus*) from Europe, and a Spotted Salamander (*Salamandra maculosa*) from Europe, presented by Mr. Hood; eleven Garden Dormice (*Myoscus quercinus*) from Spain, forty-eight Glossy Ibises (*Plegadis falcinellus*) from Spain, and four Marbled Ducks (*Anas angustirostris*) from Spain, presented by Lord Lilford, F.Z.S.; a Rose-crested Cockatoo (*Cacatua moluccensis*) from Moluccas, presented by Lady Sudeley; two Ypecaha Rails (*Aramides ypecatra*) from South America, presented by Mr. F. H. Chalk, a Boa (*Boa constrictor*) from South America, and two Great Bustards (*Otis tarda*) from Spain, deposited; and a Wapiti Deer (*Cervus canadensis*) born in the Menagerie.

OUR ASTRONOMICAL COLUMN.

Honorary Distinctions.—From the current number of *L'Astronomie* we gather that M. Janssen, director of the Observatory of Meudon, has been made a Commander of the Legion of Honour. Messrs. Callandreau and Bigourdan, assistant-astronomers at the Paris Observatory, have received the distinctions of Officers of Public Instruction, and MM. Camille Flammarion and Jordan and Hermite, of the Institute, have received from the King of Greece the Cross of the Commander of the Order of the Saviour.

A Meteor.—An observer, writing to us from Westgate-on-Sea, gives the following account of a meteor seen there on the evening of August 27:—"At about 8.40 p.m. I saw a very brilliant meteor here. The trail, as far as I could judge, must have commenced somewhere about the star β Sagittæ, but the most brilliant part of it was accurately noted as lying between two points, one being half-way between α and γ Aquilæ and the other being about a third of the distance (from η) between η and δ of the same constellation. The meteor may be described as "rapid," and its direction of motion was south. The most striking feature of this observation was the length of time (about six minutes) the trail remained visible in the heavens, and its subsequent change of shape. At first it appeared of a bluish-white colour and was very bright, its path describing practically a straight line; but about four minutes later it had dimmed very considerably (the same colour being maintained), but the trail was no longer straight but distinctly *wavy*, giving one the idea that the meteoritic dust particles must have encountered some air currents travelling at right angles to its length."

A Bequest to Astronomy.—By the will of Mr. Arthur Leake, late of Ashby, Ross, Tasmania, a sum of £10,000 was put by for the purpose of founding a school for the practical teaching of astronomy in one of the Australian universities, colleges, or leading schools. It was stipulated that a part of such teaching should consist of lectures illustrated with diagrams and instruments, and the sum of £3000 could be spent in purchasing the necessary equipment. From the proceedings of the Royal Society of Tasmania (issued June, 1893) it appears that there is a little difficulty in determining the best means of using the bequest. Mr. H. C. Russell, F.R.S., C.M.G., has drawn up a scheme for the proposed school which has much to commend it. He points out that Hobart offers special advantages of climate and position for the Leake Observatory, and suggests that £1800 should be spent in purchasing a photographic astronomical telescope, to be used for work in connection with the photographic chart. It is proposed that the University of Tasmania shall establish a school of astronomy and the observatory, and that the lecturer in mathematics and physics shall also teach astronomy, and have general control and direction of the observatory, for which he should be paid from the Leake fund £100 per annum in addition to his salary from the university. An observatory assistant is provided in the scheme with a salary of £200 per annum. The sum of £50 a year is set down for photographic plates, chemicals, &c., bringing the total annual expenditure up to £350, which is the interest on £7000 from the Leake estate. When Mr. Russell's paper was read, in August, 1892, an opinion was expressed that it was unnecessary to "import an astronomical expert in order to give the instruction in astronomy, and to superintend the observatory," and that the duties of the observer might be combined with those of the Government meteorologist. With this feeling the following resolution was passed:—"The Royal Society of Tasmania having placed itself in communication with the Council of the University with the view of formulating a scheme for securing the benefit of the Leake bequest to the colony of Tasmania, the Premier be requested to refrain from making any permanent appointment to the office of meteorologist pending the result of such conference."

GEOGRAPHICAL NOTES.

Dr. Nansen has telegraphed from Yugor Strait, at the entrance to the Kara Sea, on August 3, the message reaching the Vardö telegraph office on August 23. A good voyage had been made to Nova Zembla, the only unpleasant episodes being the occurrence of fogs and contrary winds. On the 27th ice was encountered in lat. 69° 50′ N., long. 50° E., about ten miles north-east of the Island of Kolgueff. Dr. Nansen forced his way through the ice, the *Fram* proving a splendid ship for the purpose, and reached Yugor Strait on the 29th, making a run of 250 miles in two days. The coal-ship, which was to have been waiting at Yugor Strait, had not arrived, but having sufficient coal on board Dr. Nansen intended to sail into the Kara Sea on August 3, rather than risk delay by waiting. He took on board "thirty-four splendid sledge-dogs." Little ice was reported in the southern part of the Kara Sea, a southerly wind having driven the pack northward. If the ice does not turn out worse than reported, Nansen hoped to reach the New Siberian Islands before the end of August, and if he does so he considers success almost certain. The *Fram* will touch at the Olonetz River, near the Lena delta, if there is time, and send farther news.

The geography of South America has recently been receiving great attention from German travellers and officials in the various South American republics. In a recent number of *Petermann's Mitteilungen*, Richard Payer describes a journey from Lima across the Andes and down the valley of the Ucayali to the Amazon. In the course of it he visited an interesting Tyrolese colony at Pozuzo, which he found in the course of extinction, after thirty years' hard struggle on the part of the colonists to maintain a footing in their remote and isolated settlement. Dr. Brakebusch has from time to time published portions of the material he has been collecting for an exhaustive account of the physical geography of the Argentine. He divides the country from the crest of the Andes to the valley of the Parana into successive zones—snowy summits and cliffs, high-level sand-dunes formed from glacial débris, screes, alpine pastures, low-level sand-dunes, salt flats, forests, and pampas.

Dr. Hettner has been at work on the Andes of Colombia, and Dr. Theodore Wolf has published a magnificent monograph (in Spanish) on the geography and geology of Ecuador, accompanied by the best map yet produced of the country. Dr. Tippenhauer has written a fine work on the physical geography of Haiti, and many other papers by German geographers have appeared within the last few months.

SIR WILLIAM MACGREGOR, for the British Government, and the officers of the Dutch war-vessel *Java*, have rectified the frontier between British and Dutch New Guinea. The former boundary was the 141st meridian, and the new boundary, where it cuts the coast, is a stream, chosen to furnish a recognisable border-line, in 141° 1′ 40″ E. and 9° 7′ 40″ S.

ON August 6 the new ship-canal across the Isthmus of Corinth was formally opened, thus completing a plan which was projected by Periandros about 600 B.C., and actually commenced by Nero, who was, however, compelled to abandon the work, in 68 A.D. The canal is not quite four miles long, and will effect a saving of 120 miles in the passage from the Adriatic to the Ægean. Two new towns have been planned at the entrances to the canal, which will be named Poseidonia and Isthmia.

MR. F. C. SELOUS, the recognised authority on the exploration of Mashonaland, has been induced to return there at very short notice, on account of the threatening attitude of the powerful Matabele chief, Lo Bengula, and the consequent risk of interruption in the development of the country. An important work on Mashonaland, by Mr. Selous, will be published immediately.

MR. R. M. W. SWAN, who, with Mr. Theodore Bent, surveyed the ruins of Zimbabwe, is at present engaged in a systematic survey of other groups of ruins in South Africa, and he reports the discovery of a temple on the Limpopo, "oriented" to the setting sun at the solstice.

MR. W. H. COZENS HARDY, the Oxford geographical scholar, is now engaged in carrying out his explorations in Eastern Montenegro, one of the least known parts of Europe. The work of his predecessor, Mr. Grundy, on the Battlefield of Platæa, is on the point of publication as a supplementary paper of the Royal Geographical Society.

THE BEAVER CREEK METEORITE.

SOME of the readers of NATURE will no doubt be interested in a short account of a meteoric fall which occurred recently in British Columbia, and was noted in these columns on August 10. For the circumstances in connection with the fall, and the finding of fragments of the meteorite, I am indebted to Mr. James Hislop—a former student of this University, and a most trustworthy observer—and also to a letter by Mr. E. L. McNair in the *Spokane Review* of June 2.

Both gentlemen were members of a party of engineers engaged upon a survey for the Nelson and Fort Sheppard Railway Company on Beaver Creek, about eleven miles north and five miles east of where the Columbia crosses the international boundary line. About four o'clock on the afternoon of May 26 a series of sharp reports was heard, following one another in quick succession, and apparently occupying in all about half a minute. The first report was quite loud and sharp, and each succeeding one less so, as if coming from a greater distance. Following the reports was a whizzing sound, such as might be supposed to be produced by a body moving rapidly through the air.

At the time of the "explosion" a man named Gerling was walking along the Beaver Creek trail. At first he thought that the noise was thunder, but the whizzing sound puzzled him, and on looking upward to see if he could tell whence it came, it grew louder and louder until a stone struck the ground not far from where he stood. He searched for it, but without success, as the place was thickly overgrown with bushes.

Some distance from this a fragment fell within fifty feet of a man named Edward McLeod. It buried itself in the earth, but was dug out, and found to weigh four or five pounds. On the following day (May 27), in the course of his topographical work, Mr. Hislop came upon a freshly-made hole in the ground into which the loose earth had fallen, and on following it down to a depth of three feet from the surface a portion of the meteorite weighing about twenty-five pounds was discovered. The hole made an angle of 58° with the horizontal, and its course showed that the mass had come in a direction S. 60° E. (true meridian), The writer is indebted to Mr. Hislop for a portion of this mas[s] and a preliminary examination fully establishes its meteori[c] character.

The fresh fracture is light grey in colour and harsh to th[e] touch, the crust being brown and dull. The chondritic characte[r] is distinctly seen without a lens, though the "chondra" ar[e] mostly under a millimetre in diameter. Examination of a thi[n] section with the microscope showed the presence of olivin[e,] enstatite, iron, troilite, and chromite (?). The iron is present i[n] the form of little shining grains and strings. On treatment wit[h] hydrochloric acid the powder gelatinises readily (olivine, an[d] evolves hydrogen sulphide. By means of an ordinary hors[e]shoe magnet some of the powder was separated into a magnet[ic] and a non-magnetic portion. The former amounted to abo[ut] 23·5 per cent. of the whole, and consisted mainly of nickel-iro[n,] which, however, carried with it a portion of the other co[n]stituents.

A partial analysis of the magnetic material gave:—

Iron	78·72
Nickel (including cobalt)	6·87
Insoluble in hydrochloric acid	10·04
Soluble silica	1·46
Magnesia, &c., by difference	2·91
	100·00

If all the iron and nickel present be regarded as nickel iro[n,] the percentage of nickel (with cobalt) is 8·73. No doubt, ho[w]ever, a little of the iron was derived from olivine and possib[ly] from troilite.

The writer hopes to publish before long the results of a le[ss] hurried and more detailed examination of the specimen in [his] possession.

B. J. HARRINGTON.

SPANGOLITE, A REMARKABLE CORNISH MINERAL.

AMONG the valuable Cornish minerals from the Willia[ms] collection which have recently been acquired by t[he] trustees of the British Museum[1] is one specimen which deser[ves] immediate notice, since it proves to be a recently discover[ed] mineral of which only one other example is known to ex[ist,] and that from a foreign country.

The mineral belongs to the fine series of copper ores from [the] St. Day mines, which are chiefly arsenates and phosphates, a[nd] among these, while it exceeds the remainder in scientific [in]terest, it is inferior to none in beauty.

The specimen, about the size of a hen's egg, consists o[f] granular gossany quartz carrying on both sides a little mas[s of] cuprite, which is covered and replaced by greenish alterat[ion] products—chrysocolla, malachite, liroconite, and clinocla[se,] together with a little chessylite; especially conspicuous be[ing] the bright green crystals of liroconite and indigo-blue group[s of] clinoclase.

But among these, dispersed upon both sides of the specim[en,] are numerous brilliant and translucent crystals of a c[...] emerald-green colour, which at once strike the eye as so[me]thing unusual. Their form is a hexagonal prism terminated [by] an acute hexagonal pyramid having the apex truncated b[y a] single bright plane; and one cannot call to mind any ot[her] mineral having precisely this habit.

A minute group of crystals was detached and examined [by] Mr. Prior and myself with the following result:—The min[eral] belongs to the rhombohedral system, the pyramid angle be[ing] 53° 7′; it has a perfect basal cleavage; it is uniaxial, the b[i]fringence being strong and negative; the specific gravity, de[ter]mined by suspending a fragment in solution of cadmium bo[ro]tungstate (Rohrbach's solution), is 3·07; it is insoluble in wa[ter,] but readily soluble in acids; and is found to be a hydrated [sul]phate and chloride of copper and aluminium. This indic[ates] a very remarkable and unusual composition, but the prese[nce] of both aluminium and chlorine is quite unmistakable.

In all the above characters the substance is identical w[ith] spangolite, a new copper mineral which was described by [...] S. L. Penfield in 1890 (*American Journal of Science*, [...] p. 370).

The resemblance between the two specimens extends e[ven] to the circumstances of their discovery; the original spang[olite]

[1] NATURE, vol. xlviii. p. 357.

was found in a collection of minerals where it had attracted no attention until Mr. Spang obtained the specimen and brought it to the notice of Mr. Penfield; the present specimen has probably remained unnoticed in the Cornish collection at Caerhays for a large number of years.

The local collection from which the American specimen was obtained belonged to a man living near Tombstone, Arizona, who had gathered together his minerals within a radius of about two hundred miles, so that although the exact locality and mode of occurrence are unknown, it is almost impossible that this specimen can be also Cornish.

From the typical character and appearance of the associated clinoclase and liroconite the British Museum specimen (although no label or history is attached to it) can be pronounced to be without the least doubt from the St. Day district, near Redruth, in Cornwall.

The American specimen is described as "a rounded mass of impure cuprite which was mostly covered with hexagonal crystals of spangolite, associated with a few crystals of azurite and some slender prismatic crystals of a copper mineral containing chlorine, probably atacamite"; it therefore differs considerably from the Cornish specimen as regards the associated minerals.

The only apparent difference between the spangolite on the two specimens is in the habit of the crystals, which in the American mineral are short prisms with bevilled edges and a large base, quite unlike the acute Cornish pyramids in aspect. The pyramid angle found by Penfield is 53° 11½′, and the specific gravity 3·141. Penfield further made some interesting observations concerning the etched figures of spangolite; he describes and figures certain beautiful triangular markings produced upon the basal plane by the solvent action of very dilute acids. We have found that precisely the same characteristic figures are engraved upon a cleavage flake of the Cornish mineral when it is immersed for a few minutes in dilute acid.

The American crystals attain considerable dimensions; the largest had a length of 5½ mm. and a breadth of 8 mm., and by sacrificing half the specimen Penfield was able to obtain more than 3 grams (!) of pure material for analysis. The Cornish crystals are not more than 2½ mm. in length and ¾ mm. in breadth, and it will be difficult to obtain sufficient material for a complete analysis, unless other specimens can be found. This is unfortunate, for the composition is so peculiar that, although Penfield's analysis is without doubt perfectly reliable, it would have been interesting to confirm his formula from a new locality. The preliminary examination serves, however, not only to establish the identity of the mineral, but also to prove the most important point—that the aluminium and chlorine are essential constituents.

The formula deduced by Penfield is

$$Cu_6AlClSO_{10}.9H_2O.$$

in which, as he remarks, the aluminium is just sufficient to satisfy the quantivalence of the total acids, thus:—

$$(AlCl)SO_4.6Cu(HO)_2.3H_2O.$$

The mineral is therefore closely related to connellite, a very rare sulphate and chloride of copper also found in the St. Day district, which, moreover, it somewhat resembles in appearance, having the same black colour when viewed by reflected light alone. The colour by transmitted light, together with the perfect basal cleavage are, however, sufficient to distinguish spangolite from all known minerals; further, the basal plane is as common on spangolite as it is rare on connellite.

It is to be hoped that search will be made among old collections and upon copper ores from St. Day for further specimens of this interesting mineral. H. A. MIERS.

DESULPHURISATION OF IRON.

THE elimination of sulphur from iron and the chemical reactions, whereby sulphur, in the presence of powerful basic materials, is removed from crude iron, has recently attracted considerable attention. There are many reasons for this; pure ores have become comparatively scarce, and to some extent the same may be said of the fuel or coke used in the process of smelting. And even if this be not strictly applicable in all districts where the manufacture of iron is pursued, yet it cannot be gainsaid that excessive competition, with concurrent low prices, have had an influence in rendering the strictest economy in the manufacture absolutely necessary, and thus in a measure preventing the free use of pure high-priced materials.

I may even go further and assert that under favourable conditions, that is, as regards general manufacturing expenses, localisation of plant, &c., the cost of pure good materials, unquestionably suitable for smelting purposes, may become quite prohibitive. In numerous instances manufacturers have therefore been compelled to use cheaper fuel and ores falling within the margin of economic working. At this point, however, other fresh difficulties have to be combated; for when the problem of the production of iron and steel at a reasonable rate has been solved, it is too often found that the metal thus manufactured fails to meet demanded requirements. It is often the case that when iron thus produced is converted into steel, a want of uniformity in quality can be distinctly traced throughout the manufactured product. Though the steel can hardly be termed bad, nevertheless, as a general rule, it compares unfavourably with the metal smelted from purer ores with good fuel or coke.

The causes tending to the production of this inferior metal or steel are well known, and may be summed up in a few words. (1) The use of inferior coke in the blast furnace is at once a cause of deterioration, for the heat is less intense, and this tends to the production of a low grade iron.

(2) It is evident that the use of inferior cheaper ore causes a further deterioration in quality, whilst any attempt to remedy this by lightening the furnace burden of ore—in other words, using a greater quantity of coke—is, in many instances, counterbalanced by the inevitable additional impurities charged, *i.e.* sulphur and phosphorus, and other additional incombustible matter or ash.

It follows as a matter of course that the blast furnace can only work in this direction within a very narrow limit, either plus or minus attempts to limit the quantity of coke used resulting, as before said, in the production of low grade iron. On the other hand, an increased quantity of fuel with the use of inferior ore increases the total amount of impurities.

The working limit on either side is soon reached, and any further attempts at improvement either way become simply useless. Certainly, very highly heated air or blast might to some extent obviate some of the difficulties, but as in modern practice this is already thoroughly carried out, the employment of a higher temperature of blast would appear to be practically impossible, and it is very likely that the attempted use of abnormally heated blast or air would entail other serious practical difficulties.

This is the common experience of those engaged in the manufacture of iron and steel, more especially in blast furnace smelting operations, showing that under the unfavourable conditions before mentioned, it is practically impossible to produce a high-class iron containing the minimum percentage of sulphur and phosphorus together, with the requisite quantities of silicon and graphite necessary to ensure the production of good steel.

Thanks to the painstaking investigations of Mr. Stead, we can now form a tolerably clear idea of the reactions involved in the elimination of sulphur, both in the blast furnace and by other or secondary processes. These may be broadly summed up in his statement that sulphide of iron is dissolved out of the metal in the first instance by free or loosely attached lime, in a highly reducing atmosphere at a high temperature, as by the Saniter process, where lime dissolved in calcium chloride is used; and in the blast furnace by the excess of lime in solution in the slag, or even a mixture of ordinary blast furnace slag and lime, the latter being capable of eliminating sulphur from iron, and may be substituted for Saniter's mixture. The results, however, so far as can be ascertained, are somewhat irregular with either of these methods. Finally, there can be little doubt, as suggested by Mr. Stead, that if lime alone is brought into intimate contact with molten iron by suitable mechanical appliances, neither calcium chloride nor slag is needed, these having little or no direct chemical action on the metal, but merely forming vehicles for the transmission and mixing of the lime with the iron, and consequent washing out of solution of iron sulphide, followed by the subsequent conversion into calcium sulphide and iron oxide.

"The reactions in this process are, however, exceedingly complex, and there are changes which occur of which we know little or nothing. It is, however, my opinion that the sulphide of iron is dissolved out of the metal in the first instance by the free or loosely-attached dissolved lime; but I do not care at present, without more extended investigations, to hazard an opinion as to what the subsequent reactions may be."[1] Subject to what may be said of particular instances or occasional exceptions, the statements made by me as to the result of many years' observation and experiment of others and myself are on the whole practically accepted. Probably Mr. Stead is correct when he assumes that the dissolved iron sulphide is resolved into calcium sulphide, and iron oxide, as by the Saniter process, or in the blast furnace, by the excess of lime in solution in the slag.

In this connection, as regards the blast furnace, heat plays a double part, firstly for the intensification of the chemical affinity of sulphur for the alkaline base (lime, of the slag; secondly, for the adequate liquefaction of this highly basic slag, overcharged with lime and requiring a high temperature for its perfect fusion, which otherwise would remain in and clog up the blast furnace, thus obviously checking the proper working of the furnace and the uniform descent of the materials charged above.

Phosphorus is apparently not eliminated in sensible quantities under the above conditions. Practically the whole is retained and passes into the pig iron. Blast furnace slags are, however, never quite free from phosphorus, and some species of the latter contain sensible quantities, the amount depending on the excess of phosphorus present in the ores, and the working conditions. Usually such slags contain an excess of iron oxide as compared with ordinary grey iron slags, the latter being generally free from iron oxide or, at any rate, the amount does not exceed ½ per cent. in good slag.

Metallurgical experts have for some time been engaged in devising methods for the removal of sulphur. It is needless here to recapitulate in detail the very many processes tried by them, and for the most part abandoned. All are based on the use, in one way or another, of alkaline or basic materials. However, the experience thus acquired seems to have been utilised, and has led to valuable tangible results, for of late several processes have been worked out with some degree of success, but in our opinion there is still room for improvements, both in cost and general efficiency. In addition, the time and trouble involved in these processes ("which may be classified as methods of secondary purification," *i.e.* methods by which the iron is to some extent freed from sulphur after its production in the blast furnace) are important items seriously impeding further progress. It really seems that the proposed methods of secondary purification may ultimately prove too tedious and expensive, the limit betwixt loss or gain being just now very small. Recognising this, attempts have been made to cheapen the processes, all, however, based on the use of alkaline or basic material, but so far it appears the results are somewhat uncertain.

Mr. Saniter's lime and calcium chloride method, "one of the first recently propo ed and tried," has been worked, as the writer can testify, with some success, but the costs, by general consent, are considered somewhat heavy. It is only fair to say that the inventor is not of this opinion, and he quotes reasons to the contrary which should be well weighed before a final opinion is held as to the merits of this process. Secondary processes must from their very nature be costly and troublesome when dealing with the production of thousands of tons of metal continuously flowing from the blast furnace throughout the year.

The earlier attempts to purify crude iron from sulphur, &c., merely paved the way for recent developments, and, on the whole, merely suffice to prove that alkaline or basic substances only can effectively be used. It is now generally admitted that lime is the only base which can be applied with anything approaching economic results, and the methods now being practised have resolved themselves into endeavours to use this reagent efficiently and economically. Manganese as another reagent is an effective desulphuriser, but this requires to be separately investigated.

Lime is, and always has been, used in the blast furnace for the elimination of sulphur from iron; and it is well known that a non-sulphury pig-iron cannot be manufactured unless an excess of lime be charged into the furnace over and above the lime required for the formation of a fluid slag or lime silicate. It is evident, however, that the use is limited owing to the infusibility of the basic slags formed. These are facts which need no further comment, as they are universally acknowledged on all sides. If some modification could be introduced into ordinary blast furnace charging whereby this infusible slag containing an excess of lime could be continuously cleared out of the furnace, we should have at our command a continuous *direct* method of eliminating sulphur from iron at a minimum expenditure, and at a great saving in the time and labour involved in the processes of purification.

JOHN PARRY.

[1] Stead, Iron and Steel Institute.

THE METEOROLOGICAL OBSERVATORY ON BEN NEVIS.

THE Directors of the Ben Nevis Meteorological Observatory have prepared a guide book which will be of great use to the tourist who desires to scale the top of the Ben and feast his eyes upon the crag and mist beneath, and also to the large number of people interested in meteorology. By the kindness of the publishers (Messrs. John Menzies and Co., Edinburgh and Glasgow) we are able to give three illustrations of the Observatory, with an account of its foundation and the work carried on there. For many years it has been recognised that the best means of obtaining definite information as to the vertical variation of atmospheric conditions was to establish meteorological stations differing considerably in altitude but in the same locality. In this connection we read that "in 1877 Mr. Milne Home, then Chairman of the Council of the Scottish Meteorological Society, pointed out the singular advantages of Ben Nevis as a high-level station. It is the highest mountain in the British Islands (4406 feet); its summit is, in horizontal distance, about four miles from a sea-level station at Fort William, and is situated in the track of the south-west storms from the Atlantic, which exercise such a preponderating influence on the weather of Europe, especially in autumn and winter. Its advantages are therefore unique, and observations made there have proved to be of the greatest interest and value to meteorology."

Unfortunately, though a plan of an observatory was prepared by the late Mr. Thomas Stevenson in 1879, for the Scottish Meteorological Society, the work could not be proceeded with for want of the necessary funds. From June to October, 1881, however, Mr. Clement L. Wragge made observations at the summit simultaneously with Mrs. Wragge at Fort William, and an elaborate series of simultaneous observations at different heights on the mountain were successfully made in the two following years. The discussion of these observations led to very important results, and was the means of exciting the interest in the public mind essential to the obtaining of subscriptions. An appeal for funds to enable an observing station to be erected was promptly responded to, a sum of £4,000 being soon collected. A feu of an acre of land was obtained on the top of the mountain from Mrs. Cameron Campbell, of Monzie, and upon it an observatory was erected from plans by Mr. Sydney Mitchell. "The observatory was opened by Mrs. Cameron Campbell on October 17, 1883. Observations were begun in the following month, and have been carried on ever since. At the same time a sea-level station was opened at the public school, Fort William, under charge of Mr. C. Livingston, where comparison readings were taken five times a day with great punctuality and accuracy. But a few years showed the necessity of having a continuous record at sea-level as well as on the summit, and in 1889 the directors resolved to carry out the original plan which want of funds had hitherto prevented, and set up a low-level observatory. Aided by a grant from the Edinburgh Exhibition of 1886 and contributions from the public, they were able to erect a suitable building close to sea-level, on ground feued from Mr. Cameron, of Lochiel, in the beginning of 1890. The Meteorological Council of London equipped this station with self-recording instruments, and increased their annual grant to the directors from £100 to £350. Observations began in the middle of July, 1890, and since then there has been a continuous record of barometric pressure, temperature, humidity, rainfall, &c., by day and by night, both on the summit of Ben Nevis and at sea-level. The distance between the high and low-level observatories is only 4⅔ miles, and their heights above sea-level respectively 4407 and 42 feet. Mr. Livingston also continued his observations for a year after the commencement of the low-level observatory, so that there might be a satisfactory comparison of the two sea-level stations. The telegraph wire from the summit has been extended to the low-level observatory, and the observers can communicate with each other at any time, and reports from both stations are sent daily to the newspapers. The high and low-level stations are worked as one observatory, the observers being interchangeable, and the low-level serves also as a depôt for stores, &c., which are carried up during the summer to the top." The original buildings on the hill-top were found too small for the double purpose of carrying a set of anemometers and of providing a convenient exit when the winter snows have closed the ordinary doorway.

FIG. 1.—The Observatory in Summ

FIG. 2.—The Observatory in Winter.

satisfactorily carrying on the work of the observatory, so in the summer of 1884 large additions were made, the most important being the erection of a tower about thirty feet high, which serves

The Winds of Ben Nevis.

In addition to the routine work, other observations and researches have been carried on by the observers on Ben Nevis.

"An exhaustive examination of the 'Winds of Ben Nevis' has been made by Messrs. Omond and Rankin, and the results published in the 'Transactions of the Royal Society of Edinburgh.' It is shown that while the sea-level winds in this part of Scotland are, with respect to the distribution of pressure, in accordance with Buys Ballot's 'Law of the Winds,' the Ben Nevis winds do not fit in with such a distribution of pressure, but, on the contrary, point to a widely different distribution of pressure at the height of the observatory—4407 feet above the sea—as compared with the distribution at sea-level. In large storms, with a deep barometric depression in the centre, the Ben Nevis winds are practically the same as at lower levels; but with smaller storms, whose central depression is much less, great differences are presented. In such cases it is remarkable that with a cyclone covering Scotland, the North Sea, and Southern Norway, the winds frequently blow, not in accordance with the sea-level isobars, but in the opposite direction, suggesting an upper outflow from the cyclone towards the anti-cyclone adjoining it at the time. It is further remarkable that this outflowing seldom or never occurs when the centre of the storm is to the south or west, but only when it lies to the north or east, or in the region where at the time the weather is coldest and driest. If the wind on the hill-top is not at a right angle or a greater angle from the sea level wind, it is usually nearly the same as it. The supposed veering of the wind at great heights—required by the theory that a cyclone is a whirling column, drawing the air in spirally below and pouring it out spirally above—is so seldom observed as to be the exception, and not the rule. This important result, and the analogous observation that frequently in great storms of winds prostrate trees lie practically in one direction over wide regions, show impressively how much observation has yet to contribute before a satisfactory theory, or even a merely correct description of storms can be propounded.

"The winds at Säntis, Puy de Dôme, and other high-level European observatories, which may all be practically regarded as situated in anti-cyclonic regions, have been examined, and it is found that they show the closest agreement with the winds at low levels in the same regions. This result separates the Ben Nevis Observatory from other observatories, constituting it a class by itself, the differentiating cause being the circumstance that Ben Nevis alone lies in the central track of the European cyclones. This consideration emphasises the value of the Ben Nevis observations in all discussions of weather and atmospheric movements. It may be added that, with respect to the relatio of the winds to the low-level isobars, Ben Nevis Observatory more pronouncedly a high-level observatory in winter than i summer, or, more generally, in cold than in warm weather."

The influence of high winds upon barometric pressure has als been investigated. A comparison of readings of the baromet and anemometer at both the high and low level observatori shows that "in calm weather the two reduced barometers a practically the same, but with every increase of wind whic sweeps past the higher observatory the depression of th barometer inside steadily augments. It is not till a velocity more than 20 miles an hour is reached that the depressio amounts to one-hundredth of an inch. At 57 miles it is 0·0 inch, at 77 miles 0·104 inch, and at 99 miles 0·150 inch. forecasting weather it will be necessary to keep this effect high winds on the barometer constantly in mind, with the vie of arriving at a better approximation to the geographical di tribution of pressure at the time the forecasts are being framed

Relation of Differences of Temperature to those of Pressur

A discussion of the differences between simultaneous readin of pressure and temperature at the two observatories shows th "during the period of occurrence of an anti-cyclone, when th

FIG. 3.—Observatory covered with Fog Crystals—an Observer at Work.

temperature at the top of the mountain, with reference to th at Fort William, is highest, the pressure at the top, reduced sea-level, is 0·047 inch higher than at Fort William; and, the other hand, when the temperature at the top is very grea lower than the average as compared with that at Fort Willia the pressure at the top, reduced to sea-level, is 0·029 inch low than that at Fort William. There is, therefore, a mean diff ence of 0·076 inch of pressure for these two distinct types weather. The broad result is this, and it is clear and expli that when the higher observatory has the higher temperatu and also when the differences of temperature are small, then t reduced pressure at the top of the mountain is the greater of t two; but when the differences of temperature are large, th the reduced pressure at the top is the lesser of the two. . . . T result, which is altogether unexpected, raises questions of t greatest importance, affecting the theory of storms, the effect vertical movements of great masses of air on the baromet pressure which accompanies cyclones and anti-cyclones, and t necessity there is for some accurate knowledge of the absol amounts of aqueous vapour at different heights in the atn sphere under different weather conditions, and how this kno ledge may be arrived at from the readings of the dry and wet bulb thermometers under different atmospheric pressures. Ben Nevis, with its two observatories, one at the top, the other at the foot of the mountain, would, with a third half-way up the hill, afford unique facilities for the prosecution of this all-important hygrometric inquiry, which would, however, require considerable additions, for the time it is carried on, to the observatories' present appliances and staff."

St. Elmo's Fire and Thunderstorms.

"Cases of St. Elmo's Fire are not infrequent occurrences on Ben Nevis. The cases observed have mostly occurred during the night, and during the winter months from September to February. A careful discussion of these cases shows that the weather which precedes, accompanies, and follows has quite peculiar characteristics not only on Ben Nevis but also over the West of Europe generally; indeed, so well marked is the type of weather, and so notorious is it for its stormy character, that it is familiarly known at the observatory as 'St. Elmo's weather.' It is further observed that in almost every case another cyclone, with its spell of bad weather, follows the particular cyclone on the south-eastern side of which St. Elmo's Fire is observed.

"The winter thunderstorms are observed under the identical weather conditions under which St. Elmo's Fire occurs; that is, they invariably occur on the south-east side of the cyclone's centre, with the easterly passage of which they appear to be intimately connected. The thunderstorms and cases of sheet-lightning of Ben Nevis are essentially autumn and winter occurrences, 70 per cent. of the whole having occurred from September to February."

Electric Currents.

"Prof. C. Michie Smith has shown that on the edge of a dissolving mist the potential is lower than the normal, but higher on the edge of a condensing mist. Now, almost always when the top of Ben Nevis becomes clear for a short time, a strong current comes up the telegraph cable, while as soon as the summit is again enveloped the current is reversed. The connection between the moisture of the atmosphere and the earth currents is still further shown by the rainfall. During a fall of rain or snow the current nearly always passes down the cable; and in the case of a sudden shower the current has sometimes driven the mirror of the galvanometer violently off the scale. A cessation of the rain or snow generally has an exactly opposite effect. If it be assumed that the summit of Ben Nevis takes the potential of the masses of vapour covering it, and if we consider the earth-plate at the base as the earth, or zero of potential, it is obvious that the results confirm the theory advanced by Prof. Michie Smith, a conclusive proof of which would be of the greatest importance in investigations connected with thunderstorms."

Dust Particles in the Atmosphere.

Observations of the numbers of dust particles in the atmosphere have been made by means of the dust-counting apparatus devised by Mr. John Aitken in 1889. The results show a well-defined diurnal period, the number of particles being above the average in the afternoon, and below it in the morning.

"From the whole of the observations on Ben Nevis, the mean is 696 per cubic centimètre, the maximum being 14,400, while on several occasions the minimum fell to 0. In a large number of observations made by Mr. Aitken at Kingairloch, on the west shore of Loch Linnhe, the average number was 1600 particles per cubic centimetre; in London he found, on one occasion, 100,000, and this number was exceeded in Paris."

Many other investigations of a high scientific value have been made by the Ben Nevis observers, and the observations have furnished matter for discussion to a number of meteorologists. But though much has been done, it is evident from the reports issued by the directors of the observatory from time to time that still more important results can confidently be expected.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE seventh session of the Edinburgh summer meeting ended on Saturday. As regards number of students and scope of studies this meeting is still on the increase. Among the scientific courses may be noticed contemporary social evolution, by Prof. Patrick Geddes, comparative psychology by Prof. Lloyd Morgan, bionomics by Messrs. J. Arthur Thomson and Norman Wyld, history and principles of the sciences by Prof. Cargill Knott, Prof. Geddes, Mr. Bosanquet, and others, physiology of nutrition by Dr. Louis Irvine, a regional survey of Edinburgh and neighbourhood by Mr. J. G. Goodchild, Dr. Beard, Mr. Robert Turnbull, and Mr. S. H. Capper. A healthy sign is the attention given to practical work; thus the afternoon classes of botany, zoology, and geology were wholly practical. The less strictly scientific part of the month's miniature curriculum shows an almost equal development, indeed, so many excellent subjects were offered to the students that it must have been difficult to choose a course of study. Whatever the course selected, however, there is no doubt that the students derived considerable benefit from it.

THE following list of successful candidates for Royal exhibitions, national scholarships, and free studentships, has been issued by the Department of Science and Art:—National Scholarships for Mechanics—William Buchan (Glasgow), Frederick C. Lea (Crewe), James Eagles (Bury, Lancashire), Richard H. Cabena (Glasgow); National Scholarships for Chemistry and Physics—Albert Howard, (Much Wenlock, Salop), Francis R. Penn (Northampton), Andrew N. Meldrum (Aberdeen), William A. Bradley (Lee, Kent), Robert H. Jones (Manchester); National Scholarships for Biological subjects—Arthur O. Allen, (Walthamstow), Robert Sowter, (Brighouse, Yorks); National Scholarships—Charles F. Smith (Glasgow), John B. Chambers (London), John W. Hinchley (Lincoln), Henry J. Loveridge (Southsea, Portsmouth), Bernard C. Laws (Southsea, Portsmouth), Henry T. Davidge (London), Joseph B. Butters (Brighton), Henry H. Clements (Anahilt, Co. Down), Christopher Outhett (Burnley), William Macdonald (Manchester), William N. Platt (Chester); Royal Exhibitions—George S. Blake (Manchester), William H. Atherton, (Newcastle-on-Tyne), Ernest H. Bagnall (Manchester), Frank H. Newman (London), William A. Taylor (Crewe), Joseph H. Ivey (Camborne), Joe Crowther (Brighouse, Yorks); Free Studentships—John Schofield (Huddersfield), Joseph Jeffery (Birmingham), George A. Robertson (Oldham), Charles Kelly (Belfast), John Robinson (Belfast), Edmund F. W. Mondy (London).

SCIENTIFIC SERIALS.

American Journal of Science.—August.—We notice the following papers:—The use of cupric nitrate in the voltameter, and the electro-chemical equivalent of copper, by Frederick E. Beach. Copper nitrate solution of density 1·53 possesses certain advantages over the sulphate in voltameters. It is best to add one drop of saturated NH_4Cl solution. The dependence of the amount of copper deposited upon the current density does not appear until a density of 0·25 ampères per sq. cm. of electrode is reached, and then it is counteracted by adding more NH_4Cl. With the nitrate, the weight of copper deposited is practically independent of the temperature between 10° and 35°. The solution may be used a number of times. The equivalent of copper as determined from the nitrate voltameter agrees to four figures with that calculated from the best chemical determinations. But it is essential that the solution should be pure, and especially free from traces of nitrite.—On Mackintoshite, a new thorium and uranium mineral, by Wm. Earl Hidden; with analysis by W. F. Hillebrand. This is the original mineral of which thorogummite, discovered in 1891, is the alteration product. It is an opaque black mineral of hardness 5·5, and resembles zircon and thorite in form. It differs from thorogummite by the further oxidation of the uranium and the assumption of one molecule of water. It contains three molecules of silica, one of urania, three of thoria, and three of water.—On the reduction of nitric acid by ferrous salts, by Charlotte F. Roberts. The volume of nitric oxide disengaged, swept along by carbon dioxide and collected over caustic soda, was measured for the estimation of nitrates. The best results were obtained by passing the gas through KI solution before collecting, and estimating from the total volume of gas collected. Nitric oxide, being slightly soluble in caustic soda solution, must not be left long in contact with it. When the reaction takes place at high temperatures, some higher oxides of nitrogen may be formed, but this is corrected by the KI solution.—Concerning the structure of caoutchouc, by Hermann F. Lueders. Caoutchouc has no definite structure *per se*, and all apparent structure is only the result of the conditions under which its coagulation from the latex and subsequent solidification take place.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 21.—M. Lœwy in the chair.—On the equations of motion of a solid body moving in an indefinite liquid, by M. C. Maltézos.—On the alternations of colours presented by gratings, by M. Georges Meslin. If the achromatic fringes previously obtained by the author by means of a grating are observed more and more closely to the latter, they become more and more delicate, and certain colours begin to appear. The black fringes remain dark, but of two consecutive bright fringes the one appears violet and the other yellow; the same phenomena occurs along the whole field, which is covered with these two alternate colours. On moving the microscope slowly forward, a great variety of colours is observed, but the most usual are a mauve-violet associated with yellow, green combined with pink, or blue accompanied by white. The two colours in juxtaposition are thus nearly complementary, and during this displacement the same appearances recur several times, becoming more complex as the distance diminishes. The black fringes become very fine, the interval between two of them closes up, whilst the adjoining interval opens out and splits into coloured bands with a blue, pink, or yellow axis. In every case the phenomenon retains its periodic character. M. Meslin has succeeded in obtaining some very instructive photographs of these fringes.—On two new diseases of the mulberry, by MM. G. Boyer and F. Lambert. One of these diseases is caused by a bacterium, the other by a fungus. The disease caused by the *Bacterium mori*, chiefly affects young nursery mulberries, and arrests the development of their branches. It is manifested by dark brown patches at some points on the under side of the leaves and on the branches. Artificial patches in the parenchyma and in the veins of the leaves have been produced by inoculation. The bacterium when isolated and cultivated on artificial solid media, gives hemispherical colonies passing from white to yellow. The fungus disease is the more common of the two. The buds and leaves wither and dry up. The disease proceeds from the twigs to the branches and the trunk, and finally attacks the roots. The grey colour assumed by the wood is caused by the mycelium of a parasitic fungus not yet completely isolated. The mycelium is varicose, septiferous, and ramified. Its colour passes from white to a pale yellow, and finally to brown.—On the geogeny and stratigraphy of the coal basins of Central France, by M. A. Julien.—The Cambrian of the Herault, by MM. de Rouville, Delage, and Miguel. The authors have recognised three groups in the Herault Cambrian which they provisionally name Anteparadoxidian, Paradoxidian, and Postparadoxidian, corresponding to the Longmynd, Menevian, and Tremadoc groups respectively. In the third group, corresponding to the Tremadoc slates and Lingula flags, traces of Lingulæ have been found. An important fact concerning the stratigraphy of the country has been discovered in certain inversions extending over great lengths, unaccompanied by any indication of violent dislocation or rupture.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The State of Para; Notes for the Exposition of Chicago (New York).—A Short Course in the Theory of Determinants: L. G. Weld (Macmillan).—A Treatise on the Theory of Functions: J. Harkness and F. Morley (Macmillan).—A Select Bibliography of Chemistry, 1492-1892: H. C. Bolton (Washington).—Cyclone Memoirs, No. V.: J. Eliot (Calcutta).—Rainfall in South Australia and the Northern Territory, 1892: C. Todd (Adelaide).—Observations of the Transit of Venus, December 9, 1874: H. C. Russell (Sydney).—Alembic Club, Reprints No. 3—Experiments on Air: Hon. H. Cavendish (Edinburgh, Clay).

PAMPHLETS.—Reprint on the Operations of the Department of Land Rocords and Agriculture, Madras Presidency, 1891-92 (Madras).—The State of São Paulo: A. A. Pinto (Chicago).—Meteorology at the Paris Exposition: A. L. Roth.—The Value of Hypnotism: T. Crisfield (London).—The Geometrical Properties of the Sphere; W. Briggs and F. W. Edmondson (Clive).

SERIALS.—L'Anthropologie, tome iv. No. 3 (Paris, Masson).—Journal of the Franklin Institute, August (Philadelphia).—Astronomy and Astro-Physics, August (Northfield, Minn.).—Quarterly Journal of the Royal Meteorological Society, July (Stanford).—Meteorological Record, Vol. xii. No. 48 (Stanford).—Katalog der Bibliothek der Kaiserlichen Leopoldinisch-Carolinischen Deutschen Akademie der Naturforscher, Liefg 1 to 3 (Williams and Norgate).—Katalog der Bibliothek der Kaiserlichen Leopoldinisch-Carolinischen Deutschen Akademie der Naturforscher, Vrierte, Liefg. Band II. 8 (Williams and Norgate).—Sitzungsberichte der k. Akademie der Wissenschaften. Math.-Naturw. Classe Enthält die Abhandlungen aus dem Gebiete der Chemie. Abthg. II b. 1892, June, July, October to December (Williams and Norgate).—Sitzungsberichte der k. Akademie der Wissenschaften. Math.-Naturw. Anatomie and Physiologie, &c., 1892, June, July, October to December (Williams and Norgate). Sitzungsberichte der k. Akademie der Wissenschaften. Math.-Naturw. Mineralogie, Krystallographie, &c., 1892 July, October, November, and December (Williams and Norgate).—Sitzungsberichte der k. Akademie der Wissenschaften. Math.-Naturw. Mathematik, Astronomie, &c., 1892, June, July, October, November, and December (Williams and Norgate).—Register zu den bänden 97 bis 100 der Sitzungsberichte der Mathematisch. Naturwissenchaftlichen classe der k. Akademie der Wissenschhaften xiii. (Williams and Norgate).—The Journal of the College of Science, Imperial University, Japan, Vol. v. Part 4 (Tokyo).—Journal of the Royal Microscopical Society, August (Williams and Norgate).—Journal of the Marine Biological Association, new series, vol. 3, No. 1 (Dulau).—Journal of the Polynesian Society, Vol. 2, No. 2 (Wellington).—Transactions and Proceedings of the N.Z. Institute, 1892, Vo. xxv. (Wellington).—Ergebnisse der Meteorologischen Beobachtungen, Jahrg. 3 (Bremen).—Journal de Physique Aug. (Paris).—Zeitschrift für Physikalische Chemie, xii. Band, 2 Heft (Leipzig).—Botanical Gazette, August (Bloomington, Ind.).—Bulletin of the U.S. Geological Survey, Nos. 82 to 86, 90 to 96 (Washington).—Jahrbuch der k. k. geologischen Reichsanstalt, Jahrg. 1893, xliii. Band, 1 Heft (Williams and Norgate)—Morphologisches Jahrbuch, 20 Band, 2 Heft (Williams and Norgate).—Mittheilungen von Forschungsreisenden und Galehrten aus den Deutschen Schutzgebieten, vi Band. 3 Heft (Berlin, Mittler).—The Asclepiad, No. 38, vol. x. (Longmans).—Journal of the Royal Horticultural Society, vol. xvi. Part 1 (London).—Meteorologische Zeitschrift, 1893 January to August (Wien)—Himmel und Erde, September (Berlin).—Bulletins de la Société d'Anthropologie de Paris, tome quatrième, ive série, No. 7 (Paris).

CONTENTS.

THURSDAY, SEPTEMBER 7, 1893.

THE PUBLIC HEALTH LABORATORY.

Public Health Laboratory Work. By Henry R. Kenwood, M.B., D.P.H., F.C.S., including Methods employed in Bacteriological Research, with Special Reference to the Examination of Air, Water, and Food, contributed by Robert Boyce, M.B. Crown 8vo. 491 pages. (London: H. K. Lewis, 1893.)

AN organised laboratory for the practical instruction of students of hygiene is a comparatively novel creation, the demand for which has principally arisen in connection with the various diplomas in Public Health (D.P.H.), which are now eagerly sought after by those of the younger generation of medical men who contemplate the possibility of becoming at some future time candidates for appointments as medical officers of health. Probably there are many persons who, whilst having a general acquaintance with the studies which are pursued in ordinary scientific institutions, are yet altogether ignorant of what is being done in these public health laboratories, which have grown up within recent years. A glance at the table of contents in the work before us will at once reveal what a wide and varied field this subject of public health is made to cover, including as it does the hygienic analysis of air and water, the examination of food (milk, butter, cheese, corn, bread, meat, alcoholic beverages, mustard, pepper, sugar, coffee, chocolate, tea, and tinned provisions), together with the "methods employed in bacteriological research, with special reference to the examination of air, water, and food." That this is a very comprehensive programme will be admitted by all, whilst it is equally patent to the initiated that it is one which it must be extremely difficult for a single teacher to conscientiously undertake, involving, as it does, an adequate knowledge of the most miscellaneous subjects. Inasmuch, however, as the ground covered is mainly of a chemical nature, it is obvious that the methods of work prescribed must be such as shall recommend themselves to chemists. In this connection it is interesting to note that the student is supposed to present himself at the public health laboratory without any previous knowledge of practical chemistry, at any rate as far as quantitative methods are concerned. Thus he has even to be initiated into the mysteries of such simple contrivances as the Bunsen burner, the pipe-clay triangle, and even the homely pestle and mortar, articles with which we should have supposed that most Board School children of the higher standards were now acquainted.

The first and largest section of the book is devoted to the subject of water analysis, the practice of which appears to form the *point de résistance* of the hygienic laboratory. For the information of those who have not had the benefit of receiving their instruction in such a laboratory we will cite a few examples of the practical methods which appear to be in vogue there. Chemists will be interested to learn that in using the balance the weights should be adjusted until "the index rests absolutely in a central and vertical position!" In determining the total solid matters in water, the only drying of the residue obtained by evaporation which is advocated is to place the dish containing it "for a few minutes in the water-oven," and even this appears to be regarded as an almost excessive refinement, for we are also informed that "when recourse is not had to the water-oven, the under-surface of the dish must be always carefully wiped dry before the dish and its contents are weighed." Such instructions might have been allowed to pass had some apology been made for the necessarily crude work alone to be expected from public health students, but when a little further on we are informed that the time involved in the evaporation of 100 c.c. of water is liable to introduce error through loss of organic matter in the water, and through the access of suspended matter from the air, it is obvious that the writer is under a wholly false impression as to the degree of accuracy obtainable by the methods he describes.

For the estimation of organic matter in water, the author has recourse principally to the so-called "albuminoid ammonia" process, but since the adaptation of the Kjeldahl method to water-analysis by Drown, there is now no reason why even in a poorly equipped laboratory an accurate determination of the total organic nitrogen should not be made, in addition to that of the variable fraction of this ingredient which makes its appearance on distilling the water with alkaline permanganate. The author describes the combustion process for organic carbon and nitrogen, but as something entirely beyond the sphere of the public health laboratory. The description given of this process would not appear to be derived from personal experience, whilst the suggestion that carbonic oxide is produced in the combustion, and volumetrically measured in the subsequent gas analysis, indicates but a very imperfect notion of what a satisfactory combustion with oxide of copper should accomplish.

We hardly think that the author has been successful in giving a lucid exposition of the important and much-vexed question of the activity of water on lead, for the statement that this activity "is favoured by either neutrality or slight alkalinity of the water (acidity, however, is even more important, since it aids the power of the water to carry the lead in solution)" is surely a somewhat circuitous way of saying that the lead-dissolving power of many waters is still wrapped in much obscurity.

Again, in the description of the preparation of normal solutions for volumetric analysis we read: "The number of grammes of the reagent are weighed out and dissolved in a litre of water," an inaccuracy which is repeated on the same page in the statement that a normal solution of hydrochloric acid is one consisting of "36·37 grms. of hydrochloric acid to a litre of distilled water."

In the chapter on coal-gas we are surprised to hear that the average gas supplied by the London companies contains 3 per cent. of carbonic acid: in all the published analyses of London coal-gas, and there are many, although the analysis only of Heidelberg gas (!) is recorded in the work before us, carbonic acid is either absent altogether or only present in small traces, for the gas managers are well aware that 3 per cent. of this ingredient, so prejudicial to the illuminating power, would entail great expense in bringing the luminosity of the gas up to the parliamentary standard.

Notwithstanding some shortcomings of this kind, the

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book is, on the whole, conveniently put together for the purpose it has in view, viz. the instruction of the public health student preparing for examination, for whose benefit, indeed, some of the chapters are actually furnished with schemes of analysis directing him how to make the best use of his time in the examination room.

But although this work may be well adapted to the requirements, such as they are, of the public health student, we cannot help thinking that the examples we have cited are alone sufficient to indicate the undesirability of what is in reality a very difficult branch of applied chemistry being taught outside the precincts of the chemical laboratory. In places where really accurate chemical work is not continually in progress, there must always be a tendency for rough and ready methods of analysis to creep in unchecked, with the inevitable result that a number of imperfectly trained persons are sent out into the world to undertake what ought to be regarded as highly responsible work. It is one of the most glaring anomalies of our *fin de siècle* civilisation indeed, that whilst but few educated persons would think of taking even the simplest medical remedy excepting under the advice of a duly qualified practitioner, such important questions as the water supply of a community, the detection of pernicious adulterations in articles of daily consumption, and the like, are frequently entrusted to persons who cannot furnish a shred of satisfactory evidence that they possess the necessary attainments for the performance of such responsible duties. It is deeply to be deplored, in the interests of the community, that the Institute of Chemistry has not hitherto succeeded in adequately illuminating the public on these matters. Thus, whilst the Institute has done much in prescribing educational curricula for the professional chemist, and in submitting a number of candidates to severe examinational tests, it has so far secured but little recognition for its Fellows from the general public, who certainly, as a rule, do not distinguish between them and the Fellows of the Chemical Society. In this connection, indeed, it cannot be sufficiently impressed on the laity that the Chemical Society is open, and in our opinion rightly, to *all comers who are, or profess to be, interested in chemical science*, and that its fellowship no more implies capacity to perform chemical work than fellowship of the Royal Geographical Society indicates any fitness to accompany Mr. Stanley across Central Africa, or Dr. Nansen to the Pole.

In conclusion we would point out that this type of book, embracing as it does a number of heterogeneous subjects prepared and boiled down into a sort of jelly for the pampered palate of the modern student, really raises a very important issue in connection with the much talked of technical education of the day. We perceive in the recent developments of such education a more and more marked tendency towards superficiality; year by year courses of instruction are made shorter and more composite by condensing primary subjects into a form supposed to be adapted to the requirements of particular bodies of men. All over the country we find teachers undertaking to provide a smattering in a number of different subjects, and a growing distaste on the part of students to devote time and attention to the deeper study of individual sciences. In such a subject as Public Health, the proverbial danger of a little knowledge is particularly menacing, and we are strongly of opinion that the student of this important subject, if he is to be properly trained, should receive the chemical, biological, and medical instruction involved, from a thorough chemist, a competent biologist, and a fully qualified medical man respectively, instead of imbibing only the views of a single teacher, who whilst professing a number of subjects is probably of but indifferent eminence in any one of them.

THE ARCTIC PROBLEM.

The Arctic Problem and Narrative of the Peary Relief Expedition of the Academy of Natural Sciences of Philadelphia. By Angelo Heilprin, leader of the Peary Relief Expedition. 8vo, pp. 165. (Philadelphia: Contemporary Publishing Co. 1893.)

PROF. HEILPRIN devotes almost half of his little book to the narrative of the voyage of the *Kite* to the relief of Peary, a narrative which he invests with lively interest, despite the fact that it has been anticipated by the writings of his subordinates. The record gives a very clear account of the voyage, and some admirable descriptions of Arctic scenery, supplemented by photographic reproductions printed in two tints, with a very realistic effect. Perhaps the most interesting chapter is that devoted to the naturalist of Peary's party, Mr. Verhoeff, who mysteriously disappeared just before the time fixed for returning home. A large number of men from the *Kite*, as well as Eskimos, prosecuted a minute search for several days, with the result that footprints and bits of paper were discovered on a glacier, movements on which were made difficult by the extremely rough condition of the ice. The natural inference is that Mr. Verhoeff, being alone, had fallen into a crevasse and perished there, and in this belief the search-party returned. A more romantic explanation is, however, given by some of his relatives, who believe that, enamoured of the wild life he had been leading, Mr. Verhoeff deliberately stayed behind with the object of making further explorations on his own account. Faint though the hope is, we could wish it to be true, and that when Lieutenant Peary approaches his farthest north in the new venture on which he is now embarked, he may find his old companion awaiting him.

The more important half of the book under consideration is Prof. Heilprin's clear and logical re-statement of what he aptly terms the Arctic problem. His language is frequently more perfervid than is usual amongst scientific writers on this side of the Atlantic, but his arguments are sound, and his conclusions cautious and reasonable. The discussion begins with a summary of three expeditions intended to start this summer on "the old trail" in quest of the highest latitude. On Nansen's project he wisely says little beyond stating the evidence for a transpolar current, and echoing the universal confidence in the gallant Norseman's pluck and perseverance. Nansen hopes, as our readers are aware, to approach the pole from the neighbourhood of the New Siberian Islands in longitude 140° E.

The Ekroll expedition, also a Norwegian project, has scarcely been heard about in Europe; in fact the only other reference to it which has come under our notice is a somewhat vague allusion in the annual address on geographical progress at the Paris Geographical Society. Ekroll intended, says Prof. Heilprin, to start in June, and travel northward from Cape Mohn in Spitzbergen (about longitude 20° E.), the feature of his expedition being the use of a composite structure capable of use as boat or sledge, according to the surface which has to be travelled over. This project is shown to be at least unsatisfactory, the risk of damage to the sledge (or boat) being too great, although the route to the north is an extremely suitable one. We do not know if Ekroll has set out. The third expedition is that of Peary, who is already *en route*, and intends to work northward over the frozen surface from the north coast of Greenland, where he did such brilliant service in 1892. Of the success of this enterprise Prof. Heilprin is confident; whether the Pole is reached or not he thinks that Peary has the best chance of breaking the record, and attaining a higher latitude than any of his predecessors.

Against the common plea that polar exploration having baffled the best endeavours of men whose heroism is beyond praise, any future effort is only waste of life, Prof. Heilprin urges the incontrovertible fact that in travel the almost impossible of yesterday is the easy accomplishment of to-morrow. He remarks that the ascent of Mont Blanc, at first a feat that made a man's reputation for life, is now a common tourist's pastime, while he might have added that Spitzbergen, formerly ranking as scarcely accessible Arctic land, is now within the reach of excursion steamers.

As to the best route to the Pole, he agrees that no expedition need waste its strength again on Smith's Sound, and he criticises with some severity the conclusions of the Royal Geographical Society twenty years ago before the despatch of the *Alert* and *Discovery*. The region north of Spitzbergen where Parry attained 82°45′ in 1827, only forty miles short of the point to which steam and the scientific advance of half a century enabled the best equipped expeditions to reach through Smith's Sound, certainly appears the most hopeful, and it is that in which any new expedition on a large scale that may be planned should undoubtedly make an attempt.

Without much novelty in argument or substance, Prof. Heilprin has set forth clearly and convincingly the plain issues involved in the Arctic problem, a problem which promises to be much before the public mind for some years to come.

OUR BOOK SHELF.

Vorlesung über Maxwell's Theorie der Electricität und des Lichtes. By Dr. Ludwig Boltzmann. Part I. pp. 139. (Leipzig: Johann A. Barth.)

THIS is a most interesting introduction to Maxwell's theories about electromagnetic actions. The whole question of generalised coordinates is introduced by means of models that enable the student to make a concrete picture to himself of a particular case of what he is studying. Some people may prefer to study subjects in the most general form, but the majority find very great difficulty in working out any advance on what they are taught by others without the assistance of some concrete case. In the case of most students it certainly helps them very much indeed to be provided with simple examples. Models may often do even more than facilitate the path of the student, they have before now pointed the way for the discoverer. As the mathematical part of Maxwell's theory is so largely an application of the principles of generalised coordinates this introduction to his theory is eminently interesting and suggestive. It is perhaps more suited to the state of scientific development on the Continent than in England. German and French electrical ideas had been so bound up with Coulomb and Ampère's laws of action at a distance that even the formulæ of Weber and Clausius which postulated propagation in time did not shake their faith in action at a distance, attracting and repelling electricities and currents and poles. Even yet Poincaré cannot get over the Coulomb law foundation of electrostatics. To such ideas a dynamical foundation such as Boltzmann has given should give a new direction. The whole process by which the electric current, the electrification, the magnetic pole, appear as generalised coordinates is brought out. The only objection that can be raised to the method from a British point of view is that the method is not drastic enough. It panders to the weaknesses of those who look upon the electric current as the important thing. It almost neglects the medium. It does not emphasise the connection of electric force and displacement, magnetic force and induction. It does not go even so far as Maxwell in formulating a theory as to the nature of the medium. It is too content with symbols. It introduces the propagation of the action through the medium almost as indirectly as Maxwell does. The forces and the displacements should be the foundations of electromagnetic theory and not the equation in generalised coordinates

$$2T = L_1\dot{y}_1^2 + 2M_{12}\dot{y}_1\dot{y}_2 + L_2\dot{y}_2^2$$

We must however be content to lead people gently. Prof. Boltzmann's introduction is certainly a move in the right direction, and there is every reason to think that the exertions of him and of Prof. Hertz are rapidly turning the current of continental study of electromagnetism into the right channel. In view of Prof. Boltzmann's recent interesting remarks on the value of dynamical models, it would be well worth while translating this work of his into English as an example for us how models can be employed successfully to illustrate a difficult subject. It is only of recent years that geometrical curve plotting has been popularised as a method of illustrating and facilitating mathematical investigations, and judiciously constructed models might perform a large part of a corresponding service for dynamics in the future.

Geology: an Elementary Hand-book. By A. J. Jukes-Browne. (London: Whittaker and Co., 1893.)

VIEWED as a rudimentary description of all branches of geology, Mr. Jukes-Browne's latest treatise is highly commendable. Its 248 pages contain something about everything geological. In a few places the information is rather disjointed, but that drawback is inseparable from an elementary work of limited dimensions which aims at giving students an idea as to the wide scope of geology. Of all the branches of the science, physical geology is given the most space, and rightly, for it is the division which is most intelligible to the general reader. The majority of the illustrations are rather coarse; nevertheless, they are usually of a helpful character. An objectional feature in the text is the frequent quotations from Geikie, Agassiz, and others. It seems to us that, in general, quotations should only be permissible in matters upon which a difference of opinion exists. But, on the whole, the book is a good one, and will be useful to students of elementary geology.

Recit de la Grande Expérience de l'Equilibre des Liqueurs. By Blaise Pascal. (Berlin: A. Asher and Co., 1893.)

This work forms No. 2 of the new series of publications of old books relating to meteorology and terrestrial magnetism, issued in facsimile by Prof. G. Hellmann, and was first printed in Paris in 1648. There is no copy of the work in the British Museum, and Dr. Hellmann has only been able to trace three copies, two of which are in Paris, and one in Breslau. This little work is of the greatest importance to the history of physics, to meteorology, and physical geography; it gives the first conclusive proof of the pressure of the atmosphere, and puts an end to the doctrine of the *horror vacui*. This famous experiment was made at Clermont Ferrand, and on the Puy de Dôme, on September 19, 1648, so that Pascal lost no time in making his discovery public, but it is not generally known that any account had been issued prior to the publication of the *Traitez de l'Equilibre*, printed in 1663. The work is prefaced by an interesting introduction by Prof. Hellmann, in which he refers to the doubt which exists whether the idea of the experiment was taken from Descartes. The latter has expressly asserted this to be the case, in two letters (dated June 11 and August 17, 1649), addressed to Carcavi, and the fact that Pascal never replied in any way to the letters in question, has induced many writers to adopt this view.

LETTERS TO THE EDITOR.

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

The Organisation of Scientific Literature.

I have followed the correspondence in your columns on the question of the organisation of scientific literature with very keen interest, and should esteem it a favour to be allowed to add a few remarks to what has been said. There are two ways in which the present disorganisation might be dealt with. The first is exemplified in Prof. Bonney's "Year-book of Science"; that is to attempt to provide a key to the present complex state of affairs in the form of yearly abstracts. But even supposing this year-book (invaluable as it is) were comprehensive, which it admittedly is not, of what use would it be to the many workers who have neither the time nor the opportunity to spend hours in first-class libraries, nor the means to buy even a tolerable number of the innumerable magazines, journals, reports, &c., dealing with their special subject.

This infinite multiplicity of publication is the root of all the evil, and "Free Lance" strikes at it hard and well in his pamphlet on the organisation of science.

This brings us to the second method. As pointed out by "Free Lance," the only true solution of the difficulty is that in each country each subdivision of science should have its one central and accredited journal in which all papers on that subject worthy of publication should be published. In fact, a centralisation of publishing, with as much decentralisation of scientific meeting as the intellectual wants of the country may need.

Were this condition of things realised, then by consulting one or two journals in each country a specialist might easily, and comparatively cheaply, keep himself abreast of current work. In addition, an annual index or indexes of the books published in the various departments of science and in various countries, would render very great service.

Briefly, and in conclusion, my view of an ideal organisation of scientific literature is somewhat as follows:—

(1) In each country one central and accredited journal for each branch or subdivision of science.

(2) An international bureau working somewhat as follows:— (*a*) In each country the (α) papers (β) books and pamphlets, published in that country to be abstracted or indexed by well-paid men. (*b*) The several countries to exchange abstracts. (*c*) Finally, each country to translate the other abstracts and indexes into its own language, and publish these along with its own abstracts in, say, quarterly or monthly volumes, classified and subdivided for each science and branch of science.

In the case of such an international bureau proving impracticable, then each journal might abstract the work done in its department in other countries, after the admirable manner of the Chemical Society.

It is to be hoped that the British Association this year will take up the question seriously and in its widest aspect. There is no use organising one portion of science and leaving the remainder in disorder. F. G. Donnan.

Ardmore Terrace, Holywood, Co. Down, August 28.

Several of your correspondents have called attention to the importance of distributing copies of papers in quarters where they are likely to be read. It may therefore be well to emphasise the fact that the *Philosophical Magazine* refuses to supply *gratuitous* copies. When this fact is appreciated, I think most persons will see that it is rather an unbusinesslike proceeding to pay the *Philosophical Magazine* for separate copies, when they can be obtained for nothing by communicating the paper to a society.

The "full publication of . . . papers of the societies, &c.," as recommended by Mr. Trotter, would be an infringement of copyright, and would lead to the Physical Society becoming more closely acquainted with the mysteries of the Chancery Division than its members would probably desire.

The Physical Society is a young and precocious one, and, in conjunction with its partner, the *Philosophical Magazine*, would doubtless like to obtain a monopoly of all mathematical papers except those strictly denominated *pure*, which it does not care about. But its legitimate sphere of action is *experimental and applied science*, and if it shows a disposition to poach upon the preserves of its neighbours it cannot fail to excite hostility.

I do not see any objection to the word "physicist," the literal meaning of which is "naturalist"; but is not the word "scientific" more appropriate to this discussion than "physical"? A. B. Basset.

Hotel de Russie, Ems, Germany, September 3.

Drought and Heat at Shirenewton Hall in 1893.

Rain.

Month.	1893.	Average.	Excess or defect in 1893.	Most rain in a day.	Number of rainy days in 1893.	Number of days with at least a quarter of an inch.
	Inches.	Inches.	Inches.	Inches		
March	0·4	2·7	−2·3	0·170	5	0
April	0·2	2·1	−1·9	0·091	4	0
May	2·6	3·1	−0·5	0·880	9	3
June	1·8	2·6	−0·8	1·010	10	1
July	2·9	3·7	−0·8	0·660	12	4
August (to 17th)	1·8	2·1	−0·3	0·660	8	2
Total	9·7	16·3	−6·3	1·010	48	10

Since March 1, 122 days without rain.

Heat in Shade, 1893.

Month.	Number of days the heat was above		
	60°	70°	80°
April	25	9	2
May	28	15	1
June	30	21	6
July	31	21	5
August (to 17th) ...	17	17	8

Temperature, 80° and above.

Month.	°	Month.	°
April 20	82·8	July 3	83·5
,, 21	82·2	,, 6	83·5
May 12	80·0	,, 7	90·7
June 13	80·4	Aug. 9	86·7
,, 15	82·8	,, 10	83·0
,, 16	82·0	,, 12	80·0
,, 17	84·3	,, 13	86·0
,, 18	83·8	,, 14	86·5
,, 19	88·9	,, 15	88·5
July 1	86·0	,, 16	83·6
,, 2	88·0	,, 17	86·0

Most of the rain fell in thunderstorms, but their area was very limited; the amount in that of June 15 within 5 miles of this place is an example:—

Caldicot Hall ...	0·04	Itton Court	1·50
Dennel Hill	0·17	Piercefield Park	1·79
Wirewoods Green	0·56	The Mount, Chepstow	1·96
Shirenewton Hall	1·01		

		in.		in.
The rainfall in	May	was 2·6	; of this	2·4 fell from 15th to 20th.
,,	June	,, 1·8	,,	1·0 fell on 15th.
,,	July	,, 2·9	,,	1·1 fell from 10th to 15th, and 1·0 on 18th and 19th.
,,	Aug. (to 17th)	,, 1·8	,,	1·0 fell on 1st to 3rd, and 0·6 on 10th.

Thus, of the total rainfall (9·7), 7·1 inches fell on 17 days out of the 170 days. On August 9 there was no rain, but more lightning than I had seen since the memorable storm of August 9, 1843. It commenced at 9 p.m. and lasted five hours. From very frequent counting there could not be less than 10,000 flashes (the estimate was 11,540). For three hours the most number of flashes in a minute was 121, and the least 39. Before the storm of June 15 the ground was dry to the depth of 15 inches, and this 1 inch of rain only penetrated 2 inches. The long intervals of drought have parched the ground, so that we are still suffering from want of rain.

The Drought and Heat of 1893.

The results of an unusual occurrence like the present season show as clearly as instrumental observations the exceptional character. We have a very near copy of the drought of 1868–

1870; *i.e.* Monmouthshire is repeating what in 1868–70 occurred in Nottinghamshire. Flowers and fruit have been a month earlier than usual, their period has been of short duration, and insect pests have been very great. There has been an extraordinary abundance of apples, pears, plums, cherries, gooseberries, currants, field mushrooms, butterflies, moths, flies, caterpillars, cuckoo-spit aphis, slugs, and wasps. The tree-wasp, which is rare, has had many nests, and, as the structure is not generally known, my son has taken the enclosed photograph, which clearly shows it. The tree-wasp's nest is built much earlier than that of the ordinary wasp, and equally large, a low bush being the situation usually selected. Nightingales and cuckoos have been very numerous. Grass is now being mown for hay, and four to five acres will only yield a ton, whilst the straw of corn is shorter than ever before known. Trees are also very bare of leaves. Water is scarce, as many springs have been dry for some weeks. In June the trees and shrubs were as if varnished from extensive honeydew, which the thunderstorm cleared away. Strawberries are blooming a second time, and there are many plants seeding that do not usually seed here.

E. J. LOWE.

Some Recent Restorations of Dinosaurs.

UNDER the above title, an illustrated article, by Mr. R. Lydekker, appears in NATURE, July 27, 1893, p. 302. This purports to give a summary of what has recently been done in restoring certain remarkable forms of extinct reptiles. Most of the statements made are correct, but with them are a number of serious errors that may mislead readers not familiar with the subject. As the restorations given are, with one exception, my own, and represent indirectly several years' work in the field and museum, I trust you will allow me to call attention to some mistakes in this article, which were perhaps made by Mr. Lydekker through inadvertence, or from his not having seen the specimens described.

In the introduction, the date 1878 is given for the first of my memoirs on Jurassic Dinosaurs; whereas in the previous year I described (1) the earliest of the huge Sauropoda found in America, proposing the family name Atlantosauridæ for the genera Atlantosaurus and Apatosaurus; (2) various carnivorous Dinosaurs of the present order Theropoda, including the genera Allosaurus and Dryptosaurus; (3) the Stegosauria, represented by Stegosaurus, the first American genus of the group; and (4) several small forms of true Ornithopoda, including Nanosaurus. The family Atlantosauridæ, the sub-order Stegosauria, and the genera here mentioned, were thus established by me in 1877 in the *American Journal of Science*, vol. xiv.; a small matter in itself, but the beginning of a long investigation.

The first restoration given by Mr. Lydekker, Fig. 1, is that of my *Brontosaurus excelsus*, reduced from an outline sketch published, as stated, in August, 1883; but no reason is assigned for not using, especially in a summary of recent work, my more complete restoration of 1891, which includes the results of much additional study. This figure represents a typical member of the order I have called Sauropoda, but in the text the name used is Sauropsida, a much more comprehensive term.

The second restoration, Fig. 2, called "A Carnivorous Dinosaur," is said to have been reproduced from my figures. This must be a mistake. It is evidently printed from one of my *clichés*, and is certainly used without authority. Moreover, the name I gave to the animal represented (*Ceratosaurus nasicornis*) is not even mentioned, but it is incidentally stated that my genus Ceratosaurus, based on this unique specimen, is inseparable from the European Megalosaurus. This statement could not be fairly made by anyone familiar with the type specimens of the two genera, or even with the literature. Only a few authentic remains of Megalosaurus are known, and I have studied all the important specimens with care. There is no evidence that the skulls are identical in the two forms, and much against it. The plano-concave cervical vertebræ of Ceratosaurus, unknown in any other Dinosaur, are radically different from the convexo-concave vertebræ of Megalosaurus. The complete co-ossification of all the pelvic elements of Ceratosaurus is another distinctive character, and the union of the metatarsals also is important. An elementary knowledge of the structure of Dinosaurs is quite sufficient to show any anatomist that the two belong to genera widely different, and to indicate for them distinct families. Additional remains, obtained since Ceratosaurus was described, have in great part removed the objection that the co-ossification mentioned may have been pathological. My restoration will be found in the American *Journal of Science* for October, 1892, and in the *Geological Magazine* for April, 1893.

The third figure given by Mr. Lydekker is a reduced copy of my restoration of *Stegosaurus ungulatus*, published in August, 1891. This reptile he calls Hypsirophus, giving that name priority over Stegosaurus, but without citing any authority for such a statement. A single reference to the literature would have proved this to be a mistake, as Stegosaurus was published by me in 1877, as above stated (*American Journal of Science* (3), vol. xiv. p. 513), while the name Hypsirophus was given by Cope in 1878 (*American Naturalist*, vol. xii. p. 188). Another error of less importance is in regard to the specimen on which the restoration is based, although this was clearly stated in the description accompanying my figure. The type specimen of *Stegosaurus ungulatus* Mr. Lydekker apparently confuses with a second skeleton, of a different species, which was even more perfect when found.

The fourth restoration given is a reduced copy of my figure of the skeleton of *Triceratops prorsus*, which, like the preceding restorations, has already been published by me, both in the *American Journal of Science* and in the *Geological Magazine*. Here again Mr. Lydekker rejects my generic name Triceratops, and even puts that and another genus of mine (Ceratops) as synonyms of Agathaumas without giving any reasons for doing so. The type specimens of the literature would show any candid anatomist that the three forms named, and another which I called Torosaurus, are all distinct genera, separated by well-defined characters. These characters I have given in detail in the *American Journal of Science*, accompanied by accurate figures of the forms I have described (vol. xliii. pp. 81–84, plates ii. and iii., January, 1892).

The remaining restoration given in Fig. 5 represents a well-known skeleton of Iguanodon in the Royal Museum of Belgium. In regard to this figure I have at present nothing to say, except that I have carefully studied the original specimen and those found with it, having made several visits to Brussels for this purpose.

The omissions from this article are perhaps as noteworthy as what it contains. No reference is made to two restorations of American Dinosaurs which I have recently published; Claosaurus from the Cretaceous, and Anchisaurus from the Triassic, although each is based on a nearly perfect skeleton. Both of these restorations have appeared in the *American Journal of Science* and also in the *Geological Magazine* within the past year. Mr. Lydekker likewise omits the restoration of Megalosaurus, which he has lately given to the public, although many palæontologists would be glad to know more about it, especially about the remains on which it is based.

Mr. Lydekker begins his article by referring to the discouragements of palæontologists in the investigation of fossil vertebrates, but ends with some words of encouragement. He might have added that one discouragement to active workers who devote years to exploration and study is to have the results of their labour used without due credit, or disparaged by those who do not understand them. O. C. MARSH.

Yale University, New Haven, Conn., August 15.

Insects Attracted by Solanum.

SIR JOHN LUBBOCK, in his "British Wild Flowers in Relation to Insects," remarks (p. 133) that *Solanum* is little visited by insects. Darwin, in "Effects of Cross and Self Fertilisation," has some observations (p. 387) to the same effect. It will therefore be useful to record that, however it may be with European species, an abundant *Solanum* of New Mexico is very attractive to insects. The species in question is *S. elæagnifolium*, Cav., which has deep lilac flowers not unlike those of the potato. I was especially successful in capturing interesting aculeate hymenoptera on this plant, as the following list will show. All listed were taken in Las Cruces, and all (except the *Megacilissa*, July 12) on July 13.

Hymenoptera taken on Solanum elæagnifolium, 1893.

Ammophila pruinosa, Cr. ♀.
,, *varipes*, Cr.
Anthophora urbana, Cr. ♀.
Halictus, sp. ♀.
Megacilissa gloriosa, Fox.
Melissodes menuacha, Cr. var.? ♀
Myzine frontalis, Cr. MS.
Mysson texanus, Cr. ♀.
,, n. sp.
Odynerus bravo, Sauss. (new to U.S. fauna).
Pelopæus servillei, Lef.
Plenoculus, n. sp.
Sphærophthalma coccineohirta, Blake, ♂ var.
Stizus agilis, Sm.
,, *flavus*, Cam. (new to U.S. fauna).
Tachysphex, sp. ♀.
Tachytes elongatus, Cr. ♂.
Trypoxylon texense, Sauss.

For the identifications of the species I am indebted to Mr. W. J. Fox. T. D. A. COCKERELL.

Agricultural College, Las Cruces, New Mexico, U.S.A. August 16.

Old and New Astronomy.

IN your notice of the "Old and New Astronomy," your reviewer has, I think, misunderstood the passage with respect to reflecting telescopes, on p. 45, which he refers to as indicating that Mr. Proctor supposed that the image in the principal focus of a reflecting telescope was affected with chromatic aberration or false colouring. Section 97, to which I conclude your reviewer refers, evidently refers to the magnified image which enters the eye of an observer when a "*real image* of an object is submitted to microscopical examination."

No one who knew Mr. Proctor could suppose him to make such a mistake; and that he was perfectly well aware that the image thrown by a reflector was not affected with chromatic aberration, would, I think, have been evident to your reviewer if he had read to the bottom of the page, where in Section 101 Mr. Proctor says:—"Newton supposed that it was impossible to get rid of this defect (*i.e.* chromatic aberration), and therefore turned his attention to the construction of reflectors," a clear proof that Mr. Proctor was in no doubt upon the subject, and only referred in the previous passage to the false colouring of an image formed by a lens. S. D. PROCTOR-SMYTH.

8 Duncairn Street, Belfast, August 23.

MRS. PROCTOR-SMYTH is in error in supposing that my note referred to Section 97 of "Old and New Astronomy." I referred to Section 100, in which the author says "the pencil of light proceeding from a point such as P, Figs. 14, 16, and 18, consists of rays of different refrangibility, and therefore *not converging to a focal point such as p but to a focal line in the axis of the pencil.*" (The italics are mine.) Fig. 18 is a diagram of the formation of a real image by a reflector. The reference to Fig. 18 may have been a slip; if so, it should have been corrected in the completed volume, as otherwise the student, reading the subsequent paragraphs, to which Mrs. Proctor-Smyth refers, is confused as to what the author really means, and is doubtful whether the reflector does or does not suffer from chromatic aberration. THE REVIEWER.

Suicide of Rattlesnake.

ANOTHER question raised by the late snake story is, How long does it take to drown snakes? Some of the non-poisonous kind at the Zoological Gardens, in certain states of the weather, are fond of hanging themselves over the edge of their tank, with their heads immersed in the water, for as long as an hour together. E. L. GARBETT.

August 29.

THE EARLY ASTERISMS.

I.

NOT very many years ago, when the literature of China and India was as a sealed book, and the hieroglyphics of Egypt and the wedges of Babylonia were still unread, we had to depend for the earliest traces of astronomical observation upon the literatures of Greece and Syria, and according to these sources the asterisms first specialised and named were as follows:—

The Great Bear	Job (xxxviii. 31), Homer.
Orion	Job (ix. 9), Homer, Hesiod.
Pleiades, Heiades	Job (xxxviii. 31), Homer, Hesiod.
Sirius, the Great Dog ...	Hesiod (viii.), the name; Homer called it the Star of Autumn.
Aldebaran, the Bull... ...	Homer, Hesiod.
Arcturus	Job, Homer, Hesiod.
The Little Bear	Thales, Eudoxus, Aratus,
The Dragon	Eudoxus, Aratus.

It follows from the investigation into the orientation of Egyptian temples that the stars α Ursæ Majoris, Capella, Antares, Phact, and α Centauri were carefully observed, some of them as early as 5000 B.C., the others between 4000 and 3000 B.C. Further, that the constellations of the Thigh (Ursa Major), the Hippopotamus (Draco), the Bull, and the Scorpion had been established in Pyramid times.

It becomes important therefore, if we recognise this as the dawn of astronomy in Egypt, to see if any information is extant, giving us information concerning Babylonia, so that we may be able to compare the observations made in the two regions, not only with a view of tracing the relative times at which they were made, but to gather from these any conclusions that may be suggested in the course of the inquiry.

The inquiry must be limited to certain detailed points; we know quite well already, as I stated in the introduction, that the omen tablets of Sargon I., who reigned in Babylon 3700 B.C., prove unquestionably that astronomy had been cultivated for thousands of years before that date.[1] But to institute a comparison we must leave the general and come to the particular. I will begin with the northern constellations, as it follows from my researches that very early at Denderah and Thebes, and in all probability at On, temples were erected for their worship—the worship of Anubis or Set, as I have shown, that is α Ursæ Majoris and γ Draconis.

According to Maspero, Set formed one of the divine dynasties at On, and the northern stars seem to have been worshipped there. I suppose there is now no question among Egyptologists that the gods Set, Sit, Typhon, Bes, Sutekh, are identical. It is also equally well known that Sutekh was a god of the Canaanites[2] that the hippopotamus, the emblem of Set and Typhon, was the hieroglyph of the Babylonian god Baal,[3] and Bes is identified with Set in the book of the dead.[4]

It is also stated by Maspero that at Memphis[5] [time not given] there were temples dedicated to Soutekh and Baal. In the article on the circumpolar stars I have suggested that they were taken as typifying the powers of darkness and of the lower world, and I believe it is conceded by Egyptologists that Anubis in jackal form preceded Osiris in this capacity.

In the exact centre of the circular zodiac of Denderah we find the jackal located at the pole of the equator; it obviously represents the present Little Bear.

Do we get the jackal constellation in Babylon astronomy? Of this there is no question, and in early times. Jensen refers[1] to the various readings "jackal" and "leopard," and states that it is only doubtful whether by this figure the *god* ANU or the *pole of the ecliptic* ANU is meant. Either will certainly serve our present purpose.

I know not whether the similarity in the words Anu and Anubis results merely from a coincidence, but it is quite certain that the seven stars in Ursa Minor make a very good jackal with pendant tail, as generally represented by the Egyptians, and that they form the nearest compact constellation to the pole of the ecliptic.

It seems extremely probable, therefore, that the worship of the circumpolar stars went on in Babylonia as well as in Egypt in the earliest times we can get at.

A very wonderful thing also is that, apparently in very early times, the Babylonians had made out the pole of the equator as contradistinguished from the pole of the ecliptic. This they called Bīl. With this Jensen finds no star associated,[2] but 6000 B.C. this pole would be not far removed from those stars in the present constellation Draco, out of which I have suggested the old Egyptian asterism of the hippopotamus was formed.

Now I gather from Prof. Sayce[3] that Anu and Bīl ranked as two members of a triad from the commencement of the Semitic period, the third member being probably a southern star symbolised as we shall see in the sequel.

The whole triad was stellar and two-thirds circumpolar; it was only in later ages that we get a triad consisting of sun, moon, and Venus,[4] Venus being replaced at Babylon by Sirius.[5]

To these two northern divinities temples were built, both were worshipped in one temple at Babylon,[6] which must therefore have been oriented due north, and the pole of the equator, the altitude of which (equal to the latitude of the place) was probably in some way indicated. Here there was no rising and setting observations, for Eridu the most southern of the old Babylonian cities had about the same latitude as Bubastis, in Egypt. The pole of the ecliptic (Anu) would revolve round the pole of the equator (Bīl) always above the horizon.

So that since	Sutech = Anu
and	Baal = Bīl,

the temple at Memphis to those divinities reported by Maspero (see *ante*) must have been oriented in the same way as the one at Babylon; and if the above evidence be considered strong enough to enable us to associate the Babylonian Bīl with the Egyptian Taurt, we have not only Ursa Minor but Draco represented in the mythology both of Egypt and early Babylonia.

I gather from Prof. Sayce's "Hibbert Lectures"[7] that there is a distinct evidence of a change of thought with regard to Anu. Observations of stars near the pole of the ecliptic appear to have been utilised before they were taken as representing either the superior or inferior powers—before in fact the Anubis or Set stage *quâ* Egypt was reached. After this had been accomplished there was still another advance in which Anu assigns places to sun, moon, and evening star, and symbolises the forces of nature.

It seems probable that the same rectangular arrangement of temples which held in Egypt, held also in Babylonia,[8] and this perhaps may be the reason why Bīl seems so often to refer to the sun, whereas it was the name given to the combined worship. Sometimes, on the other hand, the worship of the stars is distinctly

[1] Besides the book on omens we have "The Observations of Bel," or "Illumination of Bel" (Mul-lil), seventy-two books dealing with conjunctions of Sun and Moon, phases of Venus, and appearance of comets. "Hibbert Lectures," (Sayce, 1887, 29).
[2] Maspero, "Histoire Ancienne," p. 165.
[3] Pierret, "Le Panthéon Egyptien," p. 4.
[4] *Idem*, p. 48.
[5] Maspero, p. 357.

[1] Kosmologie der Babylonier, p. 147 on the word Anu.
[2] P. 147.
[3] Sayce, p. 193.
[4] Sayce, p. 193.
[5] Jensen, p. 149.
[6] Sayce, p. 439.
[7] P. 190.
[8] In the ceremonials in the temples also the statues of the gods in boats or arks were carried in procession. Sayce, p. 280.

referred to as taking place in a solar temple. Thus at Marduk's temple, E-Sagila we are told "two hours after nightfall the priest must come and take of the waters of the river, must enter into the presence of Bīl, and putting on a stole in the presence of Bīl must say this prayer," &c.[1] The temple then will have been probably oriented to the north.

Nor was this all; movements in relation to the ecliptic had been differentiated from movements in relation to the equator. We have inscriptions running:—

"*The way in reference to Anu,*" that is the ecliptic with its pole at Anu.

"*The way in reference to Bīl,*" the equator with its pole at Bīl.

In other words, the daily and yearly apparent movements of the heavenly bodies were clearly distinguished, while we note also

Kabal šami, "the middle of the Heavens" defining the meridian.

So far as I have been able to gather any myth like that of Horus involving combats between the sun and circumpolar star gods is entirely lacking, but a similar myth in relation to some of the ecliptic constellations is among the best known.

The Ecliptic Constellations.

I have already in previous articles pointed out that at On we seemed limited to Set as a stellar divinity; so soon as pyramid times are reached, however, this is changed.

I have given before the list of the gods of Heliopolis, and have shown that with the exception of Sit none are stellar. But we find in pyramid times the list is increased; only the sun gods Ra, Horus, Osiris, are common to the two. As new divinities we have[2]:—

Isis.
Hathor.
Nephthys.
Ptah.
Selkit.
Sokhit.

Of these the first two and the last two undoubtedly symbolised stars, and there can be no question that the temples of Isis built at the pyramids, Bubastis, Tanis, and elsewhere, were built to watch the rising of some of them.

The temple of Saïs, as I have said, had east and west walls, and so had Memphis, according to Lepsius. The form of Isis at Saïs was the goddess Neith, which, according to some authorities, was the precursor of Athene. The temple of Athene at Athens was oriented to the Pleiades.

There is also no question that the goddess Selk symbolised Antares.

We find ourselves then in the presence of the worship of the sun and stars in the constellations of the ecliptic in Egypt, in pyramid times, and in constellations connected with the Equinoxes; for if we are right above the Pleiades and Antares these are the stars which would herald the sunrise at the Vernal and Autumnal Equinox respectively, when the sun was in Taurus and Scorpion.

Now associated with the introduction of these new worships in pyramid times was the worship of the bull Apis.

The worship of Apis preceded the building of pyramids. Mini is credited by some authors with its introduction,[3] but at any rate Kakau of the second dynasty issued proclamations regarding it,[4] and a statue of Hapi was in the temple of Cheops.[5]

The first question which now arises is When were these constellations established in Babylonia? Is there any information?

[1] Sayce, p. 101.
[2] Maspero, *op. cit.* p. 64.
[3] Maspero, *op. cit.* p. 44. note.
[4] Maspero, *op. cit.* p. 64.
[5] Maspero, *op. cit.* p. 46.

With regard to the constellations of the Bull and Scorpion, there does seem to be some information, and on this point in a subsequent article I shall have to refer at some length to Jensen's recent important book.[1]

J. NORMAN LOCKYER.

(*To be continued.*)

PUBLICATIONS OF THE ZOOLOGICAL STATION AT NAPLES.[2]

DURING the winter of 1876, when the Zoological Station was already a fact in brick and mortar, and my late friend, Mr. Frank Balfour, had already shown by his famous work on the Elasmobranch Development how profitable its arrangements might turn out for the progress of research in morphology, I began to busy myself with the literary phase of my enterprise. From the very beginning it had been my intention to erect not merely a simple laboratory, in which a more or less long series of "Contributions to the knowledge" of all sorts of groups or problems ought to be worked out, but to create an organisation which by its own power and weight might influence the further progress and development of morphological science in the direction of greater concentration and by production of such scientific work as could hardly be taken up and still less carried through by individual effort alone. Of course the Zoological Station ought to have its own Journal, similar to the many Journals or Zeitschriften or Archives of other and perhaps less powerful institutions or societies, but I hoped to do more than that. If my ideas of, and confidence in, the future development of the Zoological Station were right, more important productions might be expected from it, and thus it became only a question of organisation and combination of means and ends to secure such a result. I had learned by almost daily experience how difficult, almost hopeless, it was to succeed with the specific determination of all the numberless organisms, worms, crustaceans, hydroids, tunicates, &c., &c., which our fishermen brought to light day by day. Even if the library of the Zoological Station at that time had been complete enough, it would have been almost impossible to ascertain the names of all these creatures, the descriptions and figures in former works being far too incomplete and too superficial to enable even specialists of all these groups to decide which name belonged to which animal. All attempts to form a well-determined collection of any group—not excluding even the larger crustaceans, echinoderms, and medusæ—failed, and sometimes to such a degree that my assistants and myself simply felt ourselves in the midst of chaos. This may sound strange to conchologists, ornithologists, and entomologists, who can rely on splendid monographs and innumerable synopsis and similar works for classification, but it is nevertheless a deplorable fact for the marine fauna of almost all the seas. And the want is greatly felt, for the marine organisms in by far the greater number of cases require not only an outside investigation by a simple magnifying glass, but microscopical examination of anatomy and development, both embryological and larval, to state definitely to which species they belong, the sexual difference being often so great as to have given occasion to create different genera and even groups for male and female of the same species, and the larval forms in many cases being so utterly unlike the adults that they have been classified in different orders! Tornaria is now known as the larva of Balanoglossus, whereas not long ago it was

[1] "Kosmologie der Babylonier," p. 315, *et seq.*
[2] "Systematik und Faunistik der Pelagischen Copepoda des Golfes von Neapel," von Wilh. Giesbrecht. XIX. "Monograph of the Fauna and Flora of the Gulf of Naples," published by the Naples Zoological Station, 1892, pp. 1–831, pl. 1–54.

supposed to belong to the Echinoderms. What can be more unlike each other than male and female of *Bonellia viridis?* How long did it take to ascertain the true relation of the so-called Hectocotylus to the Cephalopods? And only a few years ago a simple appendage of a well-known mollusc, Tethys, was described as a special genus by one of the most distinguished French zoologists. Such being the difficulties it can hardly be wondered at that, for instance, the same species of a Pycnogonid has had the honour of being described under nine specific and generic names, the greater part of them even by the same author, because he ignored that male and female differed, and that their larval stages again differed from each other and from the adult.

It was then that I planned the publication of a great series of monographs under the title "Fauna and Flora of the Gulf of Naples." Several of my assistants and myself set to work, each one selecting a group of lower marine animals. The main object of these monographs was to create a firm basis for systematical knowledge, but in the meantime I left everybody free to incorporate as much of anatomy, histology, and embryology as he thought convenient, thus giving greater variety to the monographs, and leaving the authors free to follow up those lines of research for which they had the greatest interest.

I wished to lay great stress upon illustrations. In looking over the existing iconography of the lower marine animals, and comparing them with those of terrestrial animals, the inferiority of existing illustrations of the former was apparent, and especially as regards the reproduction of the colouring of the living marine organisms. Colour in animals may have relatively little scientific interest compared with structure, nevertheless it has a meaning, and its good reproduction facilitates greatly the recognition of the species. Besides, practical reasons spoke very much in favour of good coloured illustrations as a means to facilitate the sale of the monographs, which were to be published on subscription, and as the safest way for covering the great expenses which were to be incurred.

I remember in this regard a conversation which I had with the great German publisher, Wilh. Engelmann, of Leipzig, to whom I offered the commission of all the publications of the Zoological Station. When discussing the project of the "Fauna and Flora" I asked his advice as to the number of copies to be printed, and proposed myself 500. Engelmann almost fainted when I pronounced that number. "My dear friend," exclaimed he, "you are going to ruin yourself! There is not the remotest possibility of such a number! Of such costly publications as you project hardly one hundred copies are sold, and if we print 150 copies, it will be more than enough." I remonstrated, and insisted on at least 300, and as I intended to pay all the expenses, Dr. Engelmann on his side kindly reducing the cost of commission to five per cent., I felt pretty safe, to find the necessary number of subscribers in the course of time—a confidence which was not in the least shared by Dr. Engelmann, who called me a Phantast, and a Utopian—denominations to which I had already become so much used that they made hardly any impression upon me. And I have only to regret that I did not insist on my first proposition, for the first volume of the "Fauna and Flora," the monograph on the Ctenophora by Prof. Chun, has been out of print for almost ten years, and single copies are sold at double the original price.

The secret of this success consisted largely in the magnificent plates which accompanied this and the following volumes. It is true that the high scientific standard of these monographs and the low rate of subscription for them caused their sale among all the more important libraries and universities, but the large number of public and private libraries who subscribed to the "Fauna and Flora" did so partly out of sympathy for the Zoological Station, and partly out of enthusiasm for the splendid illustrations which accompany the greater part of the nineteen published volumes, and are executed in the most masterly way by the celebrated lithographic firm of Werner and Winter, at Frankfurt-on-Maine. In fact, it is not too much to say that the world-wide fame of this firm has partly been created by the first volume of the "Fauna and Flora of the Gulf of Naples," whose illustrations were all personally engraved by Mr. Winter himself.

It is doubtless true that the cost of production of these plates is very great; nevertheless, I may be permitted to state that the balance-sheet of the "Fauna and Flora" shows how justly I appreciated the chances when I began this large publication; and though since the last four or five years the number of subscribers has decreased, chiefly by death, the Zoological Station hopes, nevertheless, to continue the series of monographs in the same way for many years to come.

The volume which I have under review is a very fair specimen of the value of these plates, for I hardly say too much if I state my conviction that nowhere have illustrations of Copepoda been produced to rival those of Dr. Giesbrecht's volume. One can hardly look on the first five plates without wishing that some of these fantastical and splendid figures might find their way even beyond the range of scientific literature, and serve as decorative elements in art and industry, where birds, butterflies, and flowers already occupy such an enormous field.

Thirty years have elapsed since the appearance of Claus's well-known monograph of the free-living Copepoda. Many smaller, and even some larger works have been published in the interval, enlarging the field to such a degree that it seemed advisable to divide the whole group into several parts for a new monographical study. Dr. Giesbrecht selected the *pelagic* marine forms instead of the *littoral* ones, partly on account of their better qualification for anatomical and ontogenetical researches, partly because they are yet less known than the others, and lastly, because he thinks they include the more ancestral forms of the whole entomostracous crustaceans. The bulky volume lying before us forms only the first part of the monograph, treating the systematical and faunistical chapters. But as such it gives much more than its title announces, for not only have the pelagic Copepoda of the Gulf of Naples been examined, but the whole mass of forms resulting from the oceanic cruise of the *Vettor Pisani*, an Italian corvette, and captured and carefully preserved by Capt. Chierchia, so well known among biologists, are included in Giesbrecht's work. Altogether, this volume treats of 298 species of pelagic Copepoda; 125 belong to the fauna of the Gulf of Naples, whilst 229 have been captured by Capt. Chierchia all over the globe. If one compares the last number with that of the *Challenger* expedition, where only 85 species of Copepoda are reported, one can imagine with what industry Capt. Chierchia went to work, and how carefully Dr. Giesbrecht examined the material.

The descriptions of the author are extraordinarily detailed; nevertheless he obviates great bulkiness and repetition, having introduced abbreviations for homological parts of the body and the extremities, which are also adopted on the plates. Moreover, the single species are not described one after the other, as is usually the case, but those belonging to the same genus are treated as a whole, their differences being treated in a diagnosis and by the help of synoptical lists (pp. 706–766) and indication of the plates where their specific characteristics are figured, the determination is greatly facilitated. As to nomenclature and synonymy, Giesbrecht is very rigorous in favour of priority, thus restoring even many older names to species described by Claus. A complete list of all described species, with complete indication of bibliography, is to be found on pages 676-705. The 54 plates contain 2300 figures, drawn masterly from nature by the author himself, and the first five plates, as mentioned above, give an idea of the variety of colour and form of appendages which exists even among these small marine organisms.

The systematical views and arrangements of Giesbrecht differ considerably from those of former authors. It is well known that the near relationship of the parasitical with the free-living Copepoda has been recognised already by H. Milne-Edwards; but it was Zenker who established systematically the two great groups of Natantia or Gnathostomata, and Parasita or Siphonostomata, a division which hitherto has been universally accepted. Giesbrecht points out the difficulties with which this division meets when one considers natural affinities, and thinks it impossible to adopt the manifold varieties of the construction of the oral appendages as a fundamental basis for classification. He proposes to divide the whole class into two great groups—the Gymnoplea and the Podoplea. The Gymnoplea are to be recognised by the following characteristics:—(1) chief body division occurring between the segment of the 5th foot-pair and the genital segment; (2) abdomen without rudiments of feet; (3) 5th foot-pair of the male transformed to an organ of copulation, genital organs asymmetrical; (4) heart in most cases present; (5) female carrying rarely ovisacs; (6) extremities plentifully articulated and provided with appendages. On the other hand, the Pleopoda are distinguished by (1) chief body division before the fifth pair of feet; (2) this latter rudimentary never serving as copulation organ; (3) male genital openings symmetrical; (4) heart always wanting; (5) female carrying always one or two ovisacs; (6) extremities rather scarcely provided with articulations and appendages. The great group of the Gymnoplea is further divided into two tribes—the Amphaskandria (male with symmetrical antennæ: family Calanidæ) and the Heterarthrandria (male on one side with prehensile antenna: families Centropagidæ, Candatidæ, Pontellidæ); to the family Centropagidæ are to be numbered all the Gymnoplea of fresh water. The description of the group of the Podoplea only takes up a small portion of the present monograph; therefore our author does not enter into a more detailed discussion of its classification, especially as not only all the littoral forms but most likely all the parasites belong to this group; he divides the group into two tribes—the Ampharthrandria (first pair of antennæ of the male symmetrical prehensile organs: families Misophriidæ, Mormonillidæ, Cyclopidæ, Harpactitidæ, Monstrillidæ) and the Isokerandria (antennæ of the male similar to those of the female; genital openings of the female dorsally situated: families Ontæidæ, Corycæidæ).

The rich harvest of pelagic Copepoda made by Capt. Chierchia on the three years' expedition of the Italian corvette, *Vettor Pisani*, enabled our author not only to describe a great number of new or incompletely characterised species of former authors, especially Dana's, but it gave him the possibility of explaining his views on the geographical distribution of the group, which we will only sketch with a few words, since a larger discussion of these views is impossible on account of the necessity to enter on the general conditions of pelagic life. According to Dr. Giesbrecht there are three great districts in the distribution of the pelagic Copepoda: two arctic ones, north and south, whose boundaries are at 47° N. and 44° S., and the intermediate one. The number of species belonging to this latter one is by far the greatest, almost 85 per cent. of all known species, whilst the north Arctic contains $5\frac{1}{3}$ per cent., the south Arctic $1\frac{2}{3}$ per cent. The faunistic differences between these three districts are greater than those of the three oceans; nevertheless there occur also in the Atlantic and in the Pacific species peculiar to each of them, especially in their northern parts. Pelagic Copepoda occur down to a depth of 4000 metres, and it seems that the boundaries of the above-named three districts stretch even down to these depths. Some species seem to live in very different depths, others exclusively near the surface; whether there are such that live exclusively in greater depths has not as yet been established. The character of the fauna depending more on latitude than on longitude it seems the determining causes of their geographical distribution must depend chiefly on physical agents such as light and temperature, but since the abyssal forms in the tropical parts of the Pacific are not identical with those of the northern and southern seas, which live on the same conditions of light and temperature, the difference in the three faunistic districts must be explained in part by still other causes. The distribution of other holopelagic animals seems to be identical with those of the Copepoda. According to Giesbrecht one seems to be justified in attributing the causes of the daily vertical wandering of pelagic animals to the influence of light, whilst the annual wanderings depend on temperature; besides these periodical wanderings some pelagic Copepoda seem to exist as eggs in greater depths and go slowly to the surface after their Nauplius stage.

I refrain from entering here into any greater details of the 831 large quarto pages of the volume lying before me, expressing only the hope that Dr. Giesbrecht may soon be able to publish his anatomical and embryological researches on the same group in a second volume. But as editor of the "Fauna and Flora," I may be permitted to congratulate the Zoological Station and science in general on the production of this volume, which answers fully to the programme of the whole series of monographs.

I may be permitted to state here that another big volume, treating of the Gammaridæ of the Gulf of Naples, and prepared by Prof. Della Valle, of the University of Modena, will soon follow the Copepoda of Giesbrecht, and will examine in a complete way these interesting crustaceans, including their embryology and anatomy. Splendid plates accompany also the work of Della Valle, and will give perhaps for the first time the varied and remarkable natural colouring of these creatures, generally only figured in outline and diagram by former authors.

After Della Valle's monograph a large, highly interesting, and most complete monograph of the Enteropneusta (Balanoglossus), by Prof. Spengel (Giessen), will be published. Most likely both these volumes will appear this year. A very large work on the Cephalopods by Dr. Tatta is in preparation, and its first volume, containing the classification and grosser anatomy, accompanied by most splendid plates, is nearly ready. A monograph by Dr. Bürger of Göttingen, treating the Nemerteans, is ready in MSS., and the Ostracods, by Dr. W. Müller, of Greifswald, are in the press; the Hirudinea by Prof. Apathy, of Klausenburg, have been in hand for five years, a botanical monograph treating the Rhodomeleæ, by Prof. Falckenburg, of Rostock, is near completion; Prof. Ludwig will contribute several volumes on the Echinoderms, of which most marvellous drawings by the artist of the Zoological Station, Mr. Mercoliano, have been prepared, and several other authors are engaged on other groups.

Some years ago a discussion took place at the British Association, whether it would be right to continue the grant for a table, and it was questioned whether the Zoological Station at Naples was really destined for research and not rather an educational institution; if it were necessary to strengthen the arguments in favour of the first statement, I think the enumeration of the monographs of the

"Fauna and Flora of the Gulf of Naples," either already published (Dr. Giesbrecht's monograph is the nineteenth volume published) or in preparation may convince also those who may still be doubtful in this regard.

Later, and in another article, I may be permitted to discuss some questions regarding another great publication of the Zoological Station, the *Zoologischer Jahresbericht*, a discussion which will touch some of the most vital questions of scientific organisation.

ANTON DOHRN.

BRITISH ASSOCIATION, NOTTINGHAM MEETING.

FURTHER information has been forwarded since the last issue of NATURE from Presidents and Recorders of Sections, of which the following statement is a summary:—

In Section B the following papers are promised, in addition to those already mentioned:—"The Action of Permanganate on Sulphites and Thiosulphates," by G. E. Brown and W. W. J. Nicol; "The Relation existing between Chromium and Certain Organic Acids, and some New Chromoxalates," and on "The Action of Phosphorus Pentachloride on Urethanes," by Emil A. Werner; "The Occurrence of Cyanonitride of Titanium in Ferromanganese," by T. W. Hogg; "Hydrogen Flame-cap Measurements, and the Adaptation of the Hydrogen-flame to the Miners' Safety-lamp," by Prof. Frank Clowes. A general statement of the arrangement of work in this Section appeared in last week's NATURE. The only probable alteration is the shifting of M. Moissan's demonstration to Friday, September 15, and of the Bacteriological discussion to Monday, 18.

An interesting paper is promised to Section E by Mr. Cope Whitehouse, a distinguished American citizen of New York and Cairo.

The presidential address in Section F, on "The Reaction in favour of the Classical Political Economy" will be mainly inspired by the idea that the principles and methods of the classical and orthodox economists have only been modified and supplemented, not displaced, by recent writers; and that both theoretically and practically there are signs of a reaction in favour of the older doctrines as against socialism.

The probable arrangement of work in Section H is as follows:—On Thursday, September 14, the President's address will be delivered, and a few papers on physical anthropology will be read. On Friday, 15, Dr. Hans Hildebrand, Royal Antiquary of Sweden, will read his paper on "Anglo-Saxon Remains, and the Coeval Ones in Scandinavia," and this will be followed by archæological papers. On Monday, 18, various papers will be taken. On Tuesday, 19, Dr. Munro will describe "The Structure of Lake Dwellings," and Mr. Arthur Bulleid will give an account of "The Recently Discovered Lake or Marsh Village near Glastonbury."

Papers which have not been already mentioned in Section H are—"Anthropometric Work in Schools," by Prof. Windle; "The Prehistoric Evolution of the Theories of Punishment, Revenge and Atonement," by Rev. G. Hartwell Jones; "Pin-wells and Rag-bushes," by Mr. Hartland; and "The Tribes of the Congo," by Mr. Herbert Ward.

The Local Secretaries wish to announce that the local programme and the list of hotels and lodgings are ready for issue, and may be obtained by application at the British Association Office, Guildhall, Nottingham, until September 9; after that, application should be made at the Reception Room, Mechanics' Institution. It may also be stated that the local committee has engaged the Theatre Royal for Wednesday night, September 20, when Mr. Wilson Barrett's Company will give the new play "Pharaoh." It is hoped that members will avail themselves of the invitation extended to them for this entertainment, and that it will induce them to remain in Nottingham, and take advantage of the excursions arranged for the following day. Other items worthy of mention are a special concert, which will be given by the Nottingham Sacred Harmonic Society on the Saturday night; and a garden-party, given by Mr. J. W. Leavers, in whose grounds some of the old rock-dwellings of Nottingham are to be seen. Geologists and naturalists will be interested to know that amongst the special local literature will be a little book entitled "Contributions to the Geology and Natural History of Nottinghamshire," which has been edited by Mr. J. W. Carr, M.A., with the assistance of local specialists.

FRANK CLOWES.

SCIENCE IN THE MAGAZINES.

SCIENCE makes a poor show in the September magazines. There are, however, one or two important articles which claim attention. In the *Contemporary Review* Prof. A. Weismann writes on "The All-Sufficiency of Natural Selection," his essay being an answer to two articles by Mr. Herbert Spencer directed against Prof. Weismann's views on heredity and natural selection. The essay is not merely controversial, but also a clear explanation of Weismannism. The following is the concluding paragraph:—

I hold it to be demonstrated that all hereditary adaptation rests on natural selection, and that natural selection is the one great principle that enables organisms to conform, to a certain high degree, to their varying conditions, by constructing new adaptations out of old ones. It is not merely an accessory principle, which only comes into operation when the assumed transmission of functional variations fails; but it is the chief principle in the variation of organisms, and compared to it, the primary variation which is due to the direct action of external influences on the germ-plasm, is of very secondary importance. For, as I previously said, the organism is composed of adaptations, some of which are of recent date, some are older, some very old; but the influence of primary variations on the physiognomy of species has been slight and of subordinate importance. Therefore I hold the discovery of natural selection to be one of the most fundamental ever made in the field of biology, and one that is alone sufficient to immortalise the names of Charles Darwin and Alfred Wallace. When my opponents set me down as an ultra-Darwinist, who takes a one-sided and exaggerated view of the principle discovered by the great naturalist, perhaps that may make an impression on some of the timid souls who always act on the supposition that the *juste-milieu* is proper; but it seems to me that it is never possible to say *a priori* how far-reaching a principle of explanation is: it must be tried first; and to have made such a trial has been my offence or my merit. Only very gradually have I learned the full scope of the principle of selection; and certainly I have been led beyond Darwin's conclusions. Progress in science usually involves a struggle against deep-rooted prejudices: such was the belief in the transmission of acquired characters; and it is only now that it has fortunately been overcome that the full significance of natural selection can be discerned. Now, for the first time, consummation of the principle is possible; and so my work has not been to exaggerate, but to complete.

Two articles of scientific interest appear in the *Fortnightly Review*. One, by Mr. W. Bevan Lewis, on "The Origin of Crime," deals with drunkenness, insanity, epilepsy, and similar affections in their mutual relationship to crime; in the second, entitled "The Climbing of High Mountains," Mr. W. M. Conway enthusiastically supports mountaineering in unexplored regions. Ordinary official surveys do not supply the detailed information with regard to buttress and fold in which resides the clue of mountain structure. It is for mountaineers to make up the deficiency.

In Mr. Conway's words:—

The Arctic and Antarctic regions remain for the future, and so do almost all the great mountain ranges in the world. The Alps alone are explored. The exploration of the Caucasus has been well begun, perhaps half done. Mr. Whymper has accomplished as much as one man can do in a season in the great Andes of Ecuador, but the Andes as a whole are little known. A good deal has been done in parts of the Rocky Mountains. Our New Zealand fellow-countrymen have boldly attacked the beautiful mountain fastnesses which belong to them. All these are hopeful beginnings, but the mountains of Central Africa and all the ranges of Asia are practically unknown. Thus the future of exploration is in the hands of climbers. The exploration of the Alps is a mere specimen on a small scale of the greater work which remains to be accomplished over areas incomparably vaster, and amongst ranges loftier and far more difficult than the Alps. . . . . Whilst the Himalayas have been in large part surveyed by the Indian Government, they are not, from a mountaineer's point of view, surveyed at all. No attempt has been made to give a true physical representation of the highest levels. The glaciation has been treated in the vaguest fashion and upon the ditch theory. From such work a mountain student cannot learn much. It was for this reason that I was tempted to make, in the year 1892, an expedition into the Karakoram Mountains, where are gathered together the mightiest group of glaciers in the world outside the Polar regions. The Hispar, the Biafo, and the Baltoro glaciers had for me the attraction of size as well as remoteness. The Hispar glacier was unsurveyed. The lower portions of the other two had been mapped by Colonel Godwin-Austen years ago, but their upper regions were unknown. The journey that I planned was duly carried out and resulted in the physical survey of some three thousand square miles of high mountain country. A map of the Central Asiatic mountain region lies before me as I write. It measures twelve by fifteen inches. On the same scale, the portion surveyed by me measures less than a square inch. This will give some idea of the amount of work that remains to be done in Asia by mountaineers.

The great difficulty in climbing at considerable altitudes lies in the diminished atmospheric pressure. Says Mr. Conway:—

It is more felt in hollow places than on ridges, more on snow than rocks, more in still air than a breeze, more in sunshine than under clouds or by night. It seems probable that the healthy human body can be accustomed to altitudes up to 18,000 or 19,000 feet. Above 19,000 feet a cumulative effect of discomfort is produced.

Mr. Conway and his party reached an altitude of 22,500 feet in the journey to the Karakorams referred to above, and he thinks an altitude of 24,000 feet may eventually be attained, but it will probably not be much exceeded.

Miss A. R. Taylor describes her sojourn in Thibet in the *National Review*.

Scribner's Magazine contains an interesting article on "The Tides of the Bay of Fundy," by Mr. Gustav Kobbé. Who has not heard of these tides, and wondered at their reputed magnitude? Statistics regarding the range are often so loosely stated that the following quotation is justifiable:—

At Grand Manan the fall is from twelve to fifteen feet, at Lubec and Eastport twenty feet, at St. John from twenty-four to thirty feet, at Monckton, on the bend of the Pelitcodiac, seventy feet, while the distance between high and low water mark on the Cobequid River is twelve miles—the river actually being twelve miles longer at high than at low water.

Under the title, "The First Artists of Europe," the Rev. S. Baring Gould gives, in *Good Words*, a well-illustrated description of the flint implements and tools, carvings on bone, horn, and ivory, sculptures, engravings, and sketches left by prehistoric reindeer hunters in caves, and beneath overhanging rocks in the valley of the Vézère, France. "The Story of the South African Diamond Fields" is told by the Rev. John Reid in the same magazine, and Mr. E. W. Abram contributes a biography of the Rev. F. O. Morris, whose volumes on "Birds" and "Butterflies and Moths" are known to all naturalists, and earned for him the name of "Gilbert White of the North."

"Bacterial Life and Light" is the title of an article by Mrs. Percy Frankland, in *Longman's Magazine*, in which the recent work that has been done on the bactericidal action of sunlight is brightly described.

NOTES.

MR. SCOTT ELLIOT has obtained a grant from the Government Grant Committee of the Royal Society for the purpose of exploring Uganda. We understand that his intention is to start from Mombassa and proceed direct to Lake Victoria Nyanza. After a short stay near the lake Mr. Scott Elliot hopes to leave for Ruwenzari, and to spend as long a time as his funds permit in exploring the botany, geology, and natural history of this mountain chain. Both Dr. Stuhlman and Dr. Baumann have been very lately in this neighbourhood, but still something of interest may be expected from Mr. Elliot's exploration.

THE works of the Cataract Construction Company at Niagara Falls are rapidly approaching completion. The tunnel is really finished, and so is the canal. The wheel-pits have had to be cut out of the solid rock. A power house is now being constructed to carry a travelling crane worked by an electric motor, the current for which will be supplied by a Westinghouse Engine and dynamo. The first of the three turbines of 5,000 horse-power has been made by the Morris Company, of Philadelphia, from designs by Faesch and Picard, of Geneva, and will be set up as soon as the electric crane is in its place. Prof. George Forbes, F.R.S., the electrical consulting engineer to the Cataract Company, has completed the plans for the electrical transmission, which will be by an alternating current. Vertical-shaft dynamos, each of 5,000 horse power, and capable of giving current in one or two phases, will be employed. It is hoped that the first of these dynamos will be built in about four months. The power will first be used at the new works of the Pittsburg Reduction Company, on the road towards Buffalo, for the production of aluminium. To hold the conductors, a roomy subway of concrete is being constructed. Cast-iron frames are built into the concrete, and brackets are fixed to them carrying insulators upon which the conductors will be supported. It will be seen from this that all the work is now well advanced, and a difficult enterprise is being brought to a successful termination.

THE exceptionally heavy cyclone which swept along the American coast on August 28 and 29, and was noted in our last issue, occasioned great loss of life and property both at sea and on land. The principal violence of the storm appears to have occurred in Georgia and South Carolina, and the fury of the wind completely swept down houses which were in the track of the hurricane. The storm was also accompanied by a tidal wave, which added immensely to the destruction on the sea-coast and on the islands in the main track of the disturbance. The wind is reported to have attained a velocity of 120 miles an hour, but much yet has to be learned from the numerous meteorological stations situated in or near to the storm's path. The cyclone was evidently an ordinary West Indian hurricane, which storms are not of uncommon occurrence at this season of the year; but it is unusual for these disturbances to maintain their full energy when they continue their course to the northward, and extend to regions well outside the tropics. This hurricane is said to have been experienced in the Bahamas three or four days before it broke with such fury on the shore of the mainland, and it is reported to have finally retreated out to sea as an ordinary gale. Just ten years ago a very severe storm traversed the south of England, and by means of ship's observations over the North Atlantic the disturbance was tracked from the tropics, along the coast of the United States, and eventually to our own shores. Doubtless the Weather Bureau of the United States will undertake a thorough and exhaustive study of the cyclone which has but just occurred.

ON the 28th ult. a hurricane passed over the more northerly of the Azores Islands, and caused great damage.

THE Rev. Leonard Blomefield, father of the Linnean Society, died at Bath on September 1, in his ninety-first year.

AN International Exposition will be held in the city of San Francisco, State of California, beginning on January 1, 1894, and continuing for six months. The general classification will be as follows:—Department A—Agriculture, food and its accessories, forestry and forest products, agricultural machinery and appliances; horticulture, viticulture, and pomology; fish, fisheries, products and apparatus of fishing. Department B—Machinery; mines, mining, and metallurgy; transportation—railway, vessels, vehicles; electricity and electrical appliances. Department C—Manufactures; liberal arts—education, literature, engineering, public works, constructive architecture, music and the drama; ethnology, archæology; progress of labour and invention. Department D—Fine arts: painting, sculpture, architecture, decoration. Department E—Isolated and collective exhibits. Mr. M. H. de Young is the Director-General and President of the Executive Committee, and all applications for space, &c., must be made to him, addressed Director-General, California Midwinter International Exposition, San Francisco, California, U.S.A.

IT is a custom to break clay vessels as a funeral rite in modern Greece, and there are proofs of the existence of similar customs among various Asiatic, African, American, and Australian peoples. Prof. N. G. Politis has investigated the origin of the practice (*Journal of the Anthropolgical Institute*, August), and has been led to conclude that it is connected with the purifications which now, as of old, form part of the funeral ritual. In a great many places, people on returning from a funeral or visiting a house of mourning, wash their hands, or are purified in some way with water, the vessels and towel used being afterwards destroyed. Prof. Politis is therefore of the opinion that the breaking of vessels is based upon two leading notions: (1) that everything used in the ritual of purification ought to be destroyed, lest the efficacy of the purificatory act be annulled through the profane use afterwards of things employed in its performance; and (2) that objects given to the dead must be destroyed, to guard against the possibility of their use for other purposes which annul their dedication to the dead, the belief being that all chattels must perish by fracture or mutilation of some kind in order to serve the purpose of a dead person, becoming through such mutilation unfit for living use.

IN "Midsummer Night's Dream," Shakespeare refers to "Russet-pated choughs many in sort, rising and cawing at the gun's report," but there appears to be a difference of opinion among ornithologists as to the bird so distinguished. So far back as 1871 Mr. J. E. Harting, in his "Ornithology of Shakespeare," interpreted the expression as meaning the gray-headed jackdaw, but the reviewer of the book in these columns remarked at the time that "without doubt the poet had in his mind the real Cornish chough, and the expression is quite accurate. 'Russet-pated' is having red *pattes*, or feet (*e.g.* the heraldic *croix pattée*, not a red *pate* or head), a feature equally inapplicable to chough or daw, while the red feet of the former are as diagnostic as can be." Mr. Harting returns to the subject in the *Zoologist* for September, and, in support of his view that the gray-headed jackdaw, and not the red-legged chough, is referred to, brings forward evidence to show (1) that the name *chough* was not exclusively bestowed upon the bird with red bill and red legs, but was also applied to the jackdaw; (2) that "pated" means "headed," and cannot be read "patted" for "footed"; (3) that "russet" is not red, though it may be reddish and is often used for gray; and (4) that the habit of the birds referred to by Shakespeare as "many in sort, rising and cawing," indicate a mixed flock of jackdaws and rooks, and not choughs and rooks.

WE have received from the *Deutsche Seewarte* vol. xv. of *Aus dem Archiv*, containing the report upon the work of that institution for the year 1892. In the department of maritime meteorology, especially, much activity has been shown, notwithstanding the serious obstacles experienced by the lamentable cholera epidemic. The various publications under this head include sailing directions for the Indian Ocean, daily synoptic weather charts for the North Atlantic (in conjunction with the Meteorological Institute in Copenhagen), and the collection of observations made beyond the sea. The observations received from ships alone amounted to an aggregate of 192 years, and these are used in the discussion of the meteorology of the ocean, which for this purpose is divided, according to the usual practice, into squares of ten degrees of latitude by ten of longitude. The department of weather telegraphy is also conducted with marked activity, and daily and monthly reports are regularly published. In addition to these operations, and the testing of numerous meteorological instruments and chronometers, many valuable discussions are undertaken, some of which are contained in the monthly *Annalen der Hydrographie*, &c. We shall refer later on to one or two of the special discussions included in the present volume.

As regards the behaviour of pathogenic forms in vegetable tissues, Russell states that, with but few exceptions, they were unable to exist for any length of time under these conditions. Lominsky, however, who conducted no less than 300 experiments on the vitality of anthrax, the typhoid bacillus, and staphylococcus pyogenes aureus in plants (Wratsch 1890), found that these organisms were not only able to exist but to multiply. Of especial interest was the behaviour of the anthrax bacillus when inoculated into agapanthus leaves. The bacilli grew into long threads, and at the end of seven days signs of spore formation were detected, both spores and threads being found later, not only at the point of inoculation, but within the healthy cells of the soft part of the leaf; moreover, after forty-two days' residence in the leaf, their virulence, as shown by inoculation into animals, was in no way impaired. Although saprophytic bacteria, as well as pathogenic forms, have not so far been found capable of inducing any disease in plants when artificially introduced, yet bacteria have been isolated which are especially pathogenic to plants. Amongst these may be mentioned the *B. hyacinthi* of Wakker affecting the bulbs and leaves of hyacinths, and the more recent *B. hyacinthi septicus* of Heinz, which affects also the flower clusters. The pear blight has been traced to a distinct bacillus, and Savastano describes a bacillus (*B. oleæ-tuberculosis*) causing destruction of tissue and formation of spaces in the tissue of numerous fruit trees, whilst closely allied to this form is a bacillus which produces tumours on the Aleppo pine. The list, although limited, is receiving constant additions, and there is a wide field open for researches on the bacterial diseases of plants, which may, moreover, be prosecuted without the intervention at present of the anti-vivisectionist!

HERR F. VON HEFNER-ALTENECK, in the *Electrotechnische Anzeiger*, makes a provisional statement about a system of electric control of clocks which appears likely to solve this much-attempted problem in a satisfactory manner. The main difficulty up to the present has been the necessity for a special wire system, central station, and attendance, the cost of which could not be defrayed by the limited public likely to require a luxury of this sort. Whenever, on the other hand, an enterprise was started with faulty mains and insufficient staff, the system was doomed to fail and to create a prejudice against the principle itself. All these difficulties are avoided by incorporating the control system with the electric light or power installation already existing. This is done by means of a clock invented by Herr von Hefner-Alteneck, which is placed in circuit like an ordinary incandescent lamp. It is kept wound up by the current, at an annual cost not exceeding that of one 16-candle lamp burning for ten hours, *i.e.* about 4*d.* In case of interruption of circuit, the clock will go about twelve hours independently of the current. The control is effected once a day by a momentary drop of the circuit potential by about 6 or 10 volts at 5 A.M., which has the effect of pointing all the clocks in the circuit at 5. The effect upon the lamps is inappreciable. The control can be performed by hand in the dynamo room, or automatically through the assistance of an observatory. The General Electric Company of Berlin proposes shortly to embody the system in its enterprises.

Messrs. Gauthier-Villars have issued their quarterly list of new publications.

We have received the Transactions and Proceedings of the New Zealand Institute, vol. xxv. 1892.

The report and proceedings of the Manchester Field Naturalists' and Archæologists' Society has been issued for the year 1892.

The Geological Survey of Alabama has issued a report, by Mr. A. M. Gibson, on the "Geological Structure of Murphree's Valley." The report deals particularly with the mineral resources of the region.

The University Correspondence College Press has published the fourth Intermediate Science and Preliminary Scientific Directory, containing the papers set at the examinations in July last, and the answers fully worked.

The Toynbee Hall Natural History Society recently organised an excursion to Jersey. Seventeen members took part in the expedition, and represented three sections—Botany, Geology, and Zoology. The whole of the coast and much of the interior was visited. At the monthly meeting of the Society, held Monday, September 4, many of the results of a fortnight's natural history work in the island were exhibited.

Two new volumes have been added to the Aide-Mémoire series edited by M. Léauté, and published by Messrs. Gauthier-Villars and M. G. Masson. "Accidents de Chaudières," by M. F. Sinigaglia, deals with the causes and prevention of boiler accidents, and M. H. Laurent, in his "Théorie des Jeux de Hasard," gives a number of problems connected with games of chance.

Messrs. John Bartholomew and Co., Edinburgh, have published a "Naturalists' Map of Scotland," showing (*a*) Faunal divisions and lighthouses; (*b*) Height of land and depth of sea; (*c*) Deer forests and salmon rivers; (*d*) Areas of moorland, hill pastures, and other uncultivated lands; (*e*) Areas of cultivated land. The map is excellently lithographed, and will doubtless be appreciated by the tourist as well as by the naturalist.

Mr. William F. Clay, Edinburgh, has published, as an Alembic Club reprint, the two papers by Cavendish, which appeared in the *Philosophical Transactions* under the title "Experiments on Air." The first paper appeared in 1784, and contains an account of Cavendish's researches into the composition of water; the second paper, published in the following year, contains the description of his discovery of nitric acid.

In 1891 a biological survey of parts of California, Nevada, Arizona, and Utah was conducted by the U.S. Department of Agriculture, Dr. C. Hart Merriam being in charge. The second part of the report on the results of this—the Death Valley Expedition—has just been published, and forms the seventh number of "North American Fauna." It consists of the special reports on birds, reptiles, batrachians, fishes, molluscs, insects, and the shrubs of the desert region, cacti and yuccas. The first part of the report, containing the narrative of the expedition, discussion of life-zones, and the list of mammalia, has not yet appeared.

Too great praise cannot be given to the authorities of the Natural History Museum for the excellent series of guide-books that are being issued from time to time by the various departments. The latest addition to this series is a guide to Sowerby's models of British Fungi in the department of botany, prepared by Mr. Worthington G. Smith. The Sowerby collection was acquired by the Museum in 1844, and consists of more than two hundred models made of unbaked pipeclay. Mr. Smith's description of the fungi should be widely distributed, for it will enable the public to distinguish easily the edible and poisonous species.

The benefits derived by science from the Smithsonian Institution are almost incalculable. Memoirs, monographs, and bibliographies of a most important character are distributed to private individuals and libraries with so free a hand that every one interested in the matters with which they deal must learn of their publication. A very important volume has recently been received from the institution; it is "A Select Bibliography of Chemistry," by Mr. Henry Carrington Bolton. The volume gives the titles of practically all the books on chemistry published in Europe and America between 1492 and 1892. It contains works in every department of both pure and applied chemistry. Academic dissertations, however, and theses, are not, as a rule, included, neither is the voluminous literature of periodicals. The works are arranged into seven sections as follows:—(1) Bibliography, (2) Dictionaries, (3) History, (4) Biography, (5) Chemistry, pure and applied, (6) Alchemy, (7) Periodicals. Section v. is more extensive than the other six combined. Besides pure chemistry, the book comprises works in every department of chemistry applied to the arts, but not to the arts themselves. In each section, with the exception of those of biography and periodicals, the titles are arranged alphabetically by authors. Altogether, 12,031 titles have been indexed, of which 4507 are in German, 2765 in English, and 2141 in French. In addition to the author's index, there is a subject-index which very considerably facilitates reference. For the conception of the bibliography and the completion of a stupendous work, Mr. Bolton deserves the thanks of all chemists. A debt of gratitude is also due to the Smithsonian Institution for publishing so useful a volume.

A further communication upon the manufacture of oxygen from the air by the agency of calcium plumbate, Ca_2PbO_4, the compound formed by lime with peroxide of lead, is contributed by Herr G. Kassner to the current number of the *Chemiker Zeitung.* Oxygen is now so important a commercial article that any new mode of advantageously preparing it upon a large scale must of necessity be of considerable interest. The success of the "Brin" method of isolating it indirectly from the atmosphere by the agency of barium peroxide has given rise to several attempts to discover some other substance capable of yielding oxygen of an equal degree of purity and under equally favourable conditions as regards cost of plant and working. Calcium plumbate would appear to possess several properties capable of rendering it an efficient substitute for barium peroxide, and Herr Kassner even claims for it a distinct superiority.

Whether this be indeed the case or not, can of course only be tested by actual working during a sufficiently long period of time. The method as described by Herr Kassner is briefly as follows. Calcium plumbate in the form of spongy porous pieces is first exposed to the action of moist furnace gases, which have been previously well washed, at a temperature not exceeding 100° C. The calcium plumbate under these conditions rapidly absorbs the carbon dioxide contained in the furnace gases, becoming thereby decomposed with formation of calcium carbonate and free peroxide of lead; that is to say, the acid properties of carbon dioxide are superior to those of lead peroxide, and so the former expels the latter from its state of combination with lime. This decomposition is unaccompanied by any change of form, the spongy pieces of material remaining precisely the same in shape and texture, like the pseudomorphs of mineralogy. The product of this first operation, when fully saturated with carbon dioxide, is transferred to a strongly constructed retort heated to redness, when oxygen is rapidly disengaged. The evolution of the oxygen is facilitated by leading superheated steam through the retort. When the peroxide of lead has yielded up most of its available oxygen, carbon dioxide commences to be evolved, and subsequently the issuing gas is pure carbon dioxide, which is collected separately. The carbon dioxide evolved during the intermediate phase is removed from the oxygen by allowing the gases to pass over a further quantity of calcium plumbate, which absorbs it entirely, allowing only pure oxygen to escape. The last phase in which pure carbon dioxide is evolved is carried on to completion, after which the residue is readily reconverted into calcium plumbate, for use in a subsequent operation, by driving a current of air through the retort.

IN addition to Kassner's process, above described, another has been patented by Peitz, in which instead of furnace gases pure carbon dioxide is employed. Le Chatelier has also recently published a paper upon the subject, in which, however, he does not appear to have been acquainted with the whole of Kassner's publications. Le Chatelier concludes that calcium plumbate gives up its available oxygen by merely heating it to a temperature of 200° higher than that employed in Brin's process in the case of barium peroxide, and that the heated residue absorbs oxygen from the air again much more rapidly than the latter substance. Kassner has already previously stated these facts, and now asserts that his indirect method possesses two great advantages over the direct one proposed by Le Chatelier, namely, that a lower temperature is required, and a consequent saving of fuel and wear of retorts effected, and that pure carbon dioxide is obtained as a very valuable by-product. The very fact, however, that there are so many possible modes of treating calcium plumbate, goes far to indicate that there is at least some ground for the proposal to employ it as a substitute for barium peroxide.

NOTES from the Marine Biological Station, Plymouth.—Last week's captures include the Polychæte *Eunice Harassii*, the Decapod *Pirimela denticulata*, and the Opisthobranchs *Hermæa bifida*, *Embletonia pulchra*, *Antiopa hyalina*, and *Thecacera pennigera*. The floating fauna retains its recent character, *Muggiæa atlantica*, *Evadne Nordmanni* and Ophiuroid *Plutei* having been especially plentiful. The larvæ of *Polygordius*, *Magelona*, *Nerine*, *Phoronis* and of several Crustacea Decapoda have been taken; and Müller's Polyclad larvæ have made their first appearance, although as yet only in small numbers. *Pilidium* has been scarce, but other Nemertine larvæ fairly numerous. *Doliolum Tritonis*, first recorded a fortnight since, has been represented by several specimens in almost every haul of the tow-nets. The following animals are now breeding:—The Polyclads *Eurylepta cornuta* and *Stylostomum variabile*, the Polychæte *Ophryotrocha* (in the aquarium), and the parasitic Isopod *Pleurocrypta Galatheæ*. The Gymnoblastic Hydroids *Perigonimus repens* and *Podocoryne carnea* are giving off medusæ.

THE additions to the Zoological Society's Gardens during the past week include a Malayan Bear (*Ursus malayanus*, ♀) from Malacca, presented by Mr. E. Sydney Wooduviss; a Feldegg's Falcon (*Falco feldeggi*) from Morocco, and two White-shafted Francolins (*Francolinus leucoscepus*, ♀ ♀) from North-east Africa, presented by Lord Lilford, F.Z.S.; two Common Buzzards (*Buteo vulgaris*) from Europe, presented by Mrs. Henry Goodbun; a Ring Ouzel (*Turdus torquatus*, ♂) from British Isles, presented by Mr. Samuel Radcliffe; two Sulphury Tyrants (*Pitangus sulphuratus*) from South America; a Chukar Partridge (*Caccabis chukar*) from North-west India, and a Bamboo Partridge (*Bambusicola thoracica*) from North China, presented by Mr. H. H. Sharland; a Land Rail (*Crex pratensis*) from British Isles, presented by Mr. W. Stanley; an Arabian Baboon (*Cynocephalus hamadryas*, ♀) from Arabia, and a Hairy Tapir (*Tapirus roulini*) from Columbia, deposited; two Sun Bitterns (*Europyga helias*, ♂ ♀) from South America, four Patagonian Cavies (*Dolichotis patachonica*, ♂ ♂ ♀ ♀) bred in France; an Elliot's Pheasant (*Phasianus ellioti*, ♂) from China, three Chilian Teal (*Querquedula creecoides*) from Antarctic America, and two Viscachas (*Lagostomus trichodactylus*, ♂ ♀) from Buenos Ayres, purchased.

OUR ASTRONOMICAL COLUMN.

THE TRANSIT OF VENUS OF 1874.—The reports and drawings of the New South Wales observers of this transit have already been published by the Royal Astronomical Society, so that the volume which we have received, containing the observations, published by authority of her Majesty's Government in New South Wales, cannot be looked upon as containing much that is new. Mr. Russell, the Government astronomer, under whose direction this work has been compiled, seems to have taken great pains in bringing it out, for besides a long introduction summing up the results, and separate accounts of each of the reports, the book is illustrated with several photographs and drawings, a frontispiece containing photographs of the observers, and is bound in a very elaborate cover. The value of this publication lies in the fact that each observer's record is published in full, and is accompanied by numerous printed diagrams, which help to make more clear the various descriptions of phenomena that were noticed. Passing over the observations of contacts, we may refer to some of the physical phenomena which seemed to have claimed attention. With regard, first, to the black drop, it seems that only those who were using telescopes of small aperture, 1½ to 2 inch, and low power eyepieces, saw it, while on the photographs not the slightest trace of it could be seen. The evidence, as far as the New South Wales observations go, shows, as Mr. Russell states, that "the black drop does not seem to be due to the atmospheric conditions, but rather to the imperfections of telescopes of small apertures and low power." The curious "faint tremulous shaking," as noticed at the times of the planet's ingress and egress, are put down to the temporary unsteadiness in the atmosphere. Three important phenomena which seem to have been generally observed were the rings of light and the halo seen surrounding the planet, and the ring of light round that part of the planet projected on the sky. Mr. Russell is of opinion that the atmosphere of Venus probably does not extend far enough to produce the observed phenomena of the halo, but, perhaps, a part of it could be attributed to the haze in the atmosphere caused by the forming of moisture at that time. The bright ring, described as very brilliant, was found to affect the chemicals more than the sun itself, as shown on the photographic plates; its brilliancy accounts for it being only seen on the limb not projected on the sun, and it is suggested that perhaps under favourable conditions this halo might be seen when the planet is lost in the sunlight.

THE PLANET VENUS.—Some time ago we noticed in these columns a short monograph on the "Planet Jupiter and his

Satellites," by Ellen M. Clerke. We have now before us a second one, entitled "The Planet Venus," in which the authoress lays before us in a pleasant manner a similar summary of the more important points connected with this planet's appearance. Commencing with a few words with regard to the position of Venus with relation to the other planets in the solar system, one is introduced successively to her changes of aspect due to her varying positions in her orbit, to the "silver crown" or halo produced by the refraction of the sun's rays round her globe, and to her rotation, general appearance, and polar caps. Her appearance at times of transit, and the phantom satellite, are then dealt with, the concluding chapter speaking of her in connection with the Star of Bethlehem. In this last reference is made to the "enhanced splendour with which she occasionally—once or twice in a century or so—shines at such times." That the planet does assume this increase of brightness, in addition to that due to her position, seems very doubtful, and the explanation here given to account for it depends on the luminous clouds theory suggested by the lectures on the liquefaction of gases by Prof. Dewar. The monograph is well worth a perusal, and should be widely read.

"Memoire della Societa," &c.—Among the contributions to these memoirs for the month of July will be found a detailed account of the late eclipse of the sun as observed from the Royal Observatory of Catania; a note by Millosevich giving some data with a map for the eclipses of May 28, 1900, and August 30, 1905; and the spectroscopic observations given in graphical form of the sun's limb, made at Palermo and Rome during the months of October, November, and December of 1891.

GEOGRAPHICAL NOTES.

In the September number of the *Geographical Journal*, Mr. Fred. Jeppe has a paper dealing in great detail with the Zoutpansberg gold-fields in the north of the Transvaal, illustrated by a new map of the district on a large scale, and by several photographs of characteristic scenery. The paper is historical as well as topographical, and contains an interesting account of the ancient workings in the Palabora region. The difficulty of orthography of place-names is referred to, several examples of alternative spelling being given, of which the series Li-Thaba, Lehlaba, Lechlaba, Lethaba, Letaba, Taba is characteristic. The district appears capable of great development when difficulties of transport are overcome by a branch from the Delagoa Bay railway.

Dr. R. Hansen contributes a paper to the last number of *Petermann's Mitteilungen* on the changes in the coastline of south-western Schleswig, with maps showing the coast as it existed in 1240, 1634, and 1892. These maps present a striking picture of the progressive diminution in area of the islands north of the mouth of the river Eider, especially Nordstrand, while those immediately adjoining the river mouth have been united with the mainland, and extended in area by the erection of dykes. As the islands have been inhabited from very early times, and protected to a certain extent by dykes, the process of coast-erosion has not been as continuous and gentle as would naturally be the case, but it has been a succession of artificial catyclasms—if the phrase may be used—brought about by exceptional storms destroying the sea-walls. In the old time each of these catastrophes was recorded amongst the islanders by the name of the patron saint of the day when it occurred.

Petermann's Mitteilungen also publishes a new map of Chitral and the surrounding districts of the Hindukush, by Mr. F. Immanuel, who describes the region in a short article.

Mr. H. M. Dickson spent the month of August on board H.M.S. *Jackal*, on behalf of the Fishery Board for Scotland, in carrying out a series of physical observations on the water between the Orkney, Shetland, and Faeroe Islands. This work was, to a certain extent, in concert with that being done by the Danish and Swedish Governments on the entrance to the Baltic and the neighbouring ports of the North Sea.

MEETING OF THE FRENCH ASSOCIATION.

The twenty-second meeting of the Association Française pour l'Avancement des Sciences was held this year at Besançon (Department du Doubs.), capital of the old province of Franche Comté. Few towns in France, even although small, are wanting in historic or antiquarian attractions, and in these respects Besançon has much to interest the antiquarian as well as the man of science, and therefore on its own merit is well worthy of a visit. The meeting of the French Association in this town not only enabled many to see it who otherwise would perhaps never have had occasion to do so, but owing to the facilities afforded, both by the municipality and by the civil and military authorities, practically everything interesting in the town and in the environs was liberally put within the reach of the members of the Association.

The meetings of the Association were held in the Lycée, which was built by the Jesuits about the commencement of the seventeenth century, and by reason of the great number of class-rooms afforded the necessary facilities for the meetings of the different sections for correspondence, &c.

The Association, although modelled on the lines of the British Association, has a slightly different scope, owing to the conditions which brought it into existence. It really commenced as the "Association Scientifique de France" in 1864, when it was founded by Le Verrier, but this subsequently to 1871 became combined with the Association Française pour l'Avancement des Sciences, the object of which was not only scientific after the mode of the British Association, but also aimed at reviving the study of science and of stimulating scientific research in the departments by bringing French scientific men together in the different principal towns throughout the country, enabling them thus to become better and more practically acquainted with France as a whole, and with the wishes, wants, and requirements of the populations. This patriotic object has been well kept in view, and the cordiality of the reception afforded to the Association wherever it goes shows how well its work is appreciated by the country. It would therefore follow that the study of the district visited forms an important part of the work of the Association, and that the "Excursions" are just as much sought after as in the meetings of the British Association.

The business usually commences with a general meeting, held either in the theatre of the town visited or other public building capable of affording the necessary facilities; in this case it was held in the theatre, a remarkable structure dating back to 1778, and inaugurated in 1784 by the Prince de Condé and his son, the Duc de Bourbon. On the stage facing the house was the table, at which sat the principal authorities of the town, civil and military, the president and principal officers of the Association, and ranged behind them the invited guests, notabilities, and chairmen of sections or committees, &c., evening dress being practically *de rigueur*. The business commenced by the Maire of Besançon reading an address of welcome to the Association, and of hearty sympathy with its objects. Then the president for the year, Dr. Bouchard, Membre de l'Institut and de l'Académie de Médicine, Professeur à la Faculté de Médicine de Paris, read his address, of which the following may be taken as the leading points. Having thanked the town of Pau for the reception given to the Association in 1892, and thanked the Maire of Besançon for the cordiality of his welcome, he defined the double object sought by the French Association's scientific progress, having for ulterior aim the greatness of their country. He paid a well-merited compliment to Besançon for its traditional love of learning and spirit of culture manifested in its celebrated men and scientific institutions. Turning then to the subject proper of his address, he expressed the desire to speak of the scientific movement and the position of scientific men at the present period, and in order to speak with competence he proposed to take his examples from the profession "which he cultivates, teaches, and practises," being justified in doing so by the fact of his having been called on to preside in his quality of a doctor. He then pointed to the wonderful development of scientific study at present, and stated that in the Faculty of Medicine of Paris 1200 students present themselves each year for the degree of M.D. (Doctorat en Médicine); of these 700 soon give up, while 500 persevere and attain their degree.

He pointed out that, whatever the causes, it is manifest that during the past fifteen years the number of students has been on the increase. He then entered on an analysis of the causes of this movement which extend to other branches of science.

"It has been said that the German schoolmaster was the conqueror at Sadowa; it was repeated after more recent disasters. It is false," but the "*mot fit fortune chez nous*," and the whole of France resolved to accept sacrifices equal in extent to those entailed by the defeat, in order to insure a national recovery. This sentiment dominated at the foundation of the French Association. Schools in every grade have been multiplied, as also new chairs. Their faculties have been created, at least for medicine, but have not given results expected of them. The real object sought was to retain in a certain number of university centres the crowd of students which encumber the Faculty of Medicine of Paris without profit for themselves or for it. "This encumberment seems not to have diminished at Paris, and our provincial faculties might without harm see their scholastic population trebled." As a matter of fact, the newly created chairs, laboratories, and faculties have in a remarkable manner multiplied sources of employment and created outlets for young men. It is certain that many have commenced working in order to make themselves positions in the teaching world. They have subsequently seriously taken up scientific study and disinterested scientific work. "Young men of science desire, and naturally so, that their work should be immediately remunerated. This is a novelty in our old university." These pretensions are to some extent legitimate, and the budget must provide for them, but the budget is beginning to resist, and the day is approaching when the State will only ask for, and will only accept, the absolutely necessary services, while on the other hand insuring to those who devote themselves to scientific instruction a honourable position and a satisfactory future.

"The public powers must become persuaded that instruction in every degree and in every direction of employment is and must be treated as a career."

As may be seen, we have reached a critical period when the plethora is become excessive, and a situation which has become painful has to be remedied somehow: "The raising of the standard of the position of men of science is one of the spontaneous consequences of progress, at once natural and necessary."

The applications of science carry with them certain advantages; one of these well calculated to entice generous natures, is the degree of esteem accorded to a profession. Certain professions enjoy more favour in given periods than others—military men during the First Empire, lawyers under the Restoration, engineers towards 1848, and under the Second Empire during the period of railway building. The turn of the doctor has perhaps come. "I am inclined to think so when I consider the extraordinary number of doctors who sit in the elected consultative bodies, and the important *rôles* that they play therein. Dr. Bouchard then cited their influence on Parliamentary legislation in the matters of vaccination, the use of antiseptics, and sanitation. In no way does the parallel progress of scientific dignity and public esteem manifest itself more strongly than in the matter of specialties. Knowledge is no longer encyclopædic. A doctor can no longer become learned but on condition of becoming a specialist. Surgeons have been the first specialists. They have extended to so many objects their fecund activity, and enlarged their domain to such an extent, that surgery, having absorbed everything about it, will soon cease to have a separate existence. It dismembers itself into specialties which multiply day by day. "I see approaching the day when there will be no longer either doctors or surgeons, and when there will exist for those who dedicate themselves to the art of healing a general pathology with general therapeutics, including amongst other things the laws and processes of operative intervention." Starting from this general fund of knowledge, doctors will classify themselves according to the natural groups of maladies to the study and treatment of which they may dedicate themselves. "It will be necessary that the State and the teaching bodies should comprehend, foresee, and provide for this evolution which is certain to be accomplished. It is necessary, above all, that those who dedicate themselves to the medical profession should receive a common and general solid instruction which will enable each one to work out later on, with fruit, his specialisation."

He then cited the position which oculists have attained in the public esteem. They have constituted a science. The art of the oculist has become ophthalmology, "the most brilliant, sure, and, I was about to say, most perfect branch of medicine." He considers in the same way the position attained by the dentist. In changing their titles oculists and dentists wish to mark the arrival of a new age, the accession of their arts to the real scientific period.

After a few words upon the position of men of science, Dr. Bouchard stated, as showing the wide field still open for modest efforts, that of the 36,000 communes of France 29,000 have no doctor. It is a field opened up for active and devoted work.

But neither ambition nor the satisfaction of worldy requirements, nor even the thirst for self-sacrifice suffice to explain the intensity of the movement which carries along to scientific occupations so many men belonging to the intellectual and moral *élite* of the nation. People go towards science because of its attractions and fascinations. If geometry can excite a very passion, why not the study of physical phenomena, the determination of biological laws? "Medicine has seductions which may raise a smile, but which all those who have dedicated their existence to it understand." To grasp the causes of disease, discern their modes of action, is the question which has been posed since the origin of medicine; it is the problem which for the last 2000 years and more has tormented the greatest intellects of the medical profession. These causes have been revealed to us for a great number of maladies by a man who was not a doctor. This revelation dates from but yesterday, and it is only since yesterday that we have been able to introduce into experimentation this factor up to the present unknown—the morbific cause (*la cause morbifique*). From this day dates the great reform in medicine. The modes of work of the old school were then compared with those of the new. They did what they could, what they would always have been obliged to do. They worked out the natural history of malady. They have seen the dawn of a new day. They have become acquainted with the *rôle* of the microbe in the universal transformation of matter, whether dead or alive, organic or inorganic, an idea so great and so fecund that each science in particular owes to it a part of its progress, while to it medicine owes its very renewal. Herein we have the true reason of this allurement which carries away so many liberal minds to the study of medicine. He then pointed out the parallel development of the study of septicism, and of the intimate relations of the various organs in their functions, and finished by indicating as the principal directing ideas of contemporary medicine, infection, diathesis, auto-intoxication, useful *rôle* of the internal secretions, nervous reactions, provoking and impeding healthy actions. He finished with some remarks as to the *rôle* of the Association—one of its great objects being to produce a scientific decentralisation. This decentralisation has been attained; it is in the minds while waiting to be affirmed by our Institutions. Meanwhile we continue our yearly peregrinations. "*Nous sommes en train de découvrer la France.*"

The address was remarkably well received.

The Secretary of the Association afterwards read a report on the work done during the last season, and the Treasurer rendered an account of the financial state of the Association, showing a balance in its favour of about 800,000 francs; Dr. Bouchard then declared the twenty-second session of their congress opened.

In the evening there was a reception held by the Maire at the Hotel de Ville, which was well attended.

At five o'clock on the same evening the bureaux or staff of officers of the different sections were fixed, and the agendas for the meetings to be held next morning. There were no addresses from the presidents of the sections.

Of the seventeen sections, Nos. 1 and 2 were devoted to Mathematics and Astronomy, 3 and 4 to Civil and Military Engineering, 5 and 7 to Physics and Meteorology, 6 to Chemistry, 8 to Geology and Mineralogy, and 9 to Botany. Section 10 dealt with Zoology and Physiology, 11 with Anthropology, 12 Medical Sciences, and 13 Agriculture. Geography was considered in section 14, Political Economy in 15, Pedagogy in 16, and Hygiene in 17. To all these sections a large number of important communications were made.

EXCURSIONS.

Sunday, August 6, Salins and Source of the Lison River.—Leaving at 6.30 a.m. by special train, Salins, situated about twenty-three miles south-south-west of Besançon, was reached at 7.30 a.m., after running through a hilly country showing the limestone formation of the Jura and fully cultivated. Salins is, as the name indicates, situated in a salt district, and the salt springs have been worked from very early if not prehistoric times. At present it is very much frequented on account of the medicinal action of the water. The situation is remarkable, being overlooked by bold heights which rise to altitudes of 620m. (Fort Belin) and 599m. (Fort St. André), the town itself being at an altitude of 354m. above the sea-level. The curative effects of the salt waters (the mother-liquors remaining after the separation of the salt) are mainly attributed to their remarkable richness in bromide of potassium 322 c. gr. per kg. of water. The natural salt springs worked contain 27 gr., 5 of chloride of sodium per kg., and yield about 13,000 h.lit. per day at 12° C.; they are also largely used for bathing purposes. The total production in salt of these works is about 6000 tons per annum.

Leaving Salins in carriages, the excursionists followed the road which winds up through the heights, and thus had an occasion of seeing the successive outcrops of the geological formations so characteristic of the district, Trias, Lias and Lower Jurassic, the roadsides affording plenty of fossils at different points. The "Col" having been reached, a high undulating district was attained showing the influence of altitude by the relative lateness of the crops, oats, &c., and their sparseness. The farmhouses also mark the vicinity of the high Jura in their form, high-pitched tiled roofs, massiveness, and overhangings, all evidencing relative comfort and prosperity. Having passed the bridge called the Pont du Diable, from the fantastic head sculptured on the keystone of the principal arch, and from the wildness of the gorge over which the road leads, the excursion reached about 11 a.m. the charming and well-wooded valley, deeply enclosed in bold and picturesque Jurassic escarpments, called Nans sous Ste. Anne. Here an excellent *déjeuner* was served under a tent, and in the afternoon a visit was made to the sources of the Lison, situated in a deep hollow, worn out in the Jurassic beds, and receiving from a certain height a cascade which disappears in one of those caves so common to all limestone formations.

The return to Salins was by a different route to that of the morning, but showing fine vistas, and displaying on all sides careful culture and abundant forest growth, which is mostly communal and worked with great care and skill. Along the road in the morning lay piles of timber showing diameters at the butts of 2 feet and 2½ feet, and lengths of 15 to 20–25 yards. Having visited the salt-works in the town, and seen the evidence of their antiquity in the succession of massive masonry constructions required from time to time for their preservation, dinner was served about seven o'clock in the hotel of the baths, and the party returned to Besançon.

Tuesday, August 8, Montbéliard and Belfort. — Leaving Besançon at 6.15 a.m., with the continued fine and warm weather of this wonderful season, the line ran along the Doubs River through a very picturesque and highly cultivated country. Montbéliard was reached about 7.50, when after a short halt the excursionists proceeded by steam tram to the works of Messrs. Peugeot Bros., at Audincourt. The visitors were divided in two series, A and B; the first were conveyed to the workshops of Valentigney (rolling mills, manufacture of springs and saws), and the workshops of Beaulieu (manufacture of bicycles); the last section, B, was conducted through the workshops of Terre Blanche (tools, hardware in general, coffee-mills, coach factory, electrical force plant, &c.). These works seem very active, well organised, and well in touch with the requirements of their markets, the tools manufactured by the firm having a high reputation for quality and cheapness. Everything indicated care and attention to the wants of the working people, and the general air of comfort and prosperity which was apparent in other parts of the department, and about Besançon, were here equally evident. Montbéliard was reached about twelve o'clock. There is little remarkable in it except a château of the fifteenth and sixteenth century, which now serves as barracks for the troops. The town is largely inhabited by a race of Protestants, descendants of the Anabaptists who sought refuge there from Friseland. There is also a Jewish element in the population, as indeed also at Besançon and Dijon, marked by the synagogue of a conventional style of architecture and the Hebrew inscriptions. Montbéliard is a very pretty busy town as regards manufactures, but the sewage arrangements *laissent à désirer*; this is to a certain degree intelligible from the fact of the town being situated on the canal which joins the Rhône and the Rhine at the junction of the rivers Allaine, Savoureuse, and Lizaine, at an altitude of 322m. As seen on the occasion of the visit, that is, during a season of great drought, there were evidently elements of typhoid fever, whether prevalent or not was not ascertained.

From Montbéliard to Belfort the line ran through a more rolling country than that in the immediate neighbourhood of Besançon. Belfort (pronounced by the French "Bay four") was reached at 2.15 (after an excellent *déjeuner* at Montbéliard, served in the gymnasium). Situated on the frontier, always a fortress of note, and now rendered celebrated by its splendid defence by Colonel Denfert during the campaign of 1870, its historic interest overpowers its other attractions. Special permission had been obtained for the excursionists to visit the château or citadel. This permission was largely taken advantage of by the excursionists, notwithstanding the somewhat abnormal heat of the afternoon sun. Guided by the officers of the Association and by those of the military service, the visitors were first conducted to the site of the splendid colossal lion which graces the western face of the fortress. Designed by Bartoldi, and executed in Vosges sandstone, it harmonises admirably with the lines of the ground and of the fortress structure. Whether the colour adopted is the best artistically is a matter for the sculptor and artists in general, but the lines are very fine, and the attitude of the lion very happy and expressive. The visitors were then conducted to the plateau, or flat roof, which crowns this part of the fortress, from which is discovered a splendid panoramic view of the surrounding country. An officer of the fort very obligingly gave a detailed description of the district surveyed, explained the position of the German army of siege, showed the line now forming the frontier, pointed out the various points of interest in view from the Ballons des Vosges in the north, to the Swiss Jura in the south, with the vast and fertile plain of Alsace lying between these points, here and there dotted with villages in the distance. One could not fail to appreciate the significance of the absence of a natural frontier line at this point, and at once to understand the vastness of the armaments which have to make good the security of a country so bounded.

A visit was then paid to the monument raised to the volunteers who fell during the campaign of 1870, and then a return was made to the principal square, in which the Town Hall is situated; here, at seven o'clock, dinner was served in a splendid hall ornamented with a set of very fine historic paintings illustrating events in the history of the place. A few and deeply felt words of welcome from the Maire, an equally short but expressive speech from the Préfect of the Department, and the dinner ended under the happiest of conditions for the visitors. A municipal band played during the dinner, and gave the members of the Association a *retraite aux flambeaux* to the station, whence Besançon was reached about 11.15 p.m.

Visit of the Citadel of Besançon, August 7.—By special permission the citadel was opened to the members of the Association in the afternoon of this day. The members, taking advantage of it, assembled at the Roman triumphal arch still preserved and known as the Porte Noire. Thence ascends the steep road conducting into the fort, and remembering that it may have been, or rather must have been, used by Cæsar when occupying and holding garrison in this city, one could not but feel a greater interest attaching to the various points presented by the guide. The structure of the fort is mainly due to Vauban, but of course is now somewhat out of date, but the position, taken in conjunction with the occupation of the neighbouring heights, is still very strong, and of great military value. From the parapet of the highest part of the fortress a splendid bird's-eye view is had of the town and its surroundings, while the windings of the River Doubs underneath, the variety of the culture clothing the neighbouring hills, the forts quietly looking out over all, and the hum of activity ascending the town, rendered the visit highly interesting, despite the abnormal heat and the climb to the lofty point of view. During the reconstruction of the fort by Vauban, he was obliged to demolish the church of Ste. Etienne, badly injured during the siege. The material was not, however, lost, and amongst other usages a tombstone, evidently of a bishop or an abbot of the Middle Ages, was used as a flooring for one of the sentry boxes or videttes which line the parapet or path running round the summit of the fortress. Other remains have been preserved, partly in the fort, and partly in the garden near the Porte Noire, the former site of a Roman theatre.

Final Excursion, August 11 to 13.—An accident, slight in itself but troublesome for the time, prevented me assisting at this excursion, which comprehended the source of the Loue Pontarlier, Neuchâtel, Bienne, Chaux de Fonds, and the Saut du Doubs, that is, an extremely dangerous and picturesque district on the frontier of Switzerland.

J. P. O'REILLY.

VARIATIONS OF LATITUDE.[1]

"ALL astronomy," says Laplace, "depends upon the invariability of the earth's axis of rotation upon the terrestrial spheroid and upon the uniformity of this rotation." He adds that "since the epoch when the application of the telescope to astronomical instruments gave the means of observing terrestrial latitudes with precision, no variations in such latitudes have been found which could not be attributed to errors of observation, which proves that since this epoch the axis of rotation has remained very near the same point on the terrestrial surface." ("Mécanique Céleste," tome v. page 22.) Admitting then the position of the earth's axis, and consequently the values of terrestrial latitudes, to be sufficiently invariable for the purposes of the astronomer, the question has been many times raised whether this conclusion represents more than a kind of first approximation to the truth.

As this subject, or something very much like it, was receiving more or less attention on the part of the ancient geographers two thousand years ago or more, we can hardly claim for it the charm of novelty. An important feature of the geography of Eratos Thenis, written between 200 and 300 B.C., was a critical review of the work of his predecessors. His map of the world, which represented the best and latest information of his day, had as a sort of base line, or axis of reference, a parallel of latitude drawn from the pillars of Hercules towards the east, passing north of the island of Sicily, across the southern part of the Peloponnesus, and eastward across the continent of Asia. The positions of many places with reference to this line differed very considerably from those assigned by his predecessors. At the time of Ptolemy—400 years later—it was known that the map of Eratos Thenis failed in many particulars to conform to the then existing order of things. The conclusion was obvious; evidently changes had taken place in the relative positions of a number of prominent places on the earth; nor were these changes simply the trifling fractions of a second with which men are struggling so valiantly in these degenerate days, but such satisfactory and tangible quantities as three, four, or five degrees. Ptolemy's geography furnished the basis for comparisons and discussions of this kind for fifteen hundred years. Some few of his latitudes, as that of Alexandria, were determined with such precision as was possible in those days, while the foundation of very many was little more than guess-work. Comparisons from time to time with later determinations brought to light discrepancies which served to keep the question open and to furnish material for speculation.

In this connection we shall stop only to mention Dominique Maria de Ferrare, who enjoys the distinction of having had as a disciple the illustrious Copernicus. This philosopher believed that the evidence showed conclusively a progressive change in the position of the pole, and that in time the torrid and frigid regions would in a manner change places.

So far as the latitudes of Ptolemy were concerned it was pointed out[2] that the discrepancies were in part due to the method employed in their determination—that of the gnomon which gave the altitude of the sun's upper limb, and consequently a value of the latitude too small by a quarter of a degree.

Two or three hundred years ago much interest was taken in this question. We find associated with it the familiar names of Tycho, Rœmer, Hevelius, Picard, Cassini, and many others. As greater accuracy in methods and instruments prevailed, it became evident that the rough positions of Ptolemy could not be employed with any confidence in discussions of this character. In connection with these more exact methods also a new phenomenon began to manifest itself, viz., changes of short period.

Christopher Rothman, a contemporary of Tycho, found systematic differences between the determinations of the latitude of his observatory made in summer and winter. Tycho's observations at Prague showed a like peculiarity. Rœmer also discovered it. He attributed it confidently to periodic changes in the position of the earth's axis, and hoped in time to give a complete theory of the same.

A memoir by J. D. Cassini,[3] published in 1693—200 years ago almost precisely—gives a very complete summary of the state of the problem at that day. After a detailed examination of the evidence he concludes:—"Notwithstanding all these apparent variations, we may say that not only has no extraordinary change in the altitude of the pole or in the meridian altitude of the sun occurred in recent times, but that the heavens have at all times occupied the same position with regard to the earth as during the past century. For there is reason to believe that all these variations which have been mentioned came from several defects which occur in observation." He then goes over in detail those sources of error which are so familiar to us—instrumental errors and defects in theory—one only having a somewhat unfamiliar appearance, viz., we may reasonably suppose that variations in the direction of the plumb line occur similar to those of the magnetic needle. Nevertheless he says it is very probable that from time to time small changes in the altitude of the pole actually do occur, but they are periodic in character and do not exceed two minutes in amount. Thus, instead of several degrees which were conceded by the astronomers of previous centuries, only a paltry two minutes was now allowed, but with improved instruments, with the discovery of aberration and nutation, and the perfection of the theory of refraction, even this modest allowance was gradually reduced to a vanishing quantity.

Meanwhile new arguments were found for a reconsideration of the question. Geology had taken its place among the sciences. In the investigation of the fossil remains of plant and animal life abundant evidence was found of a former temperate or subtropical climate within the Arctic circle. It was also evident that at one time considerable portions of Europe and North America had been covered with glacial ice. Laplace mentions the argument for a change in the position of the earth's axis, founded on the existence of the fossil remains of elephants in Northern Siberia, but believes that the discovery of the remains of one of these animals preserved in ice, the body of which was covered with thick hair, turns the argument against those who employ it (M.C. v. p. 20).

In the *Quarterly Journal of the Geological Society* for 1848 is found a communication from a mathematician and astronomer, Sir John Lubbock, on changes in climate resulting from changes in the earth's axis of rotation. He suggests a mathematical discussion of the problem in order to determine, as he says, "under what hypothesis a change of the position of the axis of rotation is possible or not." The President of the Association, Sir Henry T. de la Beche, in the annual address of 1849, deals at some length with this subject. Again, in 1876, we find Sir John Evans, then president of the Society, discussing the problem (*Quarterly Journal of the Geological Society*, 1876, p. 60). He describes with much detail the fossil remains found in Spitzenbergen and Greenland belonging to the Miocene, upper and lower Cretaceous, Jurassic, and other geological periods, all of which point to a former temperature much above the present. Thus, among the Miocene plants of Spitzenbergen Prof. Nordenshiäld mentions the swamp cypress, now found in Texas, siquoias of great size, limes, oaks, and even magnolias. So in the Lower Cretaceous period Prof. O. Heer distinguished seventy-five species, including ferns, Cycadeæ and Coniferæ, many of which are closely allied to species now found in sub-tropical regions. From these remains Prof. Heer infers that the climate of Greenland and Spitzenbergen during the Cretaceous period was very much the same as that which now prevails in Egypt and the Canary Isles. The existence of beds of coal, of mountain limestone formed of the remains of corals and bryozoa, and shells of marine molluscs, the remains of Ammonites, Nautili, and even a Saurian—the *Ichthyosaurus polaris*—all point in the same direction. While, as Prof. Houghton remarks, the arguments from the presence of Ammonites and Coalplants strengthen each other, the one demanding heat, the other light.

Sir John Evans sums up the arguments as follows:—"The three points which it appears to me are most important to bear in mind with regard to the article of flora are (1) that for vegetation such as has been described there must, according to all analogy, have been a greater aggregate amount of summer heat supplied than is now due to such high latitudes. (2) That there must have been a far less degree of winter cold than is in any way compatible with the position on the globe; and (3) that in all probability the amount and distribution of light which at present prevail within the Arctic circle are not such as would suffice for the life of the trees."

He afterwards supposes a hypothetical case of possible

[1] Address before Section A (Astronomy) of the American Association for the Advancement of Science, at Madison, Wisconsin, by Prof. C. L. Doolittle, of South Bethlehem, Pa., President of the Section.

[2] Delambre, "Histoire de l'Astronomie au Dix-huitième Siècle," p. 155.

[3] S'il est arrivé du changement dans la hauteur du pole au dans la Cones du Soleil? (*Memoires de l'Academie*, tome x. p. 360.)

elevation and depression, to which he invites the attention of mathematicians to determine whether it would not produce a change of 15″ or 20° in the position of the pole.

The invitation was duly accepted by Sir Wm. Thompson—now Lord Kelvin—and by Prof. G. H. Darwin. The former, by a process which he does not explain, convinced himself that a *vera causa* existed in the distortion of the earth, as shown by geological and other evidence, sufficient to produce large deviations in the position of the axis. To quote his own eloquent words, "Consider the great facts of the Himalayas and Andes, and Africa, and the depths of the Atlantic, and America, and the depths of the Pacific and Australia; and consider further the ellipticity of the equatorial section of the sea-level, estimated by Capt. Clarke at about one-tenth of the mean ellipticity of meridianal sections of the sea-level. We need no brush from the camel's tail to account for a change in the earth's axis; we need no violent convulsions, producing a sudden distortion on a great scale, with change of axis of maximum moment of inertia, followed by gigantic deluges; and we may not merely admit, but assert as highly probable, that the axis of maximum inertia and the axis of rotation, always very near one another, may have been in ancient times very far from the present geographical position, and may have gradually shifted through 10, 20, 30, or 40 or more degrees, without at any time any perceptible sudden disturbance of either land or water." (British Association Reports, 1876, Sections, p. 11).

Prof. G. H. Darwin has made this the subject of an elaborate mathematical investigation (*Phil. Trans.* 1877, p. 271). As the basis he takes the earth as we find it, assuming that the elevations of the continents and depressions of the ocean represent the kind and amount of distortion to which the earth has been subjected in the course of its past history. The mean elevation of the continents being about 1100 feet, and the mean depth of the oceans about 15,000 feet, it follows that in order to convert an ocean bed into a continent, or *vice versa*, an elevation or subsidence of 16,000 feet must have taken place. This would not, however, correctly represent the distortion of the earth, for the waters of the ocean flowing into the depressions would considerably modify the result. Taking into account the density of water as compared with the surface rocks, it appears that an extreme elevation of 16,000 feet from the bottom of the ocean to the surface of the supposed continent would be equivalent to an effective elevation of about 10,000 feet on a sealess globe. In case of a perfectly rigid globe, the only deformation which could take place would be that due to a redistribution of the surface materials. For a given elevation with a corresponding depression the maximum effect upon the position of the earth's axis would be produced when the elevations occurred in latitude 45° in two diametrically opposite quarters of the earth with corresponding depressions in the remaining quarters. In such a globe Prof. Darwin's analysis showed that the pole could never have wandered more than 3° from its original position as a consequence of the continents and oceans changing places. If, however, the earth is sufficiently plastic to admit of readjustment to new forms of equilibrium by earthquakes or otherwise, possible changes of 10° or 15° may have occurred.

This would, however, require such a complete changing about of the continents and oceans, with maximum elevations and depressions in precisely the most favourable places, as has certainly never occurred within geologic time. In fact, the evidence indicates that the continental areas have always occupied about the same position as now.

It would appear, therefore, that the geologist must give up this hypothesis of great changes in latitudes as a factor in the earth's development, unless, indeed, some other cause can be found of sufficient potency to produce the desired result. Such an agency is, perhaps, alluded to by Prof. Arthur Schuster in his address before Section A of the British Association a year ago (NATURE, 1892, Aug. 4, p. 327). He propounds this question: "Is there sufficient matter in interplanetary space to make it a conductor of electricity?" He adds that he believes the evidence to be in favour of this view; but the conductivity can only be small, for otherwise the earth would gradually set itself to revolve about its magnetic poles. If such an action were admitted, we must suppose the poles of revolution and magnetic poles would long since have been brought into practical coincidence, unless this consummation were frustrated by changes in the position of the latter.

However all this may be, the question before the practical astronomer is this—Have we any reliable evidence showing that progressive changes in the position of the pole are now taking place? If this question were submitted to a jury composed of twelve good men and true from the astronomical profession, the chances would be largely in favour of a verdict in agreement with Laplace's decision seventy years ago.

At the International Geodetic Conference held in Rome ten years ago, Mr. Fergola brought forward a plan looking to a systematic study of this and other questions connected with changes of terrestrial latitudes. This plan, which was favourably received, consisted in a scheme for simultaneous series of observations at pairs of observatories on nearly the same parallel of latitude, but differing widely in longitude. The instruments were to be prime vertical transits, and the same stars to be employed at each of the two stations. Several pairs of observatories were designated by Fergola as being favourably situated for the purpose. Among others, Washington and Lisbon, the difference of latitude being 11′ 7″, that of longitude 4h. 31m. It is understood that efforts in this direction were made at Washington, but the necessary cooperation at the other end of the line was not secured, and the plan came to naught. It has not come to my knowledge that the scheme was at that time seriously considered at any of the other points selected.

Fergola gave a tabular statement which at that time seemed to show small but progressive diminutions of latitudes in Europe and North America. This table, with some additions—the latter enclosed in brackets—is as follows:—

		°	′	″
Washington ...	1845	38	53	39·25
	1863			38·78
	[1883			38·94]
Paris	1825	48	50	13·0
	1853			11·2
	[1891			10·95]
Milan	1811	45	27	60·7
	1871			59·19
Rome	1810	41	53	54·26
	1866			54·09
Naples	1820	40	51	46·63
	1871			45·4[illegible]
Königsberg ...	1820	54	42	50·71
	1843			50·56
Greenwich ...	1838	51	28	38·43
	1845			38·17
	1856			37·92

In all these cases there is an apparent diminution during the present century. A similar tendency is shown by the observations of Peters, Gyldèn, and Nyrèn at Pulkowa, also by my own observations at Bethlehem since 1875. Instances are not wanting, however, where this diminution fails to manifest itself. Possibly most of the discrepancies shown here may be referred to periodic changes, the existence of which is no longer in doubt. It is by no means impossible or improbable that small local changes of latitude may occur due to slipping of the superficial strata of the earth's crust. That such lateral movements have taken place in times past in connection with mountain upheavals is, without doubt, true. That they are still going on in certain localities is probable; whether they are of sufficient magnitude to admit of measurement can only be determined by observation.

When we remember how few points there are on the surface of the earth, whose latitude was determined even no longer ago than fifty years, within one or two seconds of the truth, probably we should suspend judgment for the present with reference to the whole subject of progressive changes.

We come now to a phase of our subject with reference to which we can speak with some confidence, viz. periodic changes.

That in the case of a perfectly rigid earth, theory points to the existence of such a periodic change, completing its cycle in about ten months, has been long understood. In connection with the general problem of the motion of a free body under the action of any system of forces, the consideration of which was suggested by the problems of the solar system, we find the names of the leading mathematicians of the last century, d'Alembert, Segner, and Euler, not to mention others. It was the latter who, in 1765, in a work entitled "Theory of the Motion of Solid and Rigid Bodies," gave the equations the final form which Laplace declares seem to him the most simple which can possibly be obtained. (M. C.V. p. 284.)

The elegant form of these equations was due to the employment of the principle discovered by Segner, viz. that at every point of a body there are at least three principal axes of inertia at right angles to each other, which possess some very important properties. One of these properties is this—that if the body be set revolving about one of these axes which passes through its centre of inertia, and is understood by outside forces, it will continue to revolve about this axis for ever. If, however, it be started in its revolution about some other axis, the condition of things will be different.

In the first approximation to the solution of Euler's equations when applied to the earth, we meet with two constants of integration, whose values depend upon the position of the axis of revolution with respect to the principal axis of inertia (from which it can never differ greatly) at the instant which we take as the starting point of our integration. We further find that the presence of these quantities in our equations shows a revolution of the instantaneous axis of rotation about the principal axis of inertia. This rotation is in the same direction as the diurnal motion, the angular velocity y being expressed by the formula

$$y = \frac{C - A}{A} u$$

Where u is the velocity of diurnal rotation, C and A are the principal moments of inertia of the earth, the first with respect to the polar axis, the second with respect to an equatorial axis, the figure being regarded as that of an ellipsoid of revolution. The ratio

$$\frac{C - A}{A}$$

is found from the value of the constant of nutation, the degree of accuracy being such that the theoretical period of this rotation is known probably within one or two days. The value given by Oppolzer is 304·8 mean solar days. We shall assume it to be 305 days.

The angular distance between the two axes, evidently very small in case of the earth, can only be determined by observation, and will manifest its existence by fluctuations in the latitude having a period of 305 days. The first attempt to find by observation whether or not this movement was appreciable was by Bessel. This method was not well adapted to the purpose, and the result was negative or inconclusive.

The first quantitative determination which seemed worthy of confidence was made by Dr. C. A. F. Peters, of Pulkowa ("Recherches sur la Parallax des Etoiles Fixes," p. 146), in 1842. From a careful series of meridian circle observations carried on for thirteen months he found for the angle between the two axes ·071″ ± 017. Nyrèn followed with a careful discussion of the value given by the observations of Peters, Gyldèn, and himself with the same instrument. The results were ·101″, ·125″, and ·058″. Downing found from the Greenwich observations from 1868–77 ·075″ (*Monthly Notices, R.A.S.* March, 1892), while Newcomb found the somewhat smaller value ·04″ from the Washington prime vertical work.

These results are in reasonably good accord, and at first sight seem to show conclusively a real separation of the two axes, but as pointed out by Hall ("American Journal of Science," March, 1885, p 223), the form of the expressions for determining the quantity is such that an apparently real value will always be obtained. If we assume a uniform rotation of one pole about the other our equations will contain two unknown quantities, x and y, where $x = \rho \cos \xi \,.\, y = \rho \sin \xi$, therefore whatever values we may find for x and y . ρ will always have a real and positive value. This may, therefore, be nothing more than a function of the errors of observation. The true test was therefore to be sought in the agreement of the values of ξ when reduced to a common epoch. These were found to be quite discordant, so much so as to throw doubt upon the reality of the results. The truth, as we now understand it, being that Euler's theory, perfect as it is, does not apply without modification to the present problem—the earth not being strictly a rigid body. Doubts as to the absolute rigidity of the earth had been expressed by more than one investigator, and the matter was discussed in 1876 by Lord Kelvin (British Association Reports, 1876, Sections, p. 11), and in 1879 by Prof. George Darwin (*Phil. Trans.* 1879), in relation to the problems of precession, nutation and tidal action—the conclusion being that the rigidity of the earth is probably between that of steel and glass. The bearing of this upon the present investigation was first pointed out by Newcomb (*Monthly Notices*) *Royal Astronomical Soc.*, March, 1892), viz. that in consequence of the elastic yielding of the earth as a whole the period of this rotation would be lengthened.

Before considering this matter in detail, however, the exigencies of historical continuity require us to glance at some remarkable results of observation.

In the spring of 1884 Dr. F. Küstner, of Berlin, began a series of observations, the results of which were destined to awaken a widespread interest in this subject, or, perhaps more properly, to crystallise the interest which already existed. His original purpose was sufficiently modest. The great meridian circle of the observatory requiring some repairs, he proposed to employ the interval while it was out of service in making a limited series of observations with another instrument, the universal transit, according to the Horrebow-Talcott method for the investigation of the constant of aberration. His purpose was not so much that of deriving a new and definitive value of this constant, which should be entitled to rank with the excellent results previously obtained, as to test practically the applicability of the method to this purpose, and to acquire the experience which at a future time might lead to a favourable result in a more complete series. Possibly it would be overstraining a time-worn simile to compare the modest investigator with Saul, son of Kish, who, going forth to seek his father's asses, found a kingdom; but certain it is that his results were vastly more important and far-reaching than anything which he could have anticipated in his original programme. His observations, not numerous, but of the first order of excellence, led to a value of the constant of aberration which appeared to be wholly inadmissible. Many an investigator would have been discouraged with this apparent failure, and the world would have known nothing of it. Not so with Küstner. Instead of abandoning the experiment as a failure he set himself resolutely to work to discover the cause of the anomaly. After examining the various causes which might be supposed to have contributed to such a result, personal, instrumental, and refractional, he announced without hesitation that it was due to a change in the latitude itself, viz., that from August to November, 1884, the latitude of Berlin had been from 0.2″ to 0.3″ greater than from March to May in 1884 and 1885. This conclusion was materially strengthened by the examination of a considerable amount of collateral evidence, particularly Nyrèn's elaborate series of observations at Pulkowa from 1879 to 1882, employed by the latter in discussing the constant of aberration. This somewhat bold hypothesis naturally provoked much discussion, and many were sceptical as to its truth; but instead of resorting to polemics, and quoting the authority of Aristotle and the sacred Scriptures on the one side or on the other, means were promptly found for testing it. These comprised both a re-examination of old observations and new ones, undertaken for this express purpose. Among the latter were special series of latitude determinations extending over an entire year or more at Berlin, Potsdam, Prague, and Bethlehem, all by Talcott's method. All of these agreed most satisfactorily in showing the reality of the fluctuation during the years 1888, 1889 and 1890. But the final test which should determine whether the changes observed were due to movements of the earth's axis required observations to be carried on simultaneously at points differing widely in longitude. A latitude campaign instituted for this purpose was therefore entered upon in the summer of 1891, under the auspices of the International Geodetic Association, operations being carried on at Berlin, Prague, Strassburg, Rockside, San Francisco, and Waikiki.

Some of the results have been in possession of the public for several months, and they show in the most conclusive manner that we are dealing with a movement of the earth's axis.

A series of latitude observations was also carried on at Paris from December, 1890, to August, 1891; part of the time two different observers were employed using different instruments, their results agreeing almost exactly. (*Comptes Rendus*, 1892,

p. 895.) Science acknowledges no national allegiance, but it is interesting to note that this series fails to show any trace of the periodic change; considering the smallness of the quantity in question and the limited scope of the series this failure proves nothing *pro* or *con*. Yet Admiral Mauchez expressed the opinion that the fluctuations which the Germans had been attributing to changes of latitude were due to some other cause (*Comptes Rendus*, 1892, p. 862.) It is also noteworthy that the value of the latitude found at this time is 0·8″ smaller than given by the elaborate investigation of M. Galliot in 1879, in which he employed 1077 observations by ten different observers. (*Comptes Rendus*, vol. lxxxvii. p. 684.) In this discussion an annual period, having a semi-amplitude of 0·20″ manifested itself somewhat obscurely; but M. Galliot placed on record his opinion that this had its origin in some cause other than a change in the latitude.

We have seen how it came about that the reality of periodic fluctuations in the earth's axis was placed beyond dispute. As to the true nature and law of these fluctuations we should probably now be groping in darkness but for the services which Dr. S. C. Chandler has rendered in the way of solving the mystery. Before Dr. Chandler attacked the problem no one appears to have called in question the applicability of Euler's theory to the case of the earth. The impression was indeed quite general that the changes were for the most part of a fortuitous character, produced by precipitation of rain and snow, by ocean currents and aerial currents acting unequally in different hemispheres, and therefore in so far as they might manifest a periodicity, this would be annual in its character. As early as 1876 Lord Kelvin expressed the opinion that the causes were sometimes sufficient to produce change of half a second in the course of a year. (British Association Reports, 1876, Sections p. 11.) It seemed therefore beyond question that any periodic change must conform to the 305 day period of Euler, or to an annual period, or a combination of the two. The latter hypothesis was worked out very completely by Messrs. R. Radeau (*Comptes Rendus*, vol. iii. p. 568) and F. R. Helmert (*Astronomische Nachrichten*, vol. cxxvi. p. 217).

Matters were in this condition when in 1891 Chandler attacked the problem. The main features of this investigation are given in a series of seven remarkable papers published in the *Astronomical Journal*, written from time to time while the work was still in progress, and when, as a matter of course, the final result could not be known. Like Kepler, the author carries us with him along the successive stage of the investigation, we share with him his triumphs and disappointments, and rejoice with him when well-merited success crowns his efforts. As to his methods and purpose, these are given in his own words. "I deliberately put aside all teachings of theory, because it seemed to me high time that the facts should be examined by a purely inductive process that the nugatory results of all attempts to detect the existence of Eulerian period probably arose from a defect of the theory itself; and that the entangled condition of the whole subject required that it should be examined afresh by processes unfettered by any preconceived notions whatever. . . . The problem which I therefore proposed to myself was to see whether it would not be possible to lay the numerous ghosts in the shape of various discordant residual phenomena pertaining to determinations of aberration, parallaxes, latitudes, and the like, which had heretofore flitted elusively about the astronomy of precision during the century; or to reduce them to some tangible form by some simple consistent hypothesis. . . . It was thought if this could be done, a study of the nature of the forces as thus indicated by which the earth's rotation is influenced might lead to a physical explanation of them."

From May 29, 1884, to June 25, 1885, almost exactly the time covered by the observations of Küstner, at Berlin, Chandler was observing at Cambridge with the Almucantar. The resulting values of the latitude shared a progressive change, for which there seemed no explanation unless the change were that of the latitude itself. At that time this seemed too radical an hypothesis, so the results were printed as they appeared, leaving the explanation to the future. The close agreement of Küstner's results, the verification by the subsequent work at Berlin, Pulkowa, Potsdam, and Prague seemed to warrant the expenditure of the labour involved in a thorough investigation of the entire subject. He began with Küstner's work at Berlin, the vertical circle observations of Gyldèn and Nyrèn at Pulkowa, and the precise vertical observations of α Lyrae at Washington 1862–66. These agreed in showing a period of 427 days. The examination of observations of circumpolar stars at Melbourne, and of Polaris at Leyden, partially confirmed the result.

Next came the observations of Bradley at Kew, Wanstead, and Greenwich. Here a very puzzling phenomenon appeared, the period being only about one year, with an amplitude of nearly an entire second. In discussing the observations of Brindley at Dublin, made during the early part of the present century, an opportunity occurred to wrestle, and that successfully, with one of the ghosts before referred to, viz., the singular results which Brindley had obtained for the parallaxes of a number of stars, and which led to an interesting discussion between Pond and himself.

Thus series after series was analysed with results in the main encouraging, frequently puzzling, and sometimes disappointing. The law, if such existed, did not appear on the surface. The secret could only be discovered by an elaborate analysis of the material. Accordingly, forty-five different series, extending from 1837 to 1891, comprising more than 33,000 observations, were examined, from which an empirical law was deduced as follows.

The velocity of rotation of the pole was a maximum about 1774, the period being about 348 days. Since then the velocity has diminished at an accelerated rate, the period in 1890 being 443 days.

During the last half century the semi-amplitude has remained sensibly constant at 0·22″.

Only three of the forty-five series examined, and these among the least precise, intrinsically gave results contradictory of the general law. The next step in the process was to analyse the observations in a different manner, to discover whether the deviations from the provisional law were real, also in what manner the variations of the period were brought about. For this purpose the results were tabulated chronologically at twenty-day intervals, all reduced to the meridian of Greenwich. As a result the real nature of the phenomenon was most distinctly revealed, and was as follows.

The observed value of the latitude is the resultant curve arising from two periodic fluctuations superposed upon each other. The first of these, and in general the more considerable, has a period of about 427 days, and a semi-amplitude of about 0·12″. The second has an annual period with a range variable between ·04″ and ·20″ during the last half-century. The maximum and minimum of this annual component of the variation occur at the meridian of Greenwich about ten days before the vernal and autumnal equinoxes respectively, and it becomes zero just before the solstices.

As the resultant of these two motions, the variations of the latitude is subject to systematic alterations in a cycle of seven years' duration, resulting from the commensurability of the two terms. According as they conspire or interfere, the total range varies between two-thirds of a second at a maximum to but a few hundredths of a second at a minimum.

Accompanying the paper is a diagram showing the relation between this theory and the observations of the fifty-four years on which it is based. The agreement, at times almost perfect, at other times shows deviations, apparently systematic, which are perhaps due to imperfect knowledge of the constants, or to erratic deviations of meteorological origin.

Dr. Chandler finds the general outcome full of promise for the astronomy of precision, showing that observations are free from defects of a systematic character to a much greater extent than has heretofore been supposed.

As the results of which we have been speaking were announced from time to time they did not pass unchallenged. The reality of the 427-day period was very promptly called in question on account of its supposed conflict with dynamic laws.

Prof. Newcomb, who at first ranked as a sceptic, soon found a very plausible explanation by assuming that the earth is not a rigid body as required by Euler's theory. The question whether the earth as a whole should be regarded as a rigid body has long been more or less an open one. Certainly the waters of the ocean introduce an element of mobility, but the investigations of Lord Kelvin and Prof. Darwin of the bodily tides in a viscous spheroid when applied to the earth, gave very little, if any, evidence of yielding in case of the latter to external forces.

Laplace had discussed with negative results the effect upon the earth's motion of the mobility of the ocean. (M.C., tome v. p. 76.) Euler's equations had been modified by Liouville for the case of a body which is slowly changing its form from internal causes (*Liouville's Journal*, 2nd series, tome iii. 1858, p. 1), and these modified forms had been employed by Darwin in the discussion of the influence of geological changes in the earth's axis of rotation. (*Phil. Trans.* 1877, p. 271.)

No suspicion, however, seems to have entered the brain of any of these investigators that any modification of Euler's 305-day period would result either from the mobility of the ocean, or the elastic yielding of the earth as a whole.

Newcomb shows in a very simple manner how this result might follow (*Monthly Notices R.A.S.* March 1892, p. 336), for in consequence of this elastic yielding the pole of figure would be brought towards the pole of the instantaneous axis by the centrifugal force.

Let us call the undisturbed position of the pole of figure the fixed pole, the actual position at any instant the movable pole, and the pole of the instantaneous axis the pole of rotation. The movable pole is therefore constantly moving towards the pole of rotation, describing a sort of curve of pursuit; the instantaneous velocity of the latter about the former is that of Euler's period, but the effect of the motion of this movable pole is to diminish the velocity with respect to the fixed pole in the ratio of its distance from the latter to the distance from the pole of rotation.

Lord Kelvin remarks that this supplies a new and independent method of determining the effective rigidity of the earth. As will readily appear, in this distortion work is being done against resistance, and unless the earth be perfectly elastic, which is certainly not true of that part accessible to observation, the two axes would in time be brought into practical coincidence. The tidal action set up in the oceans would also tend to produce the same result. Apparently, then, the continued existence of this term requires a constantly recurring series of impulses.

Gylden remarks that the hypothesis of elasticity is not the only one which will explain the Chandlerian period. (Astronomische Nachrichten, Band 132, p. 193.) He also concludes as the result of a mathematical analysis that we must look for the impelling cause to concussions going on in the interior cavities of the globe.

Aside from the fact that these discussions are in need of explanation to an extent quite equal with that of the phenomenon itself, it is an open question whether any explanation is called for. We have no proof of the perpetuity of this term. We are in possession of no observations accurate enough to throw any light on this subject before the time of Bradley, nor can it be asserted that so small a coefficient has remained constant during the interval of 150 years; possibly it may be on the road to extinction.

As to the annual term, it seems to have no foundation in theory except as the result of meteorological causes, in which case we can hardly hope for more success in dealing with it than in predicting the weather on which it depends. For further improvement in our knowledge of this subject we must look to continued observation at a number of points carried on for this express purpose, and so conducted as to eliminate, if possible, all systematic errors. If, as seems probable, the coefficients—at least that of the annual term—partake of the erratic nature of meteorological phenomena, it will be necessary to keep this work up perpetually.

A plan is under discussion for establishing four permanent latitude stations on the same parallel of latitude, at intervals of 90° in longitude as nearly as may be. These will presumably be equipped with identical instruments of the most approved form, and the same stars employed at all of them. Until this plan, or some modification of it, is in working order—and probably for some time after—careful determinations at other points will continue to furnish valuable data, especially in settling the question of progressive changes, local or otherwise.

The instrument hitherto employed in special observations for this purpose is the zenith telescope. The possibility of determining latitude by measurement of the small difference of zenith distance of two stars properly situated—one culminating north, the other south of the zenith—was pointed out by Horrebow in his *Atrium Astronominæ* in 1732. (Wolf, "Geschichte der Astronomical," p. 608.) Possibly he may have made a practical application of the principle; if so, any account of it has escaped my notice. The method, however, was employed by Father Hell—otherwise not unknown to fame—in determining the latitude of his transit of Venus station at Wardoehume in 1769. He appears to have been unacquainted with Horrebow's previous suggestion, and determined his latitude in this way, as he says, from necessity.

The idea seems to have lain dormant until about 1834, when it was hit upon independently by Talcott in America, and Pond in England. The latter, in employing the zenith telescope—which had then been recently mounted at the Royal Observatory for the special purpose of observing γ Draconis—found that a fifth magnitude star passed the meridian thirty minutes later at nearly the same distance on the opposite side of the zenith.

By observing these two stars, reversing the instrument between them, he found certain advantages now well known to be inherent in the method. (*Phil. Trans.*, vol. cxxiv. p. 209.) Pond states that the same method may be employed with Altazimuths, and other portable instruments, but the communication appears to have attracted no attention, and apparently he made no attempt to develop it farther.

In striking contrast is the immediate success which attended the employment by Talcott of an instrument constructed to carry out this principle. The first practical application of it was in 1834, in the survey of the northern boundary of Ohio. (*Journal Franklin Institute*, October, 1838.) Its merits were very promptly recognised by the officers of the U.S. Coast Survey, where it received a number of modifications and improvements suggested by experience, making it practically the instrument which we have to-day. It was many years, however, before it came into use to any considerable extent on the eastern side of the Atlantic.

To America undoubtedly belongs the honour of practically introducing this important improvement in latitude determination.

But although Americans practically introduced the instrument to the world, it was reserved to the Germans to teach us how to use it. It is due in great measure to refinements and improvements devised by German observers and instrument makers that the probable error of a single determination is now ·12″ or ·15″, instead of three times these amounts, with which we were formerly satisfied. The essential features of this instrument are the micrometer and the level. Unless these are of a high degree of excellence first-class results cannot be obtained; especially is this true of the level, of which two are commonly employed with the best class of instruments. Only those who have experienced it are aware how difficult it is to procure levels of the necessary quality. Moreover, changes of form are liable to occur, rendering what was a good level worthless. The method so frequently employed by determining the value once for all, and continuing to use it for years without farther examination will not answer here.

This uncertainty of the level has led to devices for dispensing with it. One of these, which seems promising, is the floating Zenith telescope, invented by Fathers Hagan and Fargie. In this instrument the telescope, with its accessories, floats on the surface of a trough of mercury, the trail of the star as it crosses the field being recorded on a photographic plate, which may be measured at leisure. Possibly a way may be formed for making these exposures automatically, thus furnishing means for keeping a record continuous in so far as absence of daylight and of clouds will permit. With four stations established as described above, equipped with automatic instruments, data will be rapidly accumulated for settling the questions still remaining doubtful. It will not, however, be a work of merely one, two, or three, but of many years.

Is it too much to hope that within five or ten years we may see some such system as this in full and successful operation?

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A PARLIAMENTARY paper has just been issued in which is given an abstract of returns furnished to the Department of Science and Art, showing the manner in which, and the extent to which the councils of counties and county boroughs in England and Wales, and the county councils, town councils, and police commissioners of police burghs are devoting funds to the purposes of science, art, and technical and manual instruction. The returns were made by these bodies in response to a letter sent to them in December, 1892, by the Education Department. Much of the information contained in them was noted in these columns on August 28 (p. 404). It is remarked in the present returns: "A noticeable feature with regard to the work of the county boroughs is that many of the councils have either erected or decided to erect, technical schools, or have taken over existing schools, for the purpose of supplying technical instruction under their direct control, to which they have decided to apply the whole of the funds at their disposal, which in some cases include the proceeds of a rate levied under the Act of 1889."

AT the Cambridge summer meeting, recently concluded, a lecture was delivered in the hall of St. John's College, on the late John Couch Adams, by Dr. Donald MacAlister. The lecture gained in interest from the fact that Dr. MacAlister was a personal friend of the late professor, and was in consequence able to supply many interesting details as to his life. This was particularly the case when speaking of Dr. Adams' early training. Many know that Adams was a sizar of St. John's, but perhaps few realise what a strenuous course of self education had preceded his election. He taught himself algebra when a boy at his father's farmhouse in Cornwall, and prepared himself for Cambridge at a country school and at the local Mechanics' Institute. A curious entry is to be found in Adams' diary for June 26, 1841, during his second year at Cambridge: "Went to Johnson's (the bookseller in Trinity Street) and read Professor Airy's report on the state of astronomical science," showing, as Dr. MacAlister explained, that his interest lay in that direction at that time as at a slightly later date. In the Tripos it is well known that Adams was as far above the second wrangler, in an exceptional year, as the second was above the wooden spoon. In a surprisingly short space of time, by 1846, Adams became celebrated for his discovery of Uranus, but it may not be remembered that for a short time he was a Professor at St. Andrews. On his return to Cambridge as the Lowndean Professor, he became associated with Pembroke College, as from 1853 he was a Fellow there. The University, as a memorial, has undertaken the publication of his works, and a monument of some kind is shortly to be placed in Westminster Abbey.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 28.—M. Lœwy in the chair.—On a typhoon of last year in the China seas, by M. H. Faye.—R. P. Chevalier, Director of the Meteorological Observatory of Zi-Ka-Wey, has sent an account of the terrible typhoon of October 7-10, 1892, which led to the loss of the British mail steamer *Bokhara*, to M. Faye. A close study of the phenomenon has revealed the fact that there was no high-pressure area for a distance of 600 to 1000 miles round the centre. This result is entirely in opposition to Ferrel's theory which asserts that every cyclone is surrounded by a high pressure area representing an anti-cyclone. P. Chevalier is also convinced that in low latitudes cirrus clouds form a constant indication of a distant typhoon. According to him, the centre of a typhoon and its direction are indicated by the point on the horizon whence the cirri appear to diverge, an observation which would locate the origin of typhoons in the region of low-latitude cirri, *i.e.* at a height of about 1200 or 1300 m., instead of at the surface of the earth, as often supposed. But P. Chevalier believes that the interior motions of the cyclone are represented by rectilinear convergent trajectories curved by the rotation of the earth, so that the air ascends in all the phenomena, except at the centre, where even he does not go so far as to deny the descending movement so clearly observed by Manille. He observes, however, that the foot of the cyclone was lifted above the surface at intervals, to descend in another portion of its track, and that it was independent of the nature of the ground, thus characterising itself as a phenomenon originating in the higher atmospheric strata exclusively.—Chrono-photographic study of the different kinds of locomotion in animals, by M. Marey.—In order to photograph different animals in motion, reptiles must be placed in a sort of circular canal where they can run on indefinitely, the chrono-photographic apparatus being placed above this canal. Fishes are made to swim in a similar canal filled with water illuminated from above, so that they appear dark on a light ground, or from above, so as to appear light on a dark background. The principal difficulty lies in causing the animal to move in its natural manner. Some interesting analogies may be observed between simple creeping and more complex movements. An eel and an adder progress in the water in the same manner; a wave of lateral inflexion runs incessantly from the head to the tail, and the speed of background propagation of this wave is only slightly superior to the velocity of translation of the animal itself. If the eel and the adder are placed on the ground, the mode of creeping will be modified in the same manner in the two species. In both, the wave of reptation will have a greater amplitude, and this amplitude grows more and more as the surface becomes smoother. In fishes provided with fins, and in reptiles possessing feet, there remains, in general, a more or less pronounced trace of the undulatory motion of reptation. The grey lizard, when photographed at the rate of forty or fifty exposures per second, exhibits this clearly, and also reveals the fact that the mode of progression by means of the feet is diagonal, and analogous to trotting. This gives rise to an alternation of convexity and concavity in the body on each side.—On a property of a class of algebraic surfaces, by M. Georges Humbert.—On the third principle of energetics, by M. W. Meyerhoffer.—The new principle recently added by M. Le Chatelier to thermodynamics, to the effect that every form of energy may be decomposed into two factors, one of which is of a constant magnitude, was enunciated two years ago by M. Meyerhoffer in the following form: everything which takes place in the world consists of processes in which the different capacities change their potential without changing in quantity, where the two factors are the capacity (*Inhalt*) and the potential.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (April to June) contains the following papers of scientific interest.

April.—H. Weber: Researches in the Theory of Numbers in the domain of Elliptic Functions, III. Th. Liebisch: The Spectrum Analysis of the Interference Colours of Biaxial Crystals. G. Bodländer: Experiments in Liquids containing Substances in Suspension, I.

June.—Lazarus Fletcher: Remarks on the Catalogue of the Meteorite Collection of the Göttingen University. F. Kohlrausch and W. Hallwachs: On the Density of Dilute Watery Solutions (with diagrams). F. Hultsch: The Approximate Values of irrational square roots given by Archimedes (with diagrams).

CONTENTS.

THURSDAY, SEPTEMBER 14, 1893.

THE MECHANICS OF FLUIDS.

Hydrostatics and Elementary Hydrokinetics. By George M. Minchin, M.A., Professor of Applied Mathematics in the Royal Indian Engineering College, Coopers Hill. (Oxford: at the Clarendon Press, 1892.)

A WORK on this subject which should incorporate the latest developments has long been wanted; and Prof. Minchin has performed a very useful service in providing a treatise of a convenient size for purposes of instruction.

The first chapter starts with some general theorems on the distribution of strain and stress in the interior of a body, which to our way of thinking had better have been relegated to Chapters iii. or iv., by which time the student would be able to appreciate their importance. Mr. Minchin, however, justifies his method in eloquent language, but his simile of the danger of leaving uncaptured fortresses in the rear partakes of ante-Napoleonic ideas; as Napoleon proved it makes all the difference whether the foe is stationary or mobile.

We are pleased to see the author's practical protest against the banishment of the notation (we cannot dispense with the idea) of the Differential Calculus, traditional in our elementary treatises. A French schoolboy acquires a working knowledge of the Differential Calculus episodically, in the course of his studies of elementary algebra and trigonometry.

Mr. Minchin postulates at the outset a *perfect* fluid, that is a fluid devoid of viscosity. This is necessary when we come to the Motion of Fluids; but the theorems of Hydrostatics are true of all fluids, however viscous, such as tar, or even pitch; a fluid from its general definition is not capable of coming to rest till the *normality* of the stress has been attained.

The word *intensity* is prefixed by the author when it is wished to indicate that a stress is estimated per unit area; thus, for instance, 150 pounds on the square inch he calls the "intensity of the pressure." But this is contrary to our ordinary language, where "intensity" is never employed Mr. Minchin had better have adopted another word, "thrust," to express total pressure or push against a given area, leaving the words stress and pressure, as in common usage, to imply that they are estimated per unit area, square foot or inch, metre or centimetre.

This would not be the work of a modern college professor if the author did not explain at some length that the world has been calling things by their wrong names; thus it is maintained that the expression above "a pressure of 150 pounds on the square inch" is inaccurate, and should always be replaced by "an intensity of pressure of 150 pounds' *weight* on the square inch."

This is a counsel of perfection which a careful search would probably show is not always observed by the author himself; and it is invariably ignored and rejected by practical men, including his own engineering colleagues.

Thus Prof. Hearson, R.N., in a recent examination paper at the Naval College, Greenwich, asks for the calculation of the resistance of a train in "pounds per ton weight"; but his M.A. colleague would edit this into "pounds' weight per ton mass."

The Coopers Hill student will have to be as careful to recollect the expression appropriate for the class-room he is attending, as the Chairman of the House of Representatives in America, according to the story, in addressing the rival members of Illi*noi* and Illi*noise*.

The use of the word "weight" to designate only the accidental quality of a body due to its position on the surface of the Earth is much insisted upon by a certain school of our writers; but this temporary fad will soon pass away, we hope, as it seems to be tainted with the ancient heresy of the existence of bodies possessing positive levitation, such as the fire or inflammable air said to have been employed in Archytas's pigeon, or the rarefied dew with which Bishop Wilkins proposed to fill a number of egg-shells, and thereby fly in the air.

For instance, what is the weight of a ton (mass) of hydrogen; must we say that it is about—13 tons?

Prof. Oliver Lodge would banish the word "hundredweight" from our language; but what has he to offer the architect in exchange?

Pressures on foundations in architecture are most conveniently measured in cwt. per square foot, from the simple fact that the average weight of a cubic foot of brickwork is one hundredweight.

If the architect of the Tower of Pisa had made a calculation in accordance with the modern formula for the resistance of foundations in earth,

$$p = w\,h\left(\frac{1 + \sin\phi}{1 - \sin\phi}\right)^2,$$

in cwt. per sq. foot, at a depth of h feet in earth of density w cwt. per cubic foot, ϕ denoting the angle of repose of the earth, he would have found that his depth of 22 feet, with $w = 0{\cdot}8$ and $\phi = 22°$, would bear only 84 cwt. per square foot; while the pressure due to the weight of the tower mounted up to 145 cwt. per square foot.

Students owe a debt of gratitude to Prof. Minchin for having almost entirely banished the old-fashioned mystifications concerning

$$W = sV \text{ and } W = g\rho V;$$

and he very clearly points out that the pressure at a depth z in liquid of density ρ is not given by ρz gravitation units, but by $g\rho z$ absolute units.

But the introduction of the new term "*specific weight*" to designate what has hitherto been called the *heaviness* (or *density*) of a substance is to be deprecated, especially as the author is careful to explain that he does not mean *specific gravity* by *specific weight*.

But the German for specific gravity is *spezifische gewicht*, so that confusion is sure to arise; much the same as with the word *masseinheit*, which means unit *of measure*, and not *unit of mass*, as it has been incorrectly translated.

It is doubtful whether any advantage is gained by the introduction of absolute units into a statical subject; they are never used in experimental and practical work; but if the experimenter wishes to express his numerical results in a cosmopolitan form, he can multiply his gravitation results by the local value of g, as the last operation of all.

Unfortunately, in the C.G.S. system selected by scientific men, the units are so minute that they are only suitable for the most delicate phenomena of the physical laboratory, such as Capillarity; and numbers run very high in ordinary dynamical problems.

Millions of *boles* of impulse would be required to flick a sixpence across the counter; and the answer "millions," which Albert Smith said he received from the stoker when he asked how many degrees of temperature there were in the stoke-hold, would not be wrong if he had asked what pressure the boilers carried; "fifteen millions" might be the answer of the scientific stoker of to-day, trained in the use of the C.G.S. system.

Another banishment from this treatise to be grateful for, is that of "the whole pressure of a fluid on a curved surface."

If, however, this whole pressure is divided by the surface, we obtain the *average* pressure over the surface, a distinct mechanical motion, sometimes useful; with this resetting the "visionary problems of pure mathematics" on whole pressure might be allowed to survive, as some of them embody elegant geometrical applications.

Generally throughout the work Mr. Minchin has secured the assistance of his colleague Mr. Stocker, the Professor of Physics, for the experimental illustrations and diagrams, and we meet with many novel and ingenious experiments, for instance in the illustration of Boyle's Law in Fig. 57.

This gives a flavour of the Physical Laboratory to the book, and not that of the Engineering Theatre, except for the elegant geometrical treatment of the ine of Thrust in a Reservoir Dam. The Hydraulic Press of Fig. 7 could hardly serve to lift a girder of the Britannia Bridge, or squeeze a steel forging with a thrust of thousands of tons.

The equilibrium and stability of a floating body is illustrated in Fig. 49 by what looks like a champagne cork, and not by the cross-section of an ironclad or Atlantic steamer, with compartments bilged and full of water to illustrate the effect of petroleum or liquid cargo, or the unfortunate capsizing of the *Victoria*.

The diagram of a floating body in the ordinary mathematical treatise, where it is not like a cinder or a potato, but a vague idea of the cross-section of a ship, has the metacentre placed somewhere up the mast.

Prof. Minchin reduces this metacentric height to more reasonable figures, 5 or 6 feet; but even this is excessive, as H.M.S. *Prince Consort*, with a metacentric height of 6 feet, was a notorious bad roller; vessels of the greatest size are plying successfully with a metacentric height of under 1 foot; and we read a day or two ago of one of the largest modern steamers becoming unstable when being undocked.

The question of the stability of a ship involves the two antagonistic qualities of "stiffness" and "steadiness."

A "steady" vessel has a small initial metacentric height, and "stiffness" under sail is secured by making the metacentre rise rapidly as the ship heels.

The whole theory of the geometry of the ship is one of great mathematical interest; and the valuable compilation of all the best recent work on this subject, made by Sir E. J. Reed in his "Stability of Ships," deserves to be better known among mathematicians.

Chapter vi., on Gases, is one which will excite great admiration, from the way in which the leading parts of Thermodynamics are introduced; the most recent theories have been incorporated and illustrated numerically and experimentally; here the valuable assistance of Prof. Stocker is acknowledged. In this part of the subject we think that a simplification would be effected by pointing out that with the gravitation units employed in § 48, the quantity k in the equation $p = k\rho$ is the "height of the homogeneous atmosphere."

Hydraulic and Pneumatic Machines are carefully described and illustrated in Chapter vii. Fig. 71 of the Fire Engine is curious as illustrating the continuity of mathematical diagrams, as it might have been copied from the one given in Hero's Pneumatics B.C. 120, as invented by Ctesibius.

The hydraulic ram (*bélier hydraulique*), Fig. 73, is here attributed to Whitehurst, of Derby (1772). This will raise a protest in France, where Montgolfier is considered the inventor; but, on the other hand, Mr. Minchin gives Mariotte a half share in the discovery of Boyle's law.

Chapter viii., on "Molecular Forces and Capillarity," is very complete but rather formidable, as it does not shirk the difficult theories of Laplace on Molecular Pressure. The author must utilise in the next edition the scale invented by Mr. C. V. Boys, for drawing with accuracy the various capillary curves.

In the two hydrodynamical Chapters, ix. and x., there may appear some need for the use of the absolute units; but considering that the motion discussed is due to gravity, the only effect of a change from gravitation to absolute units is to remove g from the denominator of certain terms to the numerator of the remainder in the equations.

The use of hyperbolic functions would simplify the expressions on the last page of the book, in the discussion of Kelland's state of wave motion.

Judiciously selected examples are introduced in small sets, to illustrate the principles at easy stages; these are printed in smaller type, and the book is thereby kept within a handy size; at the expense, however, of the eyesight of some readers.

A. G. GREENHILL.

LETTERS TO THE EDITOR.

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

Palæozoic Glaciation in the Southern Hemisphere.

THE interest evinced in the above subject in so many quarters, and the evident ignorance of what has been done in the matter, is my excuse for asking space for some notes on my personal researches.

South Africa.—In July, 1872, while journeying through Bushmanland, at Mr. Niekerk's farm "Welgevonden," near Prieska, on the Orange River, I observed extensive accumulations of pebbles and boulders loosely piled, many of them striated, scored, and facetted—in fact, unmistakably ice-marked. One of the boulders I took to Cape Town, and deposited it in the South African Museum. This was the first discovery of glaciation in Cape Colony, and it attracted some attention at the time (*vide Cape Monthly Magazine*, &c.). While crossing Bushmanland, the boundaries of this conglomerate were jotted down, and they were delineated on my Sketch

Geological Map of Cape Colony, 1873, published by Stanford, London.

In the southern portion of Cape Colony no formation has excited so much interest, or proved so inscrutable a puzzle to the earlier geologists, as the zone of rock named "Porphyry" and "Trap Conglomerate" by the late A. E. Bain, "Trappean Ash" by Wylie, "Metamorphic Rock" by Pinchin, &c., and called "Bushman Graves" by the Boers. In Natal the same formation occurs, and Dr. Sutherland (of that colony) was the first to consider it as possibly of glacial origin, but he obtained no direct evidence to support that view.

As the names applied to this singular conglomerate were all misleading in my Sketch Geological Map of 1875, I named it the "Dwyka Conglomerate," on account of the excellent and characteristic sections exposed where the river of that name cuts through it.

While at Matjes Fontein, Cape Colony, in June, 1885, I obtained the first evidences of glaciation in this southern extension of the conglomerate among the loose pebbles, and more abundant evidence at Prince Albert, close by. In my report of 1886 to the Cape Government, the full extent of these conglomerates in South Africa is shown. Incidental reference and sections of the conglomerate occur in my report to the Cape Government dated 1879. The full extent of the conglomerate is also shown in my Sketch Geological Map of South Africa of 1887, published by Sands and McDougall, Melbourne.

Australia.—In 1887 I obtained indubitable evidence of glaciation in the conglomerate of Worragee, near Beechworth, Victoria, and placed well-striated pebbles and boulders in the local museum and in the Technological Museum, Melbourne. These were the first glaciated stones discovered in the palæozoic conglomerates of Victoria. Shortly afterwards, on visiting Bacchus Marsh and the Wild Duck Creek, I obtained abundant and unchallengeable testimony to the glacial origin of these conglomerates also for the first time, although their glacial origin was suspected thirty years ago by Sir A. Selwyn and the late Mr. Daintree. A paper on the subject was read before the Royal Society of Victoria in 1887, and several localities besides the above described. Another was read before the Australasian Association Meeting, December, 1890. A special report on the Wild Duck Creek conglomerate, prepared in 1891 for the Geological Survey Department, was published in 1892.

Tasmania.—In October, 1892, I once more encountered this remarkable conglomerate at the base of Mount Reid, near Strahan, and at an elevation of 3000 feet above sea-level. At this site it corresponds in a remarkable manner with both the Dwyka conglomerate of South Africa and the Wild Duck Creek conglomerate of Victoria. At the same time, and at a few miles' distance, I discovered around Lake Kora very extensive and marvellously well developed evidences of modern glaciation on a large scale. These discoveries were made public through the press at Hobart and at Melbourne in the beginning of November following, and a paper and plan has been submitted to the Royal Society of Melbourne, and read. The whole of my reports and maps have been supplied to the Geological Society, Burlington House. E. J. DUNN.

Melbourne, July 15.

Astronomical Photography.

LORD RAYLEIGH, in his letter (August 24), raises the interesting question of the adaptability of the plate to the object-glass. This is a novel idea, and I hope with him that we shall have the opinion of Captain Abney or some other authority on the question, or that it will be settled experimentally whether the use of an object-glass corrected for visual work will give, with properly prepared plates, results approximating those obtained with the photographic object-glass. In the case of Cambridge Observatory, there is already an object-glass of nearly twice the area of the proposed photographic telescope, so that it is quite possible as good results might be obtained with the Newall telescope as with the proposed one.

With the collodion process, where the curve of sensibility of the photographed spectrum had a well-defined summit, the photographic object-glass corrected for that part left very little to be desired. Now, the curves of sensibility of the different kind of plates vary extremely. We have long flat curves, or curves with two maxima; in fact, there is such a range now that it is a matter of surprise to me that any object-glass produces such good results as are obtained. Some years ago, after reading Dr. H. W. Vogel's "Photography of Coloured Objects," I thought that astronomers would be driven to the use of the only instrument that will use any and every plate—the Reflector; or if they would use the object-glass, that they would have to first find the most sensitive plate, and then make their object-glass to suit it. They should be made to suit each other. If this can be done by a variation of the photographic process without paying too dearly for it in the loss of sensitiveness, a great deal will be gained in many ways.

The great doubt in my mind is whether it is possible to get rid of the blue rays without the use of screens.

In any case, the object-glass can never properly use all the available light in the way the Reflector does, and it is a matter of extreme surprise to me that, notwithstanding the magnificent results obtained by the Reflector in astronomical photography astronomers still seem to prefer the expensive object-glass.

Ealing, September 11. A. A. COMMON.

The Greatest Rainfall in Twenty-four hours.

As a resident of Dehra Dún, I was interested in a paragraph at p. 297 of NATURE for July 27, 1893, saying that the *Indian Planters' Gazette* had recorded a rainfall of 48 inches at Dehra Dún on the night of January 24, 1893. As 48 inches is considerably more than half our average yearly rainfall (86 inches). I have looked up the official returns of the Meteorological Reporter to the Government of India. They give for the rainfall recorded at 8 a.m. on January 24, 1893, 0·26 inches only, 1·07 inch being the recorded fall on the same date at Mussoorie, on the hill range 11 miles off. I have examined the Dehra Dún rainfall records since January 1, 1867, and find that the largest amount recorded for any one day since that date is 11·60 inches, which is given for July 30, 1890. It is possible that the correspondent referred to wrote 4·8 inches, but even that amount, though not an uncommon fall for the monsoon season between June and September inclusive, would be a heavy fall for January. The highest recorded fall for any day in January is 2·84 inches on January 26, 1883.

J. S. GAMBLE.

Imperial Forest School, Dehra Dún, Aug. 22.

[The paragraph in question was taken from the *Ceylon Observer*. We append it as it appeared in our issue for July 27, together with a remark we made at the time.—ED.]

"If the *Indian Planters' Gazette* of 28 Jan., 1893, is correct, the following paragraph establishes a still higher record. On page 59 one reads: 'Our Dera Doon correspondent writes on January 24, 1893: last night we had 48 inches of rain, and all the hills are covered with snow. It is still raining.'" For this to have any scientific value, however, it must be known who were the observers, and by what means the rainfall was gauged.

Wasps.

OF late much has been written about the seasonal prevalence of wasps, and the mischief, in several places, wrought by them. May not, however, their use in keeping down many forms of insect pests be set off as some sort of palliative? Wasps are exterminators of aphides, and although the season has been favourable to insect-life, next to no damage has been done to the hop-bines or the corn or pulse crops of Worcestershire or Herefordshire by these latter pests—frequent destroyers of crops.

Is it suggestible that the excessive wasp prevalence is attributable in some measure to the abundance of their insect prey, just as has recently happened in Scotland, in the instance of the multiplication of the short-eared or "Woodcock" owl, owing to the plague of field voles? The owl is a winter immigrant, usually leaving in spring. "Nests in ordinary seasons are of rare occurrence in Great Britain, but owing to the vast increase of their favourite food—the field vole—these owls have not only arrived in increased numbers, but have remained and bred in Scotland all over the affected districts, laying from eight to thirteen eggs, and rearing large broods," instead of the few eggs these owls have hitherto been accredited with laying.

I am a fruit-grower. Much damage has this year been done to the fruit; not, however, by the wasp tribe, but by hungry birds, the fruit having even been attacked in an unripe state. According to my experience wasps do not become household pests till the falling-off of insect prey towards autumn.

Worcester, September 1. J. LLOYD BOZWARD.

THE AMERICAN ASSOCIATION.

MADISON, Wisconsin, at which the forty-second meeting of the American Association for the Advancement of Science was held, August 17 to 22, is a beautiful little University town, surrounded by clear, glacial lakes, and is the capital of the State of Wisconsin.

Several causes conspired to reduce the attendance of members at this meeting—the distraction of the World's Fair at Chicago, the financial stringency, and the remoteness of the place of meeting from the sea-board, where most of the members reside; but it was characterised by an earnest tone and an excellent quality of scientific work.

At the opening session the retiring President, Prof. Joseph Le Conte, gracefully introduced his successor, Prof. William Harkness, by remarking that while he represented geology, the president-elect represented astronomy: one the oldest, the other among the youngest of sciences; one concerned with the universe of space, the other with the universe of time; one with the law of gravitation, the other with that of evolution; one with the divine method of sustentation, the other with the divine method of creation of the universe.

Addresses of welcome followed by Major Corscot, General Lucius Fairchild, chairman of the local committee, and President C. K. Adams, of the University of Wisconsin, where the meeting was held. The latter gave a brief account of the use of the University, which has always made science prominent, and remarked that we are doubtless on the eve of wonderful discoveries. Physics and chemistry bring us near to the ultimate analysis of matter.

President Harkness, in replying, referred among other things to the British Association for the Advancement of Science as the pioneer of all such organisations. The reports of the condition of science at its organisation, over sixty years ago, were still valuable, and the early star catalogues made under its auspices were a valuable contribution to advancing science. The matter of nomenclature of electrical units was settled by the British Association, and the names, watt, ohm, ampere volt, now universally adopted, originated there.

Thursday afternoon was occupied with the addresses of the several vice-presidents, some of which will be printed in full in later numbers of NATURE. The generally high order of these addresses was matter of comment among members. The subjects presented were "Variations of Latitude," by C. L. Doolittle; "Phenomena of the Time Infinitesimal," by E. L. Nichols; "Twenty-five Years' Progress in Analytical Chemistry," by Edward Hart; "Training in Engineering Science," by S. W. Robinson; "Geological Time as indicated by the Sedimentary Rocks in North America," by C. D. Walcott; "Rise of the Mammalia," by H. F. Osborn; "Evolution and Classification," by C. E. Bessey; "The Biloxi Indians of Louisiana," by J. O. Dorsey; "The Mutual Relations of Science and Stock Breeding," by Mrs. H. Brewer.

The annual address by the retiring president, Prof. Joseph Le Conte, in the evening, on "Present State of Science on the subject of the origin of mountain ranges," was a masterly presentation of that difficult problem by an authority recognised as such throughout the world. The evening sessions were held in the capitol.

The mornings and afternoons of Friday, Monday, and Tuesday were occupied with reading of papers in the several sections.

On Friday evening Dr. Daniel G. Brinton lectured on "The Earliest Men," reviewing the latest discoveries of anthropologists. He localises the first habitat of man in southern Europe or northern Africa, or on the continuation of these latitudes in western or central southern Asia. Man seems to have been evolved *per saltum* from the highest anthropoid animal in the glacial, or possibly just before the glacial epoch, giving an antiquity of 50,000 to 100,000 years. The earliest men, so far as can be ascertained, walked erect, had full foreheads, red hair, and blue or gray eyes, were about of the same size and general appearance as now, perhaps were not even hairy, were kind to each other, social and artistic, had some sort of language, and knew how to make fire. Dr. Brinton's lecture, startling to the uninitiated by the boldness of his conjectures, derived added interest from his subsequent election as president of the association. As an anthropologist and anthropological writer, he has long occupied a front rank. He is a resident of Philadelphia, and a graduate of Yale in the class of 1858. He is a physician by profession, and a native of Chester County, Pennsylvania, where he was born in 1837.

The social features of the meeting were thoroughly delightful. The excursion to which Saturday was devoted deserves special mention, both for its pleasant relaxation and for the scientific interest of the region visited. Taking the cars of the Milwaukee and St. Paul railroad, a favourite tourist route, well known in England as well as in America, which is the only railroad leading to the scenic wonderland selected by the local committee as the best exhibit they could make to their guests, the association first passed through the remarkable driftless area ten or fifteen miles from the city. This is a region much studied by geologists as one which escaped the ice covering which extended over all the rest of the country during the glacial epoch. A ride of an hour and a half brought the train to Kilbourn city, where steamboats were taken up the Wisconsin river a distance of several miles, through "the dells" of that river, which are an expression of erosion resulting from a diversion of the Wisconsin river from its pre-glacial channel by the ice, and by the massive moraines which it produced. The rocks are Cambrian sandstone, and they show false bedding on a magnificent scale.

The places for several subsequent meetings of the association seem to be pretty clearly indicated, though no appointments were absolutely made. The new building of the Brooklyn Institute furnishes a good occasion for a meeting at Brooklyn next year, especially since that is now the only large city in the United States and Canada which has never been visited, if we except San Francisco, to which cordial invitations for a meeting in 1895 have already been received. The policy of the association, ever since its reorganisation at Buffalo in 1866, has been to hold decennial meetings at that city, so that 1896 also seems to be thus provided for.

The officers elected for next year are—president, Daniel G. Brinton, Media, Pa.; vice-presidents (Section A), Geo. C. Comstock, Madison, Wis.; (B) William A. Rogers, Waterville, Me.; (C) Thomas H. Norton, Cincinnati, O.; (D) Mansfield Merriman, South Bethlehem, Pa.; (E) Samuel Calvin, Iowa City, Iowa; (F) Samuel H. Scudder, Cambridge, Mass.; (G) Lucien M. Underwood, Greencastle, Ind.; (H) Franz Boas, Worcester, Mass.; (I) Henry Farquhar, Washington, D.C.; permanent secretary, F. W. Putnam, Cambridge, Mass.; general secretary, H. L. Fairchild, Rochester, N.Y.; secretary of the council, J. L. Howe, Louisville, Ky.; secretaries of the sections; (A) W. W. Beman, Ann Arbor, Mich.; (B) Benjamin W. Snow, Madison, Wis.; (C) S. M. Babcock, Madison, Wis.; (D) John H. Kinealy, St. Louis, Mo.; (E) Wm. M. Davis, Cambridge, Mass.; (F) Wm. Libbey, jun., Princeton, N.J.; (G) Charles R. Barnes, Madison, Wis.; (H) Alexander F. Chamberlain, Worcester, Mass.; (I) Manly Miles, Lansing, Mich.; treasurer, Wm. Lilly, Manch Chunk, Pa.

In Section A (Astronomy and Mathematics) most of the papers were as usual highly technical. The president of the section, Prof. Doolittle, carried on the line of thought presented in his annual address, by a paper on "Latitude Determination at Bethlehem in 1892–3," in which he stated that the fluctuation in latitude thus far noticed does not exceed about $0''.4$, being therefore less than fifty feet.

An interesting session was held at the Observatory, where the astronomer in charge, Prof. George C. Comstock, read a paper on "A Determination of the Constant of Aberration," and exhibited the instrument employed. It is a modified form of the Loewy prism apparatus, attached to a six-inch equatorial telescope. The principal element of the apparatus is a system of mirrors so placed before the objective as to reflect into the telescope images of the stars which are to be observed. As in the case of a sextant, images of two stars are simultaneously visible, and the apparatus may be regarded as a large reflecting instrument employed like a sextant for the measurement of the angular distance between stars, but subject to the limitation that the distances to be measured must differ but little from 120°. What is thus lost in range of application is compensated by the high degree of precision attainable with the apparatus, a discussion of nearly a thousand observations indicating $0''.3$ as the probable error for a single measured distance.

A preliminary discussion of a portion of these observations published in 1892 furnished for the value of the constant of aberration $20''.494$. A more rigorous discussion of the whole body of data, taking into account a possible annual variation in the amount of the atmospheric refraction, furnishes a value differing from the preceding by less than a thousandth of a second of arc; but this result cannot be considered definitive, since a comparison of the measured distances with values computed from the known right ascensions and declinations of the stars, indicates the existence in the observations of a systematic error depending upon the amount by which the measured distance differs from 120°. Reasons for supposing the error to be of subjective origin were indicated.

A discussion of the data thus corrected furnishes as the value of the constant of aberration $20''.445 \pm 0''.010$

As subsidiary results of this investigation it appears that the variation in the amount of the refraction from winter to summer is better represented by Regnault's value of the co-efficient of expansion of air, 0·003670, than by the values adopted in the tables of Bessel and the Pulkowa Observatory. Also, the observations are in very close agreement with the absolute values of the Pulkowa refractions, but indicate sensible corrections to Bessel's tables.

Section B (Physics) was prolific of good scientific work. The stereopticon views, with which vice-president Nichols illustrated his annual address, were a revelation of the astounding resources of photography in depicting phenomena of infinitesimal time, the alternating electric current with light and dark intervals clearly depicted, the flight of a bullet and its attendant sound waves shown as if at rest. Prof. Nichols does not think that he has yet reached the limit of these investigations. Although some of the exposures could only have been for a few millionths of a second, they were always long enough to secure a negative.

Of equal, if not superior, merit was the delicate and accurate apparatus for measuring expansions, exhibited by Profs. E. W. Morley and Wm. A. Rogers, called the Morley interferential comparator. In a paper read before the section, Prof. Morley explained that he had first described the proposed apparatus before a meeting of the Civil Engineers' Club of Cleveland, and afterwards at the Toronto meeting of this association in 1889. It was first used in a simplified form, in an experiment on the magnetic field, by Profs. Morley and Eddy, which was reported to the association at the Indianapolis meeting in 1890. The present paper was designed to recall to mind the principle of the apparatus and method, as an introduction to a paper by Prof. Rogers, in which several series of experiments with it were detailed, and also as a preparation for an exhibition of one of two forms of the apparatus which have been constructed for use in measuring expansions. These have been constructed by Prof. Rogers, with the aid of a small grant from the research fund of this association. It will measure the expansion of a metallic bar five or ten times as accurately as by old methods, being only limited by the accuracy with which temperature can be measured. It consists of two metallic bars, one of steel and one of bronze, with mirrors at each end, so adjusted that any change in adjustment is indicated by interference fringes of sodium light; 90,000 such fringes to the inch may be readily distinguished and counted. The mirrors are probably the most delicate ever made, being plain within two millionths of an inch, thus far exceeding in accuracy the best objectives of the largest telescopes.

Prof. Rogers followed with a paper in which he said that preliminary to the actual use of the interferential comparator in physical measurements, it was necessary to establish three points with great certainty.

(1) Does the value of the relative change per degree in the length of steel and bronze bars of metal, expressed in terms of wave lengths, remain constant? (2) Does the relative length of the two bars compared remain constant at the same temperature after the mirrors have been subjected to extreme temperatures? (3) Does this relative remain constant after the positions of the mirrors have been changed by means of the adjusting screws provided?

As a result of many experiments, an affirmative answer can be given to the two first inquiries. The change for each degree Centigrade was proved to be 38·31 fringes of sodium light for the steel bar, and 64·23 fringes for the bronze bar of Bailey's metal. When the observed differences in length were reduced to 5·1, the point at which the two bars had nearly the same length, it was found that the average probable error in a single comparison was about 0·72 of a single wave length, including all observations at wide ranges of temperature.

The answer to the third inquiry was less satisfactory, as occasional changes of ten fringes were obtained. The source of this error has, however, been found. In the new vacuo apparatus, the mirrors have been matched with great exactness. It was then found that the previous matching had been defective. Prof. Morley has computed the maximum effect of this error in changing the apparent relative lengths of the two bars, and has found it to be fifteen fringes.

The following are a few of the problems to the solution of which the apparatus has been applied:—

(1) The determination of the effect of slow changes in temperature upon the relative lengths of the two bars compared.

(2) The cooling effect of evaporation from a body of water placed near one of the bars.

(3) Measurement of slow changes in the bars compared due to the near presence of the observer.

(4) Measurement of the effect of obscure rays of heat stored in large masses of matter in close proximity.

(5) Measurement of the effect of flexure in changing the length of one of the bars.

(6) Measurement of changes in length produced by placing one of the bars in a magnetic field.

(7) Measurement of the heating effect of a current passed through one of the bars.

(8) Determination of the time required for the complete dissipation of a given amount of heat quickly applied to the bars.

(9) Proof that air is practically a non-conductor of heat.

(10) Determination of the value of 100 mikrons in terms of wave lengths of sodium and mercury fringes.

Prof. Alexander Macfarlane read a paper on the addition or composition of physical quantities, treating of one uniform method of the addition or composition of scalar quantities at different points, of vector quantities at the same point, of vector quantities at different points, of finite rotations round intersecting axes, of finite rotations round non-intersecting axes, and finally of screw motions. The screw motions compounded are not infinitesimal, but may be of any magnitude.

Profs. Macfarlane and G. W. Pierce contributed a paper on the electric strength of solid, liquid, and gaseous dielectrics, in which it was maintained that for a stratum of air or other gas between two parallel metal plates the electrostatic gradient when the spark passes is less the greater the distance between the plates; but for paraffined or beeswaxed paper this gradient is constant; it is also constant for paraffin oil or kerosene. The anomalous behaviour of the gaseous dielectric appears to be due to the greater freedom of motion of the molecules.

Mr. Joseph O. Thompson read a paper on "Fatigue in the Elasticity of Stretching." He remarked that attention was first called to the phenomena of elastic fatigue by Lord Kelvin some twenty-eight years ago. He used the elasticity of torsion in his experiments, and demonstrated that in some cases fatigue diminished the slide modulus as much as 6 per cent. Prof. Thompson's paper called attention to the fact hitherto undiscovered that a similar fatigue can be observed in the elasticity of stretching. Its influence in diminishing the Young's modulus amounted in these experiments to less than $\frac{1}{4}$ of 1 per cent. The wires used were 23m. long, and the metals in which the phenomenon was observed were silver, steel, and brass.

Messrs. F. Bedell, K. B. Miller, and W. F. Wagner contributed an elaborate mathematical paper on "Irregularities in Alternate Current Curves."

At the meeting of Section C (Chemistry) the notable feature was the presentation of Prof. Morley's final determination of the atomic weight of oxygen, giving results obtained by four distinct methods of investigation and with a degree of accuracy that will render this a final determination of this weight, correct to the third decimal figure. Three years ago Prof. Morley submitted a preliminary report, in which an account was given of the determination of the ratio of densities of oxygen and hydrogen as 15·884, correct within one part in four thousand. It has since been found that an accident happened to the apparatus during the last experiment of the series, which ought therefore to have been rejected. If this were now to be done, the value would become 15·882.

Two years ago some account was given of a series of determinations of the quantities of water produced from weighed quantities of oxygen and of hydrogen. Twelve experiments were made. In one the quantity of water produced was not determined, owing to accident. From the weights of hydrogen and oxygen consumed, the atomic weight of oxygen was found to be 15·8794, with a mean error of one part in 16,000 for a single experiment. From the quantities of hydrogen used and of water produced, the value obtained was 15·8792, with a mean error of one part in 7500 for a single determination.

At the present meeting, Prof. Morley reported the result of twenty determinations of the absolute density of oxygen, and twenty of that of hydrogen. The ratio of these densities found was 15·882.

If now the ratio of the volumes in which oxygen and hydrogen combine is substantially that found in these experiments, the atomic weight of oxygen computed from the densities would be 15·882 from the former series of determinations (or 15·880, if the correction is allowable), and 15·880 from the present series, we should then have :—

15·879, from ratio of H to O
15·879 ,, ,, H to H_2O
15·882 [or 15·880] ratio of densities (*a*)
15·880 from ,, ,, (*b*)

as the result so far of Prof. Morley's work.

But the later work of Scott has attained a high degree of excellence, and gives a value of the ratio of the volumes in which the gases combine, which is considerably higher than that used in this computation. Prof. Morley explained that he had himself published every experiment which he had ever made on this point, and that they had a mean error of only one part in 26,000. Since no source of constant error had yet been pointed out, he had great confidence in the accuracy of his own experiments. He, however, intended to make another series of determinations with the apparatus used before, and one with a new apparatus now constructing.

He also mentioned three other series of determinations which he is now carrying on; two are determinations of the absolute density of hydrogen, and one a determination of that of oxygen; in these a very small mean error is attainable.

Among the other papers which attracted special attention, were one on "The Constitution of Paraldehyde and Metaldehyde," by W. R. Orndorff and John White; and one on "Solubility of Lead Oxide in the normal tartrates and other normal organic salts, with observations on the rotary power of the solutions thus obtained," by L. Kahlenberg and H. W. Hillyer.

In Section D (Mechanical Science and Engineering) the number of papers was small, owing to the increasing tendency of engineers to support special technical associations.

Messrs. Wm. S. Rogers, S. W. Robinson, and J. Burkitt Webb contributed useful notes on different topics; while the secretary of the section, Prof. D. S. Jacobus, read three papers describing ingenious apparatus devised and used by him at the Stevens Institute of Technology at Hoboken, N.J.

Among the papers read, we note one by Prof. J. J. Stevenson on "the use of the term Catskill," in which he offered strong objection to the application of this term to the whole series of rocks from the Hamilton to the lower carboniferous, as has been recently advocated. Since the group is well defined below, and since the geographical term Catskill represents conditions which prevailed over an extended area only during the latter part of the upper Devonian period, Prof. Stevenson thinks that the term should be restricted as defined by Vonuxem.

Mr. J. A. Holmes gave an interesting description of a map and section of the stratified rocks of the coastal plain of southern North Carolina. Mr. William Hallock reported the results of further observations of temperature in the deep well at Wheeling, W. Va. Since 1891 this well has filled with water by leaking below the surface. Temperature determinations have been made in the water, which are practically identical with the determinations made when the well was filled with air two years ago, showing that there is not an appreciable circulation of water in a hole five inches in diameter. Down to 3200 feet the gradient is 1° F. to 81·5 feet, and near the bottom 1° F. to each 60 feet.

Dr. C. R. Van Hise, referring to the "character of the folds in Marquette iron district," called attention to the fact that what has been considered a synclinal is really a great synclinorium, having a nearly east-west axis, and having both the north and the south limbs pushed under, producing a complex fold with overturned minor folds, and comparable to some of those which Heim has described from the Alps.

Prof. C. D. Walcott exhibited beautiful specimens of trilobites which he had collected from the Utica shale of New York, on which the antennæ and legs were remarkably well preserved. Mr. F. P. Gulliver exhibited beautiful papier maché models, one of the sand plain at Newtonville, Mass., and a second showing the theoretical conditions at the time of its formation.

A paper entitled "Additional Facts Bearing on the Unity of the Glacial Period," was read by Prof. G. F. Wright, consecutively with one by Frank Leverett on "Changes of Drainage in the Rock River Basin in Illinois." The latter is important as affording means of estimating the amount of erosion in inter-glacial compared with that of post-glacial time. The wide pre-glacial channel of the Rock is followed to the Green River Basin near Inlet Swamp, when it is choked up by accumulations of drift. The change to the present course is located early in the glacial period, since the present valley can be shown to have been opened to about its present size and depth prior to the formation of the kettle moraine of the Green Bay lobe, the gravels which occupy the new course of the river being derived from the ice-sheet at the time the moraine was forming near the head waters of the river. These gravels are traceable up to the head of the moraine as a moraine-headed terrace. It is found that the post-glacial erosion in the river valley is only one-half that accomplished in inter-glacial time, and whereas the post-glacial erosion is mainly in gravel and sand, the inter-glacial erosion was mainly in rock strata. This seems to Mr. Leverett to warrant the use of the term epoch rather than episode to characterise these time relations.

Mr. Warren Upham, in his paper on "Tertiary and Quarternary Stream Erosion in North America," argued from stream erosion that an epeirogenic uplift preceded and probably produced the glacial epoch.

Section F (Zoology) having been severed from botany by the new amendment to the constitution, had comparatively few papers. The president, Prof. H. F. Osborn, carried on the line of thought contained in his annual address, by a paper on "The Mammals of the Upper Cretaceous," in which he proposed a system of classification and evolution materially differing from that of Prof. Marsh, which has so long held its ground. Prof. Osborn's studies lead him to more confidence in the belief that early forms are in many cases pretty highly specialised, and that evolution by degradation plays a pretty important part in biological investigation. This is quite in harmony with the statement of the president-elect of the association, Dr. Brinton, in his public address on "The Earliest Men," above noted, to the effect that the evolution of man appears to have been *per saltum.*

Section G (Botany) was organised at this meeting by division of the old section of biology, and considered a large number of papers of technical interest. Among the contributors were Arthur, Beal, Galloway, Dr. and Mrs. Britton, Barnes, Halstead, MacMillan, Coville. Dr. Britton discussed the question of nomenclature.

Probably the proceedings of the Botanical Club were even more interesting to botanists than those of the section, inasmuch as the club organised the Botanical Society of America with twenty-five charter members. Dr. Arthur exhibited to the club two very interesting pieces of apparatus, one a rotatory machine in which a germinating seed may be placed and subjected for hours or days to centrifugal force instead of gravitation. This apparatus gives the interesting result that the roots grow in the direction of the centrifugal force, and the leaves opposed to it. The other apparatus, called an auxanometer, shows by ingenious automatic action the rate of growth of plants.

Section H (Anthropology) furnished the largest number of papers. The first paper read in the section, by Washington Matthews, on "Songs of Sequence of the Navajos," was illustrated by reproductions of the songs by the phonograph. Dr. Joseph Jastrow gave an account of the system of psychologic investigation now pursued at the World's Fair. The recent discoveries resulting from excavations at the ancient argillite quarries on Geddes' Run, near the Delaware River, were presented by H. C. Mercer; and Ernest Volk made some observations in regard to the use of argillite by prehistoric people, as illustrated by explorations in the Delaware Valley. H. N. Rust read several papers on California Indians and implements. Prof. G. F. Wright presented a summary of the evidence in favour of the existence of glacial man in America, which commanded general attention because of the personal abuse to which Prof. Wright has recently been subjected. The subject was discussed at some length, and Prof. Wright's conclusions were violently attacked by Mr. McGee. Dr. Brinton read a paper on the "Mexican Calendar System," which he pronounces an anomaly, having no relation to the period either of solar or lunar revolution. It consists of 20 × 13, or 260 days. The 20 is a double digital basis. The 13 seems inexplicable.

The excursion of this section on Monday afternoon gave an opportunity to visit a group of effigy mounds just across Lake

Mendota, about four miles from the University. These mounds are of different shapes, that of the panther predominating, though birds and conical mounds are found also.

Section I (Economic Science and Statistics) had but few papers to consider, of which that of Mr. Henry Farquhar, on "Relations of Production and Price of Silver and Gold," introduced the topic of most general interest just now. The fallacy of attempting to maintain a silver standard of value was very apparent from the paper and the ensuing discussion. Improvements in metallurgy reduce the cost and vastly increase the production of silver, while that of gold remains almost stationary, there being really hardly any metallurgy of gold.

WM. H. HALE.

BRITISH ASSOCIATION.

NOTTINGHAM, SEPTEMBER 13.

THE meeting of the Association, which commences to-day, will take place mainly in the University College. In this building all the Sections, with the exception of the geographical, economical, and anthropological, will assemble. The Sections representing the experimental sciences will be accommodated in lecture theatres built and furnished for the express purpose of illustrating and demonstrating these sciences. Every convenience will therefore be afforded in the meeting rooms for the proper illustration of the papers which will be communicated. Further, the students' laboratories, which are in immediate connection with these theatres, will furnish most convenient exhibition rooms for the illustrative apparatus, specimens, and diagrams during the week of meeting, and when they are not required for illustration in the sectional room. The College will thus become the scientific headquarters during the meeting. It will in addition furnish convenient sectional committee rooms, sectional secretaries' rooms, anthropometric laboratory, ladies' boudoir, smoking-room, convenient retiring rooms, and a large luncheon buffet in the attached public lending library.

It is interesting to compare the facilities now offered for the meeting with those afforded during the preceding meeting in 1866 A temporary exhibition building then stood on the College site, and was used for the *conversazione*, but no suitable meeting rooms existed in the town for housing Sections A, B, C, D, and G. It will scarcely be necessary to inform those interested in the advancement of science that the existence of the College is due to the public spirit of the inhabitants of Nottingham, who willingly voted public money to establish the College, and who now mainly support it from the local rates. That such a bold experiment has met with the full success which it deserved, members of the Association who visit the town will learn and see for themselves. They will find that the initial success is leading to further success, and that outside support from the Government, from the Drapers' Company, and from other sources, is now being accorded with an ungrudging hand. It may be said with truth that since the Association last met in Nottingham, the town has become in a very important sense a centre for the advancement of science, and fully deserves all the encouragement and impetus which will be given to its comparatively new scientific work and aims by the visit of the Association.

It may be added that the Sections which meet outside the College are also accommodated in halls which were non-existent at the previous meeting in Nottingham, and that the evening meetings will take place in a large hall, which is new in the same sense. This will give some idea of the rapid progress which the town has made during the last quarter of a century.

Coming, as the Nottingham meeting does, between meetings at the venerable University towns of Edinburgh and Oxford, the status of the University College of the town must necessarily suffer by comparison. But it will be found that Nottingham, like the other provincial towns which have recently founded colleges in their midst, is by no means altogether at a disadvantage as regards its higher education by making a late start. In the matter of buildings and equipments it has benefited by the experience of its predecessors; and the absence of the fetters of an ancient *régime* has left it free to adapt its curriculum and methods to the needs of the present day.

With respect to the prospective work of the meeting, it may be stated that it promises to be fully up to the average in importance and in interest. A general statement of the papers to be brought forward, and of the discussions in the different Sections, has appeared in NATURE from time to time, and it is unnecessary to repeat the announcement of these in detail. It will be sufficient to remind members that in Section A questions of great interest and importance are put down for discussion; that in Section B, M. Moissan will d monstrate the preparation and properties of fluorine, a demonstration of absolutely unique interest, since this is the first opportunity afforded in this country of seeing these remarkable experiments. The President of the Section C and his colleagues have been most energetic in securing the attendance of distinguished foreign geologists, and in procuring numerous papers of local geological interest, in addition to discussions on points of general importance. In Section D, which will have the advantage of securing the special interest and support of the President of the Association, there will undoubtedly be good discussion of important biological problems, not only by Englishmen, but also by eminent continental biologists, who are guests of the town. In Section E the travellers are mustering in force, and will have their tales to tell of widely distant parts of the earth's surface; the photographs and paintings prepared in Antarctic regions will be of special interest in this section. Economic problems of the day are to be discussed in Section F. Section G will be represented by many eminent engineers, both English and foreign, and the experimental illustration of many of the papers, rendered possible by the meeting being held in a well-equipped engineering theatre, will add interest to the proceedings. In Section H the paper by Dr. Hans Hildebrand, and the description of the Glastonbury marsh village by Mr. Bulleid, with the discussions which they will undoubtedly give rise to, would, if they stood alone, constitute a tempting programme to anthropologists.

The efforts put forth in the town itself to make the gathering pleasant and successful will perhaps be best appreciated by reference to the local programme and maps now being issued to members. The townsmen have vindicated their character for hospitality by privately entertaining in their homes nearly 400 of their visitors. An ample list of hotels and lodgings, with a suitable map, has been issued for some weeks, some of the hotels binding themselves to a special tariff to members who engage their rooms through the local committee. The garden parties, excursions, and entertainments will be seen to have been so arranged as to leave no irksome leisure to be filled in by those who have done their duty to their Sections; and the scheme for privately engaging the Theatre Royal for the last Wednesday night will, it is hoped, justify by its success its boldness and originality.

With a programme of work of varied special and general interest and importance; with a universal desire on the part of the townsmen to do everything in their power to secure the comfort of their guests, and to afford pleasure and recreation to them; with the social element of the scientific gathering secured by the promise of attendance of men of science from all parts of our own country and from abroad; and, above all, with the promise of fine autumnal weather in a healthy, picturesque, and accessible town with most interesting surroundings, it will be strange indeed if the Nottingham meeting of 1893 should not become a record meeting, remembered by the pleasure and satisfaction it has given, if not by the largeness of the number who attend it.

FRANK CLOWES.

INAUGURAL ADDRESS BY J. S. BURDON-SANDERSON, M.A., M.D., LL.D., D.C.L., F.R.S., F.R.S.E., PROFESSOR OF PHYSIOLOGY IN THE UNIVERSITY OF OXFORD, PRESIDENT.

WE are assembled this evening as representatives of the sciences—men and women who seek to advance knowledge by scientific methods. The common ground on which we stand is that of belief in the paramount value of the end for which we are striving, of its inherent power to make men wiser, happier, and better; and our common purpose is to strengthen and encourage one another in our efforts for its attainment. We have come to learn what progress has been made in departments of knowledge which lie outside of our own special scientific interests and occupations, to widen our views, and to correct whatever misconceptions may have arisen from the necessity which limits each of us to his own field of study; and, above all, we are here for the purpose of bringing our divided energies into effectual and combined action.

Probably few of the members of the Association are fully aware of the influence which it has exercised during the last half-century and more in furthering the scientific development of this country. Wide as is the range of its activity, there has been no great question in the field of scientific inquiry which it has failed to discuss; no important line of investigation which it has not promoted; no great discovery which it has not welcomed. After more than sixty years of existence it still finds itself in the energy of middle life, looking back with satisfaction to what it has accomplished in its youth, and forward to an even more efficient future. One of the first of the national associations which exist in different countries for the advancement of science, its influence has been more felt than that of its successors because it is more wanted. The wealthiest country in the world, which has profited more—vastly more—by science than any other, England stands alone in the discredit of refusing the necessary expenditure for its development, and cares not that other nations should reap the harvest for which her own sons have laboured.

It is surely our duty not to rest satisfied with the reflection that England in the past has accomplished so much, but rather to unite and agitate in the confidence of eventual success. It is not the fault of governments, but of the nation, that the claims of science are not recognised. We have against us an overwhelming majority of the community, not merely of the ignorant, but of those who regard themselves as educated, who value science only in so far as it can be turned into money; for we are still in great measure—in greater measure than any other—a nation of shopkeepers. Let us who are of the minority—the remnant who believe that truth is in itself of supreme value, and the knowledge of it of supreme utility—do all that we can to bring public opinion to our side, so that the century which has given Young, Faraday, Lyell, Darwin, Maxwell, and Thomson to England, may before it closes see us prepared to take our part with other countries in combined action for the full development of natural knowledge.

Last year the necessity of an imperial observatory for physical science was, as no doubt many are aware, the subject of a discussion in Section A, which derived its interest from the number of leading physicists who took part in it, and especially from the presence and active participation of the distinguished man who is at the head of the National Physical Laboratory at Berlin. The equally pressing necessity for a central institution for chemistry, on a scale commensurate with the practical importance of that science, has been insisted upon in this Association and elsewhere by distinguished chemists. As regards biology I shall have a word to say in the same direction this evening. Of these three requirements it may be that the first is the most pressing. If so, let us all, whatever branch of science we represent, unite our efforts to realise it, in the assurance that if once the claim of science to liberal public support is admitted, the rest will follow.

In selecting a subject on which to address you this evening, I have followed the example of my predecessors in limiting myself to matters more or less connected with my own scientific occupations, believing that in discussing what most interests myself I should have the best chance of interesting you. The circumstance that at the last meeting of the British Association in this town, Section D assumed for the first time the title which it has since held, that of the Section of Biology, suggested to me that I might take the word "biology" as my starting-point, giving you some account of its origin and first use, and of the relations which subsist between biology and other branches of natural science.

Origin and Meaning of the Term "Biology."

The word "biology," which is now so familiar as comprising the sum of the knowledge which has as yet been acquired concerning living nature, was unknown until after the beginning of the present century. The term was first employed by Treviranus, who proposed to himself as a life-task the development of a new science, the aim of which should be to study the forms and phenomena of life, its origin and the conditions and laws of its existence, and embodied what was known on these subjects in a book of seven volumes, which he entitled "Biology, or the Philosophy of Living Nature." For its construction the material was very scanty, and was chiefly derived from the anatomists and physiologists. For botanists were entirely occupied in completing the work which Linnæus had begun, and the scope of zoology was in like manner limited to the description and classification of animals. It was a new thing to regard the study of living nature as a science by itself, worthy to occupy a place by the side of natural philosophy, and it was therefore necessary to vindicate its claim to such a position. Treviranus declined to found this claim on its useful applications to the arts of agriculture and medicine, considering that to regard any subject of study in relation to our bodily wants—in other words to utility—was to narrow it, but dwelt rather on its value as a discipline and on its surpassing interest. He commends biology to his readers as a study which, above all others, "nourishes and maintains the taste for simplicity and nobleness; which affords to the intellect ever new material for reflection, and to the imagination an inexhaustible source of attractive images."

Being himself a mathematician as well as a naturalist, he approaches the subject both from the side of natural philosophy and from that of natural history, and desires to found the new science on the fundamental distinction between living and non-living material. In discussing this distinction, he takes as his point of departure the constancy with which the activities which manifest themselves in the universe are balanced, emphasising the impossibility of excluding from that balance the vital activities of plants and animals. The difference between vital and physical processes he accordingly finds, not in the nature of the processes themselves, but in their co-ordination; that is, in their adaptedness to a given purpose, and to the peculiar and special relation in which the organism stands to the external world. All of this is expressed in a proposition difficult to translate into English, in which he defines life as consisting in the reaction of the organism to external influences, and contrasts the uniformity of vital reactions with the variety of their exciting causes.[1]

The purpose which I have in view in taking you back as I have done to the beginning of the century, is not merely to commemorate the work done by the wonderfully acute writer to whom we owe the first scientific conception of the science of life as a whole, but to show that this conception, as expressed in the definition I have given you as its foundation, can still be accepted as true. It suggests the *idea of organism* as that to which all other biological ideas must relate. It also suggests, although perhaps it does not express it, that *action* is not an attribute of the organism but of its essence—that if, on the other hand, protoplasm is the basis of life, life is the basis of protoplasm. Their relations to each other are reciprocal. We think of the visible structure only in connection with the invisible process. The definition is also of value as indicating at once the two lines of inquiry into which the science has divided by the natural evolution of knowledge. These two lines may be easily educed from the general principle from which Treviranus started, according to which it is the fundamental characteristic of the organism that all that goes on in it is to the advantage of the whole. I need scarcely say that this fundamental conception of organism has at all times presented itself

[1] "Leben besteht in der Gleichförmigkeit der Reaktionen bei ungleichförmigen Einwirkungen der Aussenwelt."—Treviranus, *Biologie oder Philosophie der lebenden Natur*, Göttingen, 1802, vol. i. p. 83.

to the minds of those who have sought to understand the distinction between living and non-living. Without going back to the true father and founder of biology, Aristotle, we may recall with interest the language employed in relation to it by the physiologists of three hundred years ago. It was at that time expressed by the term *consensus partium*—which was defined as the concurrence of parts in action, of such a nature that each does *quod suum est*, all combining to bring about one effect "as if they had been in secret council," but at the same time *constanti quadam naturæ lege*.[1] Prof. Huxley has made familiar to us how a century later Descartes imagined to himself a mechanism to carry out this *consensus*, based on such scanty knowledge as was then available of the structure of the nervous system. The discoveries of the early part of the present century relating to reflex action and the functions of sensory and motor nerves, served to realise in a wonderful way his anticipations as to the channels of influence, afferent and efferent, by which the *consensus* is maintained; and in recent times (as we hope to learn from Prof. Horsley's lecture on the physiology of the nervous system) these channels have been investigated with extraordinary minuteness and success.

Whether with the old writers we speak about *consensus*, with Treviranus about *adaptation*, or are content to take *organism* as our point of departure, it means that, regarding a plant or an animal as an organism, we concern ourselves primarily with its activities, or, to use the word which best expresses it, its energies. Now the first thing that strikes us in beginning to think about the activities of an organism is that they are naturally distinguishable into two kinds, according as we consider the action of the whole organism in its relation to the external world or to other organisms, or the action of the parts or organs in their relation to each other. The distinction to which we are thus led between the *internal* and *external* relations of plants and animals has of course always existed, but has only lately come into such prominence that it divides biologists more or less completely into two camps—on the one hand those who make it their aim to investigate the actions of the organism and its parts by the accepted methods of physics and chemistry, carrying this investigation as far as the conditions under which each process manifests itself will permit; on the other, those who interest themselves rather in considering the place which each organism occupies, and the part which it plays in the economy of nature. It is apparent that the two lines of inquiry, although they equally relate to what the organism *does*, rather than to what it *is*, and therefore both have equal right to be included in the one great science of life, or biology, yet lead in directions which are scarcely even parallel. So marked, indeed, is the distinction, that Prof. Haeckel some twenty years ago proposed to separate the study of organisms with reference to their place in nature under the designation of "œcology," defining it as comprising "the relations of the animal to its organic as well as to its inorganic environment, particularly its friendly or hostile relations to those animals or plants with which it comes into direct contact."[2] Whether this term expresses it or not, the distinction is a fundamental one. Whether with the œcologist we regard the organism in relation to the world, or with the physiologist as a wonderful complex of vital energies, the two branches have this in common, that both studies fix their attention, not on stuffed animals, butterflies in cases, or even microscopical sections of the animal or plant body—all of which relate to the framework of life—but on life itself.

The conception of biology which was developed by Treviranus as far as the knowledge of plants and animals which then existed rendered possible, seems to me still to express the scope of the science. I should have liked, had it been within my power, to present to you both aspects of the subject in equal fulness; but I feel that I shall best profit by the present opportunity if I derive my illustrations chiefly from the division of biology to which I am attached—that which concerns the *internal* relations of the organism, it being my object not to specialise in either direction, but as Treviranus desired to do, to regard it as part—surely a very important part—of the great science of nature.

The origin of life, the first transition from non-living to living, is a riddle which lies outside of our scope. No seriously-minded person, however, doubts that organised nature as it now presents itself to us has become what it is by a process of gradual perfecting or advancement, brought about by the elimination of those organisms which failed to obey the fundamental principle of adaptation which Treviranus indicated. Each step, therefore, in this evolution is a reaction to external influences, the motive of which is essentially the same as that by which from moment to moment the organism governs itself. And the whole process is a necessary outcome of the fact that those organisms are most prosperous which look best after their own welfare. As in that part of biology which deals with the internal relations of the organism, the interest of the individual is in like manner the sole motive by which every energy is guided. We may take what Treviranus called *selfish* adaptation—*Zweckmässigkeit für sich selber*—as a connecting link between the two branches of biological study. Out of this relation springs another which I need not say was not recognised until after the Darwinian epoch—that I mean, which subsists between the two evolutions, that of the race and that of the individual. Treviranus, no less distinctly than his great contemporary Lamarck, was well aware that the affinities of plants and animals must be estimated according to their developmental value, and consequently that classification must be founded on development; but it occurred to no one what the real link was between descent and development; nor was it, indeed, until several years after the publication of the "Origin" that Haeckel enunciated that "biogenetic law," according to which the development of any individual organism is but a memory, a recapitulation by the individual of the development of the race—of the process for which Fritz Müller had coined the excellent word "phylogenesis"; and that each stage of the former is but a transitory reappearance of a bygone epoch in its ancestral history. If, therefore, we are right in regarding ontogenesis as dependent on phylogenesis the origin of the former must correspond with that of the latter; that is, on the power which the race or the organism at every stage of its existence possesses of profiting by every condition or circumstance for its own advancement.

From the short summary of the connection between different parts of our science you will see that biology naturally falls into three divisions, and these are even more sharply distinguished by their methods than by their subjects; namely, *Physiology*, of which the methods are entirely experimental; *Morphology*, the science which deals with the forms and structure of plants and animals, and of which it may be said that the body is anatomy, the soul, development; and finally, *Œcology*, which uses all the knowledge it can obtain from the other two, but chiefly rests on the exploration of the endless varied phenomena of animal and plant life as they manifest themselves under natural conditions. This last branch of biology—the science which concerns itself with the external relations of plants and animals to each other, and to the past and present conditions of their existence—is by far the most attractive. In it those qualities of mind which especially distinguish the naturalist find their highest exercise, and it represents more than any other branch of the subject what Treviranus termed the "philosophy of living nature." Notwithstanding the very general interest which several of its problems excite at the present moment I do not propose to discuss any of them, but rather to limit myself to the humbler task of showing that the fundamental idea which finds one form of expression in the world of living beings regarded as a whole—the prevalence of the best—manifests itself with equal distinctness, and plays an equally essential part in the internal relations of the organism in the great science which treats of them—Physiology.

Origin and Scope of Modern Physiology.

Just as there was no true philosophy of living nature until Darwin, we may with almost equal truth say that physiology did not exist as a science before Johannes Müller. For although the sum of his numerous achievements in comparative anatomy and physiology, notwithstanding their extraordinary number and importance, could not be compared for merit and fruitfulness with the one discovery which furnished the key to so many riddles, he, no less than Darwin, by his influence on his successors was the beginner of a new era.

Müller taught in Berlin from 1833 to 1857. During that time a gradual change was in progress in the way in which biologists regarded the fundamental problem of life. Müller him-

[1] Bausner, *De Consensu Partium Humani Corporis*, Amst., 1556, Præf. ad lectorem, p. 4.

[2] These he identifies with "those complicated mutual relations which Darwin designates as conditions of the struggle for existence." Along with chorology—the distribution of animals—œcology constitutes what he calls *Relations-physiologie*. Haeckel, "Entwickelungsgang u. Aufgaben der Zoologie," *Jenaische Zeitschr.* vol. v. 1869, p. 353.

self, in common with Treviranus and all the biological teachers of his time, was a vitalist, *i.e.* he regarded what was then called the *vis vitalis*—the *Lebenskraft*—as something capable of being correlated with the physical forces; and as a necessary consequence held that phenomena should be classified or distinguished, according to the forces which produced them, as vital or physical, and that all those processes—that is groups or series of phenomena in living organisms—for which, in the then very imperfect knowledge which existed, no obvious physical explanation could be found, were sufficiently explained when they were stated to be dependent on so-called vital laws. But during the period of Müller's greatest activity times were changing, and he was changing with them. During his long career as professor at Berlin he became more and more objective in his tendencies, and exercised an influence in the same direction on the men of the next generation, teaching them that it was better and more useful to observe than to philosophise; so that, although he himself is truly regarded as the last of the vitalists—for he was a vitalist to the last—his successors were adherents of what has been very inadequately designated the mechanistic view of the phenomena of life. The change thus brought about just before the middle of this century was a revolution. It was not a substitution of one point of view for another, but simply a frank abandonment of theory for fact, of speculation for experiment. Physiologists ceased to theorise because they found something better to do. May I try to give you a sketch of this era of progress?

Great discoveries as to the structure of plants and animals had been made in the course of the previous decade, those especially which had resulted from the introduction of the microscope as an instrument of research. By its aid Schwann had been able to show that all organised structures are built up of those particles of living substance which we now call cells, and recognise as the seats and sources of every kind of vital activity. Hugo Mohl, working in another direction, had given the name "protoplasm" to a certain hyaline substance which forms the lining of the cells of plants, though no one as yet knew that it was the essential constituent of all living structures—the basis of life no less in animals than in plants. And, finally, a new branch of study—histology—founded on observations which the microscope had for the first time rendered possible, had come into existence. Bowman, one of the earliest and most successful cultivators of this new science, called it physiological anatomy,[1] and justified the title by the very important inferences as to the secreting function of epithelial cells and as to the nature of muscular contraction, which he deduced from his admirable anatomical researches. From structure to function, from microscopical observation to physiological experiment, the transition was natural. Anatomy was able to answer some questions, but asked many more. Fifty years ago physiologists had microscopes but had no laboratories. English physiologists—Bowman, Paget, Sharpey—were at the same time anatomists, and in Berlin Johannes Müller, along with anatomy and physiology, taught comparative anatomy and pathology. But soon that specialisation which, however much we may regret its necessity, is an essential concomitant of progress, became more and more inevitable. The structural conditions on which the processes of life depend, had become, if not known, at least accessible to investigation; but very little indeed had been ascertained of the nature of the processes themselves—so little indeed that if at this moment we could blot from the records of physiology the whole of the information which had been acquired, say in 1840, the loss would be difficult to trace—not that the previously known facts were of little value, but because every fact of moment has since been subjected to experimental verification. It is for this reason that, without any hesitation, we accord to Müller and to his successors Brücke, du Bois-Reymond, Helmholtz, who were his pupils, and Ludwig, in Germany, and to Claude Bernard[2] in France, the title of founders of our science. For it is the work which they began at that remarkable time (1845–55), and which is now being carried on by their pupils or their pupils' pupils in England, America, France, Germany, Denmark, Sweden, Italy, and even in that youngest contributor to the advancement of science, Japan, that physiology has been gradually built up to whatever completeness it has at present attained.

[1] The first part of the *Physiological Anatomy* appeared in 1843. It was concluded in 1856.

[2] It is worthy of note that these five distinguished men were merely contemporaries: Ludwig graduated in 1839, Bernard in 1843, the other three between those dates. Three survive—Helmholtz, Ludwig, du Bois-Reymond.

What were the conditions which brought about this great advance which coincided with the middle of the century? There is but little difficulty in answering the question. I have already said that the change was not one of doctrine, but of method. There was, however, a leading idea in the minds of those who were chiefly concerned in bringing it about. That leading notion was that, however complicated may be the conditions under which vital energies manifest themselves, they can be split into processes which are identical in nature with those of the non-living world, and, as a corollary to this, that the analysing of a vital process into its physical and chemical constituents, so as to bring these constituents into measurable relation with physical or chemical standards, is the only mode of investigating them which can lead to satisfactory results.

There were several circumstances which at that time tended to make the younger physiologists (and all of the men to whom I have just referred were then young) sanguine, perhaps too sanguine, in the hope that the application of experimental methods derived from the exact sciences would afford solutions of many physiological problems. One of these was the progress which had been made in the science of chemistry, and particularly the discovery that many of the compounds which before had been regarded as special products of vital processes could be produced in the laboratory, and the more complete knowledge which had been thereby acquired of their chemical constitutions and relations. In like manner, the new school profited by the advances which had been made in physics, partly by borrowing from the physical laboratory various improved methods of observing the phenomena of living beings, but chiefly in consequence of the direct bearing of the crowning discovery of that epoch (that of the conservation of energy) on the discussions which then took place as to the relations between vital and physical forces; in connection with which it may be noted that two of those who (along with Mr. Joule and your President at the last Nottingham meeting) took a prominent part in that discovery—Helmholtz and J. R. Mayer—were physiologists as much as they were physicists. I will not attempt even to enumerate the achievements of that epoch of progress. I may, however, without risk of wearying you, indicate the lines along which research at first proceeded, and draw your attention to the contrast between then and now. At present a young observer who is zealous to engage in research finds himself provided with the most elaborate means of investigation, the chief obstacle to his success being that the problems which have been left over by his predecessors are of extreme difficulty, all of the easier questions having been worked out. There were then also difficulties, but of an entirely different kind. The work to be done was in itself easier, but the means for doing it were wanting, and every investigator had to depend on his own resources. Consequently the successful men were those who, in addition to scientific training, possessed the ingenuity to devise and the skill to carry out methods for themselves. The work by which du Bois-Reymond laid the foundation of animal electricity would not have been possible had not its author, besides being a trained physicist, known how to do as good work in a small room in the upper floor of the old University building at Berlin as any which is now done in his splendid laboratory. Had Ludwig not possessed mechanical aptitude, in addition to scientific knowledge, he would have been unable to devise the apparatus by which he measured and recorded the variations of arterial pressure (1848), and verified the principles which Young had laid down thirty years before as to the mechanics of the circulation. Nor, lastly, could Helmholtz, had he not been a great deal more than a mere physiologist, have made those measurements of the time-relations of muscular and nervous responses to stimulation, which not only afford a solid foundation for all that has been done since in the same direction, but has served as models of physiological experiment, and as evidence that perfect work was possible and was done by capable men, even when there were no physiological laboratories.

Each of these examples relates to work done within a year or two of the middle of the century.[1] If it were possible to enter

[1] The "Untersuchungen über thierische Electricität" appeared in 1848; Ludwig's researches on the circulation, which included the first description of the "kymograph" and served as the foundation of the "graphic method" in 1847; Helmholtz's research on the propagation in motor nerves in 1851.

more fully on the scientific history of the time, we should, I think, find the clearest evidence, first, that the foundation was laid in anatomical discoveries, in which it is gratifying to remember that English anatomists (Allen Thomson, Bowman, Goodsir, Sharpey) took considerable share; secondly, that progress was rendered possible by the rapid advances which, during the previous decade, had been made in physics and chemistry, and the participation of physiology in the general awakening of the scientific spirit which these discoveries produced. I venture, however, to think that, notwithstanding the operation of these two causes, or rather combinations of causes, the development of our science would have been delayed had it not been for the exceptional endowments of the four or five young experimenters whose names I have mentioned, each of whom was capable of becoming a master in his own branch, and of guiding the future progress of inquiry.

Just as the affinities of an organism can be best learned from its development, so the scope of a science may be most easily judged of by the tendencies which it exhibits in its origin. I wish now to complete the sketch I have endeavoured to give of the way in which physiology entered on the career it has since followed for the last half-century, by a few words as to the influence exercised on general physiological theory by the progress of research. We have seen that no real advance was made until it became possible to investigate the phenomena of life by methods which approached more or less closely to those of the physicist, in exactitude. The methods of investigation being physical or chemical, the organism itself naturally came to be considered as a complex of such processes, and nothing more. And in particular the idea of adaptation, which, as I have endeavoured to show, is not a consequence of organism, but its essence, was in great measure lost sight of. Not, I think, because it was any more possible than before to conceive of the organism otherwise than as a working together of parts for the good of the whole, but rather that, if I may so express it, the minds of men were so occupied with new facts that they had not time to elaborate theories. The old meaning of the term "adaptation" as the equivalent of "design" had been abandoned, and no new meaning had yet been given to it, and consequently the word "mechanism" came to be employed as the equivalent of "process," as if the constant concomitance or sequence of two events was in itself a sufficient reason for assuming a mechanical relation between them. As in daily life so also in science, the misuse of words leads to misconceptions. To assert that the link between *a* and *b* is mechanical, for no better reason than that *b* always follows *a*, is an error of statement, which is apt to lead the incautious reader or hearer to imagine that the relation between *a* and *b* is understood, when in fact its nature may be wholly unknown. Whether or not at the time which we are considering, some physiological writers showed a tendency to commit this error, I do not think that it found expression in any generally accepted theory of life. It may, however, be admitted that the rapid progress of experimental investigation led to too confident anticipations, and that to some enthusiastic minds it appeared as if we were approaching within measurable distance of the end of knowledge. Such a tendency is, I think, a natural result of every signal advance. In an eloquent Harveian oration, delivered last autumn by Dr. Bridges, it was indicated how, after Harvey's great discovery of the circulation, men were too apt to found upon it explanations of all phenomena whether of health or disease, to such an extent that the practice of medicine was even prejudicially affected by it. In respect of its scientific importance the epoch we are considering may well be compared with that of Harvey, and may have been followed by an undue preference of the new as compared with the old, but no more permanent unfavourable results have shown themselves. As regards the science of medicine we need only remember that it was during the years between 1845 and 1860 that Virchow made those researches by which he brought the processes of disease into immediate relation with the normal processes of cell-development and growth, and so, by making pathology a part of physiology, secured its subsequent progress and its influence on practical medicine. Similarly in physiology, the achievements of those years led on without any interruption or drawback to those of the following generation; while in general biology, the revolution in the mode of regarding the internal processes of the animal or plant organism which resulted from these achievements, prepared the way for the acceptance of the still greater revolution which the Darwinian epoch brought about in the views entertained by naturalists of the relations of plants and animals to each other and to their surroundings.

It has been said that every science of observation begins by going out botanising, by which, I suppose, is meant that collecting and recording observations is the first thing to be done in entering on a new field of inquiry. The remark would scarcely be true of physiology, even at the earliest stage of its development, for the most elementary of its facts could scarcely be picked up as one gathers flowers in a wood. Each of the processes which go to make up the complex of life requires separate investigation, and in each case the investigation must consist in first splitting up the process into its constituent phenomena, and then determining their relation to each other, to the process of which they form part, and to the conditions under which they manifest themselves. It will, I think, be found that even in the simplest inquiry into the nature of vital processes some such order as this is followed. Thus, for example, if muscular contraction be the subject on which we seek information, it is obvious that, in order to measure its duration, the mechanical work it accomplishes, the heat wasted in doing it, the electro-motive forces which it develops, and the changes of form associated with these phenomena, special modes of observation must be used for each of them, that each measurement must be in the first instance separately made, under special conditions, and by methods specially adapted to the required purpose. In the synthetic part of the inquiry the guidance of experiment must again be sought for the purpose of discriminating between apparent and real causes, and of determining the order in which the phenomena occur. Even the simplest experimental investigations of vital processes are beset with difficulties. For, in addition to the extreme complexity of the phenomena to be examined and the uncertainties which arise from the relative inconstancy of the conditions of all that goes on in the living organism, there is this additional drawback, that, whereas in the exact sciences experiment is guided by well-ascertained laws, here the only principle of universal application is that of adaptation, and that even this cannot, like a law of physics, be taken as a basis for deductions, but only as a summary expression of that relation between external exciting causes and the reactions to which they give rise, which, in accordance with Treviranus' definition, is the essential character of vital activity.

The Specific Energies of the Organism.

When in 1826 J. Müller was engaged in investigating the physiology of vision and hearing he introduced into the discussion a term "specific energy," the use of which by Helmholtz[1] in his physiological writings has rendered it familiar to all students. Both writers mean by the word energy, not the "capacity of doing work," but simply *activity*, using it in its old-fashioned meaning, that of the Greek word from which it is derived. With the qualification "specific," it serves, perhaps, better than any other expression to indicate the way in which adaptation manifests itself. In this more extended sense the "specific energy" of a part or organ—whether that part be a secreting cell, a motor cell of the brain or spinal cord, or one of the photogenous cells which produce the light of the glowworm, or the protoplasmic plate which generates the discharge of the torpedo—is simply the special action which it *normally* performs, its norma or rule of action being in each instance the *interest of the organism* as a whole of which it forms part, and the exciting cause some influence outside of the excited structure, technically called a stimulus. It thus stands for a characteristic of living structures which seems to be universal. The apparent exceptions are to be found in those bodily activities which, following Bichat, we call vegetative, because they go on, so to speak, as a matter of course; but the more closely we look into them the more does it appear that they form no exception to the general rule, that every link in the chain of living action, however uniform that action may be, is a response to an antecedent influence. Nor can it well be doubted that, as every living cell or tissue is called upon to act in the interest of the whole, the organism must be capable of influencing every part so as to regulate its action. For, although there are some instances in which the channels of this influence are as yet unknown, the tendency of recent investigations has been to diminish the number of such instances. In general there is no difficulty in determining both the nature of the central influence exercised and the relation

1 "Handb. der physiologischen Optik," 1886, p. 233. Helmholtz uses the word in the plural—the "energies of the nerves of special sense."

between it and the normal function. It may help to illustrate this relation to refer to the expressive word *Auslösung* by which it has for many years been designated by German writers. This word stands for the performance of function by the "letting off" of "specific energies." Carrying out the notion of "letting off" as expressing the link between action and reaction, we might compare the whole process to the mode of working of a repeating clock (or other similar mechanism), in which case the pressure of the finger on the button would represent the external influence or stimulus, the striking of the clock, the normal reaction. And now may I ask you to consider in detail one or two illustrations of physiological reaction—of the *letting off of specific energy?*

The repeater may serve as a good example, inasmuch as it is, in biological language, a highly differentiated structure, to which a single function is assigned. So also in the living organism, we find the best examples of specific energy where Müller found them, namely, in the most differentiated, or, as we are apt to call them, the *highest* structures. The retina, with the part of the brain which belongs to it, together constitute such a structure, and will afford us therefore the illustration we want, with this advantage for our present purpose, that the phenomena are such as we all have it in our power to observe in ourselves. In the visual apparatus the principle of *normality* of reaction is fully exemplified. In the physical sense the word "light" stands for ether vibrations, but in the sensuous or subjective sense for sensations. The swings are the stimulus, the sensations are the reaction. Between the two comes the link, the "letting off," which it is our business to understand. Here let us remember that the man who first recognised this distinction between the physical and the physiological was not a biologist, but a physicist. It was Young who first made clear (though his doctrine fell on unappreciative ears) that, although in vision the external influences which give rise to the sensation of light are infinitely varied, the responses need not be more than three in number, each being, in Müller's language, a "specific energy" of some part of the visual apparatus. We speak of the organ of vision as *highly differentiated*, an expression which carries with it the suggestion of a distinction of rank between different vital processes. The suggestion is a true one; for it would be possible to arrange all those parts or organs of which the bodies of the *higher* animals consist in a series, placing at the lower end of the series those of which the functions are continuous, and therefore called vegetative; at the other, those highly specialised structures, as, *e.g.*, those in the brain, which in response to physical light produce physiological, that is subjective, light; or, to take another instance, the so-called motor cells of the surface of the brain, which in response to a stimulus of much greater complexity produce voluntary motion. And just as in civilised society an individual is valued according to his power of doing one thing well, so the high rank which is assigned to the structure, or rather to the "specific energy" which it represents, belongs to it by virtue of its specialisation. And if it be asked how this conformity is manifested, the answer is, by the quality, intensity, duration, and extension of the response, in all which respects vision serves as so good an example, that we can readily understand how it happened that it was in this field that the relation between response and stimulus was first clearly recognised. I need scarcely say that, however interesting it might be to follow out the lines of inquiry thus indicated, we cannot attempt it this evening. All that I can do is to mention one or two recent observations which, while they serve as illustrations, may perhaps be sufficiently novel to interest even those who are at home in the subject.

Probably every one is acquainted with some of the familiar proofs that an object is seen for a much longer period than it is actually exposed to view; that the visual reaction lasts much longer than its cause. More precise observations teach us that this response is regulated according to laws which it has in common with all the higher functions of an organism. If, for example, the cells in the brain of the torpedo are "let off"—that is, awakened by an external stimulus—the electrical discharge, which, as in the case of vision, follows after a certain interval, lasts a certain time, first rapidly increasing to a maximum of intensity, then more slowly diminishing. In like manner, as regards the visual apparatus, we have, in the response to a sudden invasion of the eye by light, a rise and fall of a similar character. In the case of the electrical organ, and in many analogous instances, it is easy to investigate the time relations of the successive phenomena, so as to represent them graphically. Again, it is found that in many physiological reactions, the period of rising "energy" (as Helmholtz called it), is followed by a period during which the responding structure is not only inactive, but its capacity for energising is so completely lost that the same exciting cause which a moment before "let off" the characteristic response is now without effect. As regards vision, it has long been believed that these general characteristics of physiological reaction have their counterpart in the visual process, the most striking evidence being that in the contemplation of a lightning flash—or better, of an instantaneously illuminated white disc[1]—the eye seems to receive a double stroke, indicating that, although the stimulus is single and instantaneous, the response is reduplicated. The most precise of the methods we until lately possessed for investigating the wax and wane of the visual reaction, were not only difficult to carry out but left a large margin of uncertainty. It was therefore particularly satisfactory when M. Charpentier, of Nancy, whose merits as an investigator are perhaps less known than they deserve to be, devised an experiment of extreme simplicity which enables us, not only to observe, but to measure with great facility both phases of the reaction. It is difficult to explain even the simplest apparatus without diagrams; you will, however, understand the experiment if you will imagine that you are contemplating a disc, like those ordinarily used for colour mixing; that it is divided by two radial lines which diverge from each other at an angle of 60°; that the sector which these lines enclose is white, the rest black; that the disc revolves slowly, about once in two seconds. You then see, close to the front edge of the advancing sector, a black bar, followed by a second at the same distance from itself but much fainter. Now the scientific value of the experiment consists in this, that the angular distance of the bar from the black border is in proportion to the frequency of the revolutions—the faster the wider. If, for example, when the disc makes half a revolution in a second the distance is ten degrees, this obviously means that when light bursts into the eye, the extinction happens one-eighteenth of a second after the excitation.[2]

The fact thus demonstrated, that the visual reaction consequent on an instantaneous illumination exhibits the alternations I have described, has enabled M. Charpentier to make out another fact in relation to the visual reaction which is, I think, of equal importance. In all the instances, excepting the retina, in which the physiological response to stimulus has a definite time-limitation, and in so far resembles an explosion—in other words, in all the higher forms of specific energy, it can be shown experimentally that the process is propagated from the part first directly acted on to other contiguous parts of similar endowment. Thus in the simplest of all known phenomena of this kind, the electrical change, by which the leaf of the Dionæa plant responds to the slightest touch of its sensitive hairs, is propagated from one side of the leaf to the other, so that in the opposite lobe the response occurs after a delay which is proportional to the distance between the spot excited and the spot observed. That in the retina there is also such propagation has not only been surmised from analogy, but inferred from certain observed facts. M. Charpentier has now been able by a method which, although simple, I must not attempt to describe, not only to prove its existence, but to measure its rate of progress over the visual field.

There is another aspect of the visual response to the stimulus of light which, if I am not trespassing too long on your patience, may, I think, be interesting to consider. As the relations between the sensations of colour and the physical properties of the light which excites them, are among the most certain and invariable in the whole range of vital reactions, it is obvious that they afford as fruitful a field for physiological investigation as those in which white light is concerned. We have on one side physical facts, that is, wave-lengths or vibration-rates; on the other, facts in consciousness—namely, sensations of colour—so simple that notwithstanding their subjective character there is no difficulty in measuring either their intensity or their duration. Between these there are *lines of influence*, neither physical nor psychological, which pass from the former to the latter through the visual apparatus (retina, nerve, brain).

1 The phenomenon is best seen when, in a dark room, the light of a luminous spark is thrown on to a white screen with the aid of a suitable lens.

2 Charpentier, "Réaction oscillatoire de la Rétine sous l'influence des excitations lumineuses," *Archives de Physiol.*, vol. xxiv. p. 541, and *Propagation de l'action oscillatoire*, &c., p. 362.

It is these lines of influence which interest the physiologist. The structure of the visual apparatus affords us no clues to trace them by. The most important fact we know about them is that they must be at least three in number.

It has been lately assumed by some that vision, like every other specific energy, having been developed progressively, objects were seen by the most elementary forms of eye only in chiaroscuro, that afterwards some colours were distinguished, eventually all. As regards hearing it is so. The organ which, on structural grounds, we consider to represent that of hearing in animals low in the scale of organisation—as, *e.g.*, in the Ctenophora—has nothing to do with sound,[1] but confers on its possessor the power of judging of the direction of its own movements in the water in which it swims, and of guiding these movements accordingly. In the lowest vertebrates, as, *e.g.*, in the dogfish, although the auditory apparatus is much more complicated in structure, and plainly corresponds with our own, we still find the particular part which is concerned in hearing scarcely traceable. All that is provided for is that sixth sense, which the higher animals also possess, and which enables them to judge of the direction of their own movements. But a stage higher in the vertebrate series we find the special mechanisms by which we ourselves appreciate sounds beginning to appear—not supplanting or taking the place of the imperfect organ, but added to it. As regards hearing, therefore, a new function is acquired without any transformation or fusion of the old into it. We ourselves possess the sixth sense, by which we keep our balance and which serves as the guide to our bodily movements. It resides in the part of the internal ear which is called the labyrinth. At the same time we enjoy along with it the possession of the cochlea, that more complicated apparatus by which we are able to hear sounds and to discriminate their vibration-rates.

As regards vision, evidence of this kind is wanting. There is, so far as I know, no proof that visual organs which are so imperfect as to be incapable of distinguishing the forms of objects, may not be affected differently by their colours. Even if it could be shown that the least perfect forms of eye possess only the power of discriminating between light and darkness, the question whether in our own such a faculty exists separately from that of distinguishing colours is one which can only be settled by experiment. As in all sensations of colour the sensation of brightness is mixed, it is obvious that one of the first points to be determined is whether the latter represents a "specific energy" or merely a certain combination of specific energies which are excited by colours. The question is not whether there is such a thing as white light, but whether we possess a separate faculty by which we judge of light and shade—a question which, although we have derived our knowledge of it chiefly from physical experiment, is one of eye and brain, not of wave-lengths or vibration-rates, and is therefore essentially physiological.

There is a German proverb which says, "Bei Nacht sind alle Katzen grau." The fact which this proverb expresses presents itself experimentally when a spectrum projected on a white surface is watched, while the intensity of the light is gradually diminished. As the colours fade away they become indistinguishable as such, the last seen being the primary red and green. Finally they also disappear, but a gray band of light still remains, of which the most luminous part is that which before was green.[2] Without entering into details, let us consider what this tells us of the specific energy of the visual apparatus. Whether or not the faculty by which we see gray in the dark is one which we possess in common with animals of imperfectly developed vision, there seems little doubt that there are individuals of our own species who, in the fullest sense of the expression, have no eye for colour; in whom all colour sense is absent; persons who inhabit a world of gray, seeing all things as they might have done had they and their ancestors always lived nocturnal lives. In the theory of colour vision, as it is commonly stated, no reference is made to such a faculty as we are now discussing.

Prof. Hering, whose observations as to the diminished spectrum I referred to just now, who was among the first to subject the vision of the *totally* colour-blind to accurate examination, is of opinion, on that and on other grounds, that the sensation of light and shade is a specific faculty. Very recently the same view has been advocated on a wide basis by a distinguished psychologist, Prof. Ebbinghaus.[1] Happily, as regards the actual experimental results relating to both these main subjects, there seems to be a complete coincidence of observation between observers who interpret them differently. Thus the recent elaborate investigations of Captain Abney[2] (with General Festing), representing graphically the results of his measurements of the subjective values of the different parts of the diminished spectrum, as well as those of the fully illuminated spectrum as seen by the totally colour-blind, are in the closest accord with the observations of Hering, and have, moreover, been substantially confirmed in both points by the measurements of Dr. König in Helmholtz' laboratory at Berlin.[3] That observers of such eminence as the three persons whom I have mentioned, employing different methods and with a different purpose in view, and without reference to each other's work, should arrive in so complicated an inquiry at coincident results, augurs well for the speedy settlement of this long-debated question. At present the inference seems to be that such a specific energy as Hering's theory of vision postulates actually exists, and that it has for associates the colour-perceiving activities of the visual apparatus, provided that these are present; but that whenever the intensity of the illumination is below the chromatic threshold—that is, too feeble to awaken these activities—or when, as in the totally colour-blind, they are wanting, it manifests itself independently; all of which can be most easily understood on such a hypothesis as has lately been suggested in an ingenious paper by Mrs. Ladd Franklin,[4] that each of the elements of the visual apparatus is made up of a central structure for the sensation of light and darkness, with collateral appendages for the sensations of colour—it being, of course, understood that this is a mere diagrammatic representation, which serves no purposes beyond that of facilitating the conception of the relation between the several "specific energies."

Experimental Psychology.

Resisting the temptation to pursue this subject further, I will now ask you to follow me into a region which, although closely connected with the subjects we have been considering, is beset with greater difficulties—the subject in which, under the name of Physiological or Experimental Psychology, physiologists and psychologists have of late years taken a common interest—a borderland not between fact and fancy, but between two methods of investigation of questions which are closely related, which here, though they do not overlap, at least interdigitate. It is manifest that, quite irrespectively of any foregone conclusion as to the dependence of mind on processes of which the biologist is accustomed to take cognisance, mind must be regarded as one of the "specific energies" of the organism, and should on that ground be included in the subject-matter of physiology. As, however, our science, like other sciences, is limited not merely by its subject but also by its method, it actually takes in only so much of psychology as is experimental. Thus sensation, although it is psychological, and the investigation of its relation to the special structures by which the mind keeps itself informed of what goes on in the outside world, have always been considered to be in the physiological sphere. And it is by anatomical researches relating to the minute structure and to the development of the brain, by observation of the facts of disease, and, above all, by physiological experiment, that those changes in the ganglion cells of the brain and spinal cord which are the immediate antecedents of every kind of bodily action have been traced. Between the two—that is, between sensation and the beginning of action—there is an intervening region which the physiologist has hitherto willingly resigned to psychology, feeling his incompetence to use the only instrument by which it can be explored—that of introspection. This consideration enables us to understand the course which the new study (I will not claim for it the title of a new science, regard-

[1] Verworn, "Gleichgewicht u. Otolithenorgan," *Pflüger's Archiv.*, vol. l., p. 423; also Ewald's Researches on the Labyrinth as a Sense-organ ("Ueber das Endorgan des Nervus octavus," Wiesbaden. 1892).

[2] Hering, "Untersuch. eines total Farbenblinden," *Pflüger's Arch.*, vol. xlix., 1891, p. 563.

[1] Ebbinghaus, "Theorie des Farbensehens," *Zeitschr. f. Psychol.*, vol. v., 1893, p. 145.

[2] Abney and Festing, Colour Photometry, Part III. *Phil. Trans.*, vol. clxxxiii., A, 1891, p. 531.

[3] König, "Ueber den Helligkeitwerth der Spectralfarben bei verschiedener absoluter Intensität," *Beiträge zur Psychologie*, &c., "Festschrift zu H. von Helmholtz, 70, Geburtstage," 1891, p. 309.

[4] Christine Ladd Franklin, "Eine neue Theorie der Lichtempfindungen," *Zeitschr. für Psychologie*, vol. iv., 1893, p. 211; see also the Proceedings of the last Psychological Congress in London, 1892.

ing it as merely a part of the great science of life) has hitherto followed, and why physiologists have been unwilling to enter on it. The study of the less complicated internal relations of the organism has afforded so many difficult problems that the most difficult of all have been deferred; so that although the psycho-physical method was initiated by E. H. Weber in the middle of the present century, by investigations [1] which formed part of the work done at that epoch of discovery, and although Prof. Wundt, also a physiologist, has taken a larger share in the more recent development of the new study, it is chiefly by psychologists that the researches which have given to it its importance as a new discipline have been conducted.

Although, therefore, experimental psychology has derived its methods from physical science, the result has been not so much that physiologists have become philosophers, as that philosophers have become experimental psychologists. In our own universities, in those of America, and still more in those of Germany, psychological students of mature age are to be found who are willing to place themselves in the dissecting-room side by side with beginners in anatomy, in order to acquire that exact knowledge of the framework of the organism without which no man can understand its working. Those, therefore, who are apprehensive lest the regions of mind should be invaded by the *insaniens sapientia* of the laboratory, may, I think, console themselves with the thought that the invaders are for the most part men who before they became laboratory workers had already given their allegiance to philosophy; their purpose being not to relinquish definitively, but merely to lay aside for a time, the weapons in the use of which they had been trained, in order to learn the use of ours. The motive that has encouraged them has not been any hope of finding an experimental solution of any of the ultimate problems of philosophy, but the conviction that, inasmuch as the relation between mental stimuli and the mental processes which they awaken is of the same order with the relation between every other vital process and its specific determinant, the only hope of ascertaining its nature must lie in the employment of the same methods of comparative measurement which the biologist uses for similar purposes. Not that there is necessarily anything scientific in mere measurement, but that measurement affords the only means by which it can be determined whether or not the same conformity in the relation between stimulus and reaction which we have accepted as the fundamental characteristic of life, is also to be found in mind, notwithstanding that mental processes have no known physical concomitants. The results of experimental psychology tend to show that it is so, and consequently that in so far the processes in question are as truly functions of organism as the contraction of a muscle, or as the changes produced in the retinal pigment by light.

I will make no attempt even to enumerate the special lines of inquiry which during the last decade have been conducted with such vigour in all parts of the world, all of them traceable to the influence of the Leipzig school; but will content myself with saying that the general purpose of these investigations has been to determine with the utmost attainable precision the nature of psychical relations. Some of these investigations begin with those simpler reactions which more or less resemble those of an automatic mechanism, proceeding to those in which the resulting action or movement is modified by the influence of auxiliary or antagonistic conditions, or changed by the simultaneous or antecedent action on the reagent of other stimuli, in all of which cases the effect can be expressed quantitatively; others lead to results which do not so readily admit of measurement. In pursuing this course of inquiry the physiologist finds himself as he proceeds more and more the *coadjutor* of the psychologist, less and less his *director*; for whatever advantage the former may have in the mere *technique* of observation, the things with which he has to do are revealed only to introspection, and can be studied only by methods which lie outside of his sphere. I might in illustration of this refer to many recent experimental researches—such, for example, as those by which it has been sought to obtain exact data as to the physiological concomitants of pleasure and of pain, or as to the influence of weariness and recuperation, as modifiers of psychological reactions. Another outwork of the mental citadel which has been invaded by the experimental method is that of memory. Even here it can be shown that in the comparison of transitory as compared with permanent memory—as, for example, in the getting off by heart of a wholly uninteresting series of words, with subsequent oblivion and reacquisition—the labour of acquiring and reacquiring may be measured, and consequently the relation between them; and that this ratio varies according to a simple numerical law.

[1] Weber's researches were published in Wagner's *Handwörterbuch*, I think, in 1849.

I think it not unlikely that the only effect of what I have said may be to suggest to some of my hearers the question, What is the use of such inquiries? Experimental psychology has, to the best of my knowledge, no technical application. The only satisfactory answer I can give is that it has exercised, and will exercise in future, a helpful influence on the science of life. Every science of observation, and each branch of it, derives from the peculiarities of its methods certain tendencies which are apt to predominate unduly. We speak of this as specialisation, and are constantly striving to resist its influence. The most successful way of doing so is by availing ourselves of the counteracting influence which two opposite tendencies mutually exercise when they are simultaneous. He that is skilled in the methods of introspection naturally (if I may be permitted to say so) looks at the same thing from an opposite point of view to that of the experimentalist. It is, therefore, good that the two should so work together that the tendency of the experimentalist to imagine the existence of mechanism where none is proved to exist—of the psychologist to approach the phenomena of mind too exclusively from the subjective side—may mutually correct and assist each other.

Phototaxis and Chemiotaxis.

Considering that every organism must have sprung from a unicellular ancestor, some have thought that unless we are prepared to admit a deferred epigenesis of mind, we must look for psychical manifestations even among the lowest animals, and that as in the protozoon all the vital activities are blended together, mind should be present among them not merely potentially but actually, though in diminished degree.

Such a hypothesis involves ultimate questions which it is unnecessary to enter upon: it will, however, be of interest in connection with our present subject to discuss the phenomena which served as a basis for it—those which relate to what may be termed the behaviour of unicellular organisms and of individual cells, in so far as these last are capable of reacting to external influences. The observations which afford us most information are those in which the stimuli employed can be easily measured, such as electrical currents, light, or chemical agents in solution.

A single instance, or at most two, must suffice to illustrate the influence of light in directing the movements of freely moving cells, or, as it is termed, phototaxis. The rod-like purple organism called by Engelmann *Bacterium photometricum*,[1] is such a light-lover that if you place a drop of water containing these organisms under the microscope, and focus the smallest possible beam of light on a particular spot in the field, the spot acts as a light trap and becomes so crowded with the little rodlets as to acquire a deep port-wine colour. If instead of making his trap of white light, he projected on the field a microscopic spectrum, Engelmann found that the rodlets showed their preference for a spectral colour, which is absorbed when transmitted through their bodies. By the aid of a light trap of the same kind, the very well-known spindle-shaped and flagellate cell of Euglena can be shown to have a similar power of discriminating colour, but its preference is different. This familiar organism advances with its flagellum forwards, the sharp end of the spindle having a red or orange eye point. Accordingly, the light it loves is again that which is most absorbed—viz., the blue of the spectrum (line F).

These examples may serve as an introduction to a similar one in which the directing cause of movement is not physical but chemical. The spectral light trap is used in the way already described; the organisms to be observed are not coloured, but bacteria of that common sort which twenty years ago we used to call *Bacterium termo*, and which is recognised as the ordinary determining cause of putrefaction. These organisms do not care for life, but are great oxygen-lovers. Consequently, if you illuminate with your spectrum a filament of a confervoid alga, placed in water containing bacteria, the assimilation of carbon and consequent disengagement of oxygen is most active in the part of the filament which receives the red rays (B to C). To

[1] Engelmann, "Bacterium photometricum," *Onderzoek. Physiol Lab. Utrecht*, vol. vii. p. 200; also Ueber Licht-u. Farbenperception niederster Organismen, *Pflüger's Arch*, vol. xxix. p. 387.

this part, therefore, where there is a dark band of absorption, the bacteria which want oxygen are attracted in crowds. The motive which brings them together is their desire for oxygen. Let us compare other instances in which the source of attraction is food.

The plasmodia of the myxomycetes, particularly one which has been recently investigated by Mr. Arthur Lister,[1] may be taken as a typical instance of what may be called the chemical allurement of living protoplasm. In this organism, which in the active state is an expansion of labile living material, the delicacy of the reaction is comparable to that of the sense of smell in those animals in which the olfactory organs are adapted to an aquatic life. Just as, for example, the dogfish is attracted by food which it cannot see, so the plasmodium of Badhamia becomes aware, as if it smelled it, of the presence of its food—a particular kind of fungus. I have no diagram to explain this, but will ask you to imagine an expansion of living material, quite structureless, spreading itself along a wet surface; that this expansion of transparent material is bounded by an irregular coast-line; and that somewhere near the coast there has been placed a fragment of the material on which the Badhamia feeds. The presence of this bit of *Stereum* produces an excitement at the part of the plasmodium next to it. Towards this centre of activity streams of living material converge. Soon the afflux leads to an outgrowth of the plasmodium, which in a few minutes advances towards the desired fragment, envelopes, and incorporates it.

May I give you another example also derived from the physiology of plants? Very shortly after the publication of Engelmann's observations of the attraction of bacteria by oxygen, Pfeffer made the remarkable discovery that the movements of the antherozoids of ferns and of mosses are guided by impressions derived from chemical sources, by the allurement exercised upon them by certain chemical substances in solution—in one of the instances mentioned by sugar, in the other by an organic acid. The method consisted in introducing the substance to be tested, in any required strength, into a minute capillary tube closed at one end, and placing it under the microscope in water inhabited by antherozoids, which thereupon showed their predilection for the substance, or the contrary, by its effect on their movements. In accordance with the principle followed in experimental psychology, Pfeffer[2] made it his object to determine, not the relative effects of different doses, but the smallest perceptible increase of dose which the organism was able to detect, with this result—that, just as in measurements of the relation between stimulus and reaction in ourselves we find that the sensational value of a stimulus depends, not on its absolute intensity, but on the ratio between that intensity and the previous excitation, so in this simplest of vital reagents the same so-called psycho-physical law manifests itself. It is not, however, with a view to this interesting relation that I have referred to Pfeffer's discovery, but because it serves as a centre around which other phenomena, observed alike in plants and animals, have been grouped. As a general designation of reactions of this kind Pfeffer devised the term Chemotaxis, or, as we in England prefer to call it, Chemiotaxis. Pfeffer's contrivance for chemiotactic testing was borrowed from the pathologists, who have long used it for the purpose of determining the relation between a great variety of chemical compounds or products, and the colourless corpuscles of the blood. I need, I am sure, make no apology for referring to a question which, although purely pathological, is of very great biological interest—the theory of the process by which, not only in man, but also, as Metschnikoff has strikingly shown, in animals far down in the scale of development, the organism protects itself against such harmful things as, whether particulate or not, are able to penetrate its framework. Since Cohnheim's great discovery in 1867 we have known that the central phenomenon of what is termed by pathologists *inflammation* is what would now be called a chemiotactic one; for it consists in the gathering together, like that of vultures to a carcase, of those migratory cells which have their home in the blood stream and in the lymphatic system, to any point where the living tissue of the body has been injured or damaged, as if the products of disintegration which are set free where such damage occurs were attractive to them.

The fact of chemiotaxis, therefore, as a constituent phenomenon of the process of inflammation, was familiar in pathology long before it was understood. Cohnheim himself attributed it to changes in the channels along which the cells moved, and this explanation was generally accepted, though some writers, at all events, recognised its incompleteness. But no sooner was Pfeffer's discovery known than Leber,[1] who for years had been working at the subject from the pathological side, at once saw that the two processes were of similar nature. Then followed a variety of researches of great interest, by which the importance of chemiotaxis in relation to the destruction of disease-producing microphytes was proved, by that of Buchner[2] on the chemical excitability of leucocytes being among the most important. Much discussion has taken place, as many present are aware, as to the kind of wandering cells, or leucocytes, which in the first instance attack morbific microbes, and how they deal with them. The question is not by any means decided. It has, however, I venture to think, been conclusively shown that the process of destruction is a chemical one, that the destructive agent has its source in the chemiotactic cells—that is, cells which act under the orders of chemical stimuli. Two Cambridge observers, Messrs. Kanthack and Hardy,[3] have lately shown that, in the particular instance which they have investigated, the cells which are most directly concerned in the destruction of morbific *bacilli*, although chemiotactic, do not possess the power of incorporating bacilli or particles of any other kind. While, therefore, we must regard the relation between the process of devitalising and that of incorporating as not yet sufficiently determined, it is now no longer possible to regard the latter as essential to the former.

There seems, therefore, to be very little doubt that chemiotactic cells are among the agents by which the human or animal organism protects itself against infection. There are, however, many questions connected with this action which have not yet been answered. The first of these are chemical ones—that of the nature of the attractive substance and that of the process by which the living carriers of infection are destroyed. Another point to be determined is how far the process admits of adaptation to the particular infection which is present in each case, and to the state of liability or immunity of the infected individual. The subject is therefore of great complication. None of the points I have suggested can be settled by experiments in glass tubes such as I have described to you. These serve only as indications of the course to be followed in much more complicated and difficult investigations—when we have to do with acute diseases as they actually affect ourselves or animals of similar liability to ourselves, and find ourselves face to face with the question of their causes.

It is possible that many members of the Association are not aware of the unfavourable—I will not say discreditable—position that this country at present occupies in relation to the scientific study of this great subject—the causes and mode of prevention of infectious diseases. As regards administrative efficiency in matters relating to public health England was at one time far ahead of all other countries, and still retains its superiority; but as regards scientific knowledge we are, in this subject as in others, content to borrow from our neighbours. Those who desire either to learn the methods of research or to carry out scientific inquiries, have to go to Berlin, to Munich, to Breslau, or to the Pasteur Institute in Paris, to obtain what England ought long ago to have provided. For to us, from the spread of our race all over the world, the prevention of acute infectious diseases is more important than to any other nation. At the beginning of this address I urged the claims of pure science. If I could, I should feel inclined to speak even more strongly of the application of science to the discovery of the causes of acute diseases. May I express the hope that the effort which is now being made to establish in England an institution for this purpose not inferior in efficiency to those of other countries, may have the sympathy of all present? And now may I ask your attention for a few moments more to the subject that more immediately concerns us?

Conclusion.

The purpose which I have had in view has been to show that there is one principle—that of adaptation—which separates

[1] Lister, "On the Plasmodium of *Badhamia utricularis*, &c." *Annals of Botany*, No. 5, June, 1888.

[2] Pfeffer, *Untersuch a. d. botan. Institute z. Tübingen*, vol. i., part 3, 1884.

[1] Leber, "Die Anhäufung der Leucocyten am Orte des Entzündungsreizes," &c., *Die Entstehung der Entzündung*, &c., pp. 423-464. Leipzig, 1891.

[2] Buchner, "Die chem. Reizbarkeit der Leucocyten," &c., *Berliner klin Woch.*, 1890, No. 17.

[3] Kanthack and Hardy, "On the Characters and Behaviour of the Wandering Cells of the Frog," Proceedings of the Royal Society, vol. lii., p. 267.

biology from the exact sciences, and that in the vast field of biological inquiry the end we have is not merely, as in natural philosophy, to investigate the relation between the phenomenon and the antecedent and concomitant conditions on which it depends, but to possess this knowledge in constant reference to the interest of the organism. It may perhaps be thought that this way of putting it is too teleological, and that in taking, as it were, as my text this evening so old-fashioned a biologist as Treviranus, I am yielding to a retrogressive tendency. It is not so. What I have desired to insist on is that *organism* is a fact which encounters the biologist at every step in his investigations; that in referring it to any general biological principle, such as adaptation, we are only referring it to itself, not explaining it; that no explanation will be attainable until the conditions of its coming into existence can be subjected to experimental investigation so as to correlate them with those of processes in the non-living world.

Those who were present at the meeting of the British Association at Liverpool, will remember that then, as well as at some subsequent meetings, the question whether the conditions necessary for such an inquiry could be realised was a burning one. This is no longer the case. The patient endeavours which were made about that time to obtain experimental proof of what was called *abiogenesis*, although they conduced materially to that better knowledge which we now possess of the conditions of life of bacteria, failed in the accomplishment of their purpose. The question still remains undetermined; it has, so to speak, been adjourned *sine die*. The only approach to it lies at present in the investigation of those rare instances in which, although the relations between a living organism and its environment ceases as a watch stops when it has not been wound, these relations can be re-established—the process of life reawakened—by the application of the required stimulus.

I was also desirous to illustrate the relation between physiology and its two neighbours on either side, natural philosophy (including chemistry) and psychology. As regards the latter, I need add nothing to what has already been said. As regards the former, it may be well to notice that although physiology can never become a mere branch of applied physics or chemistry, there are parts of physiology wherein the principles of these sciences may be applied directly. Thus, in the beginning of the century, Young applied his investigations as to the movements of liquids in a system of elastic tubes, directly to the phenomena of the circulation; and a century before, Borelli successfully examined the mechanisms of locomotion and the action of muscles, without reference to any, excepting mechanical principles. Similarly, the foundation of our present knowledge of the process of nutrition was laid in the researches of Bidder and Schmidt, in 1851, by determinations of the weight and composition of the body, the daily gain of weight by food or oxygen, the daily loss by the respiratory and other discharges, all of which could be accomplished by chemical means. But in by far the greater number of physiological investigations, both methods (the physical or chemical and the physiological) must be brought to bear on the same question—to co-operate for the elucidation of the same problem. In the researches, for example, which during several years have occupied Prof. Bohr, of Copenhagen, relating to the exchange of gases in respiration, he has shown that factors purely physical—namely, the partial pressures of oxygen and carbon dioxide in the blood which flows through the pulmonary capillaries—are, so to speak, interfered with in their action by the "specific energy" of the pulmonary tissue, in such a way as to render this fundamental process, which, since Lavoisier, has justly been regarded as one of the most important in physiology, much more complicated than we for a long time supposed it to be. In like manner Heidenhain has proved that the process of lymphatic absorption, which before we regarded as dependent on purely mechanical causes—*i.e.* differences of pressure—is in great measure due to the specific energy of cells, and that in various processes of secretion the principal part is not, as we were inclined not many years ago to believe, attributable to liquid diffusion, but to the same agency. I wish that there had been time to have told you something of the discoveries which have been made in this particular field by Mr. Langley, who has made the subject of "specific energy" of secreting-cells his own. It is in investigations of this kind, of which any number of examples could be given, in which vital reactions mix themselves up with physical and chemical ones so intimately that it is difficult to draw the line between them, that the physiologist derives most aid from whatever chemical and physical training he may be fortunate enough to possess.

There is, therefore, no doubt as to the advantages which physiology derives from the exact sciences. It could scarcely be averred that they would benefit in anything like the same degree from closer association with the science of life. Nevertheless, there are some points in respect of which that science may have usefully contributed to the advancement of physics or of chemistry. The discovery of Graham as to the characters of colloid substances, and as to the diffusion of bodies in solution through membranes, would never have been made had not Graham "ploughed," so to speak, "with our heifer." The relations of certain colouring matters to oxygen and carbon dioxide would have been unknown, had no experiments been made on the respiration of animals and the assimilative process in plants; and, similarly, the vast amount of knowledge which relates to the chemical action of ferments must be claimed as of physiological origin. So also there are methods, both physical and chemical, which were originally devised for physiological purposes. Thus the method by which meteorological phenomena are continuously recorded graphically, originated from that used by Ludwig (1847) in his "Researches on the Circulation"; the mercurial pump, invented by Lothar Meyer, was perfected in the physiological laboratories of Bonn and Leipzig; the rendering the galvanometer needle aperiodic by damping was first realised by du Bois-Reymond—in all of which cases invention was prompted by the requirements of physiological research.

Let me conclude with one more instance of a different kind, which may serve to show how, perhaps, the wonderful ingenuity of contrivance which is displayed in certain organised structures—the eye, the ear, or the organ of voice—may be of no less interest to the physicist than to the physiologist. Johannes Müller, as is well known, explained the compound eye of insects on the theory that an erect picture is formed on the convex retina by the combination of pencils of light, received from different parts of the visual field through the eyelets (ommatidia) directed to them. Years afterwards it was shown that in each eyelet an image is formed which is reversed. Consequently, the mosaic theory of Müller was for a long period discredited on the ground that an erect picture could not be made up of "upside-down" images. Lately the subject has been reinvestigated, with the result that the mosaic theory has regained its authority. Prof. Exner[1] has proved photographically that behind each part of the insect's eye an erect picture is formed of the objects towards which it is directed. There is, therefore, no longer any difficulty in understanding how the whole field of vision is mapped out as consistently as it is imaged on our own retina, with the difference, of course, that the picture is erect. But behind this fact lies a physical question—that of the relation between the erect picture which is photographed and the optical structure of the crystal cones which produce it—a question which, although we cannot now enter upon it, is quite as interesting as the physiological one.

With this history of a theory which, after having been for thirty years disbelieved, has been reinstated by the fortunate combination of methods derived from the two sciences, I will conclude. It may serve to show how, though physiology can never become a part of natural philosophy, the questions we have to deal with are cognate. Without forgetting that every phenomenon has to be regarded with reference to its useful purpose in the organism, the aim of the physiologist is not to inquire into final causes, but to investigate processes. His question is ever How, rather than Why.

May I illustrate this by a simple, perhaps too trivial, story, which derives its interest from its having been told of the childhood of one of the greatest natural philosophers of the present century?[2] He was even then possessed by that insatiable curiosity which is the first quality of the investigator; and it is related of him that his habitual question was "What is the *go* of it?" and if the answer was unsatisfactory, "What is the particular go of it?" That North Country boy became Prof. Clerk Maxwell. The questions he asked are those which in our various ways we are all trying to answer.

[1] Exner, "Die Physiologie der facettirten Augen von Krebsen u. Insecten," Leipzig, 1891.
[2] "Life of Clerk Maxwell" (Campbell and Garnett), p. 28.

SECTION A.

MATHEMATICS AND PHYSICS.

OPENING ADDRESS BY R. T. GLAZEBROOK, M.A., F.R.S., PRESIDENT OF THE SECTION.

BEFORE dealing with the subject which I hope to bring to your notice this morning, I wish to express my deep regret for the circumstances which have prevented Prof. Clifton, who had accepted the nomination of the Council, from being your President this year.

It was specially fitting that he who has done so much for this college, and particularly for this laboratory in which we meet, should take the chair at Nottingham. The occasions on which we see him are all too seldom; and we who come frequently to these meetings were looking forward to help and encouragement in our work, derived from his wide experience. You would desire, I feel sure, that I should convey to him the expressions of your sympathy. For myself I must ask that you will pass a lenient judgment on my efforts to fill his place.

Let me commence, then, with a brief retrospect of the past year and the events which concern our Section.

From the days of Galileo the four satellites of Jupiter have been objects of interest to the astronomer. Their existence was one of the earliest of the discoveries of the telescope; they proved conclusively that all the bodies of the solar system did not move round the earth. The year which has passed since our last meeting is memorable for the discovery of a fifth satellite. It is a year to day (September 13–14, 1892) since Prof. Barnard convinced himself that he had seen with the great telescope of the Lick Observatory this new member of our system as a star of the thirteenth magnitude, revolving round the planet in 11 hours 57 minutes 23 seconds.[1]

The conference on electrical standards, held at our meeting last year, has had important results. The resolutions adopted at Edinburgh were communicated to the Standards Committee of the Board of Trade. A supplementary report accepting these resolutions was agreed to by that Committee (November 29, 1892), and presented to the President of the Board of Trade. The definitions contained in this report will be made the basis of legislation throughout the world. They have been accepted by France, Germany, Austria, and Italy. The congress at Chicago, which has just been held, has ratified them, and thus we may claim that your Committee, co-operating with the leaders of physical science in other lands, has secured international agreement on these fundamental points.

Among the physical papers of the year I would mention a few as specially calling for notice. Mr. E. H. Griffiths's redetermination of the value of the mechanical equivalent of heat has just been published (*Phil. Trans.* vol. clxxxiv.), and is a monumental work. With untiring energy and great ability he struggled for five years against the difficulties of his task, and has produced results which, with the exception of one group of experiments, do not differ by more than 1 part in 10,000; while the results of that one excepted group differ from the mean only by 1 part in 4000.

The number of ergs of work required to raise one gramme of water 1° C. at 15° C. is $4{\cdot}198 \times 10^7$. Expressed in foot-pounds and Fahrenheit degrees, the value of J is 779·97. The value obtained by Joule from his experiments on the friction of water, when corrected in 1880 by Rowland so as to reduce his readings to the air thermometer, is 778·5 at 12°·7 C. The result at this temperature of Rowland's own valuable research is 780·1. Another satisfactory outcome of Mr. Griffiths's work is the very exact accordance between the scale of temperature as determined by the comparison of his platinum thermometer with the air thermometer, which was made by Callendar and himself in 1890, and that of the nitrogen thermometer of the Bureau International at Sèvres.

Another great work now happily complete is Rowland's "Table of Standard Wave-lengths" (*Phil. Mag.*, July, 1893). Nearly a thousand lines have been measured with the skill and accuracy for which Rowland has made himself famous; and in this table we see the results achieved by the genius which designed the concave grating and the mechanical ingenuity which contrived the almost perfect screw.

Those of us who have seen Mr. Higgs's wonderful photographs of the solar spectrum, taken with a Rowland grating, will rejoice to know that his map also is now finished.

Lord Rayleigh's paper on "The Intensity of Light reflected from Water and Mercury at nearly perpendicular incidence," (*Phil. Mag.*, October, 1892), combined with the experiments on reflexion from liquid surfaces in the neighbourhood of the polarising angle (*Phil. Mag.*, January, 1892), establishes results of the utmost importance to optical theory. "There is thus," Lord Rayleigh concludes, "no experimental evidence against the rigorous application of Fresnel's formulæ"—for the reflexion of polarised light—"to the ideal case of an abrupt transition between two uniform transparent media."

Prof. Dewar has, during the year, continued his experiments on the liquefaction of oxygen and nitrogen on a large scale. To a physicist perhaps the most important results of the research are the discovery of the magnetic properties of liquid oxygen, and the proof of the fact that the resistance of certain pure metals vanishes at absolute zero (*Phil. Mag.*, October, 1892). The last discovery is borne out by Griffiths and Callendar's experiments with their platinum thermometers (*Phil. Mag.*, December, 1892).

Mr. Williams's article on "The Relation of the Dimensions of Physical Quantities to Directions in Space" (*Phil. Mag.*, September, 1892) has led to an interesting discussion. Some of his deductions will be noticed later.

The title-page of the first edition of Maxwell's "Electricity and Magnetism" bears the date 1873. This year, 1893, we welcome a third edition, edited by Maxwell's distinguished successor, and enriched by a supplementary volume, in which Prof. J. J. Thomson describes some of the advances made by electrical science in the last twenty years. The subject matter of this volume might well serve as a text for a Presidential Address.

The choice of a subject on which to speak to-day has been no easy task. The field of physics and mathematics is a wide one. There is one matter, however, to which for a few minutes I should like to call your attention, inadequately though it be. Optical theories have, since the year 1876, when I first read Sir George Stokes's "Report on Double Refraction" (British Association Report, 1862), had a special interest for me, and I think the time has come when we may with advantage review our position with regard to them, and sum up our knowledge.[1]

That light is propagated by an undulatory motion through a medium which we call the ether is now an established fact, although we know but little of the nature or constitution of the ether. The history of this undulatory theory is full of interest, and has, it appears to me, in its earlier stages been not quite clearly apprehended. Two theories have been proposed to account for optical phenomena. Descartes was the author of the one, the emission theory. Hooke, though his work was very incomplete, was the founder of the undulatory theory. In his "Micrographia," 1664, page 56, he asserts that light is a quick and short vibratory motion, "propagated every way through an homogeneous medium by direct or straight lines extended every way like rays from the centre of a sphere. . . . Every pulse or vibration of the luminous body will generate a sphere which will continually increase and grow bigger, just after the same manner, though indefinitely swifter, as the waves or rings on the surface do swell into bigger and bigger circles about a point on it"; and he gives on this hypothesis an account of reflexion, refraction, dispersion, and the colours of thin plates. In the same work, page 58, he describes an experiment practically identical with Newton's famous prism experiment, published in 1672. Hooke used for a prism a glass vessel about two feet long, filled with water, and inclined so that the sun's rays might enter obliquely at the upper surface and traverse the water. "The top surface is covered by an opacous body, all but a hole through which the sun's beams are suffered to pass into the water, and are thereby refracted" to the bottom of the glass, "against which part if a paper be expanded on the outside there will appear all the colours of the rainbow—that is, there will be generated the two principal colours, scarlet and blue, with all the intermediate ones which arise from the composition and diluting of these two." But Hooke could make no use of his own observation; he attempted to substantiate from it his own theory of colours, and

[1] "In general," he says, "the satellite has been faint. . . . . On the 13th, however, when the air was very clear, it was quite easy."—NATURE, October 20, 1892.

[1] This address was in the printer's hands when I saw Sir George Stokes's paper on "The Luminiferous Ether," NATURE, July 27. Had I known that so great a master of my subject had dealt with it so lately, my choice might have been different; under the circumstances it was too late to change.

wrote pure nonsense in the attempt; and though his writings contain the germ of the theory, and in the light of our present knowledge it seems possible that he understood it more thoroughly than his contemporaries believed, yet his reasoning is so utterly vague and unsatisfactory that there is little ground for surprise that he convinced but few of its truth.

And then came Newton. It is claimed for him, and that with justice, that he was the true founder of the emission theory. In Descartes' hands it was a vague hypothesis. Newton deduced from it by rigid reasoning the laws of reflexion and refraction; he applied it with wondrous ingenuity to explain the colours of thin and of thick plates and the phenomena of diffraction, though in doing this he had to suppose a mechanism which he must have felt to be almost impossible; a mechanism which in time, as it was applied to explain other and more complex phenomena, became so elaborate that, in the words of Verdet, referring to a period one hundred years later, "all that is necessary to overturn this laborious scaffolding is to look at it and try to understand it."

But though Newton may with justice be called the founder of the emission theory, it is unjust to his memory to state that he accepted it as giving a full and satisfactory account of optics as they were known to him. When he first began his optical work he realised that facts and measurements were needed, and his object was to furnish the facts. He may have known of Hooke's theories. The copy of the "Micrographia" now at Trinity College was in the Library while Newton was working with his prism in rooms in college, and may have been consulted by him. An early note-book of his contains quotations from it. Still there was nothing in the theories but hypotheses unsupported by facts, and these would have no charm for Newton. The hypotheses in the main are right. Light is due to wave motion in an all-pervading ether; the principle of interference, vaguely foreshadowed by Hooke ("Micrographia," p. 66), was one which a century later was to remove the one difficulty which Newton felt. For there was one fact which Hooke's theory could not then explain, and till that explanation was given the theory must be rejected; the test was crucial, the answer was decisive.

Newton tells us repeatedly what the difficulty was. In reply to a criticism of Hooke's in 1672, he writes: "For to me the fundamental supposition itself seems impossible, namely, that the waves of vibrations of any fluid can, like the rays of light, be propagated in straight lines without continual and very extravagant spreading and bending into the quiescent medium where they are terminated by it. I mistake if there be not both experiment and demonstration to the contrary. . . . For it seems impossible that any of those motions or pressions can be propagated in straight lines without the like spreading every way into the shadowed medium."

Nor was there anything in the controversy with Hooke, which took place about 1675, to shake this belief. Hooke had read his paper describing his discovery of diffraction. He had announced it two years earlier, and there is no doubt in my mind that this was an original discovery, and not, as Newton seemed to imply soon after, taken from Grimaldi; but his paper does not remove the difficulty. Accordingly we find in the "Principia" Newton's attempted proof (lib. ii. prop. 42) that "motus omnis per fluidum propagatus divergit a recto tramite in spatia immota"—a demonstration which has convinced but few and leaves the question unsolved as before.

Again, in 1690 Huygens published his great "Traité de la Lumière," written in 1678. Huygens had clearer views than Hooke on all he wrote; many of his demonstrations may be given now as completely satisfactory, but on the one crucial matter he was fatally weak. He, rather than Hooke, is the true founder of the undulatory theory, for he showed what it would do if it could but explain the rectilinear propagation. The reasoning of the latter part of Huygens's first chapter becomes forcible enough when viewed in the light of the principle of interference enunciated by Young, November 12, 1801, and developed, independently of Young, by Fresnel in his great memoir on "Diffraction" in 1815; but without this aid it was not possible for Huygens's arguments to convince Newton, and hence in the "Opticks" (2nd edit., 1717) he wrote the celebrated Query 28: "Are not all hypotheses erroneous in which light is supposed to consist in pressure or motion propagated through a fluid medium? If it consisted in motion propagated either in an instant or in time it would bend into the shadow. For pressure or motion cannot be propagated in a fluid in right lines beyond an obstacle which stops part of the motion, but will bend and spread every way into the quiescent medium which lies outside the shadow." These were his last words on the subject. They prove that he could not accept the undulatory theory; they do not prove that he believed the emission theory to give the true explanation. Yet, in spite of this, I think that Newton had a clearer view of the undulatory theory than his contemporaries, and saw more fully than they did what that theory could achieve if but the one difficulty were removed.

This was Young's belief, who writes (*Phil. Trans.*, November 12, 1801):—"A more extensive examination of Newton's various writings has shown me that he was in reality the first who suggested such a theory as I shall endeavour to maintain; that his own opinions varied less from this theory than is now almost universally believed; and that a variety of arguments have been advanced as if to meet him which may be found in a nearly similar form in his own works." I wish to call attention to this statement, and to bring into more prominent view the grounds on which it rests, to place Newton in his true position as one of the founders of the undulatory theory.

The emission theory in Newton's hands was a dynamical theory; he traced the motion of material particles under certain forces, and found their path to coincide with that of a ray of light; and in the "Principia," prop. xcvi., Scholium, he calls attention to the similarity between these particles and light. The particles obey the laws of reflexion and refraction; but to explain why some of the incident light was reflected and some refracted Newton had to invent his hypothesis of fits of easy reflexion and transmission. These are explained in the "Opticks," book iii., props. xi., xii., and xiii. (1704), thus:—

"Light is propagated from luminous bodies in time, and spends about seven or eight minutes of an hour in passing from the sun to the earth.

"Every ray of light in its passage through any refracting surface is put into a certain transient constitution or state, which in the progress of the ray returns at equal intervals, and disposes the ray at each return to be easily transmitted through the next refracting surface, and between the returns to be easily reflected by it.

"*Definition.*—The return of the disposition of any ray to be reflected I will call its fit of easy reflexion, and those of the disposition to be transmitted its fits of easy transmission, and the space it passes between every return and the next return the interval of its fits.

"The reason why the surfaces of all thick transparent bodies reflect part of the light incident on them and refract the rest is that some rays at their incidence are in their fits of easy reflexion, some in their fits of easy transmission."

Such was Newton's theory. It accounts for some or all of the observed facts; but what causes the fits? Newton, in the "Opticks," states that he does not inquire; he suggests, for those who wish to deal in hypotheses, that the rays of light striking the bodies set up waves in the reflecting or refracting substance which move faster than the rays and overtake them. When a ray is in that part of a vibration which conspires with its motion, it easily breaks through the refracting surface—it is in a fit of easy transmission; and, conversely, when the motion of the ray and the wave are opposed, it is in a fit of easy reflexion.

But he was not always so cautious. At an earlier date (1675) he sent to Oldenburg, for the Royal Society, an "Hypothesis explaining the Properties of Light"; and we find from the journal book that "these observations so well pleased the society that they ordered Mr. Oldenburg to desire Mr. Newton to permit them to be published." Newton agreed, but asked that publication should be deferred till he had completed the account of some other experiments which ought to precede those he had described. This he never did, and the hypothesis was first printed in Birch's "History of the Royal Society," vol. iii., pp. 247, 262, 272, &c.; it is also given in Brewster's "Life of Newton," vol. i., App. II., and in the *Phil. Mag.*, September, 1846, pp. 187–213.

"Were I," he writes in this paper, "to assume an hypothesis, it should be this, if propounded more generally, so as not to assume what light is further than that it is something or other capable of exciting vibrations of the ether. First, it is to be assumed that there is an ethereal medium, much of the same constitution with air, but far rarer, subtiller, and more strongly elastic. . . . In the second place, it is to be supposed that the ether is a vibrating medium, like air, only the vibrations far more swift and minute; those of air made by a man's ordinary voice succeeding at more than half a foot or a foot distance, but those of ether at a less distance than the hundred-thousandth part of an inch. And as in air the vibrations are some larger than others, but yet all equally swift . . . so I suppose the ethereal vibrations differ in bigness but not in swiftness. . . . In the fourth place, therefore, I suppose that light is neither ether nor its vibrating motion, but something of a different kind propagated from lucid bodies. They that will may suppose it an aggregate of various peripatetic qualities. Others may suppose it multitudes of unimaginable small and swift corpuscles of various sizes springing from shining bodies at great distances one after the other, but yet without any sensible interval of time. . . . To avoid dispute and make this hypothesis general, let every man here take his fancy; only, whatever light be, I would suppose it consists of successive rays differing from one another in contingent circumstances, as bigness, force, or vigour, like as the sands on the shore . . . and, further, I would suppose it diverse from the vibrations of the ether. . . . Fifthly, it is to be supposed that light and ether mutually act upon one another." It is from this action that reflexion and refraction come about; "æthereal vibrations are therefore," he continues, "the best means by which such a subtile agent as light can shake the gross particles of solid bodies to heat them. And so, supposing that light impinging on a refracting or reflecting ethereal superficies puts it into a vibrating motion, that physical superficies being by the perpetual appulse of rays always kept in a vibrating motion, and the ether therein continually expanded and compressed by turns, if a ray of light impinge on it when it is much compressed, I suppose it is then too dense and stiff to let the ray through, and so reflects it; but the rays that impinge on it at other times, when it is either expanded by the interval between two vibrations or not too much compressed and condensed, go through and are refracted. . . . And now to explain colours. I suppose that as bodies excite sounds of various tones and consequently vibrations, in the air of various bignesses, so when the rays of light by impinging on the stiff refracting superficies excite vibrations in the ether, these rays excite vibrations of various bignesses . . . therefore, the ends of the capillamenta of the optic nerve which front or face the retina being such refracting superficies, when the rays impinge on them they must there excite these vibrations, which vibrations (like those of sound in a trumpet) will run along the aqueous pores or crystalline pith of the capillamenta through the optic nerves into the sensorium (which light itself cannot do), and there, I suppose, affect the sense with various colours, according to their bigness and mixture—the biggest with the strongest colours, reds and yellows; the least with the weakest, blues and violets; the middle with green; and a confusion of all with white."

The last idea, the relation of colour to the bigness of wave-length, is put even more plainly in the "Opticks," Query 13 (ed. 1704):—"Do not several sorts of rays make vibrations of various bignesses, which according to their bignesses excite sensations of various colours . . . and, particularly, do not the most refrangible rays excite the shortest vibrations for making a sensation of deep violet; the least refrangible the largest for making a sensation of deep red?"

The whole is but a development of a reply, written in 1672, to a criticism of Hooke's on his first optical paper, in which Newton says: "It is true that from my theory I argue the corporeity of light, but I do it without any absolute positiveness, as the word perhaps intimates, and make it at most a very plausible consequence of the doctrine, and not a fundamental supposition. Certainly," he continues, "my hypothesis has a much greater affinity with his own [Hooke's] than he seems to be aware of, the vibrations of the ether being as useful and necessary in this as in his."

Thus Newton, while in the "Opticks" he avoided declaring himself as to the mechanism by which the fits of easy reflexion and transmission were produced, has in his earlier writings developed a theory practically identical in many respects with modern views, though without saying that he accepted it. It was an hypothesis; one difficulty remained, it would not account for the rectilinear propagation, and it must be rejected till it did.

Light is neither ether nor its vibrating motion; it is energy which, emitted from luminous bodies, is carried by wave motion in rays, and falling on a reflecting surface sets up fresh waves by which it is in part transmitted and in part reflected. Light is not material, but Newton nowhere definitely asserts that it is. He "argues the corporeity of light, but without any absolute positiveness." In the "Principia," writing of his particles, his words are: "Harum attractionum haud multum dissimiles sunt Lucis reflexiones et refractiones"; and the Scholium concludes with "Igitur ob analogiam quæ est inter propagationem radiorum lucis et progressum corporum, visum est propositiones sequentes in usus opticos subjungere; interea de natura radiorum (utrum sint corpora necne) nihil omnino disputans, sed trajectorias corporum trajectoriis radiorum persimiles solummodo determinans."[1]

No doubt Newton's immediate successors interpreted his words as meaning that he believed in the corpuscular theory, conceived, as Herschel says, by Newton, and called by his illustrious name. Men learnt from the "Principia" how to deal with the motion of small particles under definite forces. The laws of wave motion were obscure, and till the days of Young and Fresnel there was no second Newton to explain them. There is truth in Whewell's words ("Inductive Sciences," ii. chap. x.): "That propositions existed in the 'Principia' which proceeded on this hypothesis was with many ground enough for adopting the doctrine." Young's view, already quoted, appears to me more just; and I see in Newton's hypothesis the first clear indication of the undulatory theory of light, the first statement of its fundamental laws.

Three years later (1678) Huygens wrote his "Traité de la Lumière," published in 1690. He failed to meet the main difficulty of the theory, but in other respects he developed its consequences to a most remarkable degree. For more than a century after this there was no progress, until in 1801 the principle of interference was discovered by Young, and again independently a few years later by Fresnel, whose genius triumphed over the difficulties to which his predecessors had succumbed, and, by combining the principles of interference and transverse vibrations, established an undulatory theory as a fact, thus making Newton's theory a *vera causa*.

There is, however, a great distinction between the emission theory as Newton left it and Fresnel's undulatory theory. The former was dynamical, though it could explain but little: the particles of light obeyed the laws of motion, like particles of matter. The undulatory theory of Huygens and Fresnel was geometrical or kinematical: the structure of the ether was and is unknown; all that was needed was that light should be due to the rapid periodic changes of some vector property of a medium capable of transmitting transverse waves. Fresnel, it is true, attempted to give a dynamical account of double refraction, and of the reflexion and refraction of polarised light, but the attempt was a failure; and not the least interesting part of Mr. L. Fletcher's recent book on double refraction ("The Optical Indicatrix") is that in which he shows that Fresnel himself in the first instance arrived at his theory by purely geometrical reasoning, and only attempted at a later date to give it its dynamical form. "If we reflect," says Stokes ("Report on Double Refraction," *Brit. Assoc Report*, 1862, p. 254), "on the state of the subject as Fresnel found it and as he left it, the wonder is, not that he failed to give a rigorous dynamical theory, but that a single mind was capable of effecting so much." Every student of optics should read Fresnel's great memoirs.

But the time was coming when the attempt to construct a dynamical theory of light could be made. Navier, in 1821, gave the first mathematical theory of elasticity. He limited himself to isotropic bodies, and worked on Boscovitch's hypothesis as to the constitution of matter. Poisson followed on the same lines, and the next year (1822) Cauchy wrote his first memoir on elasticity. The phenomena of light afforded a means of testing this theory of elasticity, and accordingly the first mechanical conception of the ether was that of Cauchy and Neumann, who conceived it to consist of distinct hard particles acting upon one another with forces in the line joining them, which vary as some function of the distances between the particles. It was now possible to work out a mechanical theory of light which should be a necessary consequence of these hy-

[1] The reflexions and refractions of light are not very unlike these attractions. Therefore, because of the analogy which exists between the propagation of rays of light and the motion of bodies, it seemed right to add the following propositions for optical purposes, not at all with any view of discussing the nature of rays (whether they are corporeal or not), but only to determine paths of particles which closely resemble the paths of rays.—"Principia," lib. i., sect. xiv., prop. xcvi., Scholium.

potheses. Cauchy's and the earlier theories do not represent the facts either in an elastic solid or in the ether. At present we are not concerned with the cause of this; we must recognise it as the first attempt to explain on a mechanical basis the phenomena observed. According to his theory in its final form, there are, in an isotropic medium, two waves which travel with velocities $\sqrt{A/\rho}$ and $\sqrt{B/\rho}$, A and B being constants and ρ the density. Adopting Cauchy's molecular hypothesis, there must be a definite relation between A and B.

A truer view of the theory of elasticity is given by Green in his paper read before the Cambridge Philosophical Society in 1837. This theory involves the two constants, but they are independent, and to account for certain optical effects A must either vanish or be infinite. The first supposition was, until a few years since, thought to be inconsistent with stability; the second leads to consequences which in part agree with the results of optical experiment, but which differ fatally from those results on other points. And so the first attempt to construct a mechanical theory of light failed. We have learnt much from it. At the death of Green the subject had advanced far beyond the point at which Fresnel left it. The causes of the failure are known, and the directions in which to look for modifications have been pointed out.

Now I believe that the effort to throw any theory into mechanical form, to conceive a model which is a concrete representation of the truth, to arrive at that which underlies our mathematical equations wherever possible, is of immense value to every student. Such a course, I am well aware, has its dangers. It may be thought that we ascribe to the reality all the properties of the model, that, in the case of the ether, we look upon it as a collection of gyrostatic molecules and springs, or of pulleys and indiarubber bands, instead of viewing it from the standpoint of Maxwell, who hoped, writing of his own model, "that by such mechanical fictions, anyone who understands the provisional and temporary character of his hypothesis will find himself helped rather than hindered in his search after the true interpretation of the phenomena." Prof. Boltzmann, in his most interesting paper on "The Methods of Theoretical Physics" (*Phil. Mag.*, July, 1893) has quoted these words, and has expressed far more ably than I can hope to do the idea I wish to convey.

The elastic solid theory, then, has failed; but are we therefore without any mechanical theory of light? Are we again reduced to merely writing down our equations, and calling some quantity which appears in them the amplitude of the light vibration, and the square of that quantity the intensity of the light? Or can we take a further step? Let us inquire what the properties of the ether must be which will lead us by strict reasoning to those equations which we know represent the laws of the propagation of light.

These equations resemble in many respects those of an elastic solid; let us, then, for a moment identify the displacement in a light-wave with an actual displacement of a molecule of some medium having properties resembling that of a solid. Then this medium must have rigidity or quasi-rigidity in order that it may transmit transverse waves; at the same time it must be incapable of transmitting normal waves, and this involves the supposition that the quantity A which appears in Green's equations must vanish or be infinite. To suppose it infinite is to recur to the incompressible solid theory; we will assume, therefore, that it is zero. Reflexion and refraction show us that the ether in a transparent medium such as glass differs in properties from that in air. It may differ either (1) in density or effective density,[1] or (2) in rigidity or effective rigidity. The laws of double refraction, and the phenomena of the scattering of light by small particles, show us that the difference is, in the main, in density or effective density; the rigidity of the ether does not greatly vary in different media. Dispersion, absorption, and anomalous dispersion all tell us that in some cases energy is absorbed from the light vibrations by the matter through which they pass, or, to be more general, by something very intimately connected with the matter.

We do not know sufficient to say what that action must be; we can, however, try the consequences of various hypotheses. Guided by the analogy of the motion of a solid in a fluid, let us assume that the action is proportional to the acceleration of the ether particles relative to the matter, and, further, that under certain circumstances some of the energy of the ether particles is transferred to the matter, thus setting them in vibration. If such action be assumed, the actual density of the ether may be the same in all media, the mathematical expression for the forces will lead to the same equations as those we obtain by supposing that there is a variation of density, and since it is clearly reasonable to suppose that this action between matter and ether is, in a crystal a function of the direction of vibration, the apparent or effective density of the ether in such a body will depend on the direction of displacement.

Now these hypotheses will conduct us by strict mathematical reasoning to laws for the propagation, reflexion and refraction, double refraction and polarisation, dispersion, absorption, and anomalous dispersion and aberration of light which are in complete accordance with the most accurate experiments.

The rotatory polarisation of quartz, sugar, and other substances points to a more complicated action between the ether and matter than is contemplated above; and, accordingly, other terms have to be introduced into the equations to account for these effects. It will be noted as a defect, and perhaps a fatal one, that the connection between electricity and light is not hinted at, but I hope to return to that point shortly.

Such a medium as I have described is afforded us by the labile ether of Lord Kelvin. It is an elastic solid or quasi-solid incapable of transmitting normal waves. The quantity A is zero, but Lord Kelvin has shown that the medium would still be stable provided its boundaries are fixed, or, which comes to the same thing, provided it extends to infinity. Such a medium would collapse if it were not held fixed at its boundaries; but if it be held fixed, and if then all points of any closed spherical surface in the medium receive a small normal displacement, so that the matter within the surface is compressed into a smaller volume, there will be no tendency either to aid or to prevent this compression, the medium in its new state will still be in equilibrium, the stresses in any portion of it which remains unaltered in shape are independent of its volume, and are functions only of the rigidity and, implicitly, of the forces which hold the boundary of the whole medium fixed.

A soap film affords in two dimensions an illustration of such a medium; the tension at any point of the film does not depend on the dimensions; we may suppose the film altered in area in any way we please—so long as it remains continuous—without changing the tension. Waves of displacement parallel to the surface of the film would not be transmitted. But such a film, in consequence of its tension, has an apparent rigidity for displacements normal to its surface: it can transmit transverse waves with a velocity which depends on the tension. Now the labile ether is a medium which has, in three dimensions, characteristics resembling those of the two-dimensional film. Its fundamental property is that the potential energy per unit volume, in an isotropic body, so far as it arises from a given strain, is proportional to the square of the resultant twist. In an incompressible elastic ether this potential energy depends upon the shearing strain. Given such a medium—and there is nothing impossible in its conception—the main phenomena of light follow as a necessary consequence. We have a mechanical theory by the aid of which we can explain the phenomena; we can go a few steps behind the symbols we use in our mathematical processes. Lord Kelvin, again, has shown us how such a medium might be made up of molecules having rotation in such a way that it could not be distinguished from an ordinary fluid in respect to any irrotational motion; it would, however, resist rotational movements with a force proportionate to the twist, just the force required; the medium has no real rigidity, but only a quasi-rigidity conferred on it by its rotational motion. The actual periodic displacements of such a medium may constitute light. We may claim, then, with some confidence, to have a mechanical theory of light.

But nowadays the ether has other functions to perform, and there is another theory to consider, which at present holds the field. Maxwell's equations of the electromagnetic field are practically identical with those of the quasi-labile ether. The symbols which occur can have an electromagnetic meaning; we speak of permeability and inductive capacity instead of rigidity and density, and take as our variables the electric or magnetic displacements instead of the actual displacement or the rotation.

[1] The equations of motion for a medium such as is supposed above can be written—

$\rho \times$ acceleration of ether $+ \rho' \times$ acceleration of matter $= \Sigma$ B $\times$ function of ether displacements, and their differential coefficients with respect to the co-ordinates $+ \Sigma$ B$' \times$ similar function for matter displacements.

The quantity ρ may be spoken of as the effective ether density, the quantities B as the effective elasticity or rigidity.

Still such a theory is not mechanical. Electric force acts on matter charged with electricity, and the ratio of the force to the charge can be measured in mechanical units. A fundamental conception in Maxwell's theory is electric displacement, and this is proportional to the electric force. Moreover, its convergence measures the quantity of electricity present per unit volume; but we have no certain mechanical conception of electric displacement or quantity of electricity, we have no satisfactory mechanical theory of the electromagnetic field. The first edition of the "Electricity and Magnetism" appeared twenty years ago. In it Maxwell says: "It must be carefully borne in mind that we have made only one step in the theory of the action of the medium. We have supposed it to be in a state of stress, but we have not in any way accounted for this stress or explained how it is maintained. This step, however, appears to me to be an important one, as it explains by the action of consecutive parts of the medium phenomena which were formerly supposed to be explicable only by direct action at a distance. I have not been able to make the next step, namely, to account by mechanical considerations for these stresses in the dielectric." And these words are true still.

But, for all this, I think it may be useful to press the theory of the quasi-labile ether as far as it will go, and endeavour to see what the consequences must be.

The analogy between the equations of the electromagnetic field and those of an elastic solid has been discussed by many writers. In a most interesting paper on the theory of dimensions, read recently before the Physical Society, Mr. Williams has called attention to the fact that two only of these analogies have throughout a simple mechanical interpretation. These two have been developed at some length by Mr. Heaviside in his paper in the *Electrician* for January 23, 1891. To one of them Lord Kelvin had previously called attention ("Collected Papers," vol. iii. p. 450.)

Starting with a quasi-labile ether, then, we may suppose that μ, the magnetic permeability of the medium, is $4\pi\rho$,[1] where ρ is the density, and that K, the inductive capacity, is $1/4\pi B$. B being the rigidity, or the quasi-rigidity conferred by the rotation.

The kinetic energy of such a medium is $\frac{1}{2}\rho(\dot\xi^2 + \dot\eta^2 + \dot\zeta^2)$, where $\dot\xi$, $\dot\eta$, $\dot\zeta$ are the components of the displacement. Let us identify this with the electromagnet energy $(\alpha^2 + \beta^2 + \gamma^2)8\pi$, α, β, γ being components of the magnetic force, so that $\alpha = \dot\xi$, $\beta = \dot\eta$, $\gamma = \dot\zeta$. Then the components of the electric displacement, assuming them to be zero initially, are given by

$$f = \frac{1}{4\pi}\left(\frac{d\zeta}{dy} - \frac{d\eta}{dz}\right), \text{ \&c.};$$

that is, the electric displacement $\mathfrak{D}$ multiplied by 4π is equal to the rotation in the medium. Denote this by Ω.

The potential energy due to the strain is

$$\tfrac{1}{2}B\Omega^2, \text{ or } \tfrac{1}{2}16\pi^2 B\mathfrak{D}^2,$$

and on substituting for B this becomes

$$\frac{1}{2}\frac{4\pi}{K}\mathfrak{D}^2,$$

which is Maxwell's expression for the electrostatic energy of the field.

Thus so far, but no farther, the analogy is complete; the kinetic energy of the medium measures the magnetic energy, the potential energy measures the electrostatic energy. The stresses in the ether, however, are not those given by Maxwell's theory.

In the other form of the analogy we are to take the inductive capacity as $4\pi\rho$ and the magnetic permeability as $1/4\pi B$. The velocity measures the electric force, and the rotation the magnetic force, so that electrostatic energy is kinetic, and magnetic energy potential. Such an arrangement is not so easy to grasp as the other. Optical experiments, however, show us that in all probability it is ρ, and not B, which varies, while from our electrical measurements we know that K is variable and μ constant; hence this is a reason for adopting the second form.

In either case we look upon the field as the seat of energy distributed per unit of volume according to Maxwell's law. The total energy is obtained by integration throughout the field.

[1] If we adopted Mr. Heaviside's rational system of units the 4π would disappear.

Now we can transform this integral by Green's theorem to a surface integral over the boundary, together with a volume integral through the space; and the form of these integrals shows us that we may look upon the effects, dealing for the present with electrostatics only, as due to the attractions and repulsions of a certain imaginary matter distributed according to a definite law over the boundary and throughout the space. To this imaginary matter, then, in the ordinary theory we give the name of Electricity.

Thus an electrified conducting sphere, according to these analogies, is not a body charged with a quantity of something we call electricity, but a surface at which there is a discontinuing in the rotation impressed upon the medium, or in the flow across the surface; for in the conductor a viscous resistance to the motion takes the place of rigidity. No permanent strain can be set up.

From this standpoint we consider electrical force as one of the manifestations of some action between ether and matter. There are certain means by which we can strain the ether: the friction of two dissimilar materials, the chemical action in a cell are two; and when, adopting the first analogy, this straining is of such a nature as to produce a rotational twist in the ether, the bodies round are said to be electrified; the energy of the system is that which would arise from the presence over their surfaces of attracting and repelling matter, attracting or repelling according to the inverse square law. We falsely assign this energy to such attractions instead of to the strains and stresses in the ether.

Such a theory has many difficulties. It is far from being proved; perhaps I have erred in trespassing on your time with it in this crude form. The words of the French *savant*, quoted by Poincaré, will apply to it: "I can understand all Maxwell except what he means by a charged body." It is not, of course, the only hypothesis which might be formed to explain the facts, perhaps not even the most probable. For many points the vortex sponge theory is its superior. Still I feel confident that in time we shall come to see that the phenomena of the electro-magnetic field may be represented by some such mechanism as has been outlined, and that confidence must be my excuse for having ventured to call your attention to the subject.

SECTION B.

CHEMISTRY.

OPENING ADDRESS BY PROF. EMERSON REYNOLDS, M.D., SC.D., F.R.S., PRESIDENT OF THE SECTION.

AT the Nottingham Meeting of the British Association in 1866, Dr. H. Bence Jones addressed the Section over which I have now the honour to preside on the place of Chemical Science in Medical Education. Without dwelling on this topic to-day, it is an agreeable duty to acknowledge the foresight of my predecessor as to the direction of medical progress. Twenty-seven years ago the methods of inquiry and instruction in medicine were essentially based on the formal lines of the last generation. Dr. Bence Jones saw that modern methods of research in chemistry—and in the experimental sciences generally—must profoundly influence medicine, and he urged the need of fuller training of medical students in those sciences.

The anticipated influence is now operative as a powerful factor in the general progress of medicine and medical education; but much remains to be desired in regard to the chemical portion of that education. In the later stages of it, undue importance is still attached to the knowledge of substances rather than of principles; of products instead of the broad characters of the chemical changes in which they are formed. Without this higher class of instruction it is unreasonable to expect an intelligent perception of complex physiological and pathological processes which are chemical in character, or much real appreciation of modern pharmacological research. I have little doubt, however, that the need for this fuller chemical education will soon be so strongly felt that the necessary reform will come from within a profession which has given ample proof in recent years of its zeal in the cause of scientific progress.

In our own branch of science the work of the year has been substantial in character, if almost unmarked by discoveries of popular interest. We may probably place in the latter category the measure of success which the skill of Moissan has enabled him to attain in the artificial production of the diamond form of carbon, apparently in minute crystals similar to those recognised by Koenig, Mallard, Daubrée, and by Friedel in the supposed meteorite of Cañon de Diablo in Arizona. Members of the Section will probably have the opportunity of examining some of these artificial diamonds through the courtesy of M. Moissan, who has also, at my request, been so good as to arrange for us a demonstration of the properties of the element fluorine, which he succeeded in isolating in 1887.

Not less interesting or valuable are the studies of Dr. Perkins, on electro-magnetic rotation; of Lord Rayleigh, on the relative densities of gases; of Dewar, on chemical relations at extremely low temperatures; of Clowes, on exact measurements of flame-cap indications afforded by miners' testing lamps; of Horace Brown and Morris, on the chemistry and physiology of foliage leaves, by which they have been led to the startling conclusion that cane-sugar is the first sugar produced during the assimilation of carbon, and that starch is formed at its expense as a more stable reserve material for subsequent use of the plant; or of Cross, Bevan, and Beadle, on the interaction of alkali-cellulose and carbon bisulphide, in the course of which they have proved that a cellulose residue can act like an alcohol radical in the formation of thiocarbonates, and thus have added another to the authors' valuable contributions to our knowledge of members of the complex group of celluloses.

But it is now an idle task for a President of this Section to attempt a slight sketch of the works of chemical philosophers even during the short space of twelve months; they are too numerous and generally too important to be lightly treated, hence we can but apply to them a paraphrase of the ancient formula—Are they not written in the books of the chronicles we term "Jahresberichte," "Annales," or "Transactions and Abstracts," according to our nationality?

I would, however, in this connection ask your consideration for a question relating to the utilisation of the vast stores of facts laid up—some might even say buried—in the records to which reference has just been made. The need exists, and almost daily becomes greater, for facile reference to this accumulated wealth, and of such a kind that an investigator, commencing a line of inquiry with whose previous history he is not familiar, can be certain to learn *all* the facts known on the subject up to a particular date, instead of having only the partial record to be found in even the best edited of the dictionaries now available. The best and most obvious method of attaining this end is the publication of a subject-matter index of an ideally complete character. I am glad to know that the Chemical Society of London will probably provide us in the years to come with a compilation which will doubtless aim at a high standard of value as a work of reference to memoirs, and in some degree to their contents, so far as the existing indexes of the volumes of the Society's Journal supply the information. Whether this subject-matter index is published or not, the time has certainly arrived for adopting the immediately useful course of publishing monographs, analogous to those now usual in Natural Science, which shall contain all the information gained up to a particular date in the branch of chemistry with which the author is specially familiar by reason of his own work in the subject. Such monographs should include much more than any mere compilation, and would form the best material from which a complete subject-matter index might ultimately be evolved.

My attention was forcibly drawn to the need of such special records by noting the comparatively numerous cases of re-discovery and imperfect identification of derivatives of thiourea. In my laboratory, where this substance was isolated, we naturally follow with interest all work connected with it, and therefore readily detect lapses of the kind just mentioned. But when it is remembered that the distinct derivatives of thiourea now known number considerably over six hundred substances, and that their descriptions are scattered through numerous British and foreign journals, considerable excuse can be found for workers overlooking former results. The difficulty which exists in this one small department of the science I hope shortly to remove, and trust that others may be induced to provide similar works of reference to the particular branches of chemistry with which they are personally most familiar.

When we consider the drift of investigation in recent years, it is easy to recognise a distinct reaction from extreme specialisation in the prominence now given to general physico-chemical problems, and to those broad questions concerning the relations of the elements which I would venture to group under the head of "Comparative Chemistry." Together these lines of inquiry afford promise of definite information about the real nature the seventy or more entities we term "elements," and ab the mechanism of that mysterious yet definite change in ma which we call "chemical action." Now and again one or ot class of investigation enables us to get some glimpse beyond known which stimulates the imaginative faculty.

For example, a curious side-light seems to be thrown on nature of the elements by the chemico-physical discussion the connection existing between the constitution of certain ganic compounds and the colours they exhibit. Without tempting to intervene in the interesting controversy in wh Armstrong and Hartly are engaged as to the nature of connection, we may take it as an established fact that a relat exists between the power which a dissolved chemical compo possesses of producing the colour impression within our co paratively small visual range, and the particular mode of gro ing of its constituent radicals in its molecule. Further, reality of this connection will be most freely admitted in class of aromatic compounds; that is, in derivatives of benze whose constituents are so closely linked together as to exh quasi-elemental persistence. If then, the possession of what call colour by a compound be connected with its constituti may we not infer that "elements" which exhibit disti colour, such as gold and copper, in thin layers and in t soluble compounds, are at least complexes analogous to definit decomposable substances? This inference, while legitimate it stands, would obviously acquire strength if we could sh that anything like isomerism exists among the elements; identity of atomic weight of any two chemically distinct e ments must, by all analogy with compounds, imply dissimila in constitution, and, therefore, definite structure, independen of any argument derived from colour. Now, nickel and cob are perfectly distinct elements, as we all know, but, so far existing evidence goes, the observed differences in their ato weights (nickel 58·6, cobalt 58·7) are so small as to be wit the range of the experimental errors to which the determinati were liable. Here, then, we seem to have the required exam of something like isomerism among elements, and consequen some evidence that these substances are complexes of differ orders; but in the cases of cobalt and nickel we also know t in transparent solutions of their salts, if not in thin layers of metals themselves, they exhibit strong and distinct colour compare the beautiful rosy tint of cobalt sulphate with the b liant green of the corresponding salt of nickel. Therefore, exhibiting characteristically different colours, these substan afford us some further evidence of structural differences betw the matter of which they consist, and support the conclusion which their apparent identity in atomic weight would lead By means of such side-lights we may gradually acquire so idea of the nature of the elements, even if we are unable to any clue to their origin other than such as may be found Crookes' interesting speculations.

Again, while our knowledge of the genesis of the chemi elements is as small as astronomers possess of the origin of t heavenly bodies, much suggestive work has recently be accomplished in the attempt to apply the principle of gravitati which simply explains the relative motions of the planets, account for the interactions of the molecules of the elemen The first step in this direction was suggested by Mendeleef in Royal Institution lecture (May 31, 1889) wherein he propos to apply Newton's third law of motion to chemical molecul regarded as systems of atoms analagous to double stars. T Rev. Dr. Haughton has followed up this idea with his we known mathematical skill, and, in a series of papers just pu lished, has shown that the three Newtonian laws are applica to explain the interactions of chemical molecules, "with t difference, that whereas the specific coefficient of gravity is same for all bodies, independent of the particular kind matter of which they are composed, the atoms have speci coefficients of attraction which vary with the nature the atoms concerned." The laws of gravitation, with t proviso, were found to apply to all the definite cases examin and it was shown that a chemical change of combination equivalent to a planetary catastrophe. So far the fundamen hypothesis of "Newtonian Chemistry" has led to conclusi which are not at variance with the facts of the science, whil gives promise of help in obtaining a solution of the great probl of the nature of chemical action.

Passing from considerations of the kind to which I have j referred, permit me to occupy the rest of the time at my posal with a short account of a line of study in what I have already termed "comparative chemistry," which is not only of inherent interest, but seems to give us the means of filling in some details of a hitherto rather neglected chapter in the early chemical history of this earth.

The most remarkable outcome of "comparative chemistry" is the periodic law of the elements, which asserts that the properties of the elements are connected in the form of a periodic function with the masses of their atoms. Concurrently with the recognition of this principle, other investigations have been in progress, aiming at more exact definitions of the characters of the relations of the elements, and ultimately of their respective offices in nature. Among inquiries of this kind the comparative study of the elements carbon and silicon appears to me to possess the highest interest. Carbon, whether combined with hydrogen, oxygen, or nitrogen, or with all three, is the great element of organic nature, while silicon, in union with oxygen and various metals, not only forms about one-third of the solid crust of the earth, but is unquestionably the most important element of inorganic nature. The chief functions of carbon are those which are performed at comparatively low temperatures; hence carbon is essentially the element of the present epoch. On the other hand, the activities of silicon are most marked at very high temperatures; hence it is the element whose chief work in nature was performed in the distant past, when the temperature of this earth was far beyond that at which the carbon compounds of organic life could exist. Yet between these dominant elements of widely different epochs remarkably close analogies are traceable, and the characteristic differences observed in their relations with other elements are just those which enable each to play its part effectively under the conditions which promote its greatest activity.

The chemical analogies of the two tetrad elements carbon and silicon are most easily recognised in compounds which either do not contain oxygen, or which are oxygen compounds of a very simple order, and the following table will recall a few of the most important of these, as well as some which have resulted from the fine researches of Friedel, Crafts, and Ladenburg:—

Some Silicon Analogues of Carbon Compounds.

SiH_4	Hydrides ...	... CH_4
$SiCl_4$	Chlorides	... CCl_4
Si_2Cl_6	Chlorides	... C_2Cl_6
SiO_2	Oxides ...	... CO_2
H_2SiO_3	Meta Acids	... H_2CO_3
$HSiHO_2$	Formic Acids	... $HCHO_2$
$(SiHO)_2O$	Formic Anhydrides	$(CHO)_2O$?
$H_2Si_2O_4$	Oxalic Acids	... $H_2C_2O_4$
$HSi(CH_3)O_2$ ...	Acetic Acids	... $HC(CH_3)O_2$
$HSi(C_6H_5)O_2$ ...	Benzoic Acids	... $HC(C_6H_5)O_2$
$SiC_8H_{19}H$	Nonyl Hydrides	... $C_9H_{19}H$
$SiC_8H_{19}OH$ ...	Nonyl Alcohols	... $C_9H_{19}OH$

But these silicon analogues of carbon compounds are, generally, very different from the latter in reactive power, especially in presence of oxygen and water. For example, hydride of silicon, even when pure, is very easily decomposed, and, if slightly warmed, is spontaneously inflammable in air; whereas the analogous marsh gas does not take fire in air below a red heat. Again, the chlorides of silicon are rapidly attacked by water affording silicon hydroxides and hydrochloric acid; but the analogous carbon chlorides are little affected by water even at comparatively high temperatures. Similarly, silicon-chloroform and water quickly produce silico-formic acid and anhydride along with hydrochloric acid, while ordinary chloroform can be kept in contact with water for a considerable time without material change.

Until recently no well-defined compounds of silicon were known including nitrogen; but we are now acquainted with a number of significant substances of this class.

Chemists have long been familiar with the fact that a violent reaction takes place when silicon chloride and ammonia are allowed to interact. Persoz, in 1830, assumed that the resulting white powder was an addition compound, and assigned to it the formula $SiCl_4$, 6 NH_3, while Besson, as lately as 1892, gave $SiCl_4$, 5 NH_3. These formulæ only express the proportions in which ammonia reacts with the chloride under different conditions and give us no information as to the real nature of the product; hence they are almost useless. Other chemists have, however, carefully examined the product of this reaction, but owing to peculiar difficulties in the way have not obtained results of a very conclusive kind. It is known that the product when strongly heated in a current of ammonia gas affords ammonium chloride, which volatilises, and a residue, to which Schutzenberger and Colson have assigned the formula Si_2N_3H. This body they regard as a definite hydride of Si_2N_3, which latter they produced by acting on silicon at a white heat with pure nitrogen. Gattermann suggests that a nearer approach to the silicon analogue of cyanogen, Si_2N_2, should be obtained from the product of the action of ammonia on silicon-chloroform; but it does not appear that this suggestion has yet borne fruit. It was scarcely probable that the above-mentioned rather indefinite compounds of silicon with nitrogen were the only ones of the class obtainable, since bodies including carbon combined with nitrogen are not only numerous but are among the most important carbon compounds known. Further investigation was therefore necessary in the interests of comparative chemistry, and for special reasons which will appear later on; but it was evident that a new point of attack must be found.

A preliminary experimental survey proved the possibility of forming numerous compounds of silicon containing nitrogen, and enabled me to select those which seemed most likely to afford definite information. For much of this kind of work silicon chloride was rather too energetic, hence I had a considerable quantity of the more manageable silicon tetrabromide prepared by Serullas' method, viz. by passing the vapour of crude bromine (containing a little chlorine) over a strongly heated mixture of silica and charcoal. In purifying this product I obtained incidentally the chloro-bromide of silicon, $SiClBr_3$, which was required in order to complete the series of possible chlorobromides of silicon.[1]

Silicon bromide was found to produce addition compounds very readily with many feebly basic substances containing nitrogen. But one group of bromides of this class has yet been investigated in detail, namely, the products afforded by thioureas. The typical member of this group is the perfectly definite but uncrystalline substance

$$SiBr_2\begin{cases}(CSN_2H^4)_4Br\\(CSN_2H_4)_4Br\end{cases}$$

Substituted thioureas afford similar bodies, the most interesting of which is the allyl compound. This is a singularly viscid liquid, which requires several days at ordinary temperatures to regain its level, when a tube containing it is inverted. But these are essentially addition compounds, and are therefore comparatively unimportant.

In most cases, however, the silicon haloids enter into very definite reaction with nitrogen compounds, especially when the latter are distinctly basic, such as aniline or any of its homologues. One of the principal products of this class of change is the beautiful typical substance on the table, which is the first well-defined crystalline compound obtained in which silicon is exclusively combined with nitrogen. Its composition is $Si(NHC_6H_5)_4$.[2] Analogous compounds have been formed with the toluidines, naphthylamines, &c., and have been examined in considerable detail, but it suffices to mention them and proceed to point out the nature of the changes we can effect by the action of heat on the comparatively simple anilide.

When silicon anilide is heated carefully *in vacuo* it loses one molecule of aniline very easily and leaves triphenyl-guanidine, probably the *a* modification; if the action of heat be continued, but at ordinary pressure and in a current of dry hydrogen, another molecule of aniline can be expelled, and, just before the last trace of the latter is removed, the previously liquid substance solidifies and affords a silicon analogue of the insoluble modification of carbodiphenyldiimide, which may then be heated moderately without undergoing further material change. A comparison of the formulæ will make the relations of the products clear:—

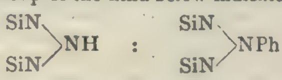
Silicotetraphenylamide—$Si(NHPh)_4$
Silicotriphenylguanidine—$Si : NPh . (NHPh)_2$
Silicodiphenyldiimide—$Si : (NPh)_2$.

Moreover, the diimide has been heated to full redness in a gas combustion furnace while dry hydrogen was still passed over it; even under these conditions little charring occurred, but some

[1] Three years later Besson formed the same compound, and described it as new.

[2] Harden has obtained an uncrystalline intermediate compound, $SiCl_2(NHC_6H_5)_2$.

nitrogen and a phenyl radical were eliminated, and the purified residue was found to approximate in composition to SiNPh, which would represent the body as phenylsilicocyanide or a polymer of it. Even careful heating of the diimide in ammonia gas has not enabled me to remove all the phenyl from the compound, but rather to retain nitrogen, as the best residue obtained from such treatment consisted of Si_2N_3Ph, or the phenylic derivative of one of the substances produced by Schutzenberger and Colson from the ammonia reaction. It may be that both these substances are compounds of silicocyanogen with an imide group of the kind below indicated—



Further investigation must decide whether this is a real relationship; if it be, we should be able to remove the imidic group and obtain silicocyanogen in the free state. One other point only need be noticed, namely, that when the above silicon compounds are heated in oxygen they are slowly converted into SiO_2; but the last traces of nitrogen are removed with great difficulty, unless water-vapour is present, when ammonia and silica are quickly formed.

Much remains to be done in this department of comparative chemistry, but we may fairly claim to have established the fact that silicon, like carbon, can be made to form perfectly well-defined compounds in which it is exclusively united with the triad nitrogen of amidic and imidic groups.

Now, having proved the capacity of silicon for the formation of compounds of this order with a triad element, Nature very distinctively lets us understand that nitrogen is not the particular element which is best adapted to place the triad *rôle* towards silicon in its high-temperature changes, which are ultimately dominated by oxygen. We are not acquainted with any natural compounds which include silicon and nitrogen; but large numbers of the most important minerals contain the pseudo-triad element aluminum combined with silicon, and few include any other triad. Phosphorus follows silicon in the periodic system of the elements as nitrogen does carbon, but silicates containing more than traces of phosphorus are rare; on the other hand, silicates are not uncommon containing boron, the lower homologue of aluminum; for example, axinite, datholite, and tourmaline.

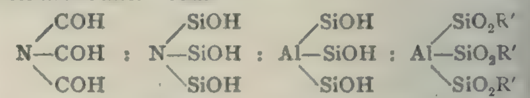
Moreover, it is well known that silicon dissolves freely in molten aluminum, though much more of the former separates on cooling. Winkler has analysed the gangue of aluminum saturated with silicon, and found that its composition is approximately represented by the formula SiAl, or, perhaps, Si_2Al_2, if we are to regard this as analogous to C_2N_2 or cyanogen. Here aluminum at least resembles nitrogen in directly forming a compound with silicon at moderately high temperature. It would appear, then, that while silicon can combine with both the triads nitrogen and aluminum, the marked positive characters of the latter, and its extremely low volatility, suit it best for the production of permanent silicon compounds similar to those which nitrogen can afford.

With these facts in mind we may carry our thoughts back to that period in the earth's history when our planet was at a higher temperature than the dissociation point of oxygen compounds. Under such conditions the least volatile elements were probably liquids, while silicides and carbides of various metals were formed in the fluid globe. We can imagine that the attraction of aluminum for the large excess of silicon would assert itself, and that, as the temperature fell below the point at which oxidation become possible, these silicides and carbides underwent some degree of oxidation, the carbides suffering most owing to the volatility of the oxides of carbon, while the fixity of the products of oxidation of silicides rendered the latter process a more gradual one. The oxidation of silicides of metals which had little attraction for silicon would lead to the formation of simple metallic silicates and to the separation of the large quantities of free silica we meet with in the solid crust of the earth, whereas oxidation of silicides of aluminum would not break up the union of the two elements, but rather cause the ultimate formation of the alumino-silicates which are so abundant in most of our rocks.

Viewed in the light of the facts already cited and the inferences we have drawn from them as to the nitrogen-like relationship of aluminum to silicon, I am disposed to regard the natural alumino-silicates as products of final oxidation of sometime active silico-aluminum analogues of carbo-nitrogen compounds rather than ordinary double salts. It is generally taken for granted that they are double salts, but recent work on the chromoxalates by E. A. Werner has shown that this view is not necessarily true of all such substances.

Without going into undue detail we can even form some conception of the general course of change from simple aluminum silicide to an alumino-silicate, if we allow the analogies already traced to lead us further.

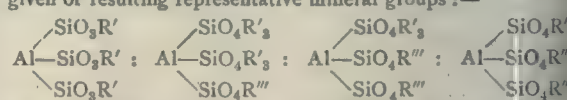
We recognise the existence of silico-formyl in Friedel and Ladenburg's silico-formic anhydride; hence silico-triformamide is a compound whose probable formation we can admit, and, on the basis of our aluminum-nitrogen analogy, an aluminum representative also. Thus—



Triformamide. Silico-triformamide. Silico-alumino-triformamide. Salt of an alumino-silicic acid.

Now, oxidation of triformamide would lead to complete resolution into nitrogen gas, carbondioxide gas and water rendering it an extremely unstable body; under similar conditions silico-triformamide would probably afford nitrogen gas and silicic acid (or silicon dioxide and water); while the third compound,[1] instead of breaking up, would (owing to the fixity of aluminum as compared with nitrogen) be likely at first to afford a salt of an alumino-silicic acid, in presence of much basic material.

The frequent recurrence of the ratios Si_3Al, Si_3Al_2, &c., in the formulæ of natural alumino-silicates, suggests that some at least of these minerals are derived from oxidation products of the above triformic type. Without stopping to trace all the possible stages in the oxidation of the primary compound $Al(SiO_3R)_3$, or variations in basicity of the products, I may cite the four following examples out of many others which might be given of resulting representative mineral groups:—



Beryl type (hemi-). Garnet type. Muscovite type. Xenolite type.

Five years ago Prof. F. W. Clarke, of the United States Geological Survey, published a most interesting paper on the structure of the natural silicates. In this he adopts the view that the mineral xenolite, $Si_3Al_4O_{12}$, is the primary from which all other alumino-silicates may be supposed to arise by various substitutions. Nature, however, seems to teach us that such minerals as xenolite, fibrolite, and the related group of "clays" are rather to be regarded as end-products of a series of hydrolytic changes of less aluminous silicates than primary substances themselves; hence the sketch which I have ventured to give above of the probable genesis of alumino-silicates seems to provide a less arbitrary basis for Clarke's interesting work, without materially disturbing the general drift of his subsequent reasoning.

We may now consider for a moment in what direction evidence can be sought for the existence in nature of derivatives of the hypothetical intermediate products of oxidation between a primary silicide and its fully oxidised silicate.

In the absence of a working hypothesis of the kind which I have already suggested it is not probable that direct evidence would yet be obtainable—this must be work for the future—but when we consider that the existence of compounds of the order in question would manifest themselves in ordinary mineral analyses by the analytical products exceeding the original weight of material, we seem to find some evidence on the point in recorded cases of the kind. A deficiency of a single atom of oxygen in compounds having the high molecular weights of those in question, would be indicated by very small excesses (from 2 to 3 per cent.) whose real meaning might be easily overlooked. Now, such results are not at all unusual in analyses of mineral alumino-silicates. For instance, *Amphibole* containing a mere trace of iron have afforded 102·75 parts from 100, and almost all analyses of *Microsommite* are high, giving as much as 103 parts. In less degree *Vesuvianite* and members of

[1] In these cases where R‴ = Al it is, of course, assumed that the latter is acting only as a basic radical.

the *Andalusite* group may be noted. All these cases may be capable of some other explanations, but I cite them to show that such excesses are commonly met with in published analyses. On the other hand, it is scarcely to be doubted that a good analyst, who obtained a really significant excess, would throw such a result aside as erroneous and never publish it. I therefore plead for much greater care in analyses of the kind in question, and closer scrutiny of results in the light of the suggestions I have ventured to offer. It is probable that silicates containing only partially oxidised aluminum are rare; nevertheless the search for them would introduce a new element of interest into mineralogical inquiries.

If the general considerations I have now endeavoured to lay before you are allowed their full weight, some of the alumino-silicates of our primary rocks reveal to us more than we hitherto supposed. Regarded from this newer standpoint, they are teleoxidised representatives of substances which foreshadowed in terms of silicon, aluminum, and oxygen the compounds of carbon, nitrogen, and hydrogen required at a later stage of the earth's history for living organisms. Thus, while the sedimentary strata contain remains which come down to us from the very dawn of life on this globe, the rocks from whose partial disintegration the preserving strata resulted contain mineral records which carry us still further back, even to Nature's earliest efforts in building up compounds similar to those suited for the purposes of organic development.

NOTES.

Prof. Max Müller has attained the jubilee of his Doctorate, having taken his degree in 1843, and in honour of the occasion the University of Leipzig has conferred a new diploma upon him.

Mr. Bell, of Carlton Street, Nottingham, has brought out, at an opportune moment, "A Contribution to the Geology and Natural History of Nottinghamshire." The little volume is edited by Mr. J. W. Carr, who in his preface records his indebtedness to various friends—specialists in certain departments—who wrote for him some portions of the book. The book was compiled at the request of the Local Excursions' Committee of the British Association, for the use of members attending the Nottingham meeting. We have no doubt that many such will avail themselves of the handy little guide-book, which has been prepared for their special benefit.

There seems to be no doubt that the latest report of the death of Emin Pasha is to be relied upon. Mr. A. J. Swann, of Ujiji, from whom the report comes, declares that in his opinion it is as conclusive as anything can be in Africa. And now within a week of the tidings of Emin's death the sudden decease is announced of another African traveller—Surgeon-Major Parke—one of the most widely-known of the members of the Emin Relief Expedition. He died suddenly on the night of Sunday last, while on a visit to the seat of the Duke of St. Albans at Alt-na-Craig.

The death is announced, at the age of sixty-one, of Dr. Alexander Strauch, the Director of the Zoological Museum of St. Petersburg. Dr. Strauch was an authority on reptiles, and the author of several zoological works.

The death is reported of Mr. T. W. Kennard, C.E., founder of the Monmouthshire Crumlin Works, designer and constructor of the Crumlin Viaduct, and engineer-in-chief of the Atlantic and Great Western Railway, United States. He died at the age of 68.

We have to record the death of a well-known inventor and civil engineer of New York, in the person of Mr. Joseph Battin. He was in his 87th year.

On and after November 1 next, the railway time throughout the kingdom of Italy will, according to a recent Act of the Legislature, be regulated by the mean solar time of the 15th meridian east of Greenwich, this being the so-called Middle European time. The hours will be reckoned from midnight to midnight. The new time will be 11 minutes in advance of the mean solar time of Rome. It is expected that the other services and the Italian public generally will soon follow the example set by the railway stations.

M. D'Arsonval, in *Électricité* for August 24, describes some experiments which he has made on the effects of strong, alternating magnetic fields on animals, his results apparently being somewhat contradictory to those recently obtained in the Edison Laboratory. M. D'Arsonval's experiments were performed by means of coils wound on cylinders of cardboard, glass or wood, large enough to accommodate a man inside them when required. The solenoid thus formed constituted the path for the discharge of a condenser of two to twelve Leyden jars, arranged in two batteries with proper precautions for rendering the discharge oscillatory. The jars were charged periodically by a transformer, giving a current at about 15,000 volts, with a frequency of sixty per second. A lamp held with one terminal in each hand of a man standing within the solenoid, may then be raised by the induced currents to bright incandescence, while M. D'Arsonval asserts that considerable physiological effects are also produced. The method used to determination the strength of these alternating magnetic fields is very ingenious; it consists simply in inserting a mercurial thermometer in the field, and noting the rise of temperature produced by the Foucault currents in the mercury. A considerable rise is very quickly produced in the strongest fields, while for weaker fields a petroleum thermometer is employed, or an air thermometer the bulb of which contains a small copper tube.

Dr. W. S. Hedley, in an article in the *Lancet*, comments on M. D'Arsonval's work, and mentions some experiments of his own which seem to support the hypothesis that the harmlessness of high frequency alternating currents may be explained by the fact that in these cases there is "virtually no current strength"; *e.g*, a current of two amperes at 200 volts, if transformed up to 100,000 volts, cannot exceed in strength 0·004 ampere. Another factor concerned in the effect is the "concentration" of the current. Passing a current of high frequency and capable of keeping a 5-candle lamp glowing, through the body by means of copper cylinders held in the hands, produced no appreciable effect beyond a slight warming under the electrodes; using a half-crown as electrode on the forearm, the same negative result follows; with a shilling, there is a slight pricking effect, which becomes quite painful with a threepenny-piece substituted for the shilling, thus indicating that other factors have to be considered, as well as more frequency, in the discussion of the "harmlessness" of alternating currents.

The issue in a compact form of the interesting series of articles on "Sewage Purification in America," by M. N. Baker, which appeared in the *Engineering News* of New York last year, furnishes an important addition to our information on this complicated subject. The treatment of the sewage of thirty municipalities in the United States and Canada is given in detail, and the description further elucidated by no less than seventy-seven illustrations, including elaborate plans showing the various arrangement of purification, plant, &c. The little pamphlet of 196 pages is well printed and is provided with a copious index. That America has recently devoted much attention to the vexed question of the purification of sewage will be remembered by all who have had occasion to consult the admirable experimental work on the chemical and bacteriological aspects of this subject, conducted at the instigation and under the superintendence of the Massachusetts State Board of Health.

"CHEMICAL and Micro-Mineralogical Researches on the Upper Cretaceous Zones of the South of England" is the title of the thesis sent in by Dr. W. F. Hume for the recent D.Sc. examination at London University. This paper gives a large amount of information on the subject; the zones described being those established by Dr. C. Barrois. The notes refer chiefly to the chalk of the Isle of Wight and Dorsetshire, but they include numerous references to the chalk of other areas, especially to that of Folkestone. The author's researches incline him to the belief that most of the chalk was deposited in fairly deep water; thus differing from M. Cayeux, whose work in the north of France led him to infer a shallow water origin for the chalk of that area. The insoluble residue decreases in quantity as we ascend in the series, and is generally greater in the Isle of Wight than at Folkestone; the excess being especially apparent in the Cenomanian zones. All the Upper Cenomanian beds have undergone secondary silicification.

THE Geological Survey of France has now published rather more than one-half of the country on the scale of 1 : 80,000—138 streets out of a total of 259. An excellent general map on the scale of 1 : 1,000,000 was issued in 1889. The first street (No. 13) of the map of the scale of 1 : 320,000 has just been published. This map, which is a reduction of sixteen streets on the larger scale, has Paris nearly in the centre, and includes Honfleur and Liseaux on the west, Chateaudun and Sens on the south, Nogent and Dormans on the east, Rouen and Beauvais on the north. The tertiary and secondary rocks are well represented within this area, the Silurian, Ordovieian, Cambrian and pre-Cambrian occupying a small space in the south-west near Mamers. The clay with flints is shown by shading over the chalk. The freshwater and estuarine strata are indicated by shading over the colour denoting the geological formations. Nnmerous notes on economic geology are printed below the map.

AN interesting study of the compounds of phosphorus and sulphur, by Herr Helff, is published in the current number of the *Zeitschrift für physikalische Chemie*. Hitherto seven sulphides of phosphorus have been described. Observations on vapour-density, and on the boiling-point of solutions in carbon bisulphide indicate, however, that four of these only are true chemical compounds, viz. P_4S_3, P_4S_7, P_3S_6, and P_2S_5. On heating two atomic proportions of phosphorus with three of sulphur, instead of P_2S_3 being formed it appears that the main product is P_4S_7, a little P_4S_3 being also obtained. The substances previously taken to be P_4S and P_4S_2 are merely solutions of sulphur in phosphorus. Incidentally the author confirms the results already arrived at by Beckmann, that when in solution in carbon bisulphide, sulphur has the molecular formula S_8 and phosphorus the formula P_4; he also shows that phosphorus and sulphur when dissolved in carbon bisulphide do not unite even on heating to the ordinary boiling-point. It is also noteworthy that the freezing-points of solutions of sulphur in phosphorus favour the view that here the molecular complexity of sulphur is the same as when it is dissolved in carbon bisulphide.

THE eighth meeting of the International Congress of Hygiene and Demography is to be held during the present month at Buda Pesth, and several international committees have, we understand, been formed with a view to carrying out the decisions of the London Congress. A separate section for tropical countries has been organised, and will meet under the presidency of Dr. Theodor Duka.

THE sixteenth annual meeting of the Library Association w held at Aberdeen on September 4 and 5. In his inaugural a dress, Dr. Garnett, Keeper of the Printed Books in the Britis Museum, dwelt upon the cataloguing of books. He said that catalogue should not merely enable the reader to find a boo with the least possible delay, but also present an epitome the life-work of every author, and assist the literary historia in his researches. Of the papers read, one by Prof. Trai on "The Classification of Books in the Natural Sciences," w of especial scientific interest.

SEVERAL very interesting lectures will shortly be delivered the evening meetings of the Camera Club. On September Prof. J. Milne, F.R.S., who is on a short visit from Japan, w discourse upon "The Earthquakes of Japan"; Mr. Lamo Howie will give a lecture, entitled "The Scottish Alps," September 28; and the October and November programm will include a paper by Prof. Marshall Ward, F.R.S.

THE Journal of the College of Science, Imperial Universit Japan, vol. vi. part 2, is devoted to a paper by Mr. Sadahi Matsuda on "The Anatomy of Magnoliaceæ." The auth splits up *Magnoliaceæ* into the four following groups: (1) Tho identical with *Magnolieæ*, (2) those identical with *Schizandr* (3) *Trochodendron* and the genera of *Illicieæ*, (4) *Eupteleæa* a *Cercidiphyllum*.

A REVISED report on the "Copepoda of Liverpool Bay by Mr. Isaac C. Thompson, has been published in the Tran actions of the Liverpool Biological Society, vol. vii. T report deals with 136 species, eighteen of which are new to t district over which the collection was made, and eleven a considered to be entirely new species. Twenty plates a included, containing a number of outline sketches for faci tating identification.

THE Anthropological Institute has issued an index to i publications. The index includes communications publish in the journal and transactions of the Ethnological Society fro 1843 to 1871; those in the journal and memoirs of the A thropological Society (1863-71), and also those that ha appeared in the *Anthropological Review*. In 1871 the Ethn logical and Anthropological Societies united to form the A thropological Institute, and since then all papers have appear in the Institute's journal. The first twenty volumes of t journal are included in the index.

Cosmos contains an article by M. C. Maze, from which appears that droughts such as we have experienced this ye follow a cycle of forty-two years. Since, however, the obser ations discussed have not been obtained from one place, a there is no clear definition as to what constitutes a dry seaso the theory can hardly be said to be above suspicion.

MESSRS. TAYLOR AND FRANCIS will shortly publish a wor by Griffith Brewer and Patrick Y. Alexander, on "Aëronautics being an abridgement of aëronautical specifications filed at t Patent Office between 1851 and 1891.

MESSRS. G. P. PUTMAN'S SONS have published for Dr. Lau Sodré, the Governor of Pará, Brazil, a work on "The State Pará." The work is in five parts, by different contributor dealing respectively with the history of Pará, physical feature public instruction, revenues and commerce, and industries.

THE *Journal of the Franklin Institute* for September contai among other things the continuation of Nikola Tesla's lectu "On Sight and other High Frequency Phenomena," and th conclusion of the lecture, by Dr. Richards, on "The Specif Heats of the Metals."

THE Calendar of the University College, Bristol, for the session 1893–94 has just been issued through Mr. Arrowsmith, of Bristol.

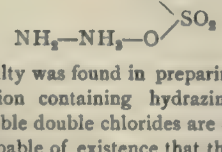
PROF. KINCH, of the Royal Agricultural College, Cirencester, has just issued a report of some of his field experiments for 1892 and 1893.

MR. W. F. STANLEY, of Great Turnstile, Holborn, has sent us the new edition of his catalogue of mathematical instruments made and sold by him. It is excellently printed upon good paper, and is very admirably classified.

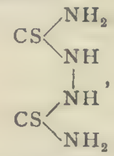
THE U.S. Department of Agriculture, division of Entomology, has lately brought out Vol. v., No. 5, of "Insect Life."

WE are informed by a correspondent that the Rev. L. Blomefield, whose death we recorded in last week's NATURE, was in his ninety-fourth year, and not, as stated by us, in his ninety-first.

FURTHER information concerning hydrazine, N_2H_4, and its compounds is contained in an inaugural dissertation by one of Prof. Curtius's assistants at Kiel, Herr Franz Schrader, and a brief account of it will be found in the current *Chemiker Zeitung*. A considerable time has now elapsed since the first preparation of hydrazine, which was announced by Prof. Curtius in June, 1887, and it is almost three years since full details were published concerning the isolation of the pure hydrate, a liquid of the composition $N_2H_4.H_2O$ which boils at 119°. It was then stated (vide NATURE, vol. 43, p. 205) that in closed vessels this hydrate may be preserved unaltered for any length of time. The experience of the last three years, however, necessitates a modification of that statement, and Herr Schrader now informs us that the liquid stored in sealed tubes decomposes sooner or later, the principal product of decomposition being ammonium hydrate. No gas appears to be generated during the process, so that tubes containing it do not become dangerous from accumulation of pressure. The reactions between the hydrate and a large number of metallic oxides are described, in which the strong reducing proclivities of hydrazine are very markedly exhibited, the reaction being frequently of an explosive character. Herr Schrader further describes a series of double sulphates containing hydrazine sulphate and the sulphate of a metal. Their general formula is $R''SO_4.(N_2H_4)_2H_2SO_4$ where R″ may represent copper, nickel, cobalt, iron, manganese, zinc and cadmium. These double sulphates, which contain no water of crystallisation, and are further distinguished from the double sulphates containing ammonium by their difficult solubility, are readily prepared by the admixture of solutions of the constituent simple sulphates. The constitution of the salts is probably expressed by the formula,



Considerable difficulty was found in preparing double chlorides of fixed composition containing hydrazine-chloride. Good crystals of very soluble double chlorides are easily obtained, but so many appear capable of existence that the conditions for the formation of salts of definite constitution have not yet been ascertained. Two entirely new compounds of hydrazine are described by Herr Schrader. By saturating hydrazine hydrate with sulphocyanic acid, or by decomposing hydrazine sulphate with barium sulphocyanate, hydrazine sulphocyanate, $N_2H_4.HSCN$, is obtained as a deliquescent solid substance which melts at 80°. When this hydrazine sulpho cyanate is heated, or when molecular proportions of hydrazine dichloride $N_2H_4\,2HCl$ and ammoniumsulpho cyanate in aqueous solution are heated for four or five hours in a sealed tube to 100°, a second new substance of urea-like constitution,



is formed. This second substance, hydrazine sulphocarbamide crystallises well from solution in hot water and melts at 214–215°. Its properties are somewhat remarkable, inasmuch as it appears to possess fairly strong acid properties, its solution yielding very characteristic precipitates with solutions of most metallic salts. The dissertation of Herr Schrader likewise reviews most of the work which has been carried out in the Kiel laboratories in connection with hydrazine, and adds many little details of importance in the practical manipulation of the substance and its compounds.

NOTES from the Marine Biological Station, Plymouth.—Last week's captures include the Actinian *Zoanthus Couchii* and the Archiannelid *Histriobdella Homari*. In the floating fauna *Noctiluca*, *Obelia* medusæ, Cirrhipede *Nauplii* and Caridid larvæ were plentiful; *Sagitta*, *Oikopleura* and the tubicolous larvæ of *Terebella* were fairly numerous. Specimens were also taken of the Leptomedusæ *Willia stellata* and *Eucopium quadratum*, of young stages of *Geryonia*, of *Doliolum Tritonis* and Ascidian larvæ, and of the larvæ of the Gephyrean *Thalassema*. The Nemertine *Amphiporus pulcher* and the Mollusc *Goniodoris castanea* are now breeding.

THE additions to the Zoological Society's Gardens during the past week include a Sooty Mangabey (*Cercocebus fuliginosus*, ♀) from West Africa, presented by Miss Grimston; two Brazilian Cariamas (*Cariama cristata*) from Brazil, presented by Mr. Lindsay C. Scott; a Melodious Jay Thrush (*Leucodioptron canorum*) from China, presented by Mr. B. H. Jones, F.Z.S.; a Wall Lizard (*Lacerta muralis* var. *taliguerta*) from Triest, presented by Mr. A. W. Arrowsmith; a Chilian Teal (*Querquedula creccoides*) from Antarctic America, a Little Tern (*Sterna hirundo*) from Brit. Isles, an Axis Deer (*Cervus axis*, ♂) from India, and a St. Thomas's Conure (*Conurus pertinax*) from West Indies, purchased.

OUR ASTRONOMICAL COLUMN.

MR. TEBBUTT'S OBSERVATORY.—We have received from Mr. Tebbutt the report of the work that has been done during the year 1892 at his observatory. In addition to meridian observations a great many extra-meridian observations were made, among which we may name the following:—Forty-five phases of occultations of stars by the moon, several observations of the phenomena of Jupiter's satellites, twenty good comparisons of the planet Mars, when in conjunction with Iota Aquarii, with that star, by means of the filar micrometer on the 8-inch equatorial, numerous observations of the comets visible in that year, about fifteen double-star measures and the variable star observations, including a few comparisons of η Argus and R. Carinæ with neighbouring stars. The meteorological observations have been regularly taken. Under the heading "Personal Establishment," an idea of the energy and zeal which Mr. Tebbutt shows for this science can be gathered from the fact that all the astronomical, and nearly all the meteorological observations are made by himself. Occasionally his son takes the meteorological readings during his absence from home, while the assistance of a computer is sometimes made use of. Although Mr. Tebbutt has received from several astronomers many suggestions as to work desirable to be done, he, nevertheless, wishes to fulfil the main work of the observatory, which consists in observations of lunar occultations of stars, southern comets, and the meteorological observations. That Mr. Tebbutt is thinking about seeking some relaxation, is only natural when one considers how his powers must have been taxed during the last few years; and we sincerely hope that after a good holiday and rest he may come back to his work again a new man, and continue the work he has so ably begun.

UNIVERSAL TIME IN AUSTRALIA.—With three meridians differing by one hour from one another passing through the continent of Australia, the question has been raised as to whether only central time should be used, or all three times. (*The Observatory* for September). Adopting the latter, it will be necessary, of course, for frequent changes of time to be made; but with the former, although places on the extreme east and west would have their time about 1½ hours away from local time, greater convenience for railways, telegraph work, &c., will be gained. Sir Charles Todd, who supports this latter view, and who is backed by the Hon. J. G. Ward (New Zealand), the Hon. J. Kidd (N.S.W.), and the Hon. A. Wynne (Victoria), came to the following conclusion at the Postal and Telegraph Conference held in Brisbane this year, when the subject of the Hour Zone Time was being considered:—"That it is desirable in the public interests that the Hour Zone system should be adopted in a modified form, so that there should be one time throughout Australia, viz. that of the 135th meridian, or nine hours east of Greenwich."

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 4.—M. Lœwy in the chair.—Report upon a memoir by M. Defforges, entitled, on the distribution of the intensity of gravity at the surface of the globe, by MM. Fizeau, Daubrée, Cornu, Bassot, Tisserand. This memoir, submitted to the judgment of the Academy by the Minister of War, summarises the theoretical and experimental researches made during eight years in the geographical service of the army, with the object of determining the absolute intensity of gravitation for a small number of primary stations, and the relative intensity for a large number of secondary stations with simplified apparatus. The latter were determined by means of the "reversible invertible pendulum" invented by M. Defforges, which exceeds all used previously in lightness and convenience, and easily gives an approximation to within 1 part in 100,000. The anomalies extending along a line from Spitzbergen through the Shetlands, Scotland, England, France, and Algiers considerably exceed any possible experimental errors, and the excess of gravitation on the islands and defect on the continents is well established. The report, which was adopted by the Academy, advises the Government to supply M. Defforges with the means to extend his work to the islands of the southern hemisphere and especially the Pacific.—The hypothesis of sub-continental bells, by M. Rateau. The phenomena of the earth's crust are well explained and connected by assuming that the crust underneath the continents does not touch the fluid globe, but is separated from it by a space filled with gaseous matter under pressure. The continents would thus form a sort of bells, very much flattened, and supported by gas, whereas the ocean beds would lie direct upon the igneous globe. The continental projections tend generally to rise, blown up as it were by the accumulating gas below, whilst the sea-beds sink. But the gases, imprisoned under high pressure, escape gradually through the fissures of the crust, when the production of new quantities from the nucleus will become insufficient, the pressure under the continents will decrease, and these will be projected upon the new crust underneath, giving rise to more or less extended crateriform configurations. This is the state in which we see the moon at the present time. If the earth's crust is assumed to be 30 km. thick, the pressure of the gases should be 650 atmospheres and their temperature 900°. The gases would be of a density nearly equal to that of water, and superposed in the order: hydrogen, methane, nitrogen, ethane, oxygen, carbonic anhydride. Hydrochloric acid and siliciuretted hydrogen would also probably be stable under these conditions. The presence of gas underneath the continents, elevated as they are above the sea and of greater density than water, is necessitated by conditions of hydrostatic equilibrium. It is easily seen why volcanoes in the interior of continents never give off larva, but only gases; also why lines of coast volcanoes have successively receded inland where the sea encroached.—On the elimination of foreign bodies in the *Acephala* and especially in *Pholas*, by M. Henri Coupin. If the mantle and the ventral siphon of the Pholas are cut along their entire length, and a collection of foreign particles are thrown upon the tentacles, the particles falling upon the dorsal tentacles are carried away with great rapidity, not towards the mouth, but upon that part of the mantle which lies between the anterior luminous organ and the palp. Thence they pass quickly towards the siphon region, and are stuck together by mucus and rolled up into balls, which are then extruded at the siphon. It is thus that the animal gets rid of the particles of rock disintegrated during its boring operations, and protects its delicate internal canals.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Index to the Publications of the Anthropological Institute (1843 to 1891): G. W. Bloxam (Anthropological Institute).—The Amphioxus and its Development: Dr. B. Hatschek, translated and edited by J. Tuckey (Sonnenschein).—The Pharmacopœia of the United States of America, 7th Decennial Revision, 1890 (Philadelphia).—London Inter. Science and Prelim. Sci. Directory, No. iv. July 1893 (London).—Accidents de Chaudières: F. Sinigaglia (Paris, Gauthier-Villars).—Théorie des Jeux de Hasard: H. Laurent (Paris, Gauthier-Villars).—Smithsonian Institution, Report of National Museum for Year ending June 30, 1891 (Washington).—An Elementary Text-book of Biology: J. R. A. Davis, 2nd edition, 2 parts (Griffin).—Publicazione della Specola Vaticana, fasc. iii. (Rome).—Bulletin of the U.S. Fish Commission, Vol. x. for 1890 (Washington).—Index Kewensis: Sir J. D. Hooker and B. D. Jackson. Part 1 (Oxford, Clarendon Press).—A Contribution to the Geology and Natural History of Nottinghamshire: edited by J. W. Carr (Nottingham, Bell).—Illustrated Hand-book of the Cape and South Africa: edited by J. Noble (Stanford).—Terra: A. A. Anderson, 2nd edition (Reeves and Turner).

PAMPHLETS.—Abstract of Returns furnished to the Department of Science and Art (Eyre and Spottiswoode).—Report of Mr. Tebbutt's Observatory, the Peninsula, Windsor, N.S.W. 1892: J. Tebbutt (Sydney).

SERIALS.—Journal of the Anthropological Institute, August (K. Paul).—Natural Science, September (Macmillan).—Geological Magazine, September (K. Paul).—American Journal of Mathematics, Vol. xv. No. 3 (Baltimore).—Journal of the Asiatic Society of Bengal, Vol. 62, Part 2, No. 1 (Calcutta).—Journal of the Chemical Society, September (Gurney and Jackson).—Proceedings of the American Philosophical Society, Vol. 31, No. 141 (Philadelphia).—Proceedings of the Rochester Academy of Science, Vol. 2, Brochure 2 (Rochester, New York).—Geological and Natural History Survey of Minnesota, Bulletin No. 8 (Minneapolis).—Medical Magazine, September (Southwood).—Proceedings of the Royal Society of Edinburgh, Session 1892–93, Vol. xx. pp. 1 to 96.—Journal of the College of Science, Imperial University, Japan, Vol. 6, Part 2 (Tokyo).

CONTENTS.

THURSDAY, SEPTEMBER 21, 1893.

THE BRITISH ASSOCIATION.

THE Nottingham meeting of the British Association must be recorded as a useful and pleasant one. There has been no tremendous sensation, but on the other hand there has not been much dulness. The weather up to Tuesday was everything that could be desired, and the proceedings were wound up yesterday by an innovation in the shape of a special performance of *Pharaoh* by Mr. Wilson Barrett and his company, to which the members of the Association were invited by the local committee.

The formal business of the Association was commenced on the 13th by a meeting of the general committee. From the council's report we cull the following announcements. The following were elected corresponding members:—Dr. Svante Arrhenius, Stockholm; Prof. Marcel Bertrand, Paris; Prof. F. Elfving, Helsingfors; Prof. Léo Errera, Brussels; Prof. G. Fritsch, Berlin; Mr. D. C. Gilman, Baltimore; Dr. C. E. Guillaume, Sèvres; Prof. Rosenthal, Erlangen; Dr. Maurits Snellen, Utrecht.

The council had drawn the attention of the Local Government Board to the desirability of the publication of the "Report on the Examination into Deviations from the Normal amongst 50,000 Children in various Schools," which had been presented to that board by the British Medical Association, and of several departments to the anthropometric method for the measurement of criminals, which is successfully in operation in France, Austria, and other continental countries.

At the meeting in the evening, in the Albert Hall, the retiring president, Sir A. Geikie, vacating the chair, spoke as follows:—Ladies and gentlemen, the last duty which your president for the year has to perform is to vacate the chair and formally introduce the new president. Allow me to thank you for the high honour of occupying the chair of the British Association, and at the same time to express the satisfaction with which I learn that the affairs of the British Association are in as satisfactory a condition as that in which I found them. The introduction of my successor is only a matter of form. His name is familiar to all of you, and he is esteemed all over the world as one of the great leaders of biological science—a great leader as well as a great investigator. He will speak to you with the authority of an acknowledged master of science. I have, therefore, great pleasure in introducing my successor in the chair, the Oxford professor, Dr. Burdon-Sanderson.

The President then delivered the address which we printed last week. Dr. Burdon-Sanderson's reference to the importance of the endowment of research has called forth remarks in the Press which clearly indicate that the people of this country do not yet see that in the peaceful war among nations that nation will win which has all the resources of science most easily at its command; that these resources are as much the first line of defence as the British Navy in actual war is our first line; and that with regard to them we are getting relatively worse equipped each year in consequence of the care with which science is being fostered by foreign governments and neglected by our own. We are in the same position to-day with regard to science as we were in the days of Queen Elizabeth with regard to the Navy.

The sectional meetings began next day. The addresses of the various presidents have shown a high level of excellence. This week we give those delivered in Sections C, D, G and H.

On Monday another meeting of the general committee was held in the afternoon for the purpose of determining upon the place of meeting in 1895. A deputation attended from Toronto, and Prof. Mavor, speaking on behalf of a local provisional committee, explained the facilities which Toronto afforded for the holding of general and sectional meetings. He also dwelt on the industries of the neighbourhood, its agriculture, and objects of scientific interest in the vicinity. It was eventually agreed that the committee express their best thanks to the provisional committee of Toronto for the invitation, and provided that suitable arrangements could be made similar to those that were made for the Montreal visit the committee would be prepared to entertain the question of meeting at Toronto before many years had elapsed.

Deputations were then introduced from Bournemouth and Ipswich. It appeared from information given by Mr. Griffith, the secretary, that Bournemouth offered greater facilities than Ipswich in the way of rooms for the meetings of the Sections. On the question being put to the vote, there appeared 31 for Ipswich and 20 for Bournemouth. It was, therefore, decided that the meeting of 1895 should be held at Ipswich.

The Marquis of Salisbury was nominated president of the meeting next year at Oxford. It was pointed out that among his claims he has been Chancellor of the University of Oxford since 1880, that he would therefore represent both hosts and guests, that he is a distinguished statesman, a courteous gentleman, a member of the council of the Royal Society, and a true man of science.

A list of vice-presidents was agreed to, and the meeting at Oxford was fixed for August 8.

The business concluded with the reappointment of Sir Douglas Galton and Mr. Vernon Harcourt as general secretaries, and Mr. G. Griffith as assistant general secretary, and Prof. Rücker as general treasurer.

The list of awards arrived at yesterday was as follows:

	£
Electrical Standards	25
Meteorological Photographs	10
Mathematical Tables	15
Solar Radiation	15
National Physical Laboratory	5
Wave-length Tables	10
Iron and Steel Analysis	15
Action of Light on Dyed Colours	5
Erratic Blocks	15
Fossil Phyllopoda	5
Geological Photographs	10
Shell-bearing Deposits at Clava, &c.	20
Eurypterids of the Pentland Hills	5
Sections of Stonesfield Slate	25
Earth Tremors	50
Exploration of Calf Hole Cave	5
Naples Zoological Station	100
Plymouth Zoological Station	15
Zoology of Sandwich Islands	100
Zoology of Irish Sea	40
Structure of Mammalian Heart	10
Climatology of Tropical Africa	10
Observations in South Georgia	50
Exploration in Arabia	30
Economic Training	10
Anthropometric Statistics	5
Ethnography of United Kingdom	10
The Glastonbury Village	40
Anthropometry in Schools	5
Mental and Physical Condition of Children ...	20
Corresponding Societies	25
	705

SECTION C.

GEOLOGY.

Opening Address by J. J. H. Teall, M.A., F.R.S., Sec.G.S., President of the Section.

It is a striking and remarkable fact that, although enormous progress has been made in petrographical science during the last hundred years, there has been comparatively little advance so far as broad, general theories relating to the origin of rocks are concerned. In Hutton's "Theory of the Earth," the outlines of which were published in 1788, the following operations are clearly recognised:—The degradation of the earth's surface by aqueous and atmospheric agencies; the deposition of the *débris* beneath the waters of the ocean; the consolidation and metamorphosis of the sedimentary deposits by the internal heat and by the injection of molten mineral matter; the disturbance and upheaval of the oceanic deposits; and, lastly, the formation of rocks by the consolidation of molten material both at the surface and in the interior of the earth.

Hutton regarded these operations as efficient causes ordained for the purpose of producing an earth adapted to sustain animal and vegetable life. His writings are saturated with the teleological philosophy of the age to which they belong, and some of his arguments strike us, therefore, as strange and inconclusive; moreover, the imperfect state of the sciences of chemistry and physics occasionally led him into serious error. Notwithstanding these imperfections, we are compelled to admit, when viewing his work in the light of modern knowledge, that we can find the traces, and sometimes far more than the traces, of those broad general theories relating to dynamical geology which are current at the present day.

If Hutton had contented himself with proving the reality of the agencies to which reference has been made it is probable that his views would have been generally accepted. But he went much further than this, and boldly maintained that one or other of these agencies, or several combined, would account for all the phenomena with which the geologist has to deal. It was this that gave rise to the controversial fire which blazed up with such fury during the early years of this century, and whose dying embers have not yet been extinguished.

The views of Hutton were in strong contrast to those of Werner, the celebrated professor of mineralogy at Freiberg, to whom science owes a debt of gratitude as great as that due to the Scottish physician. The value of a man's work must not simply be judged by the truth of the theory which he holds. I consider that the Wernerian theory—by which I understand a reference to the early stages of planetary evolution for the purpose of explaining certain geological facts—has been on the wane from the time it was propounded down to the present day; but I claim to be second to none in my admiration for the knowledge, genius, and enthusiasm of the illustrous Saxon professor. The uniformitarian doctrines of Hutton gave a very decided character to the theoretical views of British geologists during the middle of the century, in consequence of the eloquent support of Lyell; but of late there has been a tendency to hark back to a modified form of Wernerism. This tendency can, I think, be largely traced to the recognition of evolution as a factor in biology and physical astronomy. The discoveries in these sciences may necessitate a modification of the views held by some of the extreme advocates of uniformitarianism. This admission, however, by no means carries with it the conclusion that the methods based on the doctrine of uniformitarianism must be discarded. If I read the history of geology aright, every important advance in the theoretical interpretation of observed facts relating to physical geology has been made by the application of these methods. It does not, of course, follow that the progress in the future will be exactly along the same lines as that in the past; but, if I am right in the opinion I have expressed, it is a strong reason for adhering to the old methods until they have been proved to be inapplicable to at least some of the facts with which the physical geologist has to deal. Let us consider for a moment whether the recognition of evolution as a factor in biology and physical astronomy gives an *à priori* probability to some form of Wernerism.

The period of time represented by our fossiliferous records is perhaps equivalent to that occupied by the evolution of the vertebrata, but all the great subdivisions of the invertebrata were living in the Cambrian period, and must have been differentiated in still earlier times. Is it not probable, therefore, that the fossiliferous records at present known represent a period insignificant in comparison with that during which life has existed upon the earth? Again, is it not probable that the period during which life has existed is a still smaller fraction of that which has elapsed since the formation of the primitive crust? And if so, what *à priori* reason have we for believing that the rocks accessible to observation contain the records of the early stages of the planet's history? But the advocates of the diluted forms of Wernerism which find expression in geological writings at the present day almost invariably refer to recent speculations in cosmical physics. The views of astronomers have always had a powerful influence on those of geologists. Hutton wrote at a time when the astronomical world had been profoundly affected by Lagrange's discovery, in 1776, of the periodicity of the secular changes in the forms of the planetary orbits. The doubts as to the stability of the solar system which the recognition of these changes had inspired were thus removed, and astronomers could then see in the physical system of the universe "no vestige of a beginning,—no prospect of an end." Now it is otherwise. Tidal friction and the dissipation of energy by the earth and by the sun are each referred to as fixing a limit to the existing conditions. I have not the knowledge necessary to enable me to discuss these questions, and I will therefore admit, for the sake of argument, that the phenomena referred to indicate the lines along which the physical evolution of our planet has taken place; but does it follow that geologists should desert a working hypothesis which has led to brilliant results in the past for one which has been tried again and again and always found wanting?

If there were absolute unanimity amongst mathematical physicists, it might be necessary for us to reconsider our position. This, however, is not the case. After referring to the argument from tidal friction, Prof. Darwin, in his address to the Mathematical and Physical Section for 1886, says:—"On the whole, then, I can neither feel the cogency of the argument from tidal friction itself, nor, accepting it, can I place any reliance on the limits which it assigns to geological history." In reviewing the argument from the secular cooling of the earth, he points out that the possibility of the generation of heat in the interior by tidal friction has been ignored, and that the thermal data on which the calculations are based are not sufficiently complete to remove all reasonable doubt. He regards the case depending on the secular cooling of the sun as the strongest; but it is evident that, in view of undreamt-of possibilities, he would not allow it to have much weight in the face of adverse geological evidence. In conclusion he says:—"Although speculations as to the future course of science are usually of little avail, yet it seems as likely that meteorology and geology will pass the word of command to cosmical physics as the converse. At present our knowledge of a definite limit to geological time has so little precision that we should do wrong to summarily reject any theories which appear to demand longer periods of time than those which now appear allowable. In each branch of science hypothesis forms the nucleus for the aggregation of observation, and as long as facts are assimilated and co ordinated we ought to follow our theory." Now, my point is that the uniformitarian hypothesis, as applied to the rocks we can examine, has assimilated and coordinated so many facts in the past, and is assimilating and coordinating so many new discoveries, that we should continue to follow it, rather than plunge into the trackless waste of cosmogonical speculation in pursuit of what may after all prove to be a will-o'-the-wisp.

As an additional illustration of the want of agreement amongst mathematical physicists on questions relating to the earth, I may refer to certain papers by Mr. Chree.[1] This author maintains that the modern theory of elasticity points to the conclusion that if a spherical globe, composed of a nearly incompressible elastic solid of the size of the earth, were set rotating as the earth is rotating, it would take the form which the earth actually possesses. How is the question of the fixity of the earth's axis affected by Mr. Chree's researches, and by the recent observations which prove a simultaneous change of latitude, in opposite directions, in Europe and at Honolulu? If geological facts point to a shifting of the position of the axis, is there any dynamical reason why they should not receive due consideration? Geologists want as much freedom as possible. We do not object to any limitations which are necessary in the interest of science, and we cordially welcome, and as a matter

[1] C. Chree, "On Some Applications of Physics and Mathematics to Geology," *Phil. Mag.*, vol. xxxii. (1891), pp. 233, 342.

of fact are largely dependent upon, assistance from other departments of knowledge; but those who would help us should bear in mind that the problems we have still to solve are extremely difficult and complex, so that if certain avenues of thought are closed on insufficient grounds by arguments of the validity of which we are unable to judge, but which we are naturally disposed to take on trust, the difficulties of our task may be greatly augmented and the progress of science seriously retarded. So far as I can judge, there is no *à priori* reason why we should believe that any of the rocks we now see were formed during the earlier stages of planetary evolution. We are free to examine them in our own way, and to draw on the bank of time to any extent that may seem necessary.

For some years past the greater part of my time has been devoted to a study of the composition and structure of rocks, and it has occurred to me that I might, on the present occasion, give expression to my views on the question as to whether the present position of petrographical science necessitates any important modification in the theoretical views introduced by the uniformitarian geologists. Must we supplement the ideas of Hutton and Lyell by any reference to primordial conditions when we endeavour to realise the manner in which the rocks we can see and handle were produced? The question I propose to consider is not whether some of these rocks *may* have been formed under physical conditions different from those which now exist—life is too short to make a discussion of geological possibilities a profitable pursuit—but whether the present state of petrographical science renders uniformitarianism untenable as a working hypothesis; and, if so, to what extent. There is nothing original in what I am about to lay before you. All that I propose to do is to select from the numerous facts and more or less conflicting views, bearing on the question I have stated, a few of those which appear to me to be of considerable importance.

The sedimentary rocks contain the history of life upon the earth, and on this account, as well as on account of their extensive development at the surface, they have necessarily received an amount of attention which is out of all proportion to their importance as constituent portions of the planet. They are, after all, only skin deep. If they were totally removed from our globe its importance as a member of the solar system would not be appreciably diminished. The general laws governing the formation and deposition of these sediments have been fairly well understood for a long time. Hutton, as we have already seen, clearly realised that the land is always wasting away, and that the materials are accumulating on the beds of rivers, lakes, and seas. The chemical effects of denudation are mainly seen in the breaking up of certain silicates and the separation of their constituents into those which are soluble and those which are insoluble under surface conditions. The mechanical effects are seen in the disintegration of rocks, and this may, under certain circumstances, take place without the decomposition of their component minerals.[1] Quartz and the aluminous silicates, which enter largely into the composition of shales and clays, are two of the most important insoluble constituents. It must be remembered, however, that felspars often possess considerable powers of resistance, and rocks which contain them may be broken up without complete or anything like complete decomposition of these minerals. Orthoclase, microcline, and oligoclase are the varieties which most successfully resist decomposition; and, as a natural consequence, occur most abundantly in sedimentary deposits. It is commonly stated that when felspars are attacked the general effect is to reduce them to a fine powder, composed of a hydrated silicate of alumina, and to remove the alkalies, lime, and a portion of the silica. But, as Dr. Sterry Hunt has so frequently urged, the removal of alkalies is imperfect, for they are almost invariably present in argillaceous deposits. Three, four, and even five per cent., consisting mainly of potash, may frequently be found. This alkali appears to be present in micaceous minerals, which are often produced, as very minute scales, during the decomposition of felspars. White mica, whether formed in this way or as a product of igneous or metamorphic action, possesses great powers of resistance to the ordinary surface agencies of decomposition, and so may be used over and over again in the making of sedimentary deposits. Brown mica is also frequently separated from granite and other rocks, and deposited as a constituent of sediments; but it is far more liable

[1] J. W. Judd, "Deposits of the Nile Delta," *Proc. Royal Soc.*, vol. xxxix. (1886), p. 213.

to decomposition than the common white varieties, and its geological life is, therefore, comparatively short.[1] Small crystals and grains of zircon, rutile, ilmenite, cyanite, and tourmaline are nearly indestructible, and occur as accessory constituents in the finer-grained sandstones.[2] Garnet and staurolite also possess considerable powers of resistance, and are not unfrequently present in the same deposits. If we except the last two minerals and a few others, such as epidote, the silicates containing lime, iron, and magnesia are, as a rule, decomposed by surface agencies and the bases removed in solution; augite, enstatite, hornblende, and lime-felspars are extremely rare as constituents of ordinary sediments.

The insoluble constituents resulting from the waste of land surfaces are deposited as gravel, sand, and mud; the soluble constituents become separated as solid bodies by evaporation of the water in inland seas and lagoons, by chemical action, and by organic life. They are deposited as carbonates, sulphates, chlorides, and sometimes, as in the case of iron and manganese, as oxides. The soluble silica may be deposited in the opaline condition by the action of sponges, radiolaria, and diatoms, or as sinter.

The question that we have now to consider is whether there is any marked difference between ancient and modern sediments. One of the oldest deposits in the British Isles is the Torridon sandstone of the north-west of Scotland. The recent discovery of *Olenellus* high up in the stratified rocks which unconformably overlie this deposit has placed its pre-Cambrian age beyond all doubt. Now this formation is mainly composed of quartz and felspar, at least in its upper part, and the latter mineral is both abundant and very slightly altered. One is naturally tempted, at first sight, to associate the freshness of the felspar with the great age of the rock—to assume either that the sand was formed at a time when the chemical agents of decomposition did not act with the same force as now, or that they had not been in operation for a sufficient length of time to eliminate the felspar. A pure quartzose sand is probably never formed by the direct denudation of a granitic or gneissose area. The coarser sediments thus produced contain in most, if not in all, cases a considerable amount of felspar. But felspar is more liable to decomposition by percolating waters when it occurs as a constituent of grit than when present in the parent rock. Silica may thus be liberated in a soluble form, and subsequently deposited on the grains of quartz so as to give rise to secondary crystalline faces, and kaolin may be produced as beautiful six-sided tablets in the interstices of the grit. When the grit is in its turn denuded the felspar is still further reduced in amount, and a purer quartz-sand is formed. As the coarser detrital material is used over and over again, thus measuring different periods of time like the sand in an hour-glass, the felspar and other decomposable minerals are gradually eliminated. The occurrence of a large amount of fresh felspar in the Torridon sandstone might, I say, at first sight be thought to be due to the great age of the rock. Any tendency to accept a view of this kind is, however, at once checked when attention is paid to the pebbles in the coarser conglomeratic beds of the same deposit. These consist largely of quartzite—a rock formed by the consolidation of as pure a quartz-sand as any known to exist in the later formations. We are therefore led to the conclusion that the special features of the Torridon sandstone are not a function of time, but of the local conditions under which the rock was produced.

A similar conclusion may be reached by considering other types of sediment. When the stratified rocks of the different geological periods represented in any limited area are compared with each other certain marked differences may be observed, but the different types formed in any one area at different times can often be paralleled with the different types formed in different areas at the same time, and also with those now forming beneath the waters of rivers, lakes, and seas. Deep sea, shallow water, littoral and terrestrial deposits can be recognised in the formations belonging to many geological periods, from the most ancient to the most recent; and there is no evidence that any of our sedimentary rocks carry us back to a time when the physical conditions of the planet were materially different

[1] "Notes on the Probable Origin of Some Slates," by W. Maynard Hutchings, *Geol. Mag.*, 1890, p. 264.
[2] "Ueber das Vorkommen mikroskopischer Zirkone und Titan-Mineralien," von Dr. Hans Thürach, *Verhandl d. phys.-medic. Gesellschaft zu Würzburg*, N.F. xviii. "On Zircons and other Minerals contained in Sand," Allan B. Dick, NATURE, vol. xxxvi. (1887), p. 91. See also "Mem. Geol. Survey," *Geology of London*, vol. i. p. 523.

from those which now exist. After reviewing all the evidence at my disposal, I must, however, admit that the coarser as well as the finer deposits of the earlier periods appear to be more complex in composition than those of the later. The grits of the Palæozoic formations, taken as a whole, contain more felspar than the sandstones of the Mesozoic and Tertiary formations, and the slates and shales of the former contain more alkalies than the clays of the latter. This statement will hold good for the British Isles, even when allowance is made for the enormous amount of volcanic material amongst the older rocks—a phenomenon which I hold to be of purely local significance—but I strongly suspect that it will not be found to apply universally. In any case, it is not of much importance from our present point of view. All geologists will admit that denudation and deposition were taking place in pre-Cambrian times, under chemical and physical conditions very similar to, if not identical with, those of the present day.

There is, however, one general consideration of more serious import. Additions to the total amount of detrital material are now being made by the decomposition of igneous rocks, and there is no doubt that this has been going on during the whole period of time represented by our stratified deposits. It follows, therefore, as a necessary consequence that strict uniformitarianism is untenable, unless we suppose that igneous magmas are formed by the melting of sediments.

So far we have been dealing with the characters of sedimentary rocks as seen in hand-specimens rather than with those which depend on their distribution over large areas. Thanks to Delesse ("Lithologie du Fond des Mers," Paris, 1871) and the officers of the *Challenger* Expedition ("Report on Deep-sea Deposits," 1891), an attempt has now been made to construct maps on which the distribution of the sediments in course of formation at the present time is laid down. It is impossible to exaggerate the importance of such maps from a geological point of view, for on the facts which they express rests the correct interpretation of our stratigraphical records. Imperfect as is our knowledge of the sea-beds of former geological periods, it is in many respects more complete than that of the sea-beds of the present day. The former we can often examine at our leisure, and follow from point to point in innumerable exposures; the latter are known only from a few soundings, often taken at great distances apart.[1] An examination of such imperfect maps as we have raises many questions of great interest and importance, to one of which I wish to direct special attention—not because it is new, but because it is often overlooked. The boundary lines separating the distinct types of deposit on these maps are not, of course, chronological lines. They do not separate sediments produced at different times, but different sediments simultaneously forming in different places. Now, the lines on our geological maps are usually drawn by tracing the boundary between two distinct lithological types, and, as a natural consequence, such lines will not always be chronological lines. It is only when the existing outcrop runs parallel with the margin of the original area of deposit that this is the fact. Consider the case of a subsiding area—or, to avoid theory, let us say an area in which the water-level rises relatively to the land—and, for the sake of illustration, let us suppose that the boundary separating the districts over which sand and mud are accumulating remains parallel to the old coast-line during the period of deposition. This line will follow the retreating coast, so that if, after the consolidation, emergence, and denudation of the deposits, the outcrop happens to be oblique to the old shore, then the line on the geological map separating clay and sand will not be of chronological value. That portion of it which lies nearer to the position of the vanished land will represent a later period than that which lies further away. If such organisms as ammonites leave their remains in the different deposits, and thus define different chronological horizons with approximate accuracy, the imperfection of the lithological boundary as a chronological horizon will become manifest. It is not that the geological map is wrong. Such maps have necessarily to be constructed with reference to economic considerations, and from this point of view the lithological boundaries are of paramount importance. They are, moreover, in many cases the only boundaries that can be actually traced.[2]

[1] Suess, *Das Antlitz der Erde*, Bd. II., s. 267.

[2] See S. S. Buckman, "On the Cotteswold, Midford, and Yeovil Sands," *Quart. Journ. Geol. Soc.*, vol. xlv. (1889), p. 440; and the same author, "On the So-called Upper Lias Clay of Down Cliffs," *Quart Journ. Geol. Soc.*, vol. xlvi. (1890), p. 518. Also J. Starkie Gardner, "On the Relative Ages of the American and the English Cretaceous and Eocene Series," *Geol. Mag* (1884), p. 492.

The geological millennium will be near at hand when we can construct maps which shall represent the distribution of the different varieties of sediment for each of the different geological periods. All we can say at present is that increase of knowledge in this direction tends greatly to strengthen the uniformitarian hypothesis. We can see, for example, that during Triassic times marine conditions prevailed over a large part of what is now the great mountain-belt of the Euro-Asiatic continent, whilst littoral and terrestrial conditions existed in the north of Europe; and we can catch glimpses of the onward sweep of the sedimentary zones during the great Cretaceous transgression, culminating in the widespread deep-sea[1] conditions under which the chalk was deposited.

We turn now to the igneous rocks. It is no part of my purpose to treat in detail of the growth of knowledge from an historical point of view, and to attempt to allot to each observer the credit due to him; but there is one name that I desire to mention in this connection, because it is that of a man who clearly proved the essential identity of ancient and modern volcanic rocks by the application of precise petrographical methods at a time when there was a very general belief that the Tertiary and pre-Tertiary rocks were radically distinct. I need hardly say that I refer to Mr. Samuel Allport.[2] He wrote at a time when observers in this country had to prepare their own sections, and those who, like myself, have had the privilege of examining many of his slides scarcely know which to admire most—the skill and patience of which they are the evidence, or the conciseness and accuracy of his petrographical descriptions. His papers do not occupy a large number of pages, but they are based on an amount of observation which is truly surprising. The general conclusions at which he arrived as to the essential identity of ancient and modern igneous rocks are expressed with the utmost confidence, and one feels, after going over his material, that this confidence was thoroughly justified. It is curious now to note that the one British champion of the distinctness of the Tertiary and pre-Tertiary rocks pointed to the difference between the Antrim and Limerick traps. These traps differ in exactly the same way as do the corresponding Tertiary and pre-Tertiary continental rocks, with this important difference. On the Continent the ophitic structure is characteristic of the pre-Tertiary rocks, whereas in the north of Ireland it is a marked feature of those of Tertiary age. We see, therefore, that the arguments for the distinctness of the two sets of rocks derived from the two areas, based in both cases on perfectly accurate observations, neutralise each other, and the case hopelessly breaks down as regards the basalts and dolerites.

In this country it is now generally recognised that when allowance is made for alterations which are necessarily more marked in the earlier than in the later rocks, there is no important difference either in structure or composition between the rhyolites, andesites, and basalts of the Palæozoic and Tertiary periods. But identity of structure and composition may in this case be taken to imply identity as to the physical conditions under which the rocks were produced. We are thus led to picture in our minds long lines of volcanoes fringing the borders of Palæozoic continents and rising as islands in the Palæozoic seas. Then, as now, there issued from the craters of these volcanoes enormous masses of fragmental material, a large portion of which was blown to dust by the explosive escape of steam and other gases from the midst of molten rock; and then, as now, there issued from fissures on their flanks vast masses of lava which consolidated as rhyolite, andesite, and basalt. We may sum up the case as regards the volcanic rocks by saying that, so long as observations are confined to a limited area, doubts may arise as to the truth of the uniformitarian view, but these doubts gradually fade away as the area of observation is extended. There are still some outstanding difficulties, such as the apparent absence of leucite lavas amongst the Palæozoic formations; but as many similar difficulties have been overcome in the past, it is improbable that those which remain are of a very formidable character.

So far we have been referring to rocks formed at the surface of the earth under conditions similar to those now in operation. But there are others, such as granite, gneiss, and mica-schist,

[1] Theodor Fuchs, "Welche Ablagerungen haben wir als Tiefseebildungen zu betrachten?" *Neues Jahrbuch f. Miner.* &c. Beilage, Band II., p. 487.

[2] "Tertiary and Palæozoic Trap-rocks," *Geol. Mag.* (1873), p. 196; "British Carboniferous Dolorites," *Quart. Journ. Geol. Soc.*, vol. xxx. (1874), p. 529: "Ancient Devitrified Pitchstones," &c. *Quart. Journ. Geol. Soc.*, vol. xxxiii. (1877), p. 449.

which are obviously unlike any of the products of surface agencies. If these rocks are forming now, it must be beneath the surface. This point was clearly realised by Hutton. Granite was proved by him to be an igneous rock of subterranean origin. His conclusions as to the formation of the schists are expressed in a passage so remarkable when viewed in connection with what I regard as the tendency of modern research, that I make no apology for quoting it at length. "If, in examining our land, we shall find a mass of matter which had been evidently formed originally in the ordinary manner of stratification, but which is now extremely distorted in its structure, and displaced in its position—which is also extremely consolidated in its mass, and variously changed in its composition—which therefore has the marks of its original or marine composition extremely obliterated, and many subsequent veins of melted mineral matter interjected; we should then have reason to suppose that here were masses of matter which, though not different in their origin from those that are gradually deposited at the bottom of the ocean, have been more acted upon by subterranean heat and the expanding power, that is to say, have been changed in a greater degree by the operations of the mineral region. If this conclusion shall be thought reasonable, then here is an explanation of all the peculiar appearances of the Alpine schistus masses of our land, those parts which have been erroneously considered as primitive in the constitution of the earth ("Theory of the Earth," vol. i. p. 375). Surely it is not claiming too much for our author to say that we have there, sketched in broad outline, the theories of thermal and dynamic metamorphism which are attracting so much attention at the present day.

The hypogene origin of the normal plutonic rocks and their formation at different periods, even as late as the Tertiary, are facts which are now so generally recognised that we may leave these rocks without further comment and pass on to the consideration of the crystalline schists.

Everyone knows that the statement, "He who runs may read," is untrue when the stratigraphical interpretation of an intensely folded and faulted district is concerned. The complexity produced by the earth-movements in such regions can only be unravelled by detailed work after definite palæontological and lithological horizons have been established. But if the statement be untrue when applied to districts composed of ordinary stratified rocks, still less can it be true of regions of crystalline schist where the movements have often been much more intense; where the original characters of the rocks have been profoundly modified; and where all distinct traces of fossils have in most cases been obliterated. If detailed work like that of Prof. Lapworth at Dobb's Linn was required to solve the stratigraphical difficulties of the Southern Uplands, is it not probable that even more detailed work will be required to solve the structural problems of such a district as the Highlands of Scotland, where the earth-stresses, though somewhat similar, have operated with greater intensity, and where the injection of molten mineral matter has taken place more than once both on a large and on a small scale? With these few general remarks by way of introduction, I will now call attention to what appear to me to be the most promising lines of investigation in this department of geology.

The crystalline schists certainly do not form a natural group. Some are undoubtedly plutonic igneous rocks showing original fluxion; others are igneous rocks which have been deformed by earth-stresses subsequent to consolidation; others, again, are sedimentary rocks metamorphosed by dynamic and thermal agencies, and more or less injected with "molten mineral matter"; and lastly, some cannot be classified with certainty under any of these heads. So much being granted, it is obvious that we must deal with this petrographical complex by separating from it those rocks about the origin of which there can be no reasonable doubt. Until this separation has been effected, it is quite impossible to discuss with profit the question as to whether any portions of the primitive crust remain. In order to carry out this work it is necessary to establish some criterion by which the rocks of igneous may be separated from those of sedimentary origin. Such a criterion may, I think, be found, at any rate in many cases, by combining chemical with field evidence.[1] If associated rocks possess the composition of grits, sandstones, shales and limestones, and contain also traces of stratification, it seems perfectly justifiable to conclude that they must have been originally formed by processes of denudation and deposition. That we have such rocks in the Alps and in the Central Highlands of Scotland, to mention only two localities, will be admitted by all who are familiar with those regions. Again, if the associated rocks possess the composition of igneous products, it seems equally reasonable to conclude that they are of igneous origin. Such a series we find in the North-West of Scotland, in the Malvern Hills, and at the Lizard. In applying the test of chemical composition it is very necessary to remember that it must be based, not on a comparison of individual specimens, but of groups of specimens. A granite and an arkose, a granitic gneiss and a gneiss formed by the metamorphosis of a grit, may agree in chemical and even in mineralogical composition. The chemical test would therefore utterly fail if employed for the purpose of discriminating between these rocks. But when we introduce the principle of paragenesis it enables us in many cases to distinguish between them. The granitic gneiss will be associated with rocks having the composition of diorites, gabbros, and peridotites; the sedimentary gneiss with rocks answering to sandstones, shales, and limestones. Apply this test to the gneisses of Scotland, and I believe it will be found in many cases to furnish a solution of the problem. Caution, however, is necessary; for crystal-building and the formation of segregation veins and patches in the sedimentary schists clearly prove that a migration of constituents takes place under certain circumstances.

Recent work on the gneisses and schists of igneous composition has shown that the parallel structure, by no means invariably present, is sometimes the result of fluxion during the final stages of consolidation, and sometimes due to the plastic deformation of solid rocks. When compared with masses of ordinary plutonic rock, the principal points of difference, apart from those due to secondary dynamic causes, depend on what may be called their extreme petrographical differentiation. Indications of differentiation may, however, be seen in the contemporaneous veins and basic patches so common in ordinary irruptive bosses, but they are never so marked as in gneissic regions, like those of the North-West of Scotland, where specimens answering in composition to granites, diorites, and even peridotites, may be collected repeatedly in very limited areas. The nearest approach to the conditions of gneissose regions is to be found in connected masses of diverse plutonic rocks, such as those which are sometimes found on the borders of great granitic intrusions.

The tectonic relations of those gneisses which resemble igneous rocks in composition fully bear out the plutonic theory as to their origin. Thus, the intrusive character of granitic gneiss in a portion of the Himalayas has been demonstrated by General McMahon.[1] The protogine of Mont Blanc has been investigated by M. Lévy[2] with the same result. Most significant of all are the discoveries in the vast Archæan region of Canada. Professor Lawson[3] has shown that immense areas of the so-called Laurentian gneiss in the district north west of Lake Superior are intrusive in the surrounding rocks, and therefore newer, not older, than these. Professor Adams[4] has quite recently established a similar fact as regards the anorthosite rocks—the so-called Norian—of the Saguenay River and other districts lying near the eastern margin of the "Canadian shield." Now that the intrusive character of so many gneisses is being recognised, one wonders where the tide of discovery will stop. How long will it be before the existence of gneisses of Tertiary age will be generally admitted? At any rate, the discoveries of recent years have compelled the followers of Wernerian methods to evacuate large slices of territory.

Turning now to the gneisses and schists which resemble sedimentary rocks in composition, we note that the parallel structure may be due to original stratification, to subsequent deformation, or to both of these agencies combined. It must also be remembered that they have often been injected with igneous material, as Hutton pointed out. Where this has followed parallel planes of weakness, we have a banding due to alternations of igneous and sedimentary material. This injection

[1] H. Rosenbusch, "Zur Auffassung der chemischen Natur des Grundgebirges," *Min. und petro. Mitth.*, xii. (1891), p. 49.

[1] "The Geology of Dalhousie," *Records of Geol. Survey of India*, vol. xv part 1 (1882), p. 34. See also vol. xvi. part 3 (1883), p. 129.

[2] "Les Roches Crystallines et Eruptives des Environs du Mont-Blanc," *Bull. des Services de la Carte Géologique de la France*, No. 9 (1890).

[3] "On the Geology of the Rainy Lake Region," *Annual Report Geol Survey of Canada* for 1887.

[4] "Ueber das Norian oder Ober-Laurentian von Canada," *Neues Jahrbuch f. Mineralogie*, &c., Beilage, Band viii. p. 419.

lit par lit has been shown by M. Lévy to be a potent cause in the formation of certain banded gneisses.

Will the various agencies to which reference has been made explain all the phenomena of the crystalline schists and gneisses? I do not think that the present state of our knowledge justifies us in answering this question in the affirmative. Those who are working on these rocks frequently have brought under their notice specimens about the origin of which they are not able to speak with any degree of confidence. Sometimes a flood of light is suddenly thrown on a group of doubtful rocks by the recognition of a character which gives unmistakable indications of their mode of origin. Thus, some of the fine-grained quartz-felspathic rocks associated with the crystalline schists of the Central Highlands are proved to have been originally sands like those of Hampstead Heath by the presence in them of narrow bands rich in zircon, rutile, and the other heavy minerals which are so constantly present in the finer-grained arenaceous deposits of all ages. Such pleasant surprises as the recognition of a character like this increase our confidence in the theory which endeavours to explain the past by reference to the present, and refuses to admit the necessity of believing in the existence of rocks formed under physical conditions different from those which now prevail simply because there are some whose origin is still involved in mystery.

A crystalline schist has been aptly compared to a palimpsest. Historical records of priceless value have often been obscured by the superposition of later writings; so it is with the records of the rocks. In the case of the schists, the original characters have been so modified by folding, faulting, deformation, crystallisation, and segregation that they have often become unrecognisable. But when the associated rocks have the composition of sediments we need have no hesitation in attributing the banded structure in some way to stratification, provided we clearly recognise that the order of succession and the relative thicknesses of the original beds cannot be ascertained by applying the principles which are valid in comparatively undisturbed regions.

In studying the crystalline schists nothing, perhaps, strikes one more forcibly than the evidence of crystal-building in solid rocks. Chiastolite, staurolite, andalusite, garnet, albite, cordierite, micas of various kinds, and many other minerals have clearly been developed without anything like fusion having taken place. Traces of previous movements may not unfrequently be found in the arrangement of the inclusions, while the minerals themselves show no signs of deformation. Facts of this kind, when they occur, clearly indicate that the crystallisation was subsequent to the mechanical action. Nevertheless, it is probable that both phenomena were closely related, though not in all cases as cause and effect. The intrusion of large masses of plutonic rock often marks the close of a period of folding. This is well illustrated by the relation of granite to the surrounding rocks in the Lake District, the Southern Uplands of Scotland, and the West of England. Those of the two first-mentioned localities are post-Silurian and pre-Carboniferous, those of the last-mentioned locality are post-Carboniferous and pre-Permian; one set followed the Caledonian[1] folding, the other set followed the Hercynian folding. That the intrusion of these granites was subsequent to the main movements which produced the folding and cleavage is proved by the fact that the mechanical structures may often be recognised in the crystalline contact-rocks, although the individual minerals have not been strained or broken. In many other respects the rocks produced by so-called contact-metamorphism resemble those found in certain areas of crystalline schist. Many of the most characteristic minerals are common to the two sets of rocks, and so also are many structures. The cipolins and associated rocks of schistose regions have many points of resemblance to the crystalline limestones and "kalksilicathornfels" produced by contact-metamophism.[2]

These facts make it highly probable that, by studying the metamorphic action surrounding plutonic masses, we may gain an insight into the causes which have produced the crystalline schists of sedimentary origin; just as, by studying the intrusive masses themselves and noting the tendency to petrographical differentiation, especially at the margins, we may gain an insight into the causes which have produced the gneisses of igneous origin.[1] In the districts to which reference has been made the igneous material came from below into a region where the rocks had been rendered tolerably rigid. Differential movement was not taking place in these rocks when the intrusion occurred. Consider what must happen if the folding stresses operate on the zone separating the sedimentary rocks from the underlying source of igneous material. Intrusion must then take place during interstitial movement, fluxion structures will be produced in the more or less differentiated igneous magmas, the sediments will be injected and impregnated with igneous material, and thermo-metamorphism will be produced on a regional scale. The origin of gneisses and schists, in my opinion, is to be sought for in a combination of the thermal and dynamic agencies which may be reasonably supposed to operate in the deeper zones of the earth's crust. If this view be correct it is not improbable that we may have crystalline schists and gneisses of post-Silurian age in the North-West of Europe formed during the Caledonian folding, others in Central Europe of post-Devonian age due to the Hercynian folding, and yet others in Southern Europe of post-Cretaceous age produced in connection with the Alpine folding.[3] But if the existence of such schists should ultimately be established it will still probably remain true that rocks of this character are in most cases of pre-Cambrian age. May not this be due to the fact, suggested by a consideration of the biological evidence, that the time covered by our fosisliferous records is but a small fraction of that during which the present physical conditions have remained practically constant?

The good old British ship "Uniformity," built by Hutton and refitted by Lyell, has won so many glorious victories in the past, and appears still to be in such excellent fighting trim, that I see no reason why she should haul down her colours either to "Catastrophe" or "Evolution." Instead, therefore, of acceding to the request to "hurry up" we make a demand for more time. The early stages of the planet's history may form a legitimate subject for the speculations of mathematical physicists, but there seems good reason to believe that they lie beyond the ken of those geologists who concern themselves only with the records of the rocks.

In this address I have ventured to express my views on certain disputed theoretical questions, and I must not conclude without a word of caution. The fact is, I attach very little importance to my own opinions, at least on doubtful questions connected with the origin of the crystalline schists; but, as you have done me the honour to accept me as your President, I thought you might like to know my present attitude of mind towards some of the unsolved problems of geology. There is still room for legitimate difference of opinion on many of the subjects to which I have referred. Meanwhile, we cannot do better than remember the words with which one of our great living masters recently concluded an article on a controversial subject: "Let us continue our work and remain friends."

[1] This term is employed in the sense in which it is used by Suess and Bertrand.

[2] H. Rosenbusch, "Zur Auffassung des Grundgebirges," *Neues Jahr. f. Miner.*, Bd. II. (1889) p. 8.

SECTION D.

BIOLOGY.

OPENING ADDRESS BY REV. H. B. TRISTRAM, M.A., LL.D., D.D., F.R.S., PRESIDENT OF THE SECTION.

IT is difficult for the mind to grasp the advance in biological science (I use the term biology in its wide etymological, not its recently restricted sense) which has taken place since I first attended the meetings of the British Association, some forty years ago. In those days, the now familiar expressions of

[1] G. Barrow, "On an Intrusion of Muscovite-biotite-gneiss in the South Eastern Highlands of Scotland, &c." *Quart. Journ. Geol. Soc.*, vol. xlix. (1893), p. 330.

[2] Some geologists maintain that this is the case, others deny it. See H. Reusch, "Die fossilienführenden krystallinischen Schiefer von Bergen in. Norwegen," Leipzig (1883) J. Lehmann, "Uber die Entstehung der altkrystallinischen Schiefergesteine, mit besonderer Bezugnahme auf des sächsische Granulitgebirge, Erzgebirge, Fichtelgebirge, und bairisch-böhmische Grenzgebirge," Bonn, (1884): T. G. Bonney. several papers on the Alps, and especially "On the Crystalline Schists and their Relation to the Mesozoic Rocks of the Lepontine Alps," *Quart. Journ. Geol Soc.*, vol. xlvi. (1890), p. 188; A. Heim, contribution to the discussion on the last paper; C. W. Gümbel, "Geognostische Beschreibung des K. Bayern" and "Grundzüge der Geologie," Kassel (1888-1892).

Although it is convenient to speak of the three types of folding which have so largely influenced the structure of the European continent as if each belonged to a definite period, it is important to remember that this is not strictly true. The movements were prolonged; they probably crept slowly over the surface of the lithosphere, as did the zones of sedimentation, so that those of the same type are not in all places strictly contemporaneous.

"natural selection," "isolation," "the struggle for existence," "the survival of the fittest," were unheard of and unknown, though many an observer was busied in culling the facts which were being poured into the lap of the philosopher who should mould the first great epoch in natural science since the days of Linnæus.

It is to the importance and value of field observation that I would venture in the first place to direct your attention.

My predecessors in this chair have been, of recent years, distinguished men who have searched deeply into the abstrusest mysteries of physiology. Thither I do not presume to follow them. I rather come before you as a survivor of the old-world naturalist, as one whose researches have been, not in the laboratory or with the microscope, but on the wide desert, the mountain side, and the isles of the sea.

This year is the centenary of the death of Gilbert White, whom we may look upon as the father of field naturalists. It is true that Sir T. Browne, Willughby, and Ray had each, in the middle of the seventeenth century, committed various observations to print; but though Willughby, at least, recognised the importance of the soft parts in affording a key to classification, as well as the osteology, as may be seen from his observation of the peculiar formations, in the Divers (*Colymbidæ*) of the tibia, with its prolonged procnemial process, of which he has given a figure, or his description of the elongation of the posterior branches of the woodpecker's tongue, as well as by his careful description of the intestines of all specimens which came under his notice in the flesh, none of these systematically noted the habits of birds, apart from an occasional mention of their nidification, and very rarely do they even describe the eggs. But White was the first observer to recognise how much may be learnt from the life habits of birds. He is generally content with recording his observations, leaving to others to speculate. Fond of Virgilian quotations (he was a fellow of Oriel of the last century), his quotations are often made with a view to prove the scrupulous accuracy of the Roman poet, as tested by his (White's) own observations.

In an age, incredulous as to that which appears to break the uniformity of nature, but quick to recognise all the phenomena of life, a contrast arises before the mind's eye between the abiding strength of the objective method, which brings Gilbert White in touch with the great writers whose works are for all time, and the transient feebleness of the modern introspective philosophies, vexed with the problems of psychology. The modern psychologist propounds his theory of man and the universe, and we read him, and go on our way, and straightway forget. Herodotus and Thucydides tell a plain tale in plain language, or the Curate of Selborne shows us the hawk on the wing, or the snake in the grass, as he saw them day by day, and, somehow, the simple story lives and moves him who reads it long after the subtleties of this or that philosophical theory have had their day and passed into the limbo of oblivion. But, invaluable as has been the example of Gilbert White in teaching us how to observe, his field was a very narrow one, circumscribed for the most part by the boundaries of a single parish, and on the subject of geographical distribution (as we know it now) he could contribute nothing, a subject on which even the best explorers of that day were strangely inobservant and inexact. A century and a half ago, it had not come to be recognised that distribution is, along, of course, with morphology and physiology, a most important factor in determining the facts of biology. It is difficult to estimate what might have been gained in the case of many species, now irreparably lost, had Forster and the other companions of Captain Cook, to say nothing of many previous voyagers, had the slightest conception of the importance of noting the exact locality of each specimen they collected. They seem scarcely to have recognised the specific distinctions of the characteristic genera of the Pacific Islands at all, or if they did, to have dismissed them with the remark, "On this island was found a flycatcher, a pigeon, or a parrot similar to those found in New Holland, but with white tail-feathers instead of black, an orange instead of a scarlet breast, or red shoulders instead of yellow." As we turn over the pages of Latham or Shaw, how often do we find for locality one of the islands of the South Sea, and, even where the locality is given, subsequent research has proved it erroneous, as though the specimens had been subsequently ticketed; Le Vaillant described many of his South African birds from memory. Thus Latham, after describing very accurately *Rhipidura flabellifera*, from the south island of New Zealand, remarks, apparently on Forster's authority, that it is subject to variation; that in the island of Tanna another was met with, with a different tail, &c., and that there was another variety in the collection of Sir Joseph Banks. Endless perplexity has been caused by the *Psittacus pygmæus* of Gmelin (of which Latham's type is at Vienna) being stated in the inventory as from Botany Bay, by Latham from Otaheite, and in his book as inhabiting several of the islands of the South Seas, and now it proves to be the female *Psittacus palmarum* from the New Hebrides. These are but samples of the confusion caused by the inaccuracies of the old voyagers. Had there been in the first crew who landed on the island of Bourbon, I will not say a naturalist, but even a simple-hearted Leguat, to tell the artless tale of what he saw, or had there been among the Portuguese discoverers of Mauritius one who could note and describe the habits of its birds with the accuracy with which a Poulton could record the ways and doings of our Lepidoptera, how vastly would our knowledge of a perished fauna have been enriched! It is only since we learned from Darwin and Wallace the power of isolation in the differentiation of species, that special attention has been paid to the peculiarities of insular forms. Here the field naturalist comes in as the helpful servant of the philosopher and the systematist, by illustrating the operation of isolation in the differentiation of species. I may take the typical examples of two groups of oceanic islands, differing as widely as possible in their position on the globe, the Sandwich Islands in the centre of the Pacific, thousands of miles from the nearest continent, and the Canaries, within sight of the African coast; but agreeing in this, that both are truly oceanic groups, of purely volcanic origin, the ocean depths close to the Canaries, and between the different islands, varying from 1500 to 2000 fathoms. In the one we may study the expiring relics of an avifauna completely differentiated by isolation; in the other we have the opportunity of tracing the incipient stages of the same process.

The Sandwich Islands have long been known as possessing an avifauna not surpassed in interesting peculiarity by that of New Zealand or Madagascar; in fact, it seems as though their vast distance from the continent had intensified the influences of isolation. There is scarcely a passerine bird in its indigenous fauna which can be referred to any genus known elsewhere. But, until the very recent researches of Mr. Scott Wilson, and the explorations of the Hon. W. Rothschild's collectors, it was not known that almost every island of the group possessed one or more representatives of each of these peculiar genera. Thus, every island which has been thoroughly explored, and in which any extent of the primeval forest remains, possesses, or has possessed, its own peculiar species of *Hemignathus*, *Himatione*, *Phæornis*, *Acrulocercus*, *Loxops*, *Drepanis*, as well as of the massive-beaked finches, which emulate the *Geospiza* of the Galapagos. Prof. Newton has shown that while the greater number of these are probably of American origin, yet the South Pacific has contributed its quota to this museum of ornithological rarities, which Mr. Clarke very justly proposes to make a distinct biological sub-region.

That each of the islands of this group, however small, should possess a flora specifically distinct, suggests thoughts of the vast periods occupied in their differentiation.

In the Canary Islands, either because they are geologically more recent, or because of their proximity to the African coast, which has facilitated frequent immigrations from the continent, the process of differentiation is only partially accomplished. Yet there is scarcely a resident species which is not more or less modified, and this modification is yet further advanced in the westernmost islands than in those nearest to Africa. In Fuertaventura and Lanzarote, waterless and treeless, there is little change, and the fauna is almost identical with that of the neighbouring Sahara. There is a whin-chat, *Pratincola dacotiæ*, discovered by my companion, Mr. Meade-Waldo, peculiar to Fuertaventura, which may possibly be found on the opposite coast, though it has not yet been met with by any collectors there. Now, our whin-chat is a common winter visitant all down the West African coast, and it seems probable that isolation has produced the very marked characters of the Canaries form, while the continental individuals have been restrained from variation by their frequent association with their migratory relations. A similar cause may explain why the blackbird, an extremely common resident in all the Canary Islands, has not been modified in the least, since many migratory individuals of the same species sojourn every winter in the islands. Or take the blue titmouse. Our familiar resident is replaced along the coast of North Africa by a representative species, *Parus ultramarinus*, differentiated chiefly by a black instead of a blue cap, and a slate-coloured instead of a green back. The titmouse of Lanzarote and Fuertaventura is barely separable from that of Algeria, but is much smaller and paler, probably owing to scarcity of food and a dry desert climate. Passing, 100 miles further to sea, to Grand Canary, we find in the woods and forests a bird in all respects similar to the Algerian in colour and dimensions, with one exception—the greater wing coverts of the Algerian are tipped with white, forming a broad bar when the wing is closed. This, present in the Fuertaventura form, is represented in the Canarian by the faintest white tips, and in the birds from the next islands, Tenerife and Gomera, this is altogether absent. This form has been recognised as *Parus teneriffæ*. Proceeding to the north-west outermost island, Palma, we find a very distinct species, with different proportions, a longer tail, and white abdomen instead of yellow. In the Ultima Thule, Hierro, we find a second very distinct species, resembling that of Tenerife in the absence of the wing bar and in all other respects, except that the back is green like the European, instead of slate as in all the other species. Thus we find in this group a uniform graduation of variation as we proceed further from the cradle of the race.

A similar series of modifications may be traced in the chaffinch (*Fringilla*), which has been in like manner derived from the North African *F. spodiogena*, and in which the extreme variation is to be found in the westernmost islands of Palma and Hierro. The willow wren (*Phylloscopus trochilus*), extremely numerous and *resident*, has entirely changed its habits, though not its plumage, and I have felt justified in distinguishing it as *Ph. fortunatus*. In note and habits it is entirely different from our bird, and though it builds a domed nest it is always near the top of lofty trees, most frequently in palm-trees. The only external difference from our bird consists in its paler tarsi and more rounded wing, so that its power of flight is weaker. but, were it not for the marked difference in its habits and voice, I should have hesitated to differentiate it. In the kestrel and the great spotted woodpecker there are differences which suggest incipient species, while the forests of the wooded western islands yield two very peculiar pigeons, differing entirely from each other in their habits, both probably derived from our wood-pigeon, but even further removed from it than the *Columba trocaz* of Madeira, and, by their dark chestnut coloration, suggesting that peculiar food, in this case the berries of the tree laurel, has its full share in the differentiation of isolated forms. If we remember the variability of the pigments in the food of birds, and the amount absorbed and transferred to the skin and plumage, the variability in the tints and patterns of many animals can be more readily understood.

One other bird deserves notice, the *Caccabis*, or red-legged partridge, for here, and here alone, we have chronological data. The Spaniards introduced *Caccabis rufa* into Canary, and *C. petrosa* into Tenerife and Gomera, and they have never spread from their respective localities. Now, both species, after a residence of only 400 years, have become distinctly modified. *C. rufa* was introduced into the Azores also, and changed exactly in the same manner, so much so that Mr. Godman, some years ago, would have described it as distinct, but that the only specimen he procured was in moult and mutilated, and his specimen proved identical with the Canarian bird. Besides minor differences, the back is one-fourth stouter and longer than in the European bird, and the tarsus very much stouter and longer, and the back is gray rather than russet. The gray back harmonises with the volcanic dark soil of the rocks of the Canaries, as the russet does with the clay of the plains of England and France. In the Canaries the bird lives under different conditions from those of Europe. It is on the mountain sides and among rocks that the stouter beak and stronger legs are indispensable to its vigorous existence. It is needless to go into the details of many other species. We have here the effect of changed conditions of life in 400 years. What may they not have been in 400 centuries? We have the result of peculiar food in the pigeons, and of isolation in all the cases I have mentioned. Such facts can only be supplied to the generaliser and the systematist through the accurate and minute observations of the field naturalist.

The character of the avifauna of the Comoro Islands, to take another insular group, seems to stand midway in the differentiating process between the Canaries and the Sandwich Islands. From the researches of M. Humblot, worked out by MM. Milne-Edwards and Oustalet, we find that there are twenty-nine species acknowledged as peculiar; two species from South Africa and twenty-two from Madagascar in process of specification, called by M. Milne-Edwards secondary or derived species.

The little Christmas Island, an isolated rock 200 miles south of Java, only 12 miles in length, has been shown by Mr. Lister to produce distinct and peculiar forms of every class of life, vegetable and animal. Though the species are few in number, yet every mammal and land bird is endemic; but, as Darwin remarks, to ascertain whether a small isolated area, or a large open area like a continent, has been more favourable for the production of new organic forms, we ought to make the comparison between equal times, and this we are incapable of doing. My own attention was first directed to this subject when, in the year 1857–58, I spent many months in the Algerian Sahara, and noticed the remarkable variations in different groups, according to elevation from the sea, and the difference of soil and vegetation. The "Origin of Species" had not then appeared; but on my return my attention was called to the communication of Darwin and Wallace to the Linnean Society on the tendencies of species to form varieties, and on the perpetuation of varieties and species by means of natural selection. I then wrote (*Ibis* 1859, pp. 429–433): "It is hardly possible, I should think, to illustrate this theory better than by the larks and chats of North Africa. In all these, in the congeners of the wheatear, of the rock chat, of the crested lark, we trace gradual modifications of coloration and of anatomical structure, deflecting by very gentle gradations from the ordinary type, but, when we take the extremes, presenting the most marked differences. . . . In the desert, where neither trees, brushwood, nor even undulations of surface afford the slightest protection to an animal from its foes, a modification of colour, which shall be assimilated to that of the surrounding country, is absolutely necessary. Hence, without exception, the upper plumage of every bird—whether lark, chat, sylvan or land grouse—and also the fur of all the small mammals, and the skin of all the snakes and lizards, is of the uniform isabelline or sand-colour. It is very possible that some further purpose may be served by the prevailing colours, but this appears of itself a sufficient explanation. There are individual varieties of depth of hue among all creatures. In the struggle for life which we know to be going on among all species, a very slight change for the better, such as improved means of escape from its natural enemies (which would be the effect of an alteration from a conspicuous colour to one resembling the hue of the surrounding objects), would give the variety that possessed it a decided advantage over the typical or other forms of the species. . . . To apply the theory to the case of the Sahara. If the Algerian Desert were colonised by a few pairs of crested larks—putting aside the ascertained fact of the tendency of an arid, hot climate to bleach all dark colours—we know that the probability is that one or two pairs would be likely to be of a darker complexion than the others. These, and such of their offspring as most resembled them, would become more liable to capture by their natural enemies, hawks and carnivorous beasts. The lighter-coloured ones would enjoy more or less immunity from such attacks. Let this state of things continue for a few hundred years and the dark-coloured individuals would be exterminated, the light-coloured remain and inherit the land. This process, aided by the above-mentioned tendency of the climate to bleach the coloration still more, would in a few centuries produce the *Galerida abyssinica* as the typical form; and it must be noted that between it and the European *G. cristata* there is no distinction but that of colour.

"But when we turn to *Galerida isabellina*, *G. arenicola*, and *G. macrorhyncha*, we have differences, not only of colour, but of structure. These differences are most marked in the form of the bill. Now, to take the two former first, *G. arenicola* has a very long bill, *G. isabellina* a very short one; the former resorts exclusively to the deep, loose, sandy tracts, the latter haunts the hard and rocky districts. It is manifest that a bird whose food has to be sought for in deep sand derives a great advantage from any elongation, however slight, of its bill. The other, who feeds among stones and rocks, requires strength rather than length. We know that even in the type species the size of the bill varies in individuals—in the lark as well as in the snipe. Now, in the desert, the shorter-billed varieties would undergo comparative difficulty in finding food where it was not abundant, and consequently would not be in such vigorous condition as their longer-billed relations. In the breeding season, therefore, they would have fewer eggs and a weaker progeny. Often, as we know, a weakly bird will abstain from matrimony altogether. The natural result of these causes would be that in course of time the longest-billed variety would steadily predominate over the shorter, and, in a few centuries, they would be the sole existing race; their shorter-billed fellows dying out until that race was extinct. The converse will still hold good of the stout-billed and weaker billed varieties in a rocky district.

"Here are only two causes enumerated which might serve to create, as it were, a new species from an old one. Yet they are perfectly natural causes, and such as I think must have occurred, and are possibly occurring still. We know so very little of the causes which, in the majority of cases, make species rare or common that there may be hundreds of others at work, some even more powerful than these, which go to perpetuate and eliminate certain forms 'according to natural means of selection.'"

It would appear that those species in continental areas are equally liable to variation with those which are isolated in limited areas, yet that there are many counteracting influences which operate to check this tendency. It is often assumed, where we find closely allied species apparently inter-breeding at the centre of their area, that the blending of forms is caused by the two races commingling. Judging from insular experience I should be inclined to believe that the theory of inter-breeding is beginning at the wrong end, but rather that while the generalised forms remain in the centre of distribution, we find the more decidedly distinct species at the extremes of the range, caused not by inter-breeding, but by differentiation. To illustrate this by the group of the blue titmouse. We find in Central Russia, in the centre of distribution of the family, the most generalised form, *Parus pleskii*, partaking of the characters of the various species east, west, and south. In the north-east and north it becomes differentiated as *P. cyaneus*; to the south-west and south into *P. cæruleus* and its various sub-species, while a branch extending due east has assumed the form of *P. flavipectus*, bearing traces of affinity to its neighbour *P. cyaneus* in the north, which seems evidently to have been derived from it.

But the scope of field observation does not cease with geographical distribution and modification of form. The closet systematist is very apt to overlook or to take no count of habits, voice, modification, and other features of life which have an important bearing on the modification of species. To take one instance, the short-toed lark (*Calandrella brachydactyla*) is spread over the countries bordering on the Mediterranean; but, along with it, in Andalusia alone is found another species, *Cal. bætida*, of a rather darker colour, and with the secondaries generally somewhat shorter. Without further knowledge than that obtained from a comparison of skins, it might be put down as an accidental variety. But the field naturalist soon recognises it as a most distinct species. It has a different voice, a differently-shaped nest; and, while the common species breeds in the plains, this one always resorts to the hills. The Spanish shepherds on the spot recognise their distinctness, and have a name for each species. Take, again, the eastern form of the common song-thrush. The bird of North China, *Turdus auritus*, closely resembles our familiar species, but is slightly larger, and there is a minute difference in the wing formula. But the field naturalist has ascertained that it lays eggs like those of the missel-thrush, and it is the only species closely allied to our bird which does not lay eggs of a blue ground colour. The hedge accentor of Japan (*Accentor rubidus*) is distinguished from our most familiar friend, *Accentor modularis*, by delicate differences of hue. But, though in gait and manner it closely resembles it, I was surprised to find the Japanese bird strikingly distinct in habits and life, being found only in forest and brushwood several thousand feet above the sea. I met with it first at Chinsenze—6000 feet—before the snow had left the ground, and in summer it goes higher still, but never descends to the cultivated land. If both species are derived, as seems probable, from *Accentor immaculatus* of the Himalayas, then the contrast in habits is easily explained. The lofty mountain ranges of Japan have enabled the settlers there to retain their original habits, for which our humbler elevations have afforded no scope.

On the solution of the problem of the migration of birds, the most remarkable of all the phenomena of animal life, much less aid has been contributed by the observations of field naturalists than might reasonably have been expected. The facts of migration have, of course, been recognised from the earliest times, and have afforded a theme for Hebrew and Greek poets 3000 years ago. Theories which would explain it are rife enough, but it is only of late years that any systematic effort has been made to classify and summarise the thousands of data and notes which are needed in order to draw any satisfactory conclusion. The observable facts may be classified as to their bearing on the whither, when, and how, of migration, and after this we may possibly arrive at a true answer to the Why? Observation has sufficiently answered the first question, Whither?

There are scarcely any feathered denizens of earth or sea to the summer and winter ranges of which we cannot now point. Of almost all the birds of the holo-arctic fauna, we have ascertained the breeding-places and the winter resorts. Now that the knot and the sanderling have been successfully pursued even to Grinnell Land, there remains but the curlew sandpiper (*Tringa subarquata*), of all the known European birds, whose breeding ground is a virgin soil, to be trodden, let us hope, in a successful exploration by Nansen, on one side or other of the North Pole. Equally clearly ascertained are the winter quarters of all the migrants. The most casual observer cannot fail to notice in any part of Africa, north or south, west coast or interior, the myriads of familiar species which winter there. As to the time of migration, the earliest notes of field naturalists have been the records of the dates of arrival of the feathered visitors. We possess them for some localities, as for Norfolk by the Marsham family, so far back as 1736. In recent years these observations have been carried out on a larger and more systematic scale by Middendorff, who, forty years ago, devoted himself to the study of the lines of migration in the Russian Empire, tracing what he called the *isopipteses*, the lines of simultaneous arrival of particular species, and by Prof. Palmén, of Finland, who, twenty years later, pursued a similar course of investigation; and by Prof. Baird on the migration of North American birds; and subsequently by Severtzoff as regards Central Asia, and Menzbier as regards Eastern Europe. As respects our own coasts, a vast mass of statistics has been collected by the labours of the Migration Committee appointed by the British Association in 1880, for which our thanks are due to the indefatigable zeal of Mr. John Cordeaux and his colleague Mr. John Harvie Brown, the originators of the scheme by which the lighthouses were for nine years used as posts of observation on migration. The reports of that committee are familiar to us, but the inferences are not yet worked out. I cannot but regret that the committee has been allowed to drop. Prof. W. W. Cooke has been carrying on similar observations in the Mississippi valley, and others, too numerous to mention, have done the same elsewhere. But, as Prof. Newton has truly said, all these efforts may be said to pale before the stupendous amount of information amassed during more than fifty years by the venerable Herr Gätke, of Heligoland, whose work we earnestly desire may soon appear in an English version.

We have, through the labours of the writers I have named, and many others, arrived at a fair knowledge of the When? of migration. Of the How? we have ascertained a little, but very little. The lines of migration vary widely in different species, and in different longitudes. The theory of migration being directed towards the magnetic pole, first started by Middendorff, seems to be refuted by Baird, who has shown that in North America the theory will not hold. Yet, in some instances, there is evidently a converging tendency in northward migrations. The line, according to Middendorff, in Middle Siberia is due north, in Eastern Siberia south-east to north-west, and in Western Siberia from south-west to north-east. In European Russia Menzbier traces four northward routes: (1) A coast line coming up from Norway round the North Cape to Nova Zembla. (2) The Baltic line with bifurcation, one proceeding by the Gulf of Bothnia, and the other by the Gulf of Finland, which is afterwards again subdivided. (3) A Black Sea line, reaching nearly as far north as the valley of the Petchora; and (4) the Caspian line, passing up the Volga, and reaching as far east as the valley of the Obi by other anastomosing streams.

Palmén has endeavoured to trace the lines of migration on the return autumnal journey in the eastern hemisphere, and has arranged them in nine routes: (1) From Nova Zembla, round the West of Norway, to the British Isles. (2) From Spitzbergen, by Norway, to Britain, France, Portugal, and West Africa. (3) From North Russia, by the Gulf of Finland, Holstein, and Holland, and then bifurcating to the West Coast of France on the one side, and on the other up the Rhine to Italy and North

Africa. (4*a*) Down the Volga by the Sea of Azof, Asia Minor, and Egypt, while the other portion (4*b*), trending east, passes by the Caspian and Tigris to the Persian Gulf. (5) By the Yenesei to Lake Baikal and Mongolia. (6) By the Lena on to the Amoor and Japan. (7) From East Siberia to the Corea and Japan. (8) Kamschatka to Japan and the Chinese coast. (9) From Greenland, Iceland, and the Farohs, to Britain, where it joins line 2.

All courses of rivers of importance form minor routes, and consideration of these lines of migration might serve to explain the fact of North American stragglers, the waifs and strays which have fallen in with great flights of the regular migrants and been more frequently shot on the east coast of England and Scotland than on the west coast or in Ireland. They have not crossed the Atlantic, but have come from the far north, where a very slight deflection east or west might alter their whole course, and in that case they would naturally strike either Iceland or the west coast of Norway, and in either case would reach the east coast of Britain. But, if by storms, and the prevailing winds of the North Atlantic coming from the west, they had been driven out of their usual course, they would strike the coast of Norway, and so find their way hither in the company of their congeners.

As to the elevation at which migratory flights are carried on, Herr Gätke, as well as many American observers, holds that it is generally far above our ken, at least in normal conditions of the atmosphere, and that the opportunities of observation, apart from seasons and unusual atmospheric disturbance, are confined chiefly to unsuccessful and abortive attempts. It is maintained that the height of flight is some 1500 to 15,000 feet, and if this be so, as there seems every reason to admit, the aid of land bridges and river valleys becomes of very slight importance. A trivial instance will illustrate this. There are two species of blue-throat, *Cyanecula suecica* and *C. leucocyana*: the former with its red-breast patch is abundant in Sweden in summer, but is never found in Germany, except most accidentally, as the other is the common form of Central Europe. Yet both are abundant in Egypt and Syria, where they winter, and I have on several occasions obtained both species out of the same flock. Hence we infer that the Swedish bird makes its journey from its winter quarters with scarcely a halt, while the other proceeds leisurely to its nearer summer quarters. On the other hand, I have more than once seen myriads of swallows, martins, sand-martins, and, later in the season, swifts, passing up the Jordan Valley and along the Bukoa of Central Syria, at so slight an elevation that I was able to distinguish at once that the flight consisted of swallows or house-martins. This was in perfectly calm clear weather. One stream of swallows, certainly not less than a quarter of a mile wide, occupied more than half an hour in passing over one spot, and flights of house-martins, and then of sand-martins, the next day, were scarcely less numerous. These flights must have been straight up from the Red Sea, and may have been the general assembly of all those which had wintered in East Africa. I cannot think that these flights were more than 1000 feet high. On the other hand, when standing on the highest peak in the Island of Palma, 6500 feet, with a dense mass of clouds beneath us, leaving nothing of land or sea visible, save the distant Peak of Tenerife, 13,000 feet, I have watched a flock of Cornish choughs soaring above us, till at length they were absolutely undistinguishable by us except with field-glasses.

As to the speed with which the migration flights are accomplished, they require much further observation. Herr Gätke maintains that godwits and plovers can fly at the rate of 240 miles an hour (!), and the late Dr. Jerdon stated that the spine-tailed swift (*Acanthyllis caudacutus*), roosting in Ceylon, would reach the Himalayas (1200 miles) before sunset. Certainly in their ordinary flight the swift is the only bird I have ever noticed to outstrip an express train on the Great Northern Railway.

Observation has shown us that, while there is a regular and uniform migration in the case of some species, yet that, beyond these, there comes a partial migration of some species, immigrants and emigrants simultaneously, and this, besides the familiar vertical emigration from higher to lower altitudes and *vice versâ*, as in the familiar instance of the lapwing and golden plover. There is still much scope for the field naturalist in observation of these partial migrations. There are also species in which some individuals migrate and some are sedentary, *e.g.* in the few primeval forests which still remain in the Canary Islands, and which are enshrouded in almost perpetual mist, the woodcock is sedentary, and not uncommon. I have often put up the bird and seen the eggs; but in winter the number is vastly increased, and the visitors are easily to be distinguished from the residents by their lighter colour and larger size. The resident never leaves the cover of the dense forest, where the growth of ferns and shrubs is perpetual, and fosters a moist, rich, semipeaty soil, in which the woodcock finds abundant food all the year, and has thus lost its migratory instincts.

But why do birds migrate? Observation has brought to light many facts which seem to increase the difficulties of a satisfactory answer to the question. The autumnal retreat from the breeding quarters might be explained by a want of sufficient sustenance as winter approaches in the higher latitudes, but this will not account for the return migration in spring, since there is no perceptible diminution of supplies in the winter quarters. A friend of mine, who was for some time stationed at an infirmary at Kikombo, on the high plateau south-east of Victoria Nyanza Lake, almost under the equator, where there is no variation in the seasons, wrote to me that from November to March the country swarmed with swallows and martins, which seemed to the casual observer to consist almost wholly of our three species, though occasionally a few birds of different type might be noticed in the larger flocks. Towards the end of March, without any observable change in climatic or atmospheric conditions, nine-tenths of the birds suddenly disappeared, and only a sprinkling remained. These, which had previously been lost amid the myriad of winter visitants, seemed to consist of four species, of which I received specimens of two, *Hirundo puella* and *H. senegalensis*. One, described as white underneath, is probably *H. æthiopica*; and the fourth, very small, and quite black, must be a *Psalidoprocne*. All these remained through spring and summer. The northward movement of all the others must be through some impulse not yet ascertained. In many other instances observation has shown that the impulse of movement is not dependent on the weather at the moment. This is especially the case with sea birds. Prof. Newton observes that they can be trusted as the almanack itself. Foul weather or fair, heat or cold, the puffins, *Fratercula arctica*, repair to some of their stations punctually on a given day, as if their movements were regulated by clockwork. In like manner, whether the summer be cold or hot, the swifts leave their summer home in England about the first week in August, only occasional stragglers ever being seen after that date. So in three different years I noticed the appearance of the common swift (*Cypselus apus*) in myriads on one day in the first week in April. In the case of almost all the land birds, it has been ascertained by repeated observations that the male birds arrive some days before the hens. I do not think it is proved that they start earlier; but, being generally stronger than the females, it is very natural that they should outstrip their weaker mates. I think, too, that there is evidence that those species which have the most extended southerly, have also the most extended northerly range. The same may hold good of individuals of the same species, and may be accounted for by, or account for, the fact that, *e.g.*, the individuals of the wheatear or of the willow wren which penetrate furthest north have longer and stronger wings than those individuals which terminate their journey in more southern latitudes. The length of wing of two specimens of *Saxicola œnanthe* in my collection from Greenland and Labrador exceeds by ·6 inch the length of British and Syrian specimens, and the next longest, exceeding them by ·5 inch, is from the Gambia. So the sedentary *Phylloscopus trochilus* of the Canaries has a perceptibly shorter wing than European specimens.

To say that migration is performed by instinct is no explanation of the marvellous faculty, it is an evasion of the difficulty. Prof. Möbius holds that birds crossing the ocean may be guided by observing the rolling of the waves, but this will not hold good in the varying storms of the Atlantic, still less in the vast stretch of stormy and landless ocean crossed by the bronze cuckoo (*Chrysococcyx lucidus*) in its passage from New Guinea to New Zealand. Prof. Palmén ascribes the due performance of the flight to experience, but this is not confirmed by field observers. He assumes that the flights are led by the oldest and strongest, but observation by Herr Gätke has shown that among migrants, as the young and old journey apart and by different routes, the former can have had no experience. All ornithologists are aware that the parent cuckoos leave this country long before their young ones are hatched by their foster-parents. The sense of sight cannot guide birds which travel by night, or span oceans or continents in a single flight. In noticing all the phenomena of migration, there yet remains a vast untilled region for the field naturalist.

What Prof. Newton terms the sense of direction, unconsciously exercised, is the nearest approach yet made to a solution of the problem. He remarks how vastly the sense of direction varies in human beings, contrasting its absence in the dwellers in towns compared with the power of the shepherd and the countryman, and, infinitely more, with the power of the savage or the Arab. He adduces the experience of Middendorff among the Samojeds, who know how to reach their goal by the shortest way through places wholly strange to them. He had known it among dogs and horses (as we may constantly perceive), but was surprised to find the same incomprehensible animal faculty unweakened among uncivilised men. Nor could the Samojeds understand his enquiry how they did it? They disarmed him by the question, How now does the arctic fox find its way aright on the Tundra, and never go astray? and Middendorff adds: "I was thrown back on the unconscious performance of an inherited animal faculty"; and so are we!

There is one more kind of migration, on which we know nothing, and where the field naturalist has still abundant scope for the exercise of observation. I mean what is called exceptional migration, not the mere wanderings of waifs and strays, nor yet the uncertain travels of some species, as the crossbill in search of food, but the colonising parties of many gregarious species, which generally, so far as we know in our own hemisphere, travel from east to west, or from south-east to north-west. Such are the waxwing (*Ampelis garrula*), the pastor starling (*Pastor roseus*) and Pallas's sandgrouse, after intervals sometimes of many years, or sometimes for two or three years in succession. The waxwing will overspread Western Europe in winter for a short time. It appears to be equally inconstant in its choice of summer quarters, as was shown by J. Wolley in Lapland. The rose pastor regularly winters in India, but never remains to breed. For this purpose the whole race seems to collect and travel north-west, but rarely, or after intervals of many years, returns to the same quarters. Verona, Broussa, Smyrna, Odessa, the Dobrudscha have all during the last half-century been visited for one summer by tens of thousands, who are attracted by the visitations of locusts, on which they feed, rear their young, and go. These irruptions, however, cannot be classed under the laws of ordinary migration. Not less inexplicable are such migrations as those of the African darter, which, though never yet observed to the north of the African lakes, contrives to pass, every spring, unobserved to the lake of Antioch in North Syria, where I found a large colony rearing their young, which, so soon as their progeny was able to fly, disappeared to the south-east as suddenly as they had arrived.

There is one possible explanation of the sense of direction unconsciously exercised, which I submit as a working hypothesis. We are all aware of the instinct, strong both in mammals and birds without exception, which attracts them to the place of their nativity. When the increasing cold of the northern regions, in which they all had their origin, drove the mammals southward, they could not retrace their steps, because the increasing polar sea, as the arctic continent sank, barred their way. The birds reluctantly left their homes as winter came on, and followed the supply of food. But as the season in their new residence became hotter in summer, they instinctively returned to their birthplaces, and there reared their young, retiring with them when the recurring winter impelled them to seek a warmer climate. Those species which, unfitted for a greater amount of heat by their more protracted sojourn in the northern regions, persisted in revisiting their ancestral homes, or getting as near to them as they could, retained a capacity for enjoying a temperate climate, which, very gradually, was lost by the species which settled down more permanently in their new quarters, and thus a law of migration became established on the one side, and sedentary habits on the other.

If there be one question on which the field naturalist may contribute, as lion's provider to the philosopher, more than another, it is on the now much disputed topic of "mimicry," whether protective or aggressive. As Mr. Beddard has remarked on this subject, "The field of hypothesis has no limits, and what we need is more study"—and, may we not add, more accurate observation of facts. The theory of protective mimicry was first propounded by Mr. H. W. Bates, from his observations on the Amazon. He found that the group of butterflies, *Heliconiidæ*, conspicuously banded with yellow and black, were provided with certain glands which secrete a nauseating fluid, supposed to render them unpalatable to birds. In the sand districts he found also similarly coloured butterflies, belonging to the family *Pieridæ*, which so closely resembled the others in shape and markings as to be easily mistaken for them, but which, unprovided with such secreting glands, were unprotected from the attacks of birds. The resemblance, he thought, was brought about by natural selection for the protection of the edible butterflies, through the birds mistaking them for the inedible kind. Other cases of mimicry among a great variety of insects have since been pointed out, and the theory of protective mimicry has gained many adherents. Among birds, many instances have been adduced. Mr. Wallace has described the extraordinary similarity between birds of very different families, *Oriolus bouruensis* and *Philemon moluccensis*, both peculiar to the island of Bouru. Mr. H. O. Forbes has discovered a similar brown oriole, *Oriolus decipiens*, as closely imitating the appearance of the *Philemon timorlaoensis* of Timor-laut. A similar instance occurs in Ceram. But Mr. Wallace observes that, while usually the mimicking species is less numerous than the mimicked, the contrary appears to be the case in Bouru, and it is difficult to see what advantage has been gained by the mimicry. Now, all the species of *Philemon* are remarkably sombre-coloured birds, and the mimicry cannot be on their side. But there are other brown orioles, more closely resembling those named, in other Moluccan islands, and yet having no resemblance to the *Philemon* of the same island, as may be seen in the case of the *Oriolus phæochromus* and *Philemon gilolensis* from Gilolo. Yet the oriole has adopted the same livery which elsewhere is a perfect mimicry. May it not therefore be that we have, in this group of brown orioles, the original type of the family undifferentiated? As they spread east and south we may trace the gradation, through the brown striation of the New Guinea bird, to the brighter, green-tinged form of the West Australian and the green plumage of the Southern Australian, while westward the brilliant yellows of the numerous Indian and African species were developed, and another group, preferring high elevations, passing through the mountain ranges of Java, Sumatra, and Borneo, intensified the aboriginal brown into black, and hence were evolved the deep reds of the various species which culminate in the crimson of Formosa, *Oriolus ardens*, and the still deeper crimsons of *O. trailli* of the Himalayas.

It is possible that there may be similarity without mimicry, and, by the five laws of mimicry as laid down by Wallace, very many suggested cases must be eliminated. We all know that it is quite possible to find between species of very different genera extraordinary similarity which is not mimetic. Take, for instance, the remarkable identity of coloration in the case of some of the African species *Macronyx* and the American *Sturnella*, or, again, of some of the African *Campophagæ* and the American *Agelæus*. The outward resemblance occurs in both cases in the red as well as in the yellow-coloured species of all four groups. But we find that the *Macronyx* of America and the *Campophagæ* of Africa, in acquiring this coloration, have departed widely from the plain colour found in their immediate relatives. If we applied Mr. Scudder's theory on insects, we must imagine that the prototype form has become extinct, while the mimicker has established its position. This is an hypothesis which is easier to suggest than either to prove or to disprove. Similar cases may frequently be found in botany. The strawberry is not indigenous in Japan, but in the mountains there I found a potentilla in fruit which absolutely mimicked the Alpine strawberry in the minutest particulars, in its runners, its blossoms, and fruit; but the fruit was simply dry pith, supporting the seeds and retaining its colour without shrinking or falling from the stalk for weeks—a remarkable case, we cannot say of unconscious mimicry, but of unconscious resemblance. Mimicry in birds is comparatively rare, and still rarer in mammals, which is not surprising when we consider how small is the total number of the mammalia, and even of birds, compared with the countless species of invertebrates. Out of the vast assemblage of insects, with their varied colours and patterns, it would be strange if there were not many cases of accidental resemblance. A strict application of Wallace's five laws would, perhaps, if all the circumstances were known, eliminate many accepted instances.

As to cases of edible insects mimicking inedible, Mr. Poulton admits that even unpalatable animals have their special enemies, and that the enemies of palatable animals are not indefinitely numerous.

Mr. Beddard gives tables of the results obtained by Weismann, Poulton, and others, which show that it is impossible to lay down any definite law upon the subject, and that the likes and dislikes of insect-eating animals are purely relative.

One of the most interesting cases of mimicry is that of the *Volucella*, a genus of *Diptera*, whose larvæ live on the larvæ of *Hymenoptera*, and of which the perfect insect closely resembles some species of humble-bee. Though this fact is unquestioned, yet it has recently given rise to a controversy, which, so far as one who has no claim to be an entomologist can judge, proves that while there is much that can be explained by mimicry, there is, nevertheless, a danger of its advocates pressing it too far. *Volucella bombylans* occurs in two varieties, which prey upon the humble-bees, *Bombus muscorum* and *B. lapidarius*, which they respectively resemble. Mr. Bateson does not question the behaviour of the *Volucella*, but states that neither variety specially represents *B. muscorum*, and yet that they deposit their eggs more frequently in their nests than in the nests of other species which they resemble more closely. He also states that in a show-case in the Royal College of Surgeons, to illustrate mining, two specimens of another species, *B. sylvarum*, were placed alongside of the *Volucella*, which they do resemble, but were labelled *B. muscorum*.

But Mr. Hart explains the parasitism in another way. He states that a nest of *B. muscorum* is made on the surface, without much attempt at concealment, and that the bee is a peculiarly gentle species, with a very feeble sting; but that the species which the *Volucella* most resemble are irascible, and therefore more dangerous to intruders. If this be so, it is difficult to see why the *Volucella* should mimic the bee, which it does not affect, more closely than the one which is generally its victim. I do not presume to express any opinion further than this, that the instances I have cited show that there is much reason for further careful observation by the field naturalist, and much yet to be discovered by the physiologist and the chemist, as to the composition and nature of animal pigments.

I had proposed to occupy a considerable portion of my address with a statement of the present position of the controversy on heredity, by far the most difficult and important of all those subjects which at present attract the attention of the biologist; but an attack of illness has compelled me to abandon my purpose. Not that I proposed to venture to express any opinions of my own, for, with such protagonists in the field as Weismann, Wallace, Romanes, and Poulton on the one side, and Herbert Spencer and Hartog on the other, "*Non nostrum inter vos tantas componere lites.*"

So far as I can understand Weismann's theory, he assumes the separation of germ cells and somatic cells, and that each germ cell contains in its nucleus a number of "ids," each "id" representing the personality of an ancestral member of the species, or of an antecedent species. "The first multicellular organism was probably a cluster of similar cells, but these units soon lost their original homogeneity. As the result of mere relative position, some of the cells were especially fitted to provide for the nutrition of the colony, while others undertook the work of reproduction." The latter, or germ-plasm, he assumes to possess an unlimited power of continuance, and that life is endowed with a fixed duration, not because it is contrary to its natuure to be unlimited, but because the unlimited existence of individuals would be a luxury without any corresponding advantage.

Herbert Spencer remarks upon this: "The changes of every aggregate, no matter of what kind, inevitably end in a state of equilibrium. Suns and planets die, as well as organisms." But has the theory been proved, either by the histologist, the microscopist, or the chemist? Spencer presses the point that the immortality of the protozoa has not been proved. And, after all, when Weismann makes the continuity of the germ plasm the foundation of a theory of heredity, he is building upon a pure hypothesis.

From the continuity of the germ-plasm, and its relative segregation from the body at large, save with respect to nutrition, he deduces, *à priori*, the impossibility of characters acquired by the body being transmitted through the germ-plasm to the offspring. From this he implies that where we find no intelligible mechanism to convey an imprint from the body to the germ, there no imprint can be conveyed. Romanes has brought forward many instances which seem to contradict this theory, and Herbert Spencer remarks that "a recognised principle of reasoning—'the law of parsimony'—forbids the assumption of more causes than are needful for the explanation of phenomena. We have evident causes which arrest the cell multiplication, therefore it is illegitimate to ascribe this arrest to some property inherent in the cells."

With regard to the reduction or disappearance of an organ, he states "that when natural selection, either direct or reversed, is set aside, why the mere cessation of selection should cause decrease of an organ, irrespective of the direct effects of disease, I am unable to see. Beyond the production of changes in the size of parts, by the selection of fortuitously arising variation, I can see but one other cause for the production of them—the competition among the parts for nutriment. . . . The active parts are well supplied, while the inactive parts are ill supplied and dwindle, as does the arm of the Hindu fakir. This competition is the cause of economy of growth—this is the cause of decrease from disease."

I may illustrate Mr. Herbert Spencer's remarks by the familiar instance of the pinions of the Kakapo (*Stringops*)—still remaining, but powerless for flight.

As for acquired habits, such as the modification of bird architecture by the same species under changed circumstances, how they can be better accounted for than by hereditary transmitted instinct, I do not see. I mean such cases as the ground-nesting *Didunculus* in Samoa having saved itself from extinction since the introduction of cats, by roosting and nesting in trees; or the extraordinary acquired habit of the black-cap in the Canaries, observed by Dr. Lowe, of piercing the calyx of *Hibiscus rosa-sinensis*—an introduced plant—to attract insects, for which he quietly sits waiting. So the lying low of a covey of partridges under an artificial kite would seem to be a transmitted instinct from a far-off ancestry not yet lost; for many generations of partridges, I fear, must have passed since the last kite hovered over the forefathers of an English partridge, save in very few parts of the island.

I cannot conclude without recalling that the past year has witnessed the severance of the last link with the pre-Darwinian naturalists in the death of Sir Richard Owen. Though never himself a field-worker, or the discoverer of a single animal living or extinct, his career extends over the whole history of palæontology. I say palæontology, for he was not a geologist in the sense of studying the order, succession, area, structure, and disturbance of strata. But he accumulated facts on the fossil remains that came to his hands, till he won the fame of being the greatest comparative anatomist of the age. To him we owe the building up of the skeletons of the giant *Dinornithidæ* and many other of the perished forms of the gigantic sloths, armadilloes, and mastodons of South America, Australia, and Europe. He was himself a colossal worker, and he never worked for popularity. He had lived and worked too long before the Victorian age to accept readily the doctrines which have revolutionised that science, though none has had a larger share in accumulating the facts, the combination of which of necessity produced that transformation. But, though he clung fondly to his old idea of the archetype, no man did more than Owen to explode the rival theories of both Wernerians and Huttonians, till the controversies of Plutonians and Neptunians came to us from the far past with as little to move our interest as the blue and green controversies of Constantinople.

Nor can we forget that it is to Sir Richard's indomitable perseverance that we owe the magnificent palace which contains the national collections in Cromwell Road. For many years he fought the battle almost alone. His demand for a building of two stories, covering five acres, was denounced as audacious. The scheme was pronounced foolish, crazy, and extravagant; but, after twenty years' struggle, he was victorious, and in 1872 the Act was passed which gave not five, but more than seven acres for the purpose. Owen retired from its direction in 1883, having achieved the crowning victory of his life. Looking back in his old age on the scientific achievements of the past, he fully recognised the prospects of still further advances, and observed, "The known is very small compared with the knowable, and we may trust in the Author of all truth, who, I think, will not let that truth remain for ever hidden."

I have endeavoured to show that there is still room for all workers, that the naturalist has his place, though the morphologist and the physiologist have rightly come into far greater prominence, and we need not yet abandon the field-glass and the lens for the microscope and the scalpel. The studies of the laboratory still leave room for the observations of the field. The investigation of muscles, the analysis of brain tissue, the research into the chemical properties of pigment, have not rendered worthless the study and observation of life and habits. As you cannot diagnose the Red Indian and the Anglo-Saxon by a comparison of their respective skeletons or researches into their muscular structure, but require to know the habits, the language, the modes of thought of each; so the mammal, the bird, and even the invertebrate, has his character, his voice, his impulses, aye, I will add, his ideas, to be taken into account in order to discriminate him. There is something beyond matter in life, even in its lowest forms. I may quote on this the caution uttered by a predecessor of mine in this chair (Prof. Milnes Marshall): "One thing above all is apparent, that embryologists must not work single-handed; must not be satisfied with an acquaintance, however exact, with animals from the side of development only; for embryos have this in common with maps, that too close and too exclusive a study of them is apt to disturb a man's reasoning power."

The ancient Greek philosopher gives us a threefold division of the intellectual faculties—φρόνησις, ἐπιστήμη, σύνεσις—and I think we may apply it to the subdivision of labour in natural science: φρόνησις, ἡ τὰ καθ' ἕκαστα γνωρίζουσα, , is the power that divides, discerns, distinguishes—*i.e.* the naturalist; σύνεσις, the operation of the closest zoologist, who investigates and experiments; and ἐπιστήμη, the faculty of the philosopher, who draws his conclusions from facts and observations.

The older naturalists lost much from lack of the records of previous observations; their difficulties were not ours, but they went to nature for their teachings rather than to books. Now we find it hard to avoid being smothered with the literature on the subject, and being choked with the dust of libraries. The danger against which Prof. Marshall warns the embryologist is not confined to him alone; the observer of facts is equally exposed to it, and he must beware of the danger, else he may become a mere materialist. The poetic, the imaginative, the emotional, the spiritual, all go to make up the man; and if one of these is missing, he is incomplete.

I cannot but feel that the danger of this concentration upon one side only of nature is painfully illustrated in the life of our great master, Darwin. In his early days he was a lover of literature, he delighted in Shakespeare and other poets; but after years of scientific activity and interest, he found on taking them up again that he had not only grown indifferent to them, but that they were even distasteful to him. He had suffered a sort of atrophy on that side of his nature, as the disused pinions of the Kakapo have become powerless—the spiritual, the imaginative, the emotional, we may call it.

The case of Darwin illustrates a law—a principle we may call it—namely, that the spiritual faculty lives or dies by exercise or the want of it even as does the bodily. Yet the atrophy was unconscious. Far was it from Darwin to ignore or depreciate studies not his own. He has shown us this when he prefixed to the title-page of his great work the following extract from Lord Chancellor Bacon: "To conclude, therefore, let no man, out of a weak conceit of sobriety, or an ill-applied moderation, think or maintain that a man can search too far, or be too well studied in the book of God's word, or in the book of God's works, divinity or philosophy, but rather let men endeavour an endless progress or proficience in both." In true harmony this with the spirit of the father of natural history, concluding with the words, "O Lord, how manifold are Thy works, in wisdom hast Thou made them all, the earth is full of Thy riches."

SECTION G.

MECHANICAL SCIENCE.

OPENING ADDRESS BY JEREMIAH HEAD, M.INST.C.E., PAST PRES.INST.MECH.E., F.C.S., PRESIDENT OF THE SECTION.

THIS Section of the British Association for the Advancement of Science was founded with the object of making more widely known, and more generally appreciated, all well-ascertained facts and well-established principles having special reference to mechanical science.

As President of the Section for the year, it becomes my duty to inaugurate the proceedings by addressing you upon some portion of the scientific domain to which I have referred, and in which your presence here indicates that you are all more or less interested.

Mechanical Science.

The founders of the British Association no doubt regarded the field of operations which they awarded to Section G as a not less purely scientific one than those which they allotted to the other Sections. And indeed, mechanical science studied, say, by Watt was as free from suspicion of commercial bias as chemical science studied, say, by Faraday.

But whatever may have been the original idea, the practice of the Section has recently been to expend most of its available time in the consideration of more or less beneficial applications of mechanical science, rather than of the first principles thereof. Our Section has become more and more one of applied rather than of pure science. None of the other Sections is free from this fault, if fault it be (which I do not contend or admit), but Section G seems to me to be beyond all question, and beyond all others, the Section of applied science.

The charter of the Institution of Civil Engineers commences by reciting that the object of that society is "the general advancement of mechanical science, and more particularly for promoting the acquisition of that species of knowledge which constitutes the profession of a civil engineer, being the art of directing the great sources of power in nature for the use and convenience of man."

It seems that in 1828, when the Institution was incorporated, the term "mechanical science" had a wider meaning than it is now usually understood to have. For, according to the charter, the art of directing the great sources of power in nature is only a particular species of knowledge which "mechanical science" includes.

In 1836, or eight years later, the founders of our Section adopted the term without again defining it. Probably they accepted the careful definition of the Great George Street Institution. Time has shown the wisdom of that decision. For we civil engineers and other frequenters of Section G in active practice need far more knowledge than mechanical science can teach us in the ordinary or narrow sense of the term. Our art in its multifarious branches requires, if success is to be attained, the acquisition and application of almost all the other sciences which belong to the fields of research relegated to the other Sections. For how could the gigantic engineering structures of modern times be designed without recourse to mathematics, or steam and other motors without a knowledge of physics, or modern metallurgical operations be conducted without chemistry, or mining without geology, or communications by rail, ship, and wire be established and carried on with all parts of the world without attention to geography, or extensive manufacturing enterprises be developed if the laws of economics were neglected?

As to biological studies, they seem at first sight to have but little to do with mechanical science. It might even be thought that the civil engineer could afford altogether to neglect this part of the work of the Association. But I trust I shall be able to show you before I finish that any such view is absolutely untenable.

Mechanisms in Nature.

Indeed, I hope, in the course of this address, to satisfy you that mechanical science is largely indebted to mechanisms as they exist in nature, if not for its origin, at all events for much of its progress hitherto, and that nature must still be our guide.

Mechanical science has been built up entirely upon observation and experiment, and the natural laws which have been induced therefrom by man. The lower animals in their wild condition work with tools or appliances external to their bodies to but a very slight extent, and man in a primitive or savage state does the same. But many, if not most, animals can be taught to use mechanisms if carefully trained from infancy. Thus, the well-known donkey at Carisbrooke Castle draws water from a deep well by a treadmill arrangement just as well as a man could do it. He watches the rope on the barrel till the full pail rises above the parapet of the well, then slacks back a little to allow it to be rested thereon, and only then leaves the drum and retreats to his stable. But, according to his attendant, four years were needed for his education, and unless it had been commenced early it would have been useless.

I have seen a canary gradually lift from a little well, situated a foot below its perch, a thimble full of water by pulling up with its beak, bit by bit, a little chain attached to it, and securing each length lifted with its foot till it could take another pull. When the thimble reached its perch level the bird took a drink, and then let it fall back into the well. Numerous other examples will doubtless occur to you.

But though animals can be taught to make use of mechanical appliances provided for them—a fact which shows the existence in their brains of a faculty corresponding in kind, if not in degree, to the mechanical faculty in man—they rarely, on their own initiative, make use of anything external to their bodies as tools; and still more rarely, if ever, do they make, alter, or adapt such mechanical aids. Mr. C. Wood, of Middlesbrough, informs me that certain crows which frequent oyster-beds on the coast of India, wait until the receding tide uncovers the oysters, which still remain open for a time. A crow will then put a pebble inside one, and, having thus gagged it and secured its own safety, will proceed to pick it out and eat it at leisure. A monkey will crack a nut between two stones, and will hurl missiles at his enemies. But in some countries he is systematically entrapped by tying to a tree a hollow gourd containing rice, and having a hole large enough for his hand, but too small for his clenched fist, to pass through. He climbs the tree and grasps the rice, and remains there till taken, being too greedy, and not having sufficient sense, to let go the rice and withdraw his hand.

This is on a par with the snuff-taking imbecile, described by Hugh Miller ("My Schools and Schoolmasters)," whom the boys used to tease by giving him a little snuff at the bottom of a deep tin box. The imbecile would try to get at it for hours without the idea ever occurring to him that he might achieve his object by turning the box upside down.

All animals are, however, in their bodily frames, and in the intricate processes and functions which go on continuously therein, mechanisms of so elaborate a kind that we can only look and wonder and strive to imitate them a little here and there. The mechanism of their own bodily frames is that with which the lower animals have to be content, and whilst they are in the prime of life and health, and in their natural environment, it is generally sufficient for all their purposes. Man has a still more perfect, or rather a still more versatile bodily mechanism, and one which in a limited environment would be equally sufficient for his needs. But he has also an enterprising and powerful mind which impels him to strive after and enables him to enjoy fields of conquest unknown to, and uncared for by, the relatively brainless lower animals.

Urged on by these superior mental powers, man must soon have perceived that by the use of instruments he could more quickly and easily gain his ends, and he would not be long in discovering that certain other animals, such as the ox and the horse, were teachable and his willing slaves, provided only he fed and trained them, and treated them kindly.

First, in common with other animals, he would find out that stones and sticks were of some use as weapons and tools; then he would go further and utilise skins and thongs for clothing and harness; and by selecting and modifying his stones and sticks he would form them into rough implements, which would enable him to cut down trees and to make rude huts and boats. Animals caught and domesticated would first be taught to haul light logs along the ground, then to move heavier ones on rollers; and later, in order to avoid the necessity for continual replacement on the rollers, the wheel and axle would be gradually developed.

The mechanical nomenclature of all languages is largely derived from the bodies of men and other animals. From this it is clear that animals have always been recognised as mechanisms, or as closely related thereto. The names borrowed from them generally indicate a resemblance in form rather than in function, though not invariably so.

Thus in our own language we have the "head" of a ship, a river, a lake, a jetty, a bolt, a nail, a screw, a rivet, a flight of stairs, and a column of water; the brow of an incline; the crown of an arch; the toe of a pier; the foot of a wall; the forefoot, heel, ribs, waist, knees, skin, nose, and dead eyes of a ship; also turtle backs and whale backs; the jaws of a vice: the claws of a clutch; the teeth of wheels; necks, shoulders, eyes, nozzles, legs, ears, mouths, lips, cheeks, elbows, feathers, tongues, throats, and arms; caps, bonnets, collars, sleeves, saddles, gussets, paddles, fins, wings, horns, crabs, donkeys, monkeys, and dogs; flywheels, running nooses, crane necks, grasshopper engines, &c.

Not only has our mechanical nomenclature been largely taken from animals, but many of our principal mechanical devices have pre-existed in them. Thus, examples of levers of all three orders are to be found in the bodies of animals. The human foot contains instances of the first and second, and the forearm of the third order of lever. The patella, or knee-cap, is practically a part of a pulley. There are several hinges and some ball-and-socket joints, with perfect lubricating arrangements. Lungs are bellows, and the vocal organs comprise every requisite of a perfect musical instrument. The heart is a combination of four force-pumps acting harmoniously together. The wrist, ankle, and spinal vertebræ form universal joints. The eyes may be regarded as double-lens cameras, with power to adjust focal length, and able, by their stereoscopic action, to gauge size, solidity, and distance. The nerves form a complete telegraph system with separate up and down lines and a central exchange. The circulation of the blood is a double-line system of canals, in which the canal liquid and canal boats move together, making the complete circuit twice a minute, distributing supplies to wherever required, and taking up return loads wherever ready without stopping. It is also a heat-distributing apparatus, carrying heat from wherever it is generated or in excess to wherever it is deficient, and establishing a general average, just as engineers endeavour, but with less success, to do in houses and public buildings. The respiratory system may be looked upon as that whereby the internal ventilation of the bodily structure is maintained. For by it oxygen is separated from the air and imparted to the blood for conveyance and use where needed, whilst at the same time the products of combustion are extracted therefrom and discharged into the atmosphere.

Mastication, which is the first process in the alimentary system, is, or rather should be, a perfect system of cutting up and grinding, and to assist and save animal, and especially human, mastication is the chief aim and object of all the gigantic milling establishments of modern times. The later alimentary processes are rather chemical than mechanical, but still the successive muscular contractions, whereby the contents of the canal are forced through their intricate course, are distinctly mechanical, and may have suggested the action of various mechanisms which are used in the arts to operate on plastic materials, and cause them to flow into new forms and directions.

The superiority of man to the lower animals can only have become conspicuous and decided when he began to use his inventive faculties and to fashion weapons and implements of a more efficient kind than the sticks and stones which they also occasionally use.

But human races and individuals were never equally endowed by nature. Some individuals would have greater inventive powers than others, and these and their posterity would gradually become dominant races. Large masses of mankind are still more or less in the position of primeval man, which, if we accept the conclusions of Darwin, Lubbock, and other modern men of science, we must regard as one of barbarism. For they are still without tools, appliances, and clothes, except of the most elementary kinds, and mechanical science might almost be non-existent, so far as they are concerned.[1]

It would obviously be impossible for me to treat of or call attention even to an infinitesimal extent to the results of mechanical science which surround us now so profusely, and which make our life so different from that of primeval man; and, even if it were possible, it would be quite unnecessary. We have all grown up in a mechanical age. We are so familiarised with artificial aids that we have come to regard them as part of our natural environment, and their occasional absence impresses us far more than their habitual presence.

I propose, with your leave, to proceed to the consideration of how far man is, in his natural condition, and has become by aid of mechanical science, able to compete successfully with other and specially endowed animals, each in its own sphere of action.

Bodily Powers of Man and other Animals.

The bodily frame of man is adapted for life and movement only on or near to the surface of the earth. Without mechanical aids he can walk for several hours, at a speed which is ordinarily from 3 to 4 miles per hour. Under exceptional circumstances he has accomplished over 8 miles ("Whitaker's Almanack," 1893, p. 395) in one hour, and an average of

[1] Mr. H. L. Lapage, M.Inst.C.E., who has just returned from Western Australia, states that he found the natives of both sexes and all ages absolutely nude.

$2\frac{3}{4}$ miles per hour for 141 hours.[1] In running he has covered about $11\frac{1}{2}$ miles in an hour. In water he has proved himself capable of swimming 100 yards at the rate of 3 miles per hour, and 22 miles at rather over 1 mile per hour. He can easily climb the most rugged mountain path and descend the same. He can swarm up a bare pole or a rope, and when of suitable physique and trained from infancy can perform those wonderful feats of strength and agility which we are accustomed to expect from acrobats. He has shown himself able to jump as high as 6 feet $2\frac{3}{4}$ inches from the ground, and over a horizontal distance of 23 feet 3 inches, and has thrown a cricket-ball as far as $382\frac{1}{2}$ feet before it struck the ground. (*Chambers' Encyclopædia*, "Athletic Sports.")

The attitude and action of a man in throwing a stone or a cricket-ball, where he exerts a considerable force at several feet from the ground, to which the reaction has to be transmitted and to which he is in no way fastened, are unequalled in any artificial machine. The similar but contrary action of pulling a rope horizontally, as in "tug of war" competitions, is equally remarkable.

So also the power of the living human mechanism to withstand widely diverse and excessive strains is altogether unapproachable in artificial constructions. Thus, although fitted for an external atmospheric pressure of about 15 lbs. to the square inch, he has been enabled, as exemplified by Messrs. Glaisher and Coxwell in 1862, to ascend to a height of seven miles, and breathe air at a pressure of only $3\frac{1}{2}$ lbs. per square inch, and still live. And, on the other hand, divers have been down into water 80 feet deep, entailing an extra pressure of about 36 lbs. per square inch, and have returned safely. One has even been to a depth of 150 feet, but the resulting pressure of 67 lbs. per square inch cost him his life. (*Pall Mall Gazette*, July 5, 1893, p. 8.)

Recent fasting performances (if the published records are to be trusted) are not less remarkable when we are comparing the human body as a piece of mechanism with those of artificial construction. For what artificial motor could continue its functions forty days and nights without fuel, or, if the material of which it was constructed were gradually consumed to maintain the flow of energy, could afterwards build itself up again to its original substance?

These and other performances are, when considered individually and separately, often largely exceeded by other animals specially adapted to their own limited spheres of activity. The marvel is not, therefore, that the human bodily mechanism is capable of any one kind of action, but that, in its various developments, it can do all or any of them, and also carry a mind endowed with far wider powers than any other animal.

Animals other than man are also adapted for life and movement on or about the surface of the earth. This includes a certain distance below the ground, as in the case of earthworms; under the water, as in the case of fish; on the water, as in the case of swimming birds; and in the air, as with flying birds.

As far as I know, no animal burrows downwards into the earth to a greater depth than 8 feet ("Vegetable Mould and Earthworms," by Charles Darwin, p. 111), and then only in dry ground. Man is naturally very ill-adapted for boring into the earth as the earthworm does. Indeed, without mechanical aids he would be helpless in excavating or in dealing with the accumulations of water which are commonly met with underground. But by aid of the steam-engine for pumping, for air-compressing, ventilating, hauling, rock-boring, electric lighting, and so forth, and by the utilisation of explosives, he has obtained a complete mastery over the crust of the earth and its mineral contents, down to the depth where, owing to the increase of temperature, the conditions of existence become difficult to maintain.

I have said that on land, man, unaided by mechanism, has been able to cover about $11\frac{1}{2}$ miles in one hour. Two miles he has been able to run at the rate of nearly 13 miles per hour, and 100 yards at the rate of over 20 miles per hour. (*Chambers' Encyclopædia*, "Athletic Sports.") But the horse, though he cannot walk faster than man, nor exceed him in jumping heights or distances, can certainly beat him altogether when galloping or trotting. A mile has been galloped in 103 seconds, equal to 35 miles per hour; and has been trotted in 124 seconds, equal to 29 miles per hour. (*Chambers' Encyclopædia*, "Horse.")

There are many other animals, such as ostriches, greyhounds, antelopes, and wolves, which run at great speeds, but reliable records are difficult to obtain, and are scarcely necessary for our present purpose.

[1] Recent pedestrian race from Berlin to Vienna.

Mechanical Aid without Extraneous Motive-power.

Let us now consider how man's position as a competitor with other animals in speed is affected by his use of mechanical aids, but without any extraneous motive-power.

Locomotion on Land.—Where there is a stretch of good ice, and he is able to bind skates on his feet, he can thereby largely augment his running speed. This was exemplified by the winner of the match for amateurs at Haarlem last winter, who accomplished the distance of 3·1 miles at the rate of about 21 miles per hour.

But the most wonderful increase to the locomotive power of man on land is obtained by the use of the modern cycle. Cycling is easily performed only where roads, wind, and weather are favourable. But similar conditions must also be present to secure the best speed of horses, with which we have been making comparison. One mile has been cycled at the rate of 27·1 miles per hour ("Whitaker's Almanack," 1893), 50 at 20, 100 at 16·6 (*Chambers' Encyclopædia*, "Cycling"), 388 at 12·5 (*Times*, September 26 to October 7, 1892), and 900 at 12·43 ("Whitaker's Almanack," 1893), miles per hour.

The recent race between German and Austrian cavalry officers on the high road between Vienna and Berlin has afforded an excellent opportunity to judge of the speed and endurance of horses as compared with men over long distances. Count Starhemberg, the winner, performed the distance, about 388 miles, in 71·33 hours, equal to 5·45 miles per hour. He rested only one hour in twelve. His horse, though successful, has since died. (Vienna Berlin Race, June, 1893.)

Lawrence Fletcher cycled, also along the high roads, from Land's End to John o' Groat's house, 900 miles, in 72·4 hours, equal to 12·43 miles per hour, or more than double the distance that the Count rode, and at above double the speed. To the best of my knowledge he still lives, and is no worse for his effort. The horse in this case would have to carry extra weight equal to one-sixth of his own, and the cyclist equal to a quarter of his own. But the horse carried himself and his rider on his own legs, while the cyclist made his machine bear the weight of itself and rider. Herein was probably the secret of his easy victory.

With the very remarkable exception of long-distance cycling, which is of limited application, man, relying on his own bodily strength, cannot successfully compete with other animals which, like the horse, are specially fitted for rapid land locomotion. His only alternatives are either to utilise the horse and ride or drive him, and so get the benefit of his superior strength and speed, or to use his own inventive faculty and construct appliances altogether apart from animal mechanisms. In either case he virtually gives up the contest as a self-moving animal, and to a great extent abandons himself to be carried by others or by inanimate machinery.

Nearly seventy years ago mankind came to this conclusion, and the modern railway system is the result. The locomotive will go at least double the speed of the race-horse. It will carry not only itself, but three or four times its own weight in addition, and will go, not two or three, but 100 miles or more without stopping, if only the road ahead be clear. And the iron horse is fed and controlled without even so much exertion as that put forth by a man on a horse of flesh and bone.

Locomotion in Water.—Let us now consider the powers of man relatively to other animals in moving upon and through the great waters with which three-fourths of the earth's surface is covered. Here he is in competition with fishes, aquatic mammals, and swimming birds.

I have already stated that, unaided by mechanism, he has shown himself able to swim for short distances at the rate of three, and long distances (22 miles) at the rate of one mile per hour. He has also given instances of being able to remain under water for $4\frac{1}{2}$ minutes. ("Whitaker's Almanack," 1893.)

Credible eye-witnesses inform me that porpoises easily overtake and keep pace with a steamer going $12\frac{1}{2}$ knots, or, say, over 14 miles per hour, for an indefinite length of time. This is five and fifteen times the maximum swimming speed of a man for short and long distances respectively. No doubt the form and surface of a fish, whose main business is swimming, offer less resistance, and his muscular power is more concentrated and better applied towards propulsion in water than is the case with man, whose body is also adapted for so many other purposes.

I am further informed by Mr. Nelson, of Redcar, a naturalist who has made the experiment, that it is impossible for an ordinary sea-boat rowed by two men, and going at five miles per hour, to overtake the aquatic bird called the Great Northern Diver, when endeavouring to make his escape by alternately swimming on the surface and diving below. His speed is therefore nearly double the short and five times the long distance speed of unaided man in water. As regards remaining under water, fishes properly so-called have unlimited powers, and even aquatic mammals, such as whales, can remain under for 1½ hours.

Using only his own strength, but assisting himself with mechanical devices, man has been able to increase considerably his speed as a swimming animal. Mr. John McCall, of Walthamstow, informs me that in 1868 he constructed and repeatedly used an apparatus which acted like the tail of a fish. It consisted of a piece of whalebone, having a broad yet thin and elastic blade, tapering into a shank like the end of an oar. The blade was 15 inches wide and 4 feet long, including the shank. To the end of the latter a horizontal cross-bar 13 inches long was fitted, and leather pockets were provided at the ends for the feet. By swimming on his back and striking out alternately with his legs, he was able, with the assistance of this apparatus, to keep up with a sea-boat pulled by two men at about 4 miles per hour.

By means of boats, which he propels by oars or sculls, and notwithstanding the increased weight, and therefore displacement, involved by them, man has been able to increase his speed on the surface of the water to a maximum of about 12 miles per hour for about 4 miles distance, under favourable circumstances. So, by supplementing his bodily powers by means of mechanical aids, such as the diving-bell and the diving-helmet, dress, and air-pump, or by the portable self-acting apparatus used with such good effect in the construction of the Severn tunnel, man has been able to approach very nearly to the natural diving powers of, at all events, aquatic mammals, except that he cannot move about in subaqueous regions with anything approaching their ease and celerity.

Invariably on water, as almost invariably on land, man is quite unable to compete in power of locomotion with other specially adapted animals, whether or not he avails himself of mechanical aids, so long as his own bodily strength is the only motive-power he employs. He has gradually come to recognise this fact, and to see that he must use this inventive faculties and find new and powerful motors external to himself if he would really claim to dominate the great waters of the earth.

The fastest mechanism of any size, animal or man-made, which, as far as I know, has ever cut its way through the waters for any considerable distance is the torpedo-boat, *Ariete*, made by Messrs. Thornycroft and Son, of London, in 1887. It has a displacement or total weight of about 110 tons, and machinery capable of exerting 1290 effective horse-power, or 11·7 horse-power per ton of weight or displacement; or, to put it in another form, an effective horse-power is by it obtained from a weight of 191 lbs., which includes vessel, machinery, fuel, stores, and attendants. The speed accomplished at the trials of this little craft, being the average of six one-mile tests, was 26·18 knots, or 30·16 miles per hour (*Engineering*, July 15, 1887). As might be expected, it resembles a fish, in that its interior is almost exclusively devoted to the machinery and accessories necessary for propulsion. During the trials the water, fuel, stores, and other ponderable substances carried amounted to 17·35 tons. Two similar boats were able to make the voyage to South America by themselves, though at much lower speed and replenishing their fuel on the way. No fish or swimming bird can match this performance. And inasmuch as 191 lbs. of dead weight produced 1 horse-power, as compared with from 150 to 250 lbs. in certain flying birds, it would seem that with suitable adaptations the *Ariete* might even have been made to navigate the air instead of the water.[1] But I will revert to this subject later on.

Where safety in any weather, and passenger and cargo carrying powers are aimed at, as well as, or prior to, the utmost attainable speed—and these must ever be the leading features of ocean-transit steamers if they are to attain commercial success—there I must refer you to those magnificent examples of naval architecture which are more or less familiar to you all, and of which we, as a maritime nation, are so justly proud. If, for example, we turn our attention for a moment to the new Cunard liners, the *Campania* and *Lucania*, having each a weight or displacement of 18,000 tons and 24,000 effective horse-power, or 1·33 horse-power per ton of displacement, we shall find that, with the commercial advantages alluded to, they obtain a maximum speed of 22·5 knots, or about 26 miles per hour.

If, instead of 1·33 effective horse-power per ton of displacement, they were provided with eight times that amount, or 10·64 horse-power per ton, thereby sacrificing passenger and cargo accommodation and making them nearly as full of propelling machinery as the *Ariete* torpedo-boat, and if it were then found possible to apply this enormous power effectively, then there is every reason to believe they would accomplish for short distances double the speed, or, say, 45 knots, or about 52 statute miles per hour.

By inventing and utilising mechanical contrivances entirely independent of his own bodily strength, man can now pass over the surface of the waters at the rate of over 500 knots per day, and at the same time retain the comforts and conveniences of life as though he were on shore. He has in this way beaten the natural and specially fitted denizens of the deep in their own element, as regards speed and continuity of effort. But he is still behind them as to safety. We do not find that fishes or aquatic mammals often perish in numbers, as man does, by collisions in fogs, or by being cast on lee shores and rocks by stress of weather. Shall we ever arrive at the point of making ocean travelling absolutely safe? The Cunard Company is able to boast that from its commencement, fifty-three years ago, it has never lost a passenger's life or a letter, a statement which gives ground for hope that almost absolute safety is attainable. But, on the other hand, other owners of almost equal repute (not excluding the British Admiralty) are ever and anon losing magnificent vessels on rocks, in collisions, by fire, and even by stress of weather, in a way which makes us doubt whether it is possible for Britannia or any one else really to "rule the waves."

In one way the chances of serious disaster have been of late largely diminished, and here, again, Nature has been our teacher. The bodies of all animals except the very lowest are symmetrically formed on either side of a central longitudinal plane. Each important limb is in duplicate, and if one side is wounded the other can still act. We have at last found out the enormous advantage and increased safety of having the whole of our ship-propelling machinery in duplicate, and our ships made almost unsinkable by one longitudinal and numerous transverse bulkheads.

Locomotion in Air.—I now come to consider what is the position of man as regards locomotion in and through the great atmospheric envelope which surrounds the earth, in comparison with animals specially fitted by Nature for such work.

Nature seems never to bestow all her gifts on one individual or class of animals, and she never leaves any entirely destitute. For instance, the serpent, having no limbs whatever, would seem at first sight to be terribly handicapped; yet, in the language of the late Prof. Owen, "it can out-climb the monkey, out-swim the fish, out-leap the jerboa, and, suddenly loosing the close coils of its crouching spiral, it can spring in the air and seize the bird on the wing." (Pettigrew on "Animal Locomotion"). Here we have the spiral spring in nature before it was devised by man.

Flying animals seem to conform remarkably to this law. Thus we have birds like the penguin, which dive and swim but cannot fly; others, like the gannet, which dive, swim, fly, and walk; others, like the ostrich, which run, but can neither fly nor swim; and numberless kinds which can fly well, but have only slight pedestrian powers.

Man, unaided by mechanism, can, as we have seen, walk, run, swim, dive, and jump, and perform many remarkable feats; but for flying in the air he is absolutely unfitted. All his attempts (and there have been many) have up to the present been unsuccessful, whether or not he has availed himself of mechanical aids to his own bodily powers. It is said that a certain man fitted himself with apparatus in the time of James VI. of Scotland, and actually precipitated himself from the cliff below Stirling Castle, in sight of the king and his courtiers; but the apparatus collapsed, and he broke his leg, and that was the end of the experiment.

[1] M. Normand, of Havre, is building for the French Government two torpedo-boats, each having a displacement of 125 tons and 2717 effective horse-power, or 21·7 horse-power per ton of displacement. This is equivalent to 1 horse-power per 103 lbs., and is still within the limits of weight permissible for aërial flight. (See *Times*, June 19, 1893.)

But why should not man fly? It is not that he does not desire to do so. For every denizen of our precarious British climate, when he has noticed the ease with which swallows and other migratory birds fly off on the approach of winter, hundreds and even thousands of miles to the sunny south, must have wished he could do the same. One reason why we cannot fly, even with artificial aids, such as wings, is that, as in the case of the penguin or the ostrich, our bodily mechanism is specialised and our muscular power diffused in other directions, so that we could not actuate wings of sufficient area to carry us even if we had them.

M. de Lucy, a French naturalist, has shown that the wing-area of flying animals varies from about 49 square feet per lb. of weight in the gnat, and 5 square feet in the swallow, to half a square foot per lb. of weight in the Australian crane, which weighs 21 lbs. and yet flies well. If he were to adopt the last or smallest proportion, a man weighing 12 stone would require a pair of wings each of them 14 feet long by 3 feet broad, or double the area of an ordinary room door, to carry him, without taking into account the weight of the wings themselves.

In flying birds there is a strong tripod arrangement to secure firm points of attachment for the wings, and a deep keel in the breast-bone, to which the large pectoral muscles are secured. Think of the wings I have described and the absence of pivots, keel, and muscles in man, and it will be tolerably obvious why he cannot fly, even with artificial wings.

But it might be contended that a man's strength is in his legs rather than in his arms, and that it is conceivable that a successful flying-apparatus might be made if adapted for the most, instead of the least, favourable application of his bodily strength.

According to D. K. Clark ("Rules, Tables, and Data," pp. 719 and 720), a labourer working all day exerts on an average ·13 horse-power. The maximum power of a very strong man for a very short time is ·46 horse-power.

According to Dr. Haughton ("Animal Mechanics"), the oarsmen in a boat-race of 1 mile, rowed in 7 minutes, exerted each ·26 horse-power.

Suppose we take the rowing case as the maximum maintainable for, say, 7 minutes, by a man weighing 168 lbs. Then in flight he would have to sustain a weight of

$$\frac{168}{\cdot 26} = 646 \text{ lbs.}$$

per horse-power exerted, besides the weight of the apparatus.

Now, we shall find later that no birds support even half that weight per horse-power which they have the power to exert, and that recent aëroplane experiments prove its impossibility. On the ground, therefore, that he is too heavy in proportion to his strength, it is clear that man is unfitted for flight, as well as because his limbs are not adapted for it.

It does not follow, however, that by aid of mechanisms apart from his own body, and worked by power independent of his own strength, man may not imitate, compete with, and even outdo the fowls of the air.

Let us consider a few facts showing what birds can do. A gannet hovers in the air above the sea. Suddenly he nearly closes his wings, swoops down, and with a splash disappears below the surface. Shortly after he reappears with a fish in his mouth, which he swallows in a few gulps; then, after swimming on the surface a little, he reascends into the air to repeat the operation.

The swallow rises into the air with a few rapid movements of the wings, then slides down as though on an aërial switchback, and then up again till he nearly reaches his original height, or he circles round by raising one wing, like a runner rounding a curve.

The condor vulture, which measures sometimes 15 feet across the wings, will fly upwards till quite out of sight.

A flock of cranes have been seen migrating at a height of three miles, and proceeding apparently without any movement of the wings.

The peregrine falcon will swoop down upon a partridge, and, missing it by a doubling movement of the latter, will slide upwards, thus converting his kinetic into new potential energy. He will then turn and descend again, this time securing his prey.

Mr. J. E. Harting, one of the principal British ornithological authorities, has, after careful investigation, arrived at the conclusion that the speed of falcons in full flight is about 60 miles per hour. (*Field*, December 5, 1891, p. 856).

Mr. W. B. Tegetmeier, another well-known authority, gives (*Field*, January 22, 1887, p. 114) the results of a number of experiments on the speed of homing pigeons made under the auspices of the United Counties Flying Club in 1883. The average speed of the winner in eighteen races was 36 miles, and the maximum 55 miles per hour. The greatest distance flown was 309 miles.

The albatross, the largest web-footed bird, measuring sometimes 17 feet from tip to tip of wing, and weighing up to 20 lbs., frequently accompanies ocean steamers from the Cape to Melbourne, a distance of 5,500 knots, without being seen to rest on the way.

An American naturalist, Mr. J. Lancaster, who spent no less than five years on the west coast of Florida ("Problem of the Soaring Bird," *American Naturalist*, 1885, pp. 1055–1162), in order to study the habits of aquatic and other birds which frequent these shores, arrived at the following conclusions, viz.:—

Though all birds move their wings sometimes, many can remain indefinitely in the air, with wings extended and motionless, and either with or without forward movement. This he calls "soaring."

The wing-area of soaring birds varies from 1 to above 2 square feet per lb. of weight.

The larger the wings per lb. of weight the greater the power to soar.

The heavier the bird the steadier his movements.

Soaring birds always face the wind, which, if they do not move forward or downward, must not blow at a less speed than 2 to 5 miles per hour.

Mr. Lancaster specially watched a flock of buzzards about 30 feet above his head, waiting for him to leave the body of a dead porpoise. Their wings were about 8 feet from tip to tip, and their average weight about 6 lbs. During three hours at mid-day, when the wind which they faced was very strong, they flapped their wings about twenty times each. Later, during two hours, when the wind had subsided, they never moved them at all.

Mr. Lancaster timed frigate birds, and found them able to go at the rate of 100 miles per hour, and that on fixed wings; he is of opinion that at all events up to that speed they can fly just as fast as they please. He says, further, that the same birds can live in the air a week at a time, night and day, without touching a roost, and that buzzards, cranes, and gannets can do the same for several hours at a time.

The observed facts relating to the phenomena of flight are still but very imperfectly understood. That a bird should be able to maintain a downward pressure on the air sufficient to counteract the effect of its own weight, and a backward pressure sufficient to force itself forward at such speeds as I have named, seems wonderful enough when it is known that it continuously operates its wings. But that it should be able to do the same without any muscular movement at all is almost incomprehensible. It seems to be an instance of the suspension of the laws of gravity and of the existence of cause without effect, and of effect without cause. It is not a case of flotation, like a balloon, for any bird falls to the earth like a stone when shot. Mr. Lancaster suggests that the bird's own weight is the force which enables him to counteract the effect thereof, but this explanation is, I confess, beyond my comprehension.

It seems to me that for every pound of his weight pressing downwards there must be an equivalent force pressing upwards. This can be produced only by his giving downward motion to the air previously at rest, or by his arresting previous motion of air in an upward direction. The latter alternative involves the supposition that the air-currents which soaring birds face are not, as Mr. Lancaster believes, always horizontal, but must have, to some extent, an upward direction. If a parachute were falling in a current of air which was moving upwards at the same rate as the parachute fell, it would obviously retain its level, yet gravity would be acting. So, if a bird with extended wings were sliding down a stream of air which was tending upwards at the same angle and same velocity, the phenomenon of soaring would be produced.

Weight of Birds in relation to their Bulk.—It is generally believed that birds are lighter, bulk for bulk, than other animals, and that to this lightness they owe, in some degree, their power of flight and of floating on water. To account for this it is said that their bone-cavities are filled with air, and that some, though not even all, flying birds have small air-sacs under the skin. It is clear, however, that displacement of external air by air-filled cavities can only assist aërial floatation to an infinitesimal extent, unless highly heated. Such cavities would, however, help aquatic birds to swim, if situated under the immersed portion of their bodies, which is not always the case.

Some aquatic birds, such as swans, swim with head, neck, wings, tail, and half their bodies out of the water. The specific gravity of fishes and land animals is clearly about the same as water. For, when swimming, they can keep only a small portion of their heads above the surface, and that by continued exertion. Are, then, birds, in the substance of their bodies, less dense than other animals, although also composed of flesh, blood, and bone, and these components in similar proportions and of similar character and texture? If they are, then land animals might have been made lighter in proportion to their bulk or smaller in proportion to their weight than they have been. If they are not, how is it that some of them can swim and float high out of the water?

Having an opportunity recently of inspecting a large wild, or whooper, swan, I ascertained its weight to be 14 lbs. I noticed that the whole of the under-part of the body, which would be immersed when swimming, was covered with feathers and underlined with down to an average depth of not less than 1½ inches, or, when closely pressed, say 1¼ inches. The immersed surface I estimated at 1½ square feet. The weight of water displaced by this feather and down jacket, and the consequent extra buoyancy produced thereby was no less than 9·78 lbs. This would account for two-thirds of the bird's body being out of water when swimming, even if the body were of the same specific gravity as water.

I next procured a freshly-shot wild duck, which weighed 2½ lbs., and placed it in a tank of sea-water. It floated. I found the area of its immersed surface to be 54 square inches, and the average depth of its under-feathers and down to be ¾ inch. The water displaced by this envelope would weigh 1·5 lbs., and would support three-fifths of its entire weight. I then had it denuded of all its feathers and down, and again placed in the tank. It then slowly sank to the bottom.

These experiments, so far as they go, seem to prove conclusively that birds are not lighter, bulk for bulk, than other animals, but, on the other hand, about the same specific gravity, and that their floating power lies entirely in the thick jacket or life-belt with which nature has furnished those, and those only which are intended to swim.

Inasmuch, therefore, as the specific gravity of the actual bodies of all animals appears to be about the same, there is no reason to believe that any could have been constructed of lighter material or to lighter design.

Weight in Relation to their Energy.—But notwithstanding this uniformity of specific gravity, there remains the curious fact that flying birds can exert continuously about three times the horse-power per lb. of weight that man can—and, indeed, about three times what is possible for the horse. This marvellous flow of energy in proportion to weight is probably due to rapidity of limb-action rather than to increase of muscular stress. I have timed sea-gulls and found them to flap their wings two hundred times per minute when flying at about 24 knots per hour, and have estimated eider-ducks, making about 36 knots per hour, to be flapping their wings five hundred times in a minute. I say "estimated," for their movements are too rapid for precise counting. This outpouring of energy, which seems to me to be unequalled in terrestrial animals, is nevertheless maintained by birds for indefinitely long periods of time.

A proportionately increased rate of combustion and renovation of tissue as well as of food-consumption are necessary consequences. The higher temperature of the bodies of birds, as compared with other animals,[1] and the well-known voracity of those which, like sea-birds, are almost continuously on the wing, are circumstances which seem to point to the same conclusion. It is confirmed by what we know of steam and other motors. For instance, if a steamship were so built and proportioned that a ton of coal per hour consumed in the boilers would maintain the pressure at 100 lbs. per square inch and produce 1000 horse-power at the propeller; and then if, without other alteration, firing was slackened until the steam fell to 50 lbs. per square inch and there maintained, it is clear that the horse-power produced would be greatly lessened, and so would the temperature of the steam in the boilers, steam-pipes, and cylinders. Thus, other things being equal, the temperature of the steam would rise and fall with the energy given forth by the mechanism.

The suggestion is that the higher temperature of birds, as compared with other animals, is similarly connected with their superior power of producing and maintaining energetic effort.

Aërial Navigation.

Let us now consider what man has done, and may be able to do, in aërial navigation by aid of contrivances which, as in the case of railway locomotives and ocean steamers, are propelled by a power other than that of his own body.

The scientific world is greatly indebted to Mr. Hiram S. Maxim, of London, for recording, in a clear and readable form, the present position of aëronautic mechanisms.[1] So far, the only contrivances which have been fairly successful are balloons, which, unlike birds, depend on atmospheric displacement for their power of sustaining weight or rising or falling.

In balloon experiments our French neighbours have led the way, from the first attempt of the Montgolfier brothers in 1783. During the last twenty years they have made numerous experiments and substantial improvements. Captain Renard and other officers of the French army have constructed a fish-shaped apparatus, and inflated it with hydrogen. It is driven by an electric motor of 8½ horse-power, and has sufficient buoyancy to carry two aëronauts and all necessary accessories. In fair weather Captain Renard has succeeded in travelling at the rate of 12½ miles per hour, in steering in any direction, and even in returning to his point of departure. The balloon, it is said, always keeps level, and so far there have not been any accidents; but no expedition has been attempted in wet or windy weather.

Except that a more powerful motor, going at a higher speed, might be fitted to such an apparatus, Mr. Maxim thinks that it is as near perfection as is ever likely to be reached by a machine depending on aërial flotation. He proceeds to give an account of some experiments made by Prof. S. P. Langley, of the Smithsonian Institution, Washington, and of others by himself, to ascertain how much power is required to produce artificial flight by means of aëro-planes, after the manner of birds, and whether such power can be obtained without exceeding the weight which it would itself sustain.

He says that heavy birds, with relatively small wings, carry about 150 lbs. per horse-power exerted, and birds such as the albatross and vulture probably about 250 lbs. Prof. Langley, with small slanting planes, was able to carry 250 lbs. per horse-power exerted; and Mr. Maxim, using heavier weights in proportion to plane-area, 133 lbs. per horse-power, and using lighter ones, nearly the same as Prof. Langley.

Mr. Maxim has lately developed his energies to constructing a motor which should meet the requirements of the case, and has succeeded, he says, in producing one: a steam-engine burning naphtha and with atmospheric condenser, with a total weight of 8 lbs. per horse-power. He thinks, however (*Engineer*, January 13, 1893, p. 28), that by using light naphtha and its vapour in the boiler instead of water, as well as in the furnace as fuel, a weight as low as 5 lbs. per horse-power may be reached.

Meanwhile Prof. Langley's ideas have been embodied in an experimental flying-machine, a drawing and description of which will be found in the *Daily Graphic* for July 1, 1893. The body, which resembles that of a bird and is 15 feet long, contains the propelling machinery in duplicate. The wings, which are 40 feet across, are of China silk spread on a tubular framework, stiffened with wire trusses. The boilers use liquid fuel and contain a highly volatile fluid. The capabilities of the machine have not yet been practically tested.

Promising as are the results hitherto obtained, they are as yet far from placing us on a level with birds in power to utilise the atmosphere as a navigating medium. The absolutely necessary power of delicate guiding, in rising, falling, and turning, whatever the direction or force of the wind, has yet to be considered and worked out. What would happen in case of a temporary breakdown of the aëro-plane machinery we shudder to think of.

An important step has been effected by the discovery that parachutes with tubular orifices at the top are comparatively safe appliances for descending to the earth from indefinitely high altitudes. Perhaps it may be arranged that each aëronaut should

[1] *Chambers' Encyclopædia*, "Bird and Animal Heat"; *Lehrbuch der Zoologie*, by Prof. Hertwig, p. 538.

[1] "Progress in Aërial Navigation," by Hiram S. Maxim, *Fortnightly Review*, October, 1892.

be able, at a moment's warning, to gird himself with one of these as with a life-belt on board ship, and so descend in safety, or one or more automatically opening in case of disaster might be fitted to the aëro-plane as a whole.

Eventual Exhaustion of Fuel Supply.

I have still to refer to one other question, the consideration of which must always give rise to very serious thoughts. We have seen that the decisive victories which, in modern times, man has gained over matter and over other animals have been due to his use of power derived from other than animal sources. That power has invariably proceeded from the combustion and the destruction of fuel, the accumulations of which in the earth are necessarily limited.

Mechanical appliances, involving the consumption of fuel, have, for a century at least, been multiplying with alarming rapidity. Our minds have been set mainly on enlarging the uses and conveniences of man, and scarcely at all on economising the great sources of power in nature, which are now for the most part its fuels. Terrible waste of these valuable stores is daily going on in almost every department of use. Once exhausted they can never be replaced. They have been drawn upon to some extent for 1000 years, and extensively for more than 100. Authorities say that another 1000 years will exhaust all the more accessible supplies. But suppose they last 5000 years—what then? Why, then, as far as we can at present see, our only motive-powers will be wind and water and animals, and our only mode of transit, sailing and rowing, driving, cycling, riding, and walking.

Sir Robert Ball has estimated that in not less than 5,000,000 and not more than 10,000,000 years the sun will have become too cold to support life of any kind on this planet. Between the 5000 years when fuel will certainly be exhausted and the 5,000,000 years when all life may be extinguished, there will still be 4,995,000 years when, according to present appearances, man will have to give up his hardly-earned victories over matter and other animals, and the latter will again surpass him, each in its own element, because he has no fuel.

Conclusion.

Leaving to our posterity these more remote troubles, we may, I think, justly draw from the entire discussion the conclusion that we have still a great deal to learn from mechanisms as they exist in nature. Great as have been the achievements of man since he first began to study mechanical science, with a view to directing the great sources of power in nature for his own use and convenience, the entire field of research is by no means yet fully exhausted. We must continue to study the same science with undiminished ardour. In so doing we shall do well to bear in mind that success can be achieved only by the patient, accurate, and conscientious observation of the great facts of nature, which are equally open to us all and waiting for our attention; and by drawing correct inferences therefrom, and by applying such inferences correctly to the fulfilment of the future needs and destiny of our race.

SECTION H.

ANTHROPOLOGY.

OPENING ADDRESS BY ROBERT MUNRO, M.A., M.D., F.R.S.E., PRESIDENT OF THE SECTION.

THE science of anthropology, in its widest sense, embraces all the materials bearing on the origin and history of mankind. These materials are so comprehensive and diversified, both in their character and methods of study, that they become necessarily grouped into a number of subordinate departments. From a bird's-eye point of view, however, one marked line of demarcation separates them into two great divisions, according as they relate to the structure and functions of man's body, or to the works he has produced—a classification well defined by the words *anthropology* and *archæology*. The former, in its limited acceptation, deals more particularly with the development of man—his physical peculiarities, racial distinctions, linguistic manifestations, mental endowments, and, in short, every morphological or mental modification he has undergone amidst the ever-changing phenomena of his environments. The latter, on the other hand, takes cognisance of man merely as a handicraftsman. During his long journey in past time he has left behind him, scattered on the highways and byways of primeval life, numerous traces of his ways, his works, his culture, and his civilisation, all of which fall to be collected, sorted, and interpreted by the skilled archæologist. In their general aspects and relationship to each other most of the leading subjects in both these branches of the science have already been expounded, in the presidential addresses of my predecessors, by men so distinguished in their respective departments that they have left little to be said by anyone who attempts to follow in their footsteps. There is, however, one phase in the progressive career of man which has not hitherto been so fully illustrated as the subject appears to me to merit. I refer to the direct and collateral advantages which the erect position has conferred on him; and to this I will now briefly direct your attention, concentrating my observations successively on the following propositions:—

(1) The mechanical and physical advantages of the erect position.

(2) The differentiation of the limbs into hands and feet.

(3) The relation between the more perfect condition of these organs and the development of the brain.

In the process of organic evolution it would almost appear as if nature acted on teleological principles, because many of her products exhibit structures which combine the most perfect adaptation of means to ends along with the greatest economy of materials. This is well exemplified in some of the structural details of the organs of locomotion in which many of the so-called mechanical powers may be seen in actual use. The primary object of locomotion was to enable the organism to seek its food over a larger area than was attainable by a fixed position. The acquisition of this power was manifestly so advantageous to animal life that the principles by which it could be effected became important factors in natural selection. I need not here dwell on the various methods by which this has been accomplished in the lower forms of life, but proceed at once to point out that in the higher vertebrates the problem resolved itself into the well-known mechanism of four movable limbs, capable of supporting and transporting the animal. As these quadrupedal animals became more highly differentiated, in virtue of the necessities of the struggle for life and the different and ever-varying conditions of their surroundings, it followed that the limbs became also modified so as to make them suitable, not only for locomotion in various circumstances, but also useful to the animal economy in other ways. Hence they were subjected to an endless variety of secondary influences, which finally adapted them for such diverse purposes as swimming, flying, climbing, grasping, &c. The anterior limbs, owing to their proximity to the head, were more frequently selected for such transformations as may be seen, for instance, in the wings of a bird. But whatever modifications the fore limbs may have undergone, no animal, with the exception of man, has ever succeeded in divesting them altogether of their primary function. This exceptional result was due to the erect position, which necessitated a complete division of labour as regards the functions of the limbs—the two anterior being entirely restricted to manipulative and prehensile purposes, and the two posterior exclusively devoted to locomotion. Coincident with this notable specialisation of their function a new field for advancement was opened up to man, in which intelligence and mechanical skill became the leading factors in his further development.

Man is thus distinguished from all other animals by the fact that, in the normal position of walking or running, he carries his body upright, *i.e.* with the axis of the vertebral column perpendicular, instead of horizontal or oblique. In this position all its parts are so arranged as to require a minimum amount of exertion in the performance of their functions. If any of the other higher vertebrates should ever assume an erect attitude it can only be maintained temporarily, and its maintenance involves an additional expenditure of force. In a certain sense a bird may be looked upon as a biped, but there is this distinction to be drawn between it and man, viz. that the former has not only its body balanced obliquely on its two legs, but also its fore limbs converted into special organs for motion in the air. The anthropoid apes hold an intermediate position, and so carry their body in a semi-erect attitude. But this shortcoming in reaching the perfectly upright position, however slight it may be in some of these animals, represents a wide gap which can only be fully appreciated by a careful study of the physiological and psychological phenomena manifested in their respective life-functions.

Everyone acquainted with the ordinary operations of daily life knows how much labour can be saved by attention to the mere mechanical principles involved in their execution. In carrying a heavy load the great object is to adjust it so that its centre of gravity comes as nearly as possible to the vertical axis of the body, as otherwise force is uselessly expended in the effort to keep the entire moving mass in stable equilibrium—a principle well exemplified by the Italian peasant girl when she poises her basket of oranges on her head. Once upon a time a powerful waterman, accustomed to use buckets double the size of those of his fellow-watermen, had the misfortune to have one of them broken. As he could not, then and there, get another bucket to match the remaining one, and wishing to make the best possible use of the appliances at hand, he replaced the broken vessel by one half its size. He then filled both with water and attempted to carry them, as formerly, attached to a yoke, one on each side of him. But to his astonishment this arrangement would not work. The yoke became uneven, and the effort to keep it balanced on his shoulders was so troublesome that he could not proceed. This emergency led to serious reflection, but, after some experimental trials, he ascertained that, by merely making the arm of the yoke on which the small bucket was suspended double the length of the other, he could carry both buckets without inconvenience.

But let me take one other illustration. Suppose that two burglars have concocted a plan to rob a richly-stored mansion by getting access to its rooms through the windows of an upper story. In order to carry out this design they secure a ladder, easily transported by the two together though too heavy for one. So, bearing the ladder between them one at each end, they come to the house. After a considerable amount of exertion they succeed in placing the ladder in an upright position against the wall, and then one of the men mounts its steps and enters the house. The man left outside soon realised that, once the ladder was balanced perpendicularly, he himself could then easily control it. Moreover, he made the discovery that by resting its weight on each leg alternately, he could gradually shift its position from one window to another. Thus there was no interruption or limit to the extent of their depredations. Experience quickened their perceptions, and ultimately they became adepts in their respective departments—the one in the art of moving the ladder, and the other in the science of the nimble-fingered gentry. The division of labour thus practised by these two men accurately represents what the attainment of the erect attitude has accomplished for man by setting free his upper limbs from any further participation in the locomotion of his body.

The continued maintenance of this unique position necessitated great changes in the general structure of the body. The solution of the problem involved the turning of the ordinary quadruped a quarter of a circle in the vertical plane, thus placing the axis of the spine perpendicular, and consequently in line with the direction of the posterior limbs; and to effect this the osseous walls of the pelvis underwent certain modifications, so as to bear the additional strain put upon them. Stability was given to the trunk in its new position by the development of special groups of muscles, whose powerful and combined actions render to the movements of the human body their characteristic freedom and gracefulness. The lower limbs were placed as widely apart as possible at their juncture with the pelvis, and the thigh- and leg-bones were lengthened and strengthened so as to be capable of supporting the entire weight of the body and of transporting it with due efficiency when required. The spinal column assumed its well-known curves, and the skull, which formerly had to be supported by a powerful muscle attached to the spinous processes of the cervical vertebræ (*ligamentum nuchæ*), moved backwards until it became nearly equipoised on the top of the vertebral column. The upper limbs, instead of taking part in their original function of locomotion, were now themselves carried as flail-like appendages, in order to give them as much freedom and range of action as possible. The shoulder-blades receded to the posterior aspect of the trunk, having their axes at right angles to that of the spine. Further, like the haunch-bones, they underwent certain modifications, so as to afford points of attachment to the muscles required in the complex movements of the arms. In the pendulous position each arm has its axis at right angles to that of the shoulder, but by a common muscular effort the two axes can be readily brought into line. The elbow-joint became capable of performing the movements of complete extension, flexion, pronation, and supination—in which respects the upper limb of man is differentiated from that of all other vertebrates.

But it is in the distal extremities of the limbs that the most remarkable anatomical changes have to be noted. The foot is virtually a tripod, the heel and the ball of the great toe being the terminal ends of an arch, while the four outer digital columns group themselves together to form the third, or steadying, point. The outer toes thus play but a subordinate part in locomotion, and, as their prehensile function is no longer of use, they may be said to be fast approaching to the condition of rudimentary organs. The three osseous prominences which form this tripod are each covered with a soft elastic pad, which both facilitates progression and acts as a buffer for deadening any possible shock which might arise in the course of running or leaping. The chief movement in the act of progression is performed by an enormously developed group of muscles known as the calf of the leg, so characteristic of man. The walker is thereby enabled to use the heel and the ball of the great toe as successive fulcrums from which the forward spring is made, the action being greatly facilitated by that of the trunk muscles in simultaneously bending the body forwards. The human foot is thus admirably adapted to be both a pillar for supporting the weight of the body, and a lever for mechanically impelling it forwards. Hence the amount of energy expended in progression is reduced to a minimum, and when estimated proportionally to the size of the body it is believed to be considerably less than that requisite for the corresponding act in quadrupeds.

The anatomical changes effected in the extremity of the upper limb are equally radical, but of a totally different character and scope. Here we have to contemplate the transformation of the same homologous parts into an apparatus for performing a series of prehensile actions of the most intricate character, but among which neither locomotion nor support of the body forms any part whatever. This apparatus is the human hand, the most complete and perfect mechanical organ nature has yet produced. The fingers have become highly developed, and can be opposed singly or in groups to the thumb, so as to form a hook, a clasp, or a pair of pincers; and the palm can be made into a cup-shaped hollow, capable of grasping a sphere. Nor is there any limit to the direction in which many of these manipulations can be performed without any movement of the rest of the body. For example, a pencil held by the thumb and the two fore fingers, as in the act of writing, can be placed in all the directions of space by a mere act of volition.

The position of such a perfect piece of mechanism at the extremity of a movable arm attached to the upper part of the trunk, gives to man a superiority in attack and defence over all other animals, on the same principle as a soldier finds it advantageous to fight from higher ground. Moreover, he possesses the power to perform a variety of quick movements, and to assume attitudes and positions eminently adapted for the exercise of that manipulative skill with which he counteracts superior brute force of many of his antagonists. He can readily balance his body on one or both legs, can turn on his heels as if they were pivots, and can prostrate himself comfortably in the prone or supine positions. As the centre of gravity of the whole body is nearly in line with the spinal axis, stable equilibrium is easily maintained by the lumbar muscles. Altogether we have in his physical constitution a combination of structures and functions sufficiently unique in its *tout ensemble* to place man in a category by himself. But at the same time we must not forget that all his morphological peculiarities have been brought about without the destruction of any of the primary and typical homologies common to all the higher vertebrates.

Turning now to the brain, the undoubted organ of the mind, we find in its intellectual and psychical manifestations, a class of phenomena which gives to man's life-functions their most remarkable character. However difficult it may be for our limited understanding to comprehend the nature of conscious sensation, we are forced to the conclusion that the act invariably takes place through the instrumentality of a few nerve-cells, whose functional activity requires to be renovated in precisely the same manner as the muscular force expended in walking. The aggregation of such cells into ganglia and nerves, by means of which reflex action, consciousness, and a variety of psychical phenomena take place, is found to permeate, in a greater or less degree, the whole of the organic world. In the higher vertebrates the seat of these manifestations is almost exclusively confined to an enormous collection of brain substance placed at the upper end of the vertebral column, and encased in a complete osseous covering called the skull. We learn from numerous experimental researches, carried out by physiologists in recent years, that the brain is a dual organ, consisting of a double series of distinct ganglia and connected to some extent by a complex system of nervous tissues, not only with each other, but with the central seat of consciousness and volition. But the difficulty of determining the nature of its functions, and the *modus operandi* of its psychological manifestations, is so great that I must pass over this part of the subject very lightly indeed. The conditions of ordinary reflex-action require that a group of muscles, by means of which a particular bodily movement is effected, shall be connected with its co-ordinating ganglion by an afferent and an efferent system of nerves. Impressions from without are conveyed by the former, or sensory nerves, to the central ganglion, from which an impulse is retransmitted by the motor nerves and sets in operation the muscular force for producing the required movement. But this efferent message is, in many cases, absolutely controlled by volition, and not only can it prevent the muscular action from taking place, but it can effect a similar movement, *de novo*, without the direct intervention of external impressions at all. Now it has been proved experimentally that the volitional stimulus, which regulates the various movements of the body, starts from definite portions of the brain according to the different results to be produced. This localisation of brain functions, though still far from being thoroughly understood, comes very appropriately into use in this inquiry. From it we learn that the homology which characterises the structural elements of the bodies of animals extends also to the component parts of their respective brains. The law which differentiates animals according to the greater specialisation of the functions of their various organs has therefore its counterpart in the brain, and we naturally expect an increase of brain substance in every case in which the functional activity of a specific organ is extended. Thus the act of stitching with a needle and thread, an act beyond the mental and physical capacity of any animal but man, would entail a certain increase of brain substance, simply in obedience to the great complexity of the movements involved in its execution, over and above that which may be supposed to be due to the intellectual and reasoning faculties which invented it.

That man's brain and his intelligence are correlated to each other is a fact too axiomatic to require any demonstration; nor can it be doubted that the relationship between them is of the nature of cause and effect. But to maintain that the amount of the latter is directly proportional to the size of the former is rather straining the laws of legitimate inference. In drawing any general conclusion of this nature from the bulk of brain substance, there are some modifying influences which cannot be disregarded, such, for example, as the amount of cranial circulation and the quality of the brain cells. But the determination of this point is not the exact problem with which the evolutionist is primarily concerned. To him the real crux in the inquiry is to account for the evolution of man's comparatively large brain under the influence of existing cosmic forces. After duly considering this problem, and casting about for a possible explanation, I have come to the conclusion that not only is it the result of natural laws, but that one of the main factors in its production was the conversion of the upper limbs into true hands. From the first moment that man recognised the advantage of using a club or a stone in attacking his prey or defending himself from his enemies, the direct incentives to a higher brain development came into existence. He would soon learn by experience that a particular form of club or stone was more suitable for his purposes; and if the desiderated object were not to be found among the natural materials around him, he would proceed to manufacture it. Certain kinds of stones would be readily recognised as better adapted for cutting purposes than others, and he would select his materials accordingly. If these were to be found only in a special locality, he would visit that locality whenever the prised material was needed. Nor would it be an unwarrantable stretch of imagination to suppose that the circumstances would lead him to lay up a store for future use. These simple acts of intelligence assume little more than may be seen in the actions of many of the lower animals. Consciousness of his power to make and to wield a weapon was a new departure in the career of man, and every repetition of such acts became an effective and ever-accumulating training force. What a memorable event in the history of humanity was the manufacture of the first sharp stone implement! Our sapient ancestor, who first used a spear tipped with a sharp flint, became possessed of an irresistible power over his fellow men. The invention of the bow and arrow may be paralleled with the discovery of gunpowder and the use of cannon, both of which revolutionised the principles of warfare in their respective ages. The art of making fire had a greater influence on human civilisation than the modern discovery of electricity. The first boat was in all probability a log—an idea which might have been suggested by the sight of an animal clinging to a floating piece of wood carried away by a flood. To scoop this log into a hollow boat was an afterthought. The successive increments of knowledge by which a single-tree canoe has been transformed into a first-class Atlantic liner are scattered through the unwritten and written annals of many ages. In his expeditions for hunting, fishing, fruit-gathering, &c., primitive man's acquaintance with the mechanical powers of nature would be gradually extended, and *pari passu* with the increasing range of his knowledge there would be a corresponding development in his reasoning faculties. Natural phenomena suggested reflections as to their causes and effects, and so by degrees they were brought into the category of law and order. Particular sounds would be used to represent specific objects, and these would become the first rudiments of language. Thus each generalisation when added to his previous little stock of knowledge widened the basis of his intellectual powers, and as the process progressed man would acquire some notion of the abstract ideas of space, time, motion, force, number, &c.; and continuous thought and reasoning would ultimately become habitual to him. All these mental operations could only take place through the medium of additional nerve cells, and hence the brain gradually became more bulky and more complex in its structure. Thus the functions of the hand and of the brain have been correlated in a most remarkable manner. Whether the mechanical skill of the hand preceded the greater intelligence of the brain, or *vice versa*, I will not pretend to say. But between the two there must have been a constant interchange of gifts. According to Sir C. Bell, "the hand supplies all instruments, and by its correspondence with the intellect gives him universal dominion." ("The Hand," &c. "Bridgewater Treatise," p. 38.)

That mind, in its higher psychical manifestations, has sometimes been looked upon as a spiritual essence which can exist separately from its material basis need not be wondered at when we consider how the pleasing abstractions of the poet, or the fascinating creations of the novelist, roll out, as it were, from a hidden cavern without the slightest symptom of physical action. It is this marvellous power of gathering and combining ideas, previously derived through the ordinary senses, which gives a *primâ facie* appearance of having here to deal with a force exterior to the brain itself. But indeed it is questionable if such psychological phenomena are really represented by special organic equivalents. May they not be due rather to the power of volitional reflection which summons them from the materials stored up by the various localised portions into which the brain is divided? From this point of view there may be many phases of pure cerebration which, though not the result of direct natural selection, have nevertheless as natural and physical an origin as conscious sensation. Hence imagination, conception, idealisation, the moral faculties, &c., may be compared to parasites which live at the expense of their neighbours. After all the greatest mystery of life lies in the simple acts of conscious sensation, and not in the higher mental combinations into which they enter. The highest products of intellectuality are nothing more than the transformation of previously existing energy, and it is the power to utilise it that alone finds its special organic equivalent in the brain.

But this brings us on controversial ground of the highest importance. Prof. Huxley thus expresses his views on the phase of the argument now at issue:—

"I have endeavoured to show that no absolute structural line of demarcation, wider than that between the animals which immediately succeed us in the scale, can be drawn between the animal world and ourselves; and I may add the expression of my belief that the attempt to draw psychical distinction is equally futile, and that even the highest faculties of feeling and of intellect begin to germinate in lower forms of life." ("Evidences as to Man's Place in Nature," p. 109.)

On the other hand, Mr. Alfred R. Wallace, who holds such a distinguished position in this special field of research, has promulgated a most remarkable theory. This careful investigator, an original discoverer of the laws of natural selection, and a powerful advocate of their adequacy to bring about the evolution of the entire organic world, even including man up to a certain stage, believes that the cosmic forces are insufficient to account for the development of man in his civilised capacity. "Natural selection," he writes, "could only have endowed savage man with a brain a few degrees superior to that of an ape, whereas he actually possesses one very little inferior to that of a philosopher." This deficiency in the organic forces of nature he essays to supply by calling in the guiding influence of a "superior intelligence." In defending this hypothesis from hostile criticism he explains that by "superior intelligence" he means some intelligence higher than the "modern cultivated mind," something intermediate between it and Deity. But as this is a pure supposition, unsupported by any evidence, and merely a matter of personal belief, it is unnecessary to discuss it further. I would just, *en passant*, ask Mr. Wallace why he dispenses with this "higher intelligence" in the early stages of man's evolution, and finds its assistance only requisite to give the final touches to humanity.

In dealing with the detailed objections raised by Mr. Wallace against the theory of natural selection as applied to man, we are, however, strictly within the sphere of legitimate argument; and evolutionists are fairly called upon to meet them. As his own theory is founded on the supposed failure of natural selection to explain certain specified peculiarities in the life of man, it is clear that if these difficulties can be removed, *cadit quæstio*. It is only one of his objections, however, that comes within the scope of my present inquiry, viz. that which is founded on the supposed "surplusage" of brain power in savage and prehistoric races.

In comparing the brains of the anthropoid apes and man Mr. Wallace adopts the following numbers to represent their proportional average capacities, viz. anthropoid apes 10, savages 26, and civilised man 32—numbers to which there can be no objection, as they are based on data sufficiently accurate for the requirements of this discussion. In commenting on the mental ability displayed in actual life by the recipients of these various brains, he states that savage man has "in an undeveloped state faculties which he never requires to use," and that his brain is much beyond his actual requirements in daily life. He concludes his argument thus:—"We see, then, that whether we compare the savage with the higher developments of man, or with the brutes around him, we are alike driven to the conclusion that in his large and well-developed brain he possesses an organ quite disproportionate to his actual requirements—an organ that seems prepared in advance, only to be fully utilised as he progresses in civilisation. A brain one half larger than that of the gorilla would, according to the evidence before us, fully have sufficed for the limited mental development of the savage; and we must therefore admit that the large brain he actually possesses could never have been solely developed by any of those laws of evolution whose essence is that they lead to a degree of organisation exactly proportionate to the wants of each species, never beyond those wants; that no preparation can be made for the future development of the race; that one part of the body can never increase in size or complexity, except in strict co-ordination to the pressing wants of the whole. The brain of prehistoric and of savage man seems to me to prove the existence of some power distinct from that which has guided the development of the lower animals through their ever-varying forms of being." ("Natural Selection," &c. 1891, p. 193.)

With regard to the closing sentence of the above quotation, let me observe that the cosmic forces, under which the lower animals have been produced by means of natural selection, do not disclose, either in their individual or collective capacity, any guiding power in the sense of a sentient influence, and I believe that the "distinct power" which the author summons to his aid, apparently from the "vasty deep," to account for the higher development of humanity is nothing more than the gradually acquired product of the reasoning faculties themselves. Not that, for this reason, it is to be reckoned less genuine and less powerful in its operations than if it had emanated from an outside source. The reasoning power displayed by man is virtually a higher intelligence, and, ever since its appearance on the field of organic life, it has, to a certain extent, superseded the laws of natural selection. Physical science has made us acquainted with the fact that two or three simple bodies will sometimes combine chemically so as to produce a new substance, having properties totally different from those of either constituents in a state of disunion. Somethin analogous to this has taken place in the development of man' capacity for reasoning by induction. Its primary elements, whic are also those of natural selection, are conscious sensation, heredity and a few other properties of organic matter, elements whic are common, in a more or less degree, to all living things. A soon as the sequence of natural phenomena attracted the at tention of man, and his intelligence reached the stage of con secutive reasoning on the invariableness of certain effects fro given causes, this new power came into existence; and its opera tions are, apparently, so different from those of its componen elements that they can hardly be recognised as the offspring o natural forces at all. Its application to the adjustment of hi physical environments has ever since been one of the mos powerful factors, not only in the development of humanity, bu in altering the conditions and life-functions of many membe of the animal and vegetable kingdoms.

I have already pointed out that the brain can no longer b regarded as a single organ, but rather as a series of organs con nected by bonds of union—like so many departments in Government office in telephonic communication—all, howeve performing special and separate functions. When, therefor we attempt to compare the brain capacity of one animal wi that of another, with the view of ascertaining the quality their respective mental manifestations, we must first determin what are the exact homologous parts that are comparable. T draw any such inference from a comparison of two brains, b simply weighing or measuring the whole mass of each, woul be manifestly of no scientific value. For example, in the brai of a savage the portion representing highly skilled moto energies might be very much larger, while the portion represen ing logical power might be smaller, than the correspondin parts in the brain of a philosopher. But should these in equalities of development be such as to balance each other, th weight of the two organs would be equal. In this case what coul be the value of any inference as to the character of their menta endowments? Equal-sized brains do not display equivalen nor indeed analogous, results. To postulate such a doctrine woul be as irrational as to maintain that the walking capacities different persons are directly proportional to the weight of the bodies. Similar remarks are equally applicable to the skul of prehistoric races, as it would appear that evolution had don the major part of its work in brain development long befor the days of neolithic civilisation. Huxley's well-known de scription of the Engis skull—"a fair average skull, which migh have belonged to a philosopher, or might have contained th thoughtless brains of a savage"—goes far to settle the questio from its anatomical point of view. Until localisation of brai functions makes greater progress it is, therefore, futile to specu late to any great extent on the relative sizes of the skulls different races either in present or prehistoric times.

But there is another aspect of the question which militate against Mr. Wallace's hypothesis, viz. the probability th many of the present tribes of savages are, in point of civilisa tion, in a more degenerate condition than their forefathers wh acquired originally higher mental qualities under natural selec tion. There must surely be some foundation of truth in th widely-spread tradition of the fall of man. And, if such i the case, we naturally expect to find some stray races with in herited brains of greater capacity than their needs, in more de generate circumstances, may require. An exact equivalent t this may be seen in the feeble intellectuality of many of th peasants and lower classes among the civilised nations of moder times. Yet a youth born of such parents, if educated, ofte becomes a distinguished philosopher. It is well known that an organ ceases to perform its functional work it has a ten dency to deteriorate and ultimately to disappear altogether But from experience we know that it takes a long time for th effects of disuse to become manifest. It is this persistency tha accounts for a number of rudimentary organs, still to be me with in the human body, whose functional activity could onl have been exercised ages before man became differentiated fro the lower animals. Such facts give some support to the sug gestion, previously made, that philosophy, as such, has n specially localised portion in the brain. Its function is merel to direct the current of mental forces already existing.

But, again, Mr. Wallace's argument involves the assumption tha the unnecessarily large brain of the savage had been constructed o teleological principles for the sole purpose of philosophising. M opinion is that the greater portion of this so-called surplusage the organic representative of the energy expended in the exercise of the enormous complexity of human actions, as displayed in the movements of his body and in the skilful manipulations necessary to the manufacture of implements, weapons, clothing, &c. All such actions have to be represented by a larger bulk of brain matter than is required for the most profound philosophical speculations. The kind of intelligence evinced by savages, however low their position in the scale of civilisation may be, is different from, and incomparably greater than, that manifested by the most advanced of the lower animals. To me it is much more rational to suppose that the development of the large brain of man corresponded, *pari passu*, with that of his characteristic physical attributes, more especially those consequent on the attainment of the upright position. That these attributes were acquired exclusively through the instrumentality of the cosmic forces was, as the following quotation will show, the opinion of Mr. Darwin:—"We must remember that nearly all the other and more important differences between man and quadrumana are manifestly adaptive in their nature, and relate chiefly to the erect position of man; such as the structure of his hand, foot, and pelvis, the curvature of his spine, and the position of his head." ("Descent of Man," p. 149.) Mr. Wallace, however, considers the feet and hands of man "as difficulties on the theory of natural selection." "How," he exclaims, "can we conceive that early man, *as an animal*, gained anything by purely erect locomotion? Again, the hand of man contains latent capacities and powers which are unused by savages, and must have been even less used by palæolithic man and his still ruder predecessors. It has all the appearance of an organ prepared for the use of civilised man, and one which was required to render civilisation possible." ("Natural Selection," p. 198.) But here again this acute observer diverges into his favourite by-path, and introduces a "higher intelligence" to bridge over his difficulties.

We have now reached a stage in this inquiry when a number of questions of a more or less speculative character fall to be considered. On the supposition that, at the start, the evolution of the hand of man was synchronous with the higher development of his reasoning faculties, it is but natural to ask where, when, and in what precise circumstances this remarkable coalition took place. I would not, however, be justified in taking up your time now in discussing these questions in detail; not because I think the materials for their solution are unattainable, but because, in the present state of our knowledge, they are too conjectural to be of scientific value. In the dim retrospective vista which veils these materials from our cognisance I can only see a few faint landmarks. All the osseous remains of man which have hitherto been collected and examined point to the fact that, during the larger portion of the quaternary period, if not, indeed, from its very commencement, he had already acquired his human characteristics. This generalisation at once throws us back to the tertiary period in our search for man's early appearance in Europe. Another fact—disclosed by an analysis of his present corporeal structure—is that, during a certain phase of his previous existence, he passed through a stage when his limbs, like those of the present anthropoid apes, were adapted for an arboreal life. We have therefore to look for the causes which brought about the separation of man from his quadrumanous congeners, and entailed on him such a transformation in his form and habits, in the physical conditions that would supervene on a change from a warm to a cold climate. In the gradual lowering of the temperature of the subtropical climate which prevailed in Central Europe and the corresponding parts of Asia during the Miocene and Pliocene periods, and which culminated in the great Ice age, together with the concurrent changes in the distribution of land, seas, and mountains, we have the most probable explanation of these causes. Whether man forsook his arboreal habits and took to the plains from overcrowding of his own species in search of different kinds of food, before this cold period subjected him to its intensely adverse circumstances, it would be idle for me to offer an opinion. Equally conjectural would it be to inquire into the exact circumstances which led him to depend exclusively on his posterior limbs for locomotion.

During this early and transitional period in man's career there was no room for ethics. Might was right, whether it emanated from the strength of the arm, the skill of the hand, or the cunning of the brain. Life and death combats would decide the fate of many competing races. The weak would succumb to the strong, and ultimately there would survive only such as could hold their own by flight, strength, agility, or skill, just as we find among the races of man at the present day.

In summing up these somewhat discursive observations, let me just emphasise the main points of the argument. With the attainment of the erect position, and the consequent specialisation of his limbs into hands and feet, man entered on a new phase of existence. With the advantage of manipulative organs and a progressive brain he became *Homo sapiens*, and gradually developed a capacity to understand and utilise the forces of nature. As a handicraftsman he fashioned tools and weapons, with the skilful use of which he got the mastery over all other animals. With a knowledge of the uses of fire, the art of cooking his food, and the power of fabricating materials for clothing his body, he accommodated himself to the vicissitudes of climate, and so greatly extended his habitable area on the globe. As ages rolled on he accumulated more and more of the secrets of nature, and every such addition widened the basis for further discoveries. Thus commenced the grandest revolution the organic world has ever undergone—a revolution which culminated in the transformation of a brute into civilised man. During this long transitional period mankind encountered many difficulties, perhaps the most formidable being due to the internecine struggles of inimical members of their own species. In these circumstances the cosmic processes, formerly all-powerful so long as they acted only through the constitution of the individual, were of less potency than the acquired ingenuity and aptitude of man himself. Hence local combinations for the protection of common interests became necessary, and with the rise of social organisations the safety of the individual became merged in that of the community. The recognition of the principle of the division of labour laid the foundations of subsequent nationalities, arts, and sciences. Coincident with the rise of such institutions sprung up the germs of order, law, and ethics. The progress of humanity on these novel lines was slow, but in the main steadily upwards. No doubt the advanced centres of the various civilisations would oscillate, as they still do, from one region to another, according as some new discovery gave a preponderance of skill to one race over its opponents. Thus the civilised world of modern times came to be fashioned, the outcome of which has been the creation of a special code of social and moral laws for the protection and guidance of humanity. Obedience to its behests is virtue, and this, to use the recent words of a profound thinker, "involves a course of conduct which in all respects is opposed to that which leads to success in the cosmic struggle for existence. In place of ruthless self-assertion it demands self-restraint; in place of thrusting aside or treading down all competitors, it requires that the individual shall not merely respect but shall help his fellows; its influence is directed, not so much to the survival of the fittest, as to the fitting of as many as possible to survive. It repudiates the gladiatorial theory of existence. It demands that each man who enters into the enjoyment of the advantages of a polity shall be mindful of his debt to those who have laboriously constructed it, and shall take heed that no act of his weakens the fabric in which he has been permitted to live. Laws and moral precepts are directed to the end of curbing the cosmic process and reminding the individual of his duty to the community, to the protection and influence of which he owes, if not existence itself, at least the life of something better than a brutal savage." (Huxley, on "Evolution and Ethics," p. 33.)

These humble remarks will convey to your mind some idea of the scientific interest and profound human sympathies evoked by the far-reaching problems which fall to be discussed in this section. Contrasting the present state of anthropological science with its position some thirty or forty years ago, we can only marvel at the thoroughness of the change that has taken place in favour of its doctrines. Now man's immense antiquity is accepted by a vast majority of the most thoughtful men, and his place in nature, as a derivative animal at the head of the great chain of life, appeals for elucidation to all sciences and to all legitimate methods of research. But among the joyful pæans of this triumphal march, we still hear some discordant notes—notes, however, which seem to me to die with their echoes, and to have as little effect on scientific progress as the whistling of an idle wind. For my own part I cannot believe that a science which seeks in the spirit of truth to trace the mysteries of human life and civilisation to their primary rootlets, a science which aims at purging our beliefs of superstitious figments generated in days when scientific methods were too feeble to expose the errors on which they were founded, a science which reminds us in a thousand ways that success in life depends on a correct knowledge of the cosmic forces around us, can be opposed to the highest and most durable interests of humanity.

LETTERS TO THE EDITOR.

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

The Thieving of Assyrian Antiquities.

I HAD hoped that the British Museum slander case, which was decided a few weeks ago at the High Court of Justice, in regard to the calumnies which were circulated against me, would have silenced then and for ever my would-be detractors; but the review of the trial which appeared in the impression of NATURE of the 10th ult. indicates that misrepresentations are still rife, though an English Court of Justice has already sifted the matter, and gave its verdict in my favour.

2. I must answer your allegations one by one; and I ask you on public grounds to be so good as to insert my reply in the next issue of NATURE.

3. In the first place, you say "We have not referred to the case earlier, as we had hoped that some action in the public interest would have been taken by the trustees of the British Museum, which would have carried the matter a stage further. For this action however we have waited in vain."

4 The above remark plainly shows that you are not aware that I have been appealing for some time past to the trustees for a Court of Inquiry into the alleged robbery of public property, but the British Museum executive authorities persisted in refusing it. If you refer to the fourth day's trial, reported meagrely in the daily journals, you will see that I was the one who felt aggrieved that the alleged robbery of antiquities was not inquired into. The Judge was most explicit on this point, and remarked that in consequence of my representations having been ignored by the British Museum authorities I was justified in bringing my case before a Law Court.

5. Then you say, "From the evidence elicited at the trial it appeared that soon after Mr. Rassam began to dig in Babylonia, collections of tablets found their way into the London market, and these were bought by the British Museum for considerable sums of money." (*Times*, July 1.)

6. Here you are adverting to a vague evidence which was not established in Court; and if I had been called upon to controvert it, I could have shown then and there the fallacy of it, seeing that the British Museum acquired by purchase, through the late Mr. George Smith, Babylonian antiquities five years before I commenced work in Southern Mesopotamia. As a matter of fact, such antiquities have been obtainable from Armenian and Jewish dealers long before the trustees of the British Museum ever thought of conducting researches in those parts. Even I, myself, purchased a collection of tablets at Baghdad for the British Museum in 1877, long before I commenced work there, and that was by instruction from the Museum authorities.

7. Further on you state, "Now as no other excavations were being carried on except by the British Government, and as the internal evidence of the tablets indicated that those which they received from Mr. Rassam as the result of his works and those which they purchased had the same origin, it was natural that the public department should begin to grow uneasy. And this feeling became stronger when it was found that the tablets purchased were of much greater value archæologically and historically than those which arrived at the British Museum from Mr. Rassam."

8. The whole of the above assertions are contrary to known facts and the evidence which was adduced before the Court. Excavations by the Arabs have been carried on in Babylonia from time immemorial, and as the land belongs to subjects of the Sultan, and not to the British Government, I do not know by what right you think that the British Museum can prevent others from digging and from selling what they can find to whomsoever they choose.

9. As for the "public department" becoming uneasy, it is difficult to understand when and how such an uneasiness began and what caused it. I was always on intimate and friendly terms, as our correspondence shows, with the late Dr. Birch, the head of the Department of Assyrian and Babylonian Antiquities, until he died in 1885, or three years after my explorations ceased; and I was also in constant communication with the then Principal Librarian, Mr. Bond, until he resigned in 1888, or six years after the stoppage of the British Museum works in Babylonia; and neither he nor Dr. Birch ever made any complaint to me touching the alleged robbery of public property, though I was the only person who could have taken cognisance of the matter.

10. Then you go on to assert that the feeling of uneasiness became stronger when it was found that the tablets purchased were of much greater value, archæologically and historically, than those sent by me. I am certainly surprised at this remark, seeing that no public inquiry ever took place regarding the value of my discoveries.

11. Then you go on to say, "Speaking broadly, it seems from the evidence that Mr. Rassam sent home 134,000 pieces of inscribed clay from Babylonia, and of these more than 125,000 are what Sir Henry Rawlinson, Mr. Maunde Thompson, and Dr. Wallis Budge style 'rubbish.' (*Standard*, June 30, *Times*, July 3.) This represented the direct return for the outlay. What did go wrong we cannot say, but the outsider will certainly think that something did go wrong in this matter."

12. Here again you are asserting what is contrary to facts, as it is known all over Europe that I am the discoverer of Sippara or Sephervaim, and many temples and palaces in Assyria and Babylonia, from where I sent to the British Museum many valuable collections; and the 134,000 fragments were part and parcel of them. You seem to have overlooked the evidence of one of the best Assyrian scholars who is the senior assistant in the department of Babylonian and Assyrian antiquities at the British Museum, as to the value of the fragments.

13. In regard to Sir Henry Rawlinson's saying that the fragments belonging to a certain collection being "rubbish," it is certainly most startling. As you do not say where this information was obtained from, I take it for granted that it was supplied from the British Museum. Sir Henry Rawlinson would have been the very first man to condemn me if I had allowed any of the fragments to be thrown away, seeing that a mere particle might fit a broken tablet and complete an important text.

14. Further on you state that "The information which he gathered on all these points he sent home to the British Museum in the form of reports, one of the results of which was the dismissal of the native agent. On two subsequent occasions Dr. Budge visited Assyria and Babylonia, and carried on excavations for the trustees, and he acquired some thousands of tablets."

15. It is very extraordinary that the official report you quote above was withheld by the British Museum authorities from being produced in Court as a privileged document, because it contained matters which would be prejudicial to the public service, and yet a part of its contents is now revealed in NATURE.

16. In continuation of the above remarks you go on to say, "It will easily be guessed that from first to last a very considerable sum of public money, amounting to tens of thousands of pounds, has thus been spent upon excavations in Assyria and Babylonia, and the question naturally arises, Has this money been spent judiciously, and has the nation obtained what it had a right to expect in return for its money?"

17. I have no hesitation, in answer to the above remark, to say that my greatest desire is that the public *should insist* upon an open Court of Inquiry into the manner the British Museum executive authorities have carried on lately their Assyrian and Babylonian archæological researches, and find out whether the enormous amount was spent "judiciously" by the different agents they have employed.

18. You further say, "Sales at auctions have revealed the fact that sundry gentlemen had been able to acquire Assyrian slabs from the palaces of Assyrian kings, and as the excavations were carried on by the Government it is difficult to account for this fact. The public has a right to know how property of this nature came into private hands, and the question must be asked until it is satisfactorily answered. The matter cannot be allowed to rest where it is."

19. I do not know what you mean by "Assyrian slabs" having been acquired by purchase, as I know of no such sale

having taken place in England or elsewhere. I am the only explorer, after M. Botta and Sir Henry Layard, who discovered "Assyrian slabs," or bas-reliefs, but that was thirty-eight years ago; and as there have been no sculptured slabs discovered in Babylonia, it is difficult to know what is to be understood by such an assertion. I do certainly agree with you that the matter ought not to be allowed to rest, but that the public should insist upon a thorough examination into the matter.

20. In conclusion, I must touch upon one more point, which appeared near the end of the criticism under discussion, about the duty of public servants to their superiors. You say, "With the terror of the decision in this case before them, all members of the public service will be in duty bound to consider whether they are able to afford the expenses of an action at law, and the enormous costs which follow in its train, before they report unpleasant truths to their superiors."

21. It will be indeed a sad day for an old public servant, who has spent the best part of his life in the service of his adopted country, and held with undiminished confidence important appointments of trust under the Crown, to be debarred from obtaining justice elsewhere when it is denied him by the department under which he served with honour, credit, and success for many a year, when his character is unjustifiably assailed.

6 Gloucester Walk, Kensington, W. H. RASSAM.

[WE are much surprised that Mr. Rassam has taken our article as personal to himself, as we dealt with the thefts in question only from a public point of view, and they might have happened, we suppose, if Mr. Rassam had never existed.

We make the following comments on some of his paragraphs:—

Para. 4. We were not aware that Mr. Rassam had been appealing for a Court of Inquiry. There is no doubt that cause has been shown for a Treasury inquiry in the interests of the public and future explorers, and we hope it will be pressed for.

Para. 6. It was no part of our duty to *sift* the evidence. The point is that evidence was *given* (see *Pall Mall Gazette*, June 30). Did not the British Museum accountant go into the witness-box to state the amounts paid for tablets? and was not the evidence dispensed with because Dr. Budge's "vague" evidence was accepted as sufficient?

Paras. 7 *and* 8. We referred to the evidence given in Court. What else could we do? It was not disproved in Court, or we should have said so.

Para. 9. This is a statement with which only the Trustees of the British Museum can deal. We, of course, are bound to accept Mr. Rassam's statement as he makes it.

Para. 10. We do not quite seize the point of Mr. Rassam's remark here. The statement as to the greater value of the tablets *not* received from him was made by the defendant; it is not ours.

Paras. 11 *and* 12. We can only repeat that the public is interested in knowing that of 134,000 pieces of inscribed clay sent home from Babylonia—it really does not matter by whom, 125,000 have been termed rubbish by Sir H. Rawlinson one of the trustees, the principal librarian, and the present keeper of the collection. It was not necessary to refer to any subordinate official, or to point out the singular fact that he gave evidence contrary to that of three of his official superiors.

Para. 13. We quite agree that it is most startling to hear that, in Sir Henry Rawlinson's opinion, so much of what Mr. Rassam sent home was rubbish. We presume that Mr. Rassam was startled when Sir Henry Rawlinson's deposition was read in Court; that is the reason, perhaps, that he forgot it, as he appears to have done.

Para. 15. Dr. Budge's reports could not be revealed by us because we do not possess them, and have never seen them. All the facts stated were given in evidence to which alone we professed to refer.

Para. 17. Here we cordially agree with Mr. Rassam; as before stated, in our opinion a Treasury inquiry into the expenditure of the public funds on, and the method of carrying out, excavations in the region in question since, say, 1846, is most desirable.

Paras. 18 *and* 19. The article was not written by an expert, and perhaps the word "bas-relief" would have been better than "slab." But there is no doubt about what we mean. Murray's "Handbook to Dorsetshire" informs us that at Canford Hall "a gallery connected with the house by a cloister is devoted to a series of Assyrian sculptures brought from Nineveh." These sculptures—not to call them slabs—are described as "winged lions and bulls, bas-reliefs, &c., similar to those in the British Museum." Now, if there are many such galleries in England, and the objects were obtained at a low price, the whole question of excavation at the public expense is raised.—ED. NATURE.]

Bishop's Ring.

BISHOP'S RING still continues very conspicuous about sunset more so than it was for a long time previous to last November, though not so much so as at the end of 1883. It is evident there must have been an addition of some kind to the dust of our atmosphere last November, a considerable part of which yet remains. The light-coloured dust wisps reappeared faintly after the date (April 10) of my letter (p. 582), but have now entirely disappeared again (I have not seen them since July 20); the texture of the sky in the ring being perfectly smooth lately. I have not seen any other peculiar sunset phenomena of late, though Señor Arcimis (Director of the Meteorological Institute) tells me the sunsets are very brilliant at Madrid. He says he is satisfied that Bishop's Ring did not exist in Spain before the Krakatoa eruption; and he agrees with me that it has never since entirely disappeared about sunset.

Sunderland, September 11. T. W. BACKHOUSE.

Spring and Autumn of 1893.

As the peculiarities of this season are receiving attention in your pages, the following notes of things in this part of England may perhaps interest some of your readers.

On March 25 the following flowers were in bloom:—

Adoxa.	Hazel (nearly over).
Golden Saxifrage.	Larch.
Speedwell.	Celandine.
Wood Sorrel.	Cuckoo flower.
Snowdrop.	Star-wort.
Crocus (nearly over).	Broom.
Grape-hyacinth.	Peach.
Wood anemone.	Gooseberry.
Primrose.	Currant.
Violet (the white, nearly over).	Willow (nearly over).
	Cherry.

At the same date, the elm had been in flower for weeks; the ash was in full bud; one or two sycamores in leaf; chestnuts in early leaf, and showing flower buds. The helibore had been out long ago; hyacinths were beginning to flower; a few pear buds had burst; the elms and hawthorns had shown green for several days. Butterflies had been seen for several days.

The early heat did not, I suspect, suit all our spring flowers. I saw scarcely anything this year of two of our wall-plants which are usually abundant—the *Draba verna* and the *Saxifraga tridactylites*.

On March 27 bluebells were found in flower.

The state of things now on September 12 is as curious.

The wild roses (both *Rosa canina* and *arvensis*) are again flowering in the hedges—in some cases in great profusion; there are now, or a few days ago have been, in blossom the following:

Apple.	Glastonbury thorn.
Pear.	Kerria.
Holly.	Wild strawberry.
Buberis Darwini.	Dog violets.
Rhododendron.	

Some of the autumn flowers appear to me to have suffered from the heat and, perhaps, the drought. I have not seen the *Spiranthes autumnalis*, usually quite abundant here; and the *Colchicum autumnale* has been far less abundant than usual. Some garden bulbs have probably suffered in the same way.

I may add that wasps have been in extraordinary numbers; and that we have found two or three of the nests of the tree-wasp similar to the one depicted in your paper on the 7th inst.

Failand, near Bristol, September 12. EDW. FRY.

NOTES.

MR. W. SAVILLE-KENT, at present engaged as Commissioner of Fisheries to the Government of Western Australia, has shipped to London a large collection of the stony corals, *Madreporaria*, peculiar to the Western Australian coast line. These specimens, added to the extensive series indigenous to the northern and eastern districts of Australia recently contributed by him to the National Natural History Museum, and which were amassed in association with the explorations that formed the basis of his recently published work on the Australian Great Barrier Reef, will constitute the most complete collection of Australasian *Madreporaria* that has yet been brought together. This latest Western Australian consignment includes several specimens of abnormally large dimensions that should make an interesting display in the Natural History galleries. Mr. Saville-Kent anticipates completing his Australian engagements, and returning permanently to England about twelve months from the present date.

The French *Journal Officiel* has just published a decree for the organisation of the proposed Paris Universal Exhibition of 1900. M. Alfred Picard, who, it will be remembered, filled the office of *Rapporteur Général* for the 1889 Exhibition, has been appointed Commissary-General. He will be assisted by a consultative committee of 100 members.

The next meeting of the Japan Society will be held at 20 Hanover-square, on Wednesday, September 27, when Prof. John Milne will read "A Short Account of Volcanic and Earthquake Phenomena of Japan." The paper will be illustrated by photographic lantern slides, and will be followed by an exhibition of photographic slides illustrating life, customs, and scenery of Japan. The meeting would under ordinary circumstances have taken place in October; it has, however, to be held in September in consequence of Prof. Milne having to return to Japan on September 29.

The Congress of the Photographic Society of Great Britain and affiliated societies for the present year will take place on October 10, 11, and 12. The opening meeting, at which the President's annual address will be delivered, is to be held at the gallery of the Royal Society of Painters in Water Colours. The other meetings will be held in the theatre of the Society of Arts.

We hear that Mr. Max Muspratt has just gained the diploma of Chemistry awarded annually by the Swiss Government to a limited number of students for exceptional proficiency in the scientific and technical knowledge of chemistry. Mr. Muspratt, who went to Zurich direct from Clifton College, is the first Englishman to gain this distinction.

We learn from the *Lancet* that an interesting experiment is to be made in connection with next year's meeting of the Norwegian Medical Congress. At the meeting recently held in Christiania it was decided that next year members shall assemble on board a yacht, which will cruise during their deliberations. Weather and other things being favourable, the experiment should prove a very admirable mode of combining business with pleasure.

The *Ceylon Observer* for August 18 has a moderately worded editorial urging the establishment of a zoological garden in Colombo, especially for the purpose of giving the many visitors who pass through Colombo an opportunity of seeing for themselves how rich and varied is the fauna of Ceylon. The *Observer* is confident that the fees paid for viewing the collection would suffice to pay the whole, or nearly the whole, of the expenses which would be incurred.

According to the *Pharmaceutical Journal*, the Kew Herbarium has recently been enriched by the addition of forty-six dried specimens of ferns collected in Sarawak, including six new species; two hundred species of plants collected by Sintenis in Kastamuni (the ancient Paphlagonia), Asia Minor; twelve hundred dried plants collected in Kashmir; one hundred and thirty-nine specimens of Mexican plants; and one hundred and twenty-nine of the Greenland and Iceland flora.

An artificial horizon invented and recently patented by Mr. W. P. Shadbolt, possesses several advantages over other forms. The surface of the mercury is never exposed to the air, hence it does not easily become contaminated, and is also protected from wind. Further, loss of mercury is entirely prevented, thus dispensing with the necessity for taking any extra supply. The instrument permits very small altitudes to be observed, and after having it under trial for more than a year in tropical Africa, under circumstances entailing a good deal of rough usage, Mr. Shadbolt reports that its behaviour was most satisfactory.

The general report of the operations of the survey of India during the survey year ending September 30, 1892, has been issued. From it we learn that the area surveyed in detail during the year amounts to 80,101 square miles. In addition to this, transverse operations have been carried on over an area of 5921 miles. By the measurement of six arcs of longitude the original scheme of differential longitude determination within India proper has been completed. Colonel Waterhouse reports upon a method he has been using to prepare a very sensitive orthochromatic collodion-bromide emulsion. Plates coated with this new emulsion require to be used in a moist state in order to obtain maximum sensitiveness and clear negatives. But wet-plates are inconvenient, and if some means could be found of preparing equally sensitive dry-plates, the process would possess consderable advantages.

We learn from the *Botanical Gazette* that forty professed botanists are now engaged in botanical research at the fifty-four Agricultural Experiment Stations in the United States. Of this number ten are also working in entomology, three in horticulture, one in arboriculture, and one in meteorology.

No. 2 of the *Illustrated Archæologist* has just reached us. It is, if possible, more tastefully got up than No. 1, and archæologists will indeed be hard to please if they cannot find something to interest them among the eight items which go to make up the present number. Among the articles we notice "Stonehenge," by Edgar Barclay; "Notes on some of the Sculptured Tombstones of Argyllshire," by R. C. Graham; and "The Roman City of Silchester," by H. W. Young; while Prof. A. C. Haddon writes on "Wood-Carving in the Trobriands." The magazine is published by Mr. C. J. Clark, 4 Lincoln's-inn-fields.

Prof. John Milne, F.R.S., has brought out, through Messrs. Crosby Lockwood and Son, a little work of which he is the compiler, and which should be very serviceable to the class for which it is intended, viz. students and others interested in mining matters. The title of the book is "The Miner's Handbook," and is a reprint, with corrections and additions, of a compilation, the first part of which was printed at Tokio some fourteen years ago. The little volume is of handy size, has rounded corners, making it suitable for carrying in the pocket, and, with the exception of the title-page, preface, and contents, was printed (and printed well) in Japan.

We have received from the Australian Museum, Sydney, Part III. (Gasteropoda) of the "Catalogue of the Marine Shells of Australia and Tasmania," by J. Brazier. The author, in a prefatory note, says, "The present part contains only the genus Murex. The remaining genera are not included, from causes beyond my control."

Mr. D. Forbes, 29, Victoria-street, Bristol, has sent us the catalogue of a very interesting exhibit at the Bristol Industrial and Fine Art Exhibition. It is that of the collection formed by Mr. F. Mockler, of portraits, diplomas, freedoms, grants, presentations, addresses, visiting-books, correspondence, pamphlets, printed works, manuscripts, &c., once the property of the discoverer of Vaccination. The catalogue is prefaced by a brief memoir of Dr. Jenner.

THE September number of the *Board of Trade Journal* contains an interesting account of the development of the World's Telephones, by M. Daniel Bellet, translated from the *Economiste Francais*, "A Summary of Agricultural Returns of Great Britain for 1893," "Coal Production in Japan," and many other items of interest.

WE have just received the Proceedings and Transactions of the Royal Society of Canada for the year 1892. The London agent for it is Mr. Bernard Quaritch.

A LIST of observations made in 1892 by the members of the Caradoc Field Club, Shropshire, and others, has been issued under the title, "The Caradoc Record of Bare Facts."

THE report for 1892 of the Botanical Exchange Club of the British Isles has just reached us. It is issued by Messrs. James Collins and Co., Manchester.

THE Calendar of the Durham College of Science, Newcastle-on-Tyne, for the session 1893–94 has reached us. It is published by Messrs. Andrew Reid, Sons, and Co., London, and Newcastle-on-Tyne.

MESSRS. F. AND E. GIBBONS, Liverpool, have issued prospectuses of Day Classes in Arts and Science, and of the Evening Lectures, and of the Department of Engineering, in connection with the University College, Liverpool, for the session 1893–94. They contain all the preliminary information which intending students are likely to require.

THE Calendar for 1893–94 of the Glasgow and West of Scotland Technical College has just been published by Mr. Robert Anderson, Glasgow.

DR. W. H. PEARSE has sent us a copy of the address delivered by him as president of the Plymouth Institution and Devon and Cornwall Natural History Society, at the opening meeting of the session 1892–93. It deals with the subject of our present knowledge of biological science.

WE have received a printed circular signed "A Free Lance," condemning a recent action of ours in refusing to print a letter from the author on the subject of the "Publication of Physical Papers" unless, in accordance with the rule to which attention is drawn in every number of NATURE, he divulged his name. We fail to see any adequate reason for violating our rule in the favour of "A Free Lance" more than in the case of any other of our correspondents.

THE products of the sublimation of arsenic form the subject of an important communication to the latest number of the *Zeitschrift für Anorganische Chemie*, by Dr. Retgers. The various allotropic modifications of the element have been subjected to a searching investigation, and further interesting information has been acquired concerning the little known solid hydride of arsenic AsH, and the suboxide As_2O, whose existence has hitherto been considered doubtful. It is first shown that there is no amorphous modification of arsenic, the deposit of so called "black amorphous arsenic," obtained during the sublimation of the element in a current of hydrogen and in a number of high temperature decompositions of arsenic compounds, is found to be microcrystalline and to exhibit distinct evidence that it consists of the ordinary regular variety. There are consequently only two well-defined allotropic modifications of arsenic: (1) the stable form which crystallises in the hexagonal system, is silver-white in appearance, specifically heavy, and requires a comparatively high temperature for volatilisation; and (2) the specifically lighter and more volatile modification which crystallises in regular octahedrons, and exhibits a black surface. When arsenic is heated to the point of sublimation in a current of indifferent gas, the first variety condenses nearest the heated element, while the second variety, owing to its lowe temperature of volatilisation, is deposited more remote from the portion of the tube which is heated by the flame. These two forms of arsenic correspond completely with the two modifications of phosphorus, the regular black variety with the regular yellow modification of phosphorus, and the silver-white hexagonal form with the hexagonal red phosphorus. Dr. Retgers adduces some evidence also in support of the view that there is a third crystalline modification of arsenic, of which the crystals belong to the monoclinic system. The fact is also recorded that elementary arsenic, of whatever modification, is invariably opaque even when in the finest state of division; former observations of yellow and brown transparent arsenic are shown to have been due to compounds having been mistaken for the element. The brown spots which are deposited along with arsenic when the flame from a Marsh's apparatus is allowed to impinge upon cold porcelain, or which form in the Marsh sublimation tube, do not consist of the element in thin layers, but of the brown solid hydride AsH, which is produced by the partial dissociation of the gaseous trihydride AsH_3. When the last-named substance is heated during its passage along the sublimation tube, the arsenic mirror consists of both modifications of the element, the silver-white hexagonal form nearest the flame, and the black regular variety further removed. The brown deposit of solid hydride AsH is always found furthest removed of all, and thus forms, as it were, the tail of the mirror. Dr. Retgers finds that boiling xylene readily dissolves this solid hydride, thus affording an excellent mode of distinguishing it from elementary arsenic, which is totally insoluble in xylene.

THE solid hydride of arsenic was isolated some years ago by Janowsky, who obtained it as a brown velvet-like substance by decomposing potassium or sodium arsenide with water. Ogier has subsequently shown that it may likewise be obtained by the action of the silent electrical discharge upon the gaseous trihydride. The existence of the suboxide of arsenic has hitherto been so doubtful that the compilers of the new edition of "Watt's Dictionary of Chemistry" feel justified in stating that "no definite proof of the existence of an oxide with less oxygen than As_4O_6 has been given." Dr. Retgers, however, adduces weighty evidence in favour of the supposition. As explained above, when arsenic is sublimed in a current of inert gas (carbon dioxide, for instance), a deposit consisting of the two modifications of the element, white and black, is obtained. The moment, however, that a little oxygen or air is allowed to mix with the carbon dioxide a *brown* annulus commences to form between the white and the black elementary deposits. This brown sublimate is not crystalline, and is transparent, the thin films proving to be quite isotropic in polarised light. In order to produce a broad deposit of this brown substance it is advisable to employ a wide tube, and to stop the experiment as soon as the annulus is formed, as further heating soon decomposes it again. From this and further evidence adduced by Dr. Retgers, there can be no longer any reasonable doubt that a lower oxide of arsenic, probably As_2O, is capable of existence.

THE additions to the Zoological Society's Gardens during the past week include a Campbell's Monkey (*Cercopithecus campbelli*, ♀) from West Africa, presented by Miss Jane Richards; a Pig-tailed Monkey (*Macacus nemestrinus*, ♂) from Java, presented by Miss Llewellyn; an Azara's Capuchin (*Cebus azaræ*, ♀) from Paraguay, presented by Miss Hairby; two Common Marmosets (*Hapale jacchus*) from South-East Brazil, presented by Mr. E. Lake; two Lions (*Felis leo*, ♂ ♀) from East Africa, presented by H.H. the Sultan of Zanzibar; two Egyptian Jerboas (*Dipus ægyptius*) from Egypt, presented by Miss B. Dell; two Egyptian Jerboas (*Dipus ægyptius*) from

Egypt, presented by Mr. M. W. Edgley; one Egyptian Jerboa (*Dipus ægyptius*) from Egypt, presented by Mr. W. R. Clark; a Golden Eagle (*Aquila chrysætus*) from Scotland, presented by Mr. Bryan Cookson; a —— Buzzard (*Buteo* ——) from West Africa, presented by Mr. Rice; three Tench (*Tinca vulgaris*) from British Fresh Waters, presented by Mr. Arthur E. Rumsey; two Collared Fruit Bats (*Cynonycteris collaris*), a Wapiti Deer (*Cervus canadensis*, ♂), a Japanese Deer (*Cervus sika*, ♀) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

Double Star Measures.—Nos. 3185–86 of the *Astronomischen Nachrichten* contains the micrometrical measures of double stars made by Mr. Tarrant during the years 1889–92. This series is a continuation of that published in a preceding number (2991) of the same journal. The same instrument has been employed as formerly, but its position has been changed, it now being 510 feet above the sea level. Stars with considerable southern declination can thus be much more accurately measured. The objects are arranged in the following order:—Dorpat Catalogue, Pulkova Catalogue, Burnham, and Miscellaneous.

Pubblicazioni della Specola Vaticana.—In the third volume of this publication there are several contributions of interest and importance to which we can here briefly refer. In the Astronomical Section, M. P. G. Lais gives an account of the measurements of the position of Nova Aurigæ (with a photograph), and also a few words on the comets Swift, Holmes, and Brooks. M. P. F. Denza, in addition to a communication on the total eclipse of the moon that occurred on November 4, 1892, gives a summation of the observations made of the shooting stars of August in that year, and of the shooting stars of November in the same year, and also of solar spots, magnetic disturbances, and auroræ. In the Astro-Photographic Section, M. P. G. Lais and F. Mannucci give an account of the work done for the international chart and catalogue of the heavens; twenty-six photographs for the chart, and 115 for the catalogue were taken, while 154 other photographs, including groups of stars, nebulæ, comets, &c., were obtained. These communications are accompanied by some fine photographs, which include the Præsepe group, Nebula of Orion, and some of the sun. M. P. F. Denza communicates most of the articles in the Magnetic Section, while the Meteorological Section contains many important communications, with several diagrams, among which we must mention that on the classification of clouds, by M. F. Mannucci, which is illustrated by a beautiful series of photographs showing the various forms which they assume.

Comet Finlay and the Præsepe.—The ephemeris of Finlay's comet showed that a passage through the star-group Præsepe would take place about the beginning of October. In *Astronomischen Nachrichten*, No. 3187, Prof. A. Berberich gives a comparison of the ephemeris with the star-places in Yarnall's catalogue the measures of C. Wolf and Winnecke giving the following table of conjunctions. (γ. Pr. = number in Yarnall's catalogue):—

γ. Pr.		Conj in R.A. M. T. Paris. h		Comet-Star $\Delta\delta$ ′
5	...	2 Oct. 20·9	...	− 0·2
9	...	3 ,, 3·8	...	− 2·3
16	...	3 ,, 15·1	...	− 1·4
37	...	4 ,, 6·0	...	+ 0·3
59	...	4 ,, 21·1	...	− 0·6
69	..	5 ,, 2·2	...	− 1·0
74	...	5 ,, 3·0	...	+ 0·2
89	...	5 ,, 7·5	...	+ 1·0
134	...	6 ,, 8·8	...	− 0·0
148	...	7 ,, 12·7	...	− 1·4
150	...	7 ,, 17·0	...	+ 1·9

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, September 11.—M. Lœwy in the chair.—Treatment of vines infested by *Phylloxera* with peat moss impregnated with schist, by M. F. de Mély. The results of the treatment proposed last year have been controlled by the Inspector-General of Agriculture and by the Inspector-General of the Compagnie de Lyon. As a consequence of their visit, the Minister of Agriculture has sent Dr. Crolas, of Lyon, to organise further applications of the method. A vine already attacked by *Phylloxera* has been under treatment since June, and although some of the insects have survived, the vine has not turned yellow. The portion of the vineyard treated by this method for two seasons has retained its rootlets in a perfect state, and those vines which were treated with the maximum dose—viz. 2 kgr. of the mixture, containing 200 grs. of pure schist, show no trace of *Phylloxera*.—Magnetic observations recently made in Russia by M. Venukoff. Observations at about a hundred stations comprised between 45° 11′ and 36° 42′ of latitude, and 65° 47′ and 82°·17′ of longitude east of Greenwich prove that the isogonal lines inserted in Berghaus's *Physikalischer Atlas* are not exact for Central Asia; in particular, the degrees of declination accepted are too large. Local variations of the magnetic elements in European Russia have recently been investigated, and some very large disturbances have been discovered. In the province of Grodno the magnetic declination was found to change by 10° in a distance of 21 km., and in the neighbourhood of Belgorod the deviation mounted up to 180° in a space of a few tens of square km. This implies the presence of a small and perfectly local magnetic pole. It must be remembered that in the Neva delta the fortress of St. Peter and Paul is known to deflect the magnetic needle by 10°.—Presence of a ferment analogous to emulsine in mushrooms, and particularly in parasitic mushrooms of trees or those growing on wood, by M. Em. Bourquelot. It is proved that several mushrooms, and especially those developing on living or dead wood, contain a soluble ferment possessing the property of doubling various glucosides, such as amygdaline, salicine, and coniferine. It is not possible to say that this ferment is identical with the emulsine of the almonds, but it acts in the same manner and upon the same substances. This ferment was found in two ways. In one, the fresh mushroom was placed in a saturated atmosphere of ether or chloroform vapour, which produces an abundant exudation of liquid holding in solution a large portion of the principles contained in the cellular juice. This liquid was placed for 24 or 48 hours in direct contact with a solution of a glucoside; or an aqueous solution was formed by precipitation with alcohol, and treated in the same manner. In the second process, the mushroom was triturated with sand and transformed into a paste; this paste was treated with distilled water and filtered off, the liquid being used as before. One specimen, picked from an elder branch, gave a liquid which completely converted a dose of coniferine into grape-sugar in the course of three days. The ferment is limited to fungi living on wood, enabling them to assimilate the glucosides contained in it.—On a method of determining the density of gases for industrial purposes, by M. Maurice Meslans.

CONTENTS.

THURSDAY, SEPTEMBER 28, 1893.

THE PHYSIOLOGICAL PAPERS OF PROF. SACHS.

Gesammelte Abhandlungen über Pflanzen-physiologie. Von Julius Sachs. 2 vols., with 126 woodcuts and 10 plates. (Leipzig, 1892-3.)

THIS excellent collected edition of Prof. Sachs's chief contributions to the physiology of plants will e welcome to all botanists. The author in his preface xplains the very sufficient reasons which have led him o publish this collection, and the principles which have uided him in the choice of papers. He has not thought necessary to reproduce all his physiological treatises, ut has more especially aimed at selecting such as deal ith matters of fact rather than theory, while some which e considers to be sufficiently well known already are mitted.

Such a collection is a great help to the reader, and es- ecially so when it is compiled by the author himself. In his case we do not merely obtain a series of isolated apers, but have the further advantage of learning the uthor's mature view of the relative importance of his wn researches.

Many of the papers have been abridged, and some are nly given in abstract. In many cases notes have een added, which are not the least interesting part of e work, as they often indicate the author's latest views n the questions at issue.

To review adequately a collection of Prof. Sachs's hysiological treatises would be to write the history of egetable physiology from 1859 onwards. Such an at- mpt is out of the question; only a very short sketch the contents of this book can be given here.

The selected papers, 43 in number, are arranged, ac- ording to subject, in nine groups; within each group the der observed is chronological. The first volume con- ins works concerned chiefly with the chemical and ysical phenomena of vegetation, while those contained the second volume are on growth, cell-formation, and ritability.

The first section contains essays on the action of heat n plants. The first, published in 1860, is on the effects frost. The observations described will be remembered all readers of Prof. Sachs's text-book. There is much om for further research on the effects of low tempera- res on various plants, and the subject is obviously of actical as well as of physiological interest.

Other papers in this group are on the dependence of rmination on temperature, on transitory rigidity in ir- table organs, on the superior limit of temperature as ecting vegetation, and on the influence of temperature the formation of chlorophyll. All these investigations e of fundamental importance; the same perhaps can arcely be said of the last paper in this part, "On Emul- on Figures and the Grouping of Swarm-spores in ater," which is merely concerned with a possible urce of error in observations on the movements of icellular organisms.

The succeeding section, on the action of light on plants, cludes some of the best known of the author's researches, the most important perhaps being that on the effect of light of different colours on assimilation and growth. It is a little disappointing, however, to find no reference in the notes to the more recent and exact work of Timiriazeff, Engelmann, and others. The latest published paper in this section, "On the Action of the Ultra-violet Rays on the Formation of Flowers" (1883 and 1886), is probably less familiar to physiologists than the others. In this, Prof. Sachs brings forward evidence to show that when, in the case of a green plant, the ultra-violet rays alone are excluded, the development of flowers is hindered, though otherwise the plant grows normally. The conclusion which he arrives at is that the ultra-violet rays produce, in the green leaves, the "flower-forming substances."

The third group of papers, on chlorophyll and assimilation, is certainly among the most important in the collection, for by means of these researches the author first proved that the chlorophyll corpuscle is the organ of assimilation, a fact which forms the basis of the whole physiology of nutrition in plants. The investigations, dating from 1862, by which Prof. Sachs showed that starch appears in the chlorophyll corpuscles as a result (though, as we now know, not an *immediate* result) of assimilation, are of special interest at the present moment, in view of the new light recently thrown on this whole subject by the work of Messrs. Brown and Morris.

Later papers in the same section are those "On the Activity of Nutrition in Leaves" (1884), and on "The Treatment of Chlorotic Plants" (1888). The former is devoted chiefly to the determination of the energy of assimilation in the leaves of various plants. The latter is the only paper in the collection written with a "purely practical" object, namely to teach the most convenient and effective method of applying iron salts as manure to plants which, from want of iron, fail to develope their chlorophyll.

The fourth section includes the work on the movements of water in plants. Among other researches of importance, we here find the well-known treatises "On the Ascending Current of Sap in Transpiring Plants" (1877-8) and "On the Porosity of Wood" (1877-9). The former contains the author's classical determinations of the rate of ascent of the sap, by means of the Lithium spectroscopic method, while in the latter his famous "imbibition theory," according to which the water rises in the substance of the lignified cell-walls, is developed. This theory is no longer accepted by physiologists, but the author justly points out that the facts given in the paper maintain their value quite independently of the truth of his theoretical conclusions.

The papers of the fifth group, on the behaviour of the constructive materials during growth, are all of early date (1859-63), and the author regards their interest as being mainly historical. To us they seem to be among the most attractive in the collection. Most of them relate to the phenomena of germination, and especially to the changes undergone, during that period, by the reserve food substances, while many facts of morphological and histological interest are also told us.

Going on to the second volume, we find in the sixth section of the work the author's researches on the subject of growth, which he carried out with the help of the various forms of auxanometer invented by him. His results, which first established the extreme complexity of the conditions on which the rate of growth in plants depends, are familiar to readers of his text-book and lectures.

The seventh section contains the papers on "tropisms," *i.e.* the reactions of growing organs under the stimuli of gravitation, light, and moisture. The last paper in the group, that on orthotropous and plagiotropous organs, seems to us to be of the widest interest, as offering a contribution towards the solution of the most fundamental and most difficult of all biological problems, namely the question of the *causes* of the forms of organisms. This in the author's phrase is the problem of "scientific morphology."

Section VIII., on the relations between cell-formation and growth, includes the two well-known papers on the arrangement of cells (1878–9) in which the form of the network of cell-walls is explained with the help of the law of their rectangular intersection. The author shows how, in organs of similar outline, identical arrangements of the cells arise, whatever may be the morphological nature of the organ, so that the cellular structure of a hair, an antheridium, and an embryo may be the same. He has thus given a useful warning to morphologists, who have often laid too much stress on mere cell-arrangement in discussing embryological and other similar questions.

The last paper in this section is on "Energids and Cells." As it is the most recent of all (1892), and probably the only one in the book which may not yet be familiar to botanical readers, a short account of its contents may be useful.

Under the term *energid*, Prof. Sachs understands a single nucleus, together with the protoplasm governed by it, the two together forming a whole, which is an organic unit, both in the morphological and physiological sense. He has chosen the name energid in order to express the chief property of the organic unit, namely, that it possesses internal or vital energy. The conception of an energid, as distinct from that of a cell, has become necessary, owing to the discovery in recent years of so many multinucleate cells and multinucleate organisms without cellular structure, discoveries which we chiefly owe to the researches of Schmitz. Such a multinucleate cell or organism, though enclosed within the contour of a single cell-wall, is manifestly equivalent not to a single uninucleate cell, but to a multicellular structure. This is proved by the fact that the portions of protoplasm, each surrounding a nucleus, so often subsequently become free as complete and independent cells, as in the formation of the zoospores of *Saprolegnia*, or form a multicellular tissue, as in the endosperm of many Phanerogams.

It is quite evident that the word *cell* has come to be used in many different and inconsistent senses. As Prof. Sachs says: "According to the prevailing terminology, an empty wood fibre is a cell, so is an embryo-sac containing young endosperm, and so also is an Amœba, or a zoospore, or even an entire Caulerpa." Everyone who has had to teach botany will sympathise with the author in his complaints of the confusion thus caused. While other sciences keep their technical l[anguage] up to date, "the science of living things beg[ins] with a word which arose more than 200 years a[go] in consequence of a mistake." Hence, in his opinio[n] radical change in language is demanded; for the t[rue] histological unit the word *energid* is proposed, while [the] old word *cell* can be retained, either for the cell-w[all] alone (its original sense), or for the cell-wall togetl[her] with its contents, whatever they may be, and wheth[er] including one energid or many.

It appears to us that the change proposed is a real a[nd] great improvement; the only difficulty is our firmly fi[xed] habit of connecting the idea of a histological unit w[ith] the word *cell*. Whether the new term be adopted [or] not, Prof. Sachs has done good service in bring[ing] clearly before us the contradictions between our pres[ent] antiquated phraseology and histological facts as th[ey] are now known to us.

The ninth and last section of the work is on [the] causal relations of the form of plants. It consi[sts] mainly of the two essays on "*Stoff und Form*," wh[ich] have already attracted much attention, and met w[ith] much criticism. The fundamental conception on wh[ich] these essays are based, is the idea that the organs [of] plants owe their form to their substance, just as a crys[tal] owes its form to the chemical constitution of its mo[le]cules. Prof. Sachs, therefore, believes that there m[ust] be a special substance concerned in the formation of ea[ch] kind of organ; there must be a root-forming substan[ce], a shoot-forming substance, a flower-forming su[b]stance, and so on. Of course the quantity [of] the active substance by which form is det[er]mined may be extremely small in comparison with t[he] whole material of which the organ consists. Prof. Sac[hs] supposes that these hypothetical formative substanc[es] are, in the case of green plants, produced in the assim[i]lating organs, and thence conveyed to the seats of develo[p]mental activity. He is inclined to identify the formati[ve] substance with the *nucleine*, and is so far in agreeme[nt] with many modern histologists. He regards the differe[nt] specific formative substances as being possibly varieti[es] of nucleine, comparable to the isomers of grape-sugar, [or] of tartaric acid.

The extremely hypothetical character of the who[le] theory is manifest. There is at present no evidence f[or] the existence of specific formative (*e.g.* "root-forming" or "shoot-forming") substances. Even if we acce[pt] nucleine as representing them, we still have no evidenc[e] that it is formed in the assimilating organs, or indee[d] that it exists, as such, anywhere except in the nucle[us] itself. So far as we know at present it seems that t[he] nucleus forms the nucleine, not the nucleine the nucleu[s]. Until some basis of fact is found for the "*Stoff un[d] Form*" hypothesis, it can only be regarded as a forma[l], not a real explanation of the phenomena, howeve[r] valuable it may be as a stimulus to further enquiry.

An addendum to the last paper gives an extract fro[m] the Lectures on the Physiology of Plants (1st editio[n] 1882), on the continuity of the embryonic substance. [It] certainly seems to us that Prof. Sachs' idea here ex[-]pressed is essentially the same as the conception of th[e] continuity of the germ-plasm, which has played so impor[-]tant a part in recent biology. The form in which th[e] doctrine is put by Prof. Sachs is specially applicable to plants, in which the continuity of the germ-plasm can only be traced through the embryonic substance of the growing points.

This collection, containing what are probably the most important contributions of our time to the physiology of plants, is in itself a marvellous record of scientific activity. As Prof. Sachs is still engaged in physiological research, we may hope that a later edition of the work will contain many further invaluable additions to our knowledge.

D. H. S.

OUR BOOK SHELF.

In English Lagoons. By P. H. Emerson. (London: David Nutt, 1893.)

YET another book about the Norfolk Broads, or, as the author prefers to call them, the "English Lagoons." One can hardly credit that anything fresh could be said on this well-worn subject, but Mr. Emerson's book differs from all that have gone before in being a continuous narrative of a twelve months' sojourn on the Broads in his pleasure wherry, the *Maid of the Mist*, and presents to us a graphic picture of these waters under their winter aspect as well as under a summer sky. Much that he has written, more particularly his excellent descriptions of the peculiar scenery of this remarkable admixture of land and water in mid-winter, is highly interesting. The atmospheric effects under various conditions of storm and sunshine, by moonlight and at early dawn, display a keen artistic perception, but the incidents as a rule are trivial to the extreme in fact, and the constant use of the vernacular becomes tiring—whole chapters (*e.g.* Chapter xxi. of six pages) might have been well omitted.

From a naturalist's point of view the reader cannot fail to be pleased with the kindly spirit which pervades the book, the evident delight which the author took in his feathered friends, and his disgust for the wanton destruction which is too frequently committed by thoughtless visitors to these delightful retreats, but having said this we confess we are rather puzzled by Mr. Emerson's ornithology. On page 216, for instance, he mentions watching a pair of desert wheatears on Palling Sand Hills; surely he cannot have met with *Saxicola deserti* in Norfolk. Scarcely less astonishing is the mention of a blue-headed wagtail's nest, and the appearance of the white wagtail on several occasions. The present writer has known the Broads for forty years, but has never had the good fortune to meet with *Motacilla flava* or *M. alba*, both of which are excessively rare in Norfolk, and probably only occasionally appear as passing spring migrants. Many of the observations on birds are interesting, but the following passage is hardly in good taste. Speaking of Surlingham Broad, "which the late Mr. Stevenson, the local naturalist, loved," Mr. Emerson continues, "But this piece of water is to me dull and shadgless, but then Mr. Stevenson did not know shadows from reflections, nor, I suspect, beauties from commonplaces. As a naturalist, moreover, he was not to be compared to the late Mr. Booth, a true lover of birds and an outdoor life. But in Norfolk every native goose is a swan." Mr. Stevenson's reputation as an ornithologist is too well established to need any defence from my pen, but I can say without hesitation that the best general description of the Broad district ever written is to be found in the introduction to his "Birds of Norfolk," and his chapters descriptive of a summer's night and a summer's day on the very Broad which Mr. Emerson considers so uninteresting, show not only his wonderful powers of observation but his keen perception of the beauty and poetry of nature; even so familiar a bird as the redbreast is invested with fresh interest after reading his charming chapter on this pert little friend of man.

T. S.

The Mechanics of Architecture. By E. Wyndham Tarn, M.A. (Crosby Lockwood and Son, 1892.)

THE modern architect is beginning to perceive that he has allowed the engineer to cover the ground with monstrosities because his immediate predecessors considered that any scientific knowledge would spoil the artistic faculty, regardless of the great architects of the past, Sir Christopher Wren, Leonardo da Vinci, and the designers of our cathedrals.

The theories which the author discusses, as of Pillars, Roofs, Arches, Domes, and Spires, Buttresses and Foundations, are illustrated by numerical applications to well-chosen existing examples; so that the architect will thereby acquire confidence in the formulas, and not lay himself open to disaster in consequence of a mathematical misprint.

Graphical constructions are freely employed, which recommend themselves to the draughtsman, who thinks better on his drawing-board than in symbols and formulas.

G.

LETTERS TO THE EDITOR.

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

Telegony.

THIS is a term which Prof. Weismann has recently coined to designate a class of phenomena which have thus far been pretty generally accepted as of unquestionable occurrence in mammals, if not also in birds. I refer to the alleged influence of a previous sire on the progeny of a subsequent one by the same mother. The most notorious instance of this alleged fact is that of Lord Morton's Arabian chestnut mare, which had her first foal to a quagga. Subsequently she produced two colts by a black Arabian horse. These were both partially dun-coloured, and striped on the legs more plainly than the real hybrid had been. One of the colts was also striped on the neck and some other parts of the body; lastly, the mane in both resembled that of the quagga, being short, stiff, and upright. Darwin, from whom this description is taken, records an almost exactly parallel case, on the authority of Mr. James Weir. He also gives a number of references to other cases, not only in horses, but likewise in sheep, swine, dogs, &c. Within the last twelvemonth another seemingly unmistakable case of the same thing took place in the Zoological Gardens, and is recorded by Mr. Tegetmeier in one of the December numbers of the *Field*. Here the first foal was a hybrid between two species of ass, and the second by a male of the same species as the mother. Not a few further apparently well-authenticated instances might be mentioned, but these are enough for present purposes. Indeed, most breeders and fanciers are so persuaded of the truth of "telegony" as to deem a pedigree animal seriously deteriorated in value if she has been covered by an inferior male, while in Darwin's opinion "there can be no doubt" as to the fact of this influence of a previous sire being occasionally exhibited in mammals, although he expresses himself as doubtful with regard to it in the case of birds.

Prof. Weismann, however, has recently challenged the facts. He has also given his explanation of them, supposing them to be facts. Therefore I will consider these two points separately.

Several years ago I undertook an experimental inquiry upon the subject with dogs, which yielded negative results. I then obtained an introduction to Mr. Everet Millais, in order to profit by his large experience and scientific interest in all matters pertaining to dog-breeding. He suggested that the question ought to be put in the journals of fanciers in this country, and also in America, for the purpose of raising discussions upon it. This was done, with the result of letting loose floods of letters to the journals, and not a few private ones to ourselves. Of course this copious response was for the most part valueless, further than to show a general belief among fanciers and breeders in the facts of telegony, coupled, however, with great differences of opinion touching the frequency of its occurrence. Nevertheless, out of all this medley of unscientific assertion, there were a comparatively few cases where it did not appear that coincidence, pre-formed ideas, mal-observation, atavism, &c., could be reasonably assigned, and these served to indicate the most promising varieties with which to work in future experiments.

The general result of our inquiry thus far has been to corroborate the opinion with which we both started, viz. that although the fact of telegony is of very much rarer occurrence than is generally supposed, it nevertheless does appear to take place occasionally, and especially, as Mr. Herbert Spencer has recently observed, where the first offspring has been a hybrid, as distinguished from a mongrel.

On the other hand, there does not seem to be any good evidence of the phenomenon in the case of mankind. For although I have met with an alleged instance of a white woman who, after having borne children to a negro husband, had a second family to a white one, in which some negro characteristics appeared, I have not been able to meet with any corroboration of this instance. I have made inquiries among medical men in the Southern States of America, where in the days of slavery it was frequently the custom that young negresses should bear their first children to their masters, and their subsequent children to negro husbands; but it never seems to have been observed, according to my correspondents, that these subsequent children were other than pure negroes. Such, however, was not the same case as the one above mentioned, but a reciprocal case; and this may have made a difference.

So much, then, for the facts. As regards their interpretation, Mr. Herbert Spencer says, speaking on behalf of the Lamarckians, "And now, in the presence of these facts, what are we to say? Simply that they are fatal to Weismann's hypothesis. They show that there is none of the alleged independence of the reproductive cells; but that the two sets of cells are in close communion. They prove that while the reproductive cells multiply and arrange themselves during the evolution of the embryo, some of their germ-plasm passes into the mass of somatic-cells constituting the parental body, and becomes a permanent component of it. Further, they necessitate the inference that this introduced germ-plasm, everywhere diffused, is some of it included in the reproductive cells, subsequently formed. And if we thus get a demonstration that the somewhat different units of a foreign germ-plasm permeating the organism, permeate also the subsequently-formed reproductive cells, and affect the structures of the individuals arising from them, the implication is that the like happens with those native units which have been made somewhat different by modified functions: there must be a tendency to inheritance of acquired characters." (*Contemporary Review*, March.)

On the other hand, Prof. Weismann says that, even admitting the facts, they in no way militate against his theory of germ-plasm. For, as he says, "such cases could be accounted for from our point of view by supposing that spermatozoa had reached the ovary after the first sexual union had occurred, and had penetrated into certain ova, which were still immature. The immediate fertilisation of the latter is rendered inconceivable by the fact of this immaturity; but the sperm-cell must have remained in the body of the ovum until the maturation of the latter, with the nucleus of which it then united in the process of amphimixis." ("The Germ-Plasm," pp. 385–6.)

It seems to me that we have here, in principle, a sufficient answer to the Lamarckian interpretation of the facts alleged. I say "in principle," because the obvious objection that mammalian spermatozoa cannot be held capable of delving their way through the stroma of an ovary in order to reach unripe ova, may be obviated by supposing that it is the "ids" and "determinants" of disintegrated spermatozoa which do so. For, if there are any such things as ids and determinants, it is certain (from the facts of atavism) that they can survive the disintegration of their containing spermatozoon, and also that they can then penetrate somatic tissues to any extent.

But I have discussed the whole subject in a lengthy appendix to my recently published "Examination of Weismannism," to which I must refer for all details, both as regards the alleged facts and their rival interpretations. My object in raising the issues in these columns is to ascertain whether further light can be thrown upon the subject by any of your numerous read Therefore I will merely add that numerous experime which during the last eighteen months I have been conduct with birds, have yielded uniformly negative results. Sco of purely bred ducks (white Aylesbury), and dozens purely bred chickens (Polish) have been hatched; but in no case has there been the smallest resemblance to their telegon sires. In some cases a year, and in others only a fortnight allowed to elapse between the successive impregnations; bu all cases the broods are as purely bred as if their respect mothers had not previously borne offspring to males of wid different breeds.

GEORGE J. ROMANES

Christ Church, Oxford, September 16.

Quaternions and Vectors.

IN his recent letter (NATURE, August 17, p. 364), which avowedly a reply to my paper (Proc. R.S.E., 1892–93) "Recent Innovations in Vector Analysis," Prof. Gibbs d not seem to me to discuss the real point at issue.

At the end of that paper I summarised the arguments favour of quaternion vector analysis under five heads.

The first of these was: "The quaternion is as fundamenta geometrical conception as any that Prof. Gibbs has name This argument, which was a direct criticism of Prof. Gibb attack on quaternions in his letter to NATURE of two years a is not even referred to in his recent letter. It may reasonab be assumed that silence means consent.

The second summarised argument was: "In every vec analysis so far developed, the versorial character of vect cannot be got rid of." Regarding this, which was a dir criticism of the position of Mr. Heaviside and Prof. Macfarla I am glad to find that Prof. Gibbs is virtually at one with me, a brings to my support the great names of Lagrange and Poiss Now Hamilton's quaternions is admittedly the only vec calculus which takes direct cognisance and makes full consiste use of this principle, the logical consequences of which form t subject of my third and fourth summarised arguments. Th the quaternion wins all along the line.

The fifth and last summarised argument was: "T invention of new names and new notations has add nothing of importance to what we have already learned fro quaternions." This, probably, has most direct connection wi Prof. Gibbs's recent letter, which is to a large extent an expo tion of his own system. And interesting though this may be itself, it does not really make out a case against quaternion and that, be it remembered, is the point at issue. Indee Prof. Gibbs himself admits that the quaternion notation has certain advantage in simplicity. This is plainly so in the ca of ∇, of which in its quaternionic form Prof. Gibbs gives a ve neat application in an equation whose physical interpretation the solution of an important problem. But in this very conne tion, carried away by the exuberance of his humour, he seem to imagine that the *name* Nabla is of the essence of quaternion and that the quaternionist has no right to use the word potentia

I am not aware that I anywhere expressed a dislike the notations $[\phi]$, ϕ_s, $\phi_\times$, which represent quantities mo emphatically quaternionic, or at least Hamiltonian, in the origin. What I wished to emphasise was that, in gettin at the conception of the quantities ϕ_s, $\phi_\times$, Prof. Gib makes use of the so-called indeterminate product, which is n vector but is analytically the same kind of thing as the quate nion product, and that consequently his pamphlet and his fir letter to NATURE are hardly consistent with each other.

I am accused of an inadvertence in the interpretation certain integrals. I have not Prof. Gibbs's pamphlet by me present, but, if I recollect aright, there is no explicit mentio in it of the restriction that the operand is to be a constant vecto Nor do I see that such a restriction is necessarily implied in system in which operators, whether under an integral sign not, are represented symbolically apart from the operand. Th operand is virtually there all the time. The equations ar meaningless without it. To introduce the unexpressed operan is therefore a very different thing from the act of introducing a altogether extraneous vector. With the required restriction however, it appears that Professor Gibbs's integral operators ar not of such general applicability as had been hoped.

But even granting that I have been guilty of an inadvertenc on this point, that in no way affects the general argumen

Satisfactory reasons have still to be given for deserting the quaternion highway. The asserted weakness of Hamilton's calculus, as contrasted with the implied strength of its rivals, has still to be disclosed.

With a view to bring us all to one mind, Prof. Alfred Lodge suggests (NATURE, June 29) that the quaternion be regarded as the difference of its vector and scalar parts, so that the square of a vector becomes *minus* the scalar product of a vector into itself. It is not easy to see what ultimate advantage this change of sign would bring. The most obvious disadvantage would be that it would to a large extent render Hamilton's and Tait's classical treatises of little service to the student. Moreover, it would bring in the quaternion in a very artificial manner, as a kind of after-thought, so to speak; it would, I think, confuse the beginner by forbidding him to make use of powers of vectors in the way generally familiar in analysis; it would accentuate the importance of the product at the expense of the quotient of vectors; and it would tend to obscure the significance of the versor. I am afraid it is too much to ask of any who have got accustomed to the quaternion method to introduce confusion by such a change of sign. Up to a certain point, and along certain lines, Gibbs's and Heaviside's systems lead to results identical with those obtained by quaternions. It has not been shown that they lead to these results more simply or more directly, or that they are more easily mastered by the student than is the calculus of Hamilton. And the same may be predicted of the modified quaternionic system suggested by Prof. Lodge.

Musselburgh, September 4. C. G. KNOTT.

Grassmann's "Ausdehnungslehre."

SIR ROBERT BALL asks why no one has translated the "Ausdehnungslehre" into English. The answer is as regretable as simple—it would not pay. The number of mathematicians who, after the severe courses of the universities, desire to extend their reading is very small. It is something that a respectable few seek to apply what they have already learnt. The first duty of those who direct the studies of the universities is to provide that students may leave in possession of all the best means of future investigation. That fifty years after publication the principles of the "Ausdehnungslehre" should find no place in English mathematical education is indeed astonishing. Half the time given to such a wearisome subject as Lunar Theory would place a student in possession of many of the delightful surprises of Grassmann's work, and set him thinking for himself. The "Ausdehnungslehre" has won the admiration of too many distinguished mathematicians to remain longer ignored. Clifford said of it: "I may, perhaps, be permitted to express my profound admiration of that extraordinary work, and my conviction that its principles will exercise a vast influence upon the future of mathematical science." Useful or not, the work is "a thing of beauty," and no mathematician of taste should pass it by. It is possible, nay, even likely, that its principles may be taught more simply; but the work should be preserved as a classic.

I should be glad to subscribe £10 towards the expenses of translation. If others will join, perhaps some publisher will take the matter up. Is there no machinery by which the universities could be induced to subscribe?

A good book on the subject, entitled "The Directional Calculus," by Prof. E. W. Hyde, is published by Ginn and Co., Boston; and a valuable and very clever elementary exposition, on a geometrical basis, of important parts of the Calculus, by M. Carvallo, appeared in the *Nouvelles Annales de Mathématiques* of January, 1892. The latter will, in one day, enable a student to comprehend the power and elegance of Grassmann's methods.

R. W. GENESE.

Astronomical Photography.

THE nature of chromatic correction adopted for visual telescopes is uniform enough to make it possible to state what kind of photographic plate is desired for use with such telescopes.

A plate which is sensitive to light between C and F in the solar spectrum, with a marked maximum between D and *b*, and insensitive to other light, would be suitable for nearly all visual telescopes, which might in other respects (*e.g.* aperture, focal length, position as affected by climate) be available for taking special photographic records. With existing plates, so far as I have been able to acquaint myself with them, the sensitiveness in the blue and violet is the difficulty.

But whilst such a special plate as I describe would be warmly welcomed, we must not forget that the proved goodness of the photographic star-images of what may be called violet refractors, *i.e.* refractors corrected so that the minimum focus is for violet light, is in great measure to be attributed to the fact that light of short wave length is used. The increase in the diameter of star-images with increased exposures or great brightness of the star, may be, as Scheiner has lately suggested, due to defects in the mode of support of the object-glass or mirror, but doubtless the *goodness* of the images with proper exposures must be connected with the smallness of the scale of the diffraction pattern, and with the concentration of light to the centre of the pattern, which may be got at smaller expense with a violet refractor than with a visual.

Probably few astronomers would have been bold enough, if no photographic plates had been available except plates sensitive only to yellow and green, to urge the preparation of plates sensitive in the violet, on the ground that a violet refractor would give much better results, because short wave lengths were used. And yet a comparison of the results obtained with violet refractors and with reflectors would lead one to the view above expressed, and, I believe, generally accepted.

The increased *range* of sensitiveness of modern photographic plates, with respect not only to the colour, but also to the intensity of the light affecting them, is all in favour of the reflector. A greater and more desirable advance than even the preparation of plates to suit visual telescopes would, I think, be made if the difficulties of supporting, adjusting, and maintaining a mirror were overcome; so that the measurement of star-images may be regarded with as much confidence in the case of plates exposed in reflectors as in refractors. H. F. NEWALL.

Madingley Rise, Cambridge, September 25.

Hering's Theory of Colour Vision.

I AM very much surprised to see that Prof. Ebbinghaus, in the last number of the *Zeitschrift für Psychologie*, announces as new a discovery which has a critical bearing upon Hering's theory of colour-vision—the fact, namely, that two grays composed the one of blue and yellow, and the other of red and green, and made equally bright at one illumination (by admixture of black with whichever of them turns out to be the brighter), do not continue to be equally bright at a different illumination. If two complementary colours were purely antagonistic—that is, if the colour-processes simply destroyed each other, as processes of assimilation and dissimilation must do, and if the resulting white was solely due to the residual white which accompanies every colour and gives it its brightness, then the relative brightness of two grays composed out of different parts of the spectrum could not change with change of illumination. The fact that they do change is therefore completely subversive of the theory of Hering, or of any other theory in which the complementary colour-processes are of a nature to annihilate each other. This consequence of the fact, as well as the fact itself, I stated at the Congress of Psychologists in London in August, 1892, and it was printed in the abstract of my paper, which was distributed at the time, and also in the Proceedings of the Congress.

Prof. Ebbinghaus' discovery is apparently independent of mine, for he supposes that the phenomenon cannot be exhibited upon the colour-wheel. This is not the case; with fittingly-chosen papers (that is, with a red and green which need no addition of blue or yellow to make a pure gray, and with a corresponding blue and yellow) it is perfectly evident upon the colour-wheel. The same paper circles which I used to demonstrate it in Prof. König's laboratory in Berlin are, at the request of Prof. Jastrow, now on exhibition at the World's Fair at Chicago. While Prof. Ebbinghaus' discovery of the fact is therefore doubtless independent of mine, I allow myself to point out that mine is prior to his in point of time.

Baltimore. CHRISTINE LADEL FRANKLIN.

"Megamicros."

IN NATURE of August 24 the following extract from the *Bulletin de l'Académie de Belgique*, No. 6 (1893), is given, viz.:—

"According to Laplace, if the dimensions of all the bodies of the universe, their mutual distances and velocities were to increase or diminish in a constant proportion, these bodies would describe the same curves as they do now. The appearances presented to observers would be the same, and independent of the dimensions assumed. Hence the only facts we are able to appreciate are ratios. In opposition to this theorem, M. Delbœuf shows that if a system consisting of the sun and earth were to be diminished in linear dimensions to one-half, all densities remaining the same at homologous points, and the orbital velocity of the earth were reduced to one-half its value, there would be certain changes in the relations of an observer to his surroundings which could not escape notice. The velocity of sound propagation would be the same as before, but the distance traversed during a certain number of vibrations will appear larger," &c. (p. 406 of NATURE).

Here it seems to be overlooked that according to the above system of reduction of scale, the molecules of air which propagate sound would have to be conceived as diminished in size correspondingly with the planets, earth, &c., for if not, obviously the constancy of ratio of relative dimensions supposed by Laplace could not persist under this reducing process. For, considering "all the bodies in the universe," we cannot regard the linear dimensions of the earth and larger bodies as reduced to one-half, and neglect the smaller bodies (molecules). If then the dimensions of the molecules of air, and also their normal velocities be supposed reduced to one-half, then (according to what is set forth in a paper of mine in the *Philosophical Magazine*,[1] June 1877, relating to sound), the velocity of sound would be exactly halved, and therefore not remain "the same as before," as M. Delbœuf supposes. But the velocity of sound would *appear* the same as before to us with our halved standards of length on the reduced planet, in accord with what Laplace states. For as indicated in the above paper (*Phil. Mag.*), "The velocity of propagation of a wave—such as a wave of sound—in a gas is solely determined by, and proportional to, the velocity of the molecules of the gas; and the velocity of propagation of the wave is not affected by density, pressure, or by the specific gravity of a gas, or by anything else excepting the velocity of its molecules" (p. 452.)

For, on the Kinetic theory, the molecules of a gas can evidently only act upon each other by direct impact, and they therefore propagate any wave at their encounters at a rate proportional to that at which the molecules are moving in the normal state of the gas. If, we imagine then, the velocities of the smaller bodies (such as the molecules of air) to be halved, just as those of the planets, &c., are supposed halved, then the velocity of sound will be necessarily reduced to one-half, as we have seen.

Hence the above argument based on the Kinetic theory of gases would apparently support Laplace's view; and so the velocity of sound would seem to us precisely the same as before. The distance traversed during a certain number of vibrations would not then (as M. Delbœuf thinks) appear larger; all his conclusions seem to me invalidated by his assumed *unsymmetrical* selective diminution of sizes. Of course one-half the present metre would on the reduced earth be still called a "metre," because it would be a ten-millionth of the earth's quadrant, as now. A man a metre high would still be a metre high in the planet of reduced size, and the metre standard he grasped would still be the same length as himself. So it appears that if the universe known to us were suddenly halved in size by reducing the linear dimensions and velocities of all the bodies to that extent, there would be nothing to allow the change to be detected. This would also seem to harmonise with the Spencerian doctrine of the Relativity of all knowledge.

Hamburg, September 4. S. TOLVER PRESTON.

EARLY ASTERISMS.[2]

II.

AS in Egypt so in Babylonia, for the first references to the constellations we must study the religion and the mythology; Jensen shows that the first notions of the Babylonian constellations are to be got by studying the sun-gods, and especially the mythic war between the later sun-god Marduk and the monster Tiāmat.

[1] "Mode of the Propagation of Sound and the Physical Conditions which determine its Velocity on the Basis of the Kinetic Theory of Gases."
[2] Continued from p. 440.

So far as I have been able to gather, any myth like t Egyptian myth of Horus involving combats between t sun and circumpolar star-gods is entirely lacking Babylonia, but a similar myth in relation to some of t ecliptic constellations is among the best known.

In my references to the myth of Horus I have sho that in all probability an astronomical meaning is th the rising sun puts out the northern stars; and there evidence that we have a reference also to a sun-worshippi race abolishing the cult of Set representing the northe stars. I have also shown that temples built to northe stars have had their axes blocked to prevent the worsh and that the northern temples at On and Denderah we among the first founded for the worship of the Divi dynasty of Set or Anubis.

This being so, it is of importance to discuss the Bab lonian myth of the battle between Marduk and Tiām from the astronomical point of view, but before we this it will be well to see if one can trace the history the sun-god of Eridu, which city is universally conced to have been the original centre of Babylonian ide until the descent of the Northmen, and to have be founded by a colony from some other country.

The Sun-god of Eridu.

Let us assume that the earliest sun-god traced Eridu was the sun-god of those early argonauts wh founded the colony.

We are told that this sun-god was the son of Ía ar Dam-kina, his wife symbolising the earth, and that h name was Tammuz (Sayce, p. 144).[1]

This Ía was such a great god that to him was assigne the function of Maker of Men; he was also a great pott and art workman (p. 293), a point I shall return to pr sently. He eventually formed a triad with Anu and B that is, the poles of the heavens and the equator. Th Tammuz (Dumazi) was afterwards identified with Nin Girsu, and ultimately became "the Nergal of Souther Chaldæa, the sun-god of winter and night, who rule like Rhadamanthos, in the lower world" (Sayce, p. 245 and as lord of Hades he was made son of Mul-lil (Sayc p. 197).

This was at first. But what do we find afterwards?

Nergal is changed into the Midsummer Sun! (Jensen p. 484). And finally he is changed into the Spring Su Mardukat Babylon (Sayce, p. 144) where he is recog nised as the son of Ía and Duazag, that is the Easter Mountain (Jensen, p. 237).

Now however difficult it may be to follow these change from the religious point of view, from the astronomica side the changes are not only easily explained, but migh have been predicted, provided one hypothesis be permitted namely, that the colony who founded Eridu were origin ally inhabitants of some country south of the equator.

Such an hypothesis may at first sight appear strange but the view that Eridu was colonised from Cush ha been supported by no less an authority than Lepsius.[2]

Now the boundaries of Cush are not defined, but the may possibly include the Land of Punt from which certainly part of the Egyptian culture was derived.

Punt was always considered a "Holy Land," and i was acknowledged that several of the Egyptian god had been thence introduced. Hathor was "Queen of th Holy Land," "Mistress and Ruler of Punt." Amen R was "Hak" or "King" of Punt, and Horus was th Holy Morning Star which rose to the west (?) of the land of Punt.[3]

Maspero refers to an ancient tradition that the land of Punt could be reached by going up the Nile, where

[1] It would seem also that Isara = Tammuz. This connects the myths o Isis and Osiris, Tammuz and Adonis, and the cult at Byblos (see Sayce p. 228).
[2] Introduction to Nubische Grammatik, 1880.
[3] Rawlinson, ii. 134.

eventually an unknown sea was reached which bathed the land of Punt. Was this one of the great lakes?[1]

Brugsch[2] is of opinion that Punt occupied the south and west coasts of Arabia Felix, but Maspero and Mariette do not agree with him. The two latter authorities identify it with that part of the Somali land which borders on the Gulf of Aden. It is the Cinnamonifera regio or Aromatifera regio of the ancients.[3]

The inscriptions at Dêr el-Bahari make it quite certain that Punt is in Africa. Hottentot Venuses and elephants, to say nothing of the general products of the country referred to as among the freight of the ships on their homeward voyage, distinctly point to Africa, and I think a southern part of it.

The first organised expedition to Punt of which we hear anything is that organised by Se-ānχ-ka-Rā, the last king of the 11th *Theban* dynasty. This was a new traffic by way of the Red Sea. There was then no canal joining the sea with the Nile in existence; the expedition went by land to Coptos.[4]

They further indicate, as Maspero suggests, that the expedition of Hātshepset anchored up a river, and not on the sea-shore, especially since the native huts are shown as built on piles. This again makes Africa much more probable than Arabia.

If we agree that Punt is really in Africa south of Somali-land, there is a great probability that the tradition referred to by Maspero is a true one.

There is distinct evidence that Horus, Hathor, and Amen-Rā are worships coming from the south and dealing with southern stars exclusively. With regard to Horus, it is necessary to discriminate, since there were two distinct gods—Horus in N. and S. Egypt, *and Horus of the south was the elder of the two*. The Hawk God of Edfû, Harhouditi, the southern Horus, had for servants a number of individuals called Masniou or Masnitiou = blacksmiths. The Hawk God of the Delta, the northern Horus, Harsiisit, has for his entourage the Shosou Horou.

Now Maspero has recently pointed out[5] that the southern Horus may have been imported, not from Arabia Felix or Somali-land, but from Central Africa!

Among all early peoples the most important times of the year must necessarily have been those connected with seed time and harvest at each locality. Now the spring equinox and summer solstice south of the equator are represented by the autumnal equinox and the winter solstice to the north of it. If the colonists who came to Eridu came from a region south of the equator, they would naturally have brought not only their southern stars, but their southern seasons with them; but their springtime was the northern autumn, their summer solstice the northern winter. This could have gone on for a time, and we see that their great sun-god was the god of the winter solstice. Tammuz = Nergal.

But it could only have gone on for a time, the climatic facts were against such an unnatural system, and the old condition could have been brought back by calling the new winter summer, or in other words making the winter god into the summer sun-god, in short, changing Nergal into a midsummer sun-god. This it seems they did.

But why the further change from Nergal to Marduk? Because the northern races were always tending southwards, being pushed from behind, while the supply of Eridu culture was not being replenished. The religion and astronomy of the north were continually being strengthened, and among this astronomy was the cult of the sun at the vernal equinox, the springtime of the northern hemisphere, sacred to Marduk. Nergal, therefore, makes another stage onward and is changed into Marduk!

[1] Maspero, "Histoire Anc.," p. 5.
[2] Brugsch, "History of Egypt," 1891, p. 54.
[3] Mariette, "Der el-Bahari," p. 31.
[4] Rawlinson, ii. 131. [5] "L'Antropologie," 189-, No. 4.

It is also interesting to find that in Ninib, another sun god, we have almost the exact counterpart of the Egyptian Horus. He is the eastern morning sun, the son of Isara (? Osiris), and the god of agriculture.[1]

I append one out of many published hymns to the Sun God:—

O Sun (god)! on the horizon of heaven thou dawnest,
The bolt of the pure heaven thou openest,
The door of heaven thou openest.
O Sun (god)! thou liftest up thy head to the world;
O Sun (god)! thou coverest the earth with the majestic brightness of heaven.

Marduk then, the son of Ea, was finally as definite a spring equinox sun-god as Amen Rā in Egyptian mythology was a summer solstice sun-god.

Marduk was more than this, he represented the constellation of the Bull. Here I quote Jensen (p. 315).

"It has already been suggested that the Bull is a symbol of the Spring-Sun *Marduk*; that he was originally complete; that he at one time extended as far as the Fish of *Ia*, *i.e.* the western Fish; that the Fish of *Ia*, out of which the sun emerged at the end of the year in ancient times to enter Taurus, is to represent *Ia*, the God of the Ocean, out of which his son *Marduk*, the early sun, rises daily; finally, that a series of constellations west of the Fish(es) is intended to represent symbolically this same ocean. *Marduk* is on the one hand, as early sun of the day (and the year), the son of *Ia*, the god of the world-water."

As to the sun-god Marduk, then, he represents the sun at the vernal equinox, when the sunrise was heralded by the stars in the Bull.

But what, then, are the fish of *Ia* and the other constellations referred to? They are all revealed to us by the myth. They are the southern ecliptic constellations. We gather this from Jensen's account of the fight that Marduk—this Egyptian Horus—has with certain monsters inhabiting the world-ocean. The monsters being called generically Tiāmat.

Tiāmat.

Tiāmat, according to Jensen, means initially the Eastern Sea (p. 307). This was expanded to mean the "Weltwasser" (p. 315), which may be taken to mean, I suppose, the origin of the Greek ὠκεανὸς, and possibly the overlying firmament of waters.

These firmamental waters contain the southerly ecliptic constellations, the winter and bad-weather signs—the Scorpion, the Goat-fish, and the Fish among them.

It must be pointed out that these southerly constellations were associated with the winter solstice Sun-God of Eridu *in his first stage*.

The Myth of Marduk and Tiāmat.

But this Horus no longer smites the hippopotamus, that is the northern stars, his quarry is elsewhere; he does battle against this world-ocean in the form of Tiāmat and among the allies of Tiāmat we find a Scorpion-Man (p. 277), a Goat-Fish, and a Fish-Man, and to the west of the vernal equinox, *i.e.* in the 'water-region' of the Heavens, a Fish (Fish of *Ia*), a goat-fish and a scorpion.

We are evidently dealing here with Scorpio, Capricornus and Pisces, the ecliptic constellation of the winter months. Marduk against Tiāmat was the never-ending battle of May against December.

Imprimis then we have the later developed northern spring sun destroying the evil gods or spirits of winter, and chief among them, of course, the goat-fish, which, from its central position, would represent the winter solstice.

But this goat-fish was Ia of Iridu. The primal god of

[1] Jensen, p. 195, 198.

Babylonia! This Jensen, by his wonderful analysis (would that I could completely follow it in its marvellous philological twistings, pp. 73-81) puts beyond question, and clinches the argument by showing that our "tropic of Capricorn" of to-day, the goat still represented on our globes of to-day with a fish's tail! was called by the Babylonians "the path followed by Ia" or in relation to Ia.

The myth, then, has to do with the fact that the winter sun worship of Eridu was conquered by the spring sun worship of the north.

If we accept this we can compare the Egyptian and Babylonian myths from the astronomical point of view in the following manner, and a wonderful difference in the astronomical observations made as well as in the form, though not in the basis, of astronomical mythology in Egypt and Babylonia is before our eyes.

Astronomically in both countries we are dealing with the dawn preceding sunrise on new year's day, and the accompanying extinction of the stars.

But which stars? In Egypt there is no question that the stars thus fading were thought of as being chiefly represented by the stars which never set, that is the circumpolar ones, and among them the Hippopotamus chiefly.

The southern cult had conquered the northern one, the southern Horus had conquered Set.

We now learn that in Babylonia the chief change had been in the sun-god. Here the northern cult had conquered. The exotic worship of the winter constellations had been abolished, and they were pictured as destroyed under the form of Tiāmat,[1] although they were once as prominent as Set in Egypt.

Now I believe that it is generally recognised that Marduk was relatively a late intruder into the Babylonian pantheon. If he were a god brought from the north by a conquering race (whether conquering by craft or kraft does not matter), and his worship replaced that of Ia, have we not *mutatis mutandis* the exact counterpart of the Egyptian myth of Horus? In the one case we have a southern sun-worshipping race ousting north-star worshippers, in the other a northern equinoctial sun-worshipping race ousting the cult of the winter solstitial sun. In the one case we have Horus, the rising sun of every day slaying the Hippopotamus (that is the modern Draco) the regent of night; in the other Marduk, the Spring sun-god slaying the animals of Tiāmat, that is apparently the origins of the Scorpion, Capricornus, and Pisces, the constellations of the winter months which formed a belt across the sky from east to west at the vernal equinox.

J. Norman Lockyer.

(*To be continued.*)

THE BRITISH ASSOCIATION.

Nottingham, September 22.

The bright and pleasant weather universally hoped for, but very generally unexpected, has favoured the meeting of the Association after all; it had been the one uncertain element for which the local committee could make no provision. The fine weather has made the success of the gathering complete. By midday on Monday, the 11th, the reception room was in readiness for the multifarious purposes to which it had been applied, and shortly after that time the booking clerks were kept fully employed for some hours in enrolling local members. The arrival of members was less noticeable on Tuesday, but throughout Wednesday the booking clerks, lodging and hotel clerks, the postal department and the various excursion, garden party, and recreation counters were constantly besieged. The admirable writing-room also came largely into use, while the ladies found their way to their own special suite of elegantly furnished apartments. Later on the ladies obtained the privilege of entertaining gentlemen to afternoon tea in their capacious drawing-room, a privilege which became rapidly so popular that the accommodation was inadequate to the demand.

Following the strictly business meetings in the early part of the day, came the first general meeting in the Albert Hall, to hear the President's address. The large hall was comfortably filled with an attentive audience, the decorations consisting of little else than the long series of banners bearing the name, coat-of-arms, and year of service of each of the distinguished Presidents who has passed the chair during the sixty-two years of the Association's existence, the banner of this year's President being suspended in front of his reading-desk. The President's address, which was easily heard throughout the hall, was received with applause, the Mayor of Nottingham and the Bishop of Southwell, respectively proposing and seconding the vote of thanks at its conclusion.

On Thursday (14th) sectional business began in earnest by the delivery of the presidential addresses in the different sections, followed by the reading of papers and reports. The workers of the Association easily found their appointed quarters, and reached them in every case in a few minutes after leaving the reception room, since all the sectional rooms were within easy distance. Five sections met in the University College itself; one in the Poor Law Offices, opposite the College; another in the Central Hall, nearly facing the college; while the geographers had only to pass from the large hall of the Mechanics' Institution (the reception room) to the lecture hall of the same institution. Each of these sectional rooms was completely fitted with all that was requisite to illustrate the papers which were communicated, the equipment ranging from the blackboard and chalk only, to the supply of dark blinds, and lantern supplemented by large diagram frames, electric current, gas, water, compressed gases, and the many other requisites for the experimental sciences. Bearing in mind the difficulty which hard-working members have found at previous meetings in staving off starvation at the luncheon hour, a large luncheon buffet had been provided in the University College; this was accessible to all members, and entailed only a few minutes' absence for luncheon from the business of any section. In the afternoon, Sir John Turner, a local vice-president of the Association, entertained a large party of visitors, with their hosts, in his beautiful grounds at Mapperley; and in the evening the Mayor received the members in the Castle Museum building, where the extensive galleries had been hung with a specially selected series of pictures, and music and refreshments were provided.

Friday (15th) was perhaps specially noticeable for the brilliant demonstration given in Section B by Dr. Meslans, assistant to M. Moissan. The section was crowded, and the audience included a considerable number of the leading British chemists. Dr. Meslans, who had carefully rehearsed his experiments in the laboratory on the previous day, proceeded to prepare gaseous fluorine, and amidst the greatest enthusiasm, both of the experimenter and of his audience, sulphur, phosphorus, silicon, and charcoal were ignited in the stream of the element. Several chemists who entered the room sceptical of the true isolation having been effected, rose and gave their entire assent, and at the suggestion of Sir Henry Roscoe, the President, immediately dispatched a congratulatory telegram to M. Moissan, who had been detained in Paris by indisposition. In the afternoon one party of members

[1] There seems to be no question that Sit, Tiāmat, and the "Great Dragon" of the Apocalypse, represent the same idea. See Sayce, p. 102.

was entertained in the beautiful grounds of Clifton Hall, by Mr. and Mrs. H. R. Clifton; another party was similarly entertained by Mr. and Mrs. Leavers, and inspected the carefully protected rock-dwellings in the grounds. Members met once more in the evening in the Albert Hall, to listen to Prof. Smithell's description of his recent researches on "Flame," and to witness the beautiful experimental demonstration of his views. The audience, at the invitation of Dr. Emerson Reynolds and of Prof. H. B. Dixon, heartily expressed their appreciation of the eloquent discourse, and of the uniformly successful and admirably contrived experiments.

Saturday was in most Sections a *dies non*, as far as scientific work was concerned. Full advantage, however, was taken of the excursions which had been organised for the recreation of the visitors. Sherwood Forest, Haddon Hall, Buxton, Burleigh, Southwell, Minster, Lincoln, Belvoir Castle, and Donington Park were visited in gloriously fine weather; and the list of the places of interest visited was only reduced by one—Wollaton Colliery—this omission being rendered necessary by the strike of the colliers. It may be mentioned that some slight inconvenience had been caused by this lamentable occurrence. Visitors to the town found the military quartered in the neighbourhood of the Guildhall, and learned to their dismay that country houses in which they were to be entertained as guests were filled with billets of police. The railway companies had also been compelled to take off some of their trains; but the inconvenience was scarcely felt—town houses were thrown open to the would-be country guests; trains which would not affect the travelling of members were those selected for removal; and the military parading the streets added a picturesque and entirely peaceful element to the ordinary population of the town. No trouble arose from the miners themselves, although they occasionally solicited alms and food; and it may be stated with truth that visitors to the meeting suffered no more serious loss and inconvenience than that arising from the withdrawal of the permission to descend the colliery. In the evening Prof. Vivian Lewes lectured upon "Spontaneous Combustion," in "The Tabernacle," to an audience of over a thousand working men, who took it into their own hands to accord him a hearty and well-deserved vote of thanks; a similar compliment to the chairman, Dr. Burdon-Sanderson, brought the meeting to a close. Meanwhile a brilliant and crowded audience was listening in the Albert Hall to the concert given by the Sacred Harmonic Society.

"Association Sunday" was marked by the pulpits in many places of worship in the town being occupied by distinguished preachers; amongst these may be mentioned the Bishop of Southwell, Dr. Bonney, Dr. Clifford, Rev. C. Gore, and the Rev. R. F. Horton. By many members the day was, however, spent in the country, or devoted to small social gatherings.

Monday saw the recommencement of serious work in all the sections, relieved later in the day by a garden party at Wollaton Hall, the seat of Lord Middleton, and by an entertainment provided at their Basford Gas Works by the Gas Committee of the Corporation of Nottingham. In the afternoon the General Committee of the Association decided on meeting at Ipswich in 1895. Bournemouth had also applied for the honour of receiving the Association, and announced their intention of renewing their application year by year until they met with success. Application from Toronto was favourably viewed, and it was considered probable that it would be accepted for a future year. The Marquis of Salisbury was elected as President for the meeting at Oxford next year, commencing on August 8, and the other officers of the Association were re-elected. In the evening the Mayor entertained the President, Sectional Presidents, Secretaries, and Treasurer of the Association, together with a few friends, at the Exchange, to dinner; the evening concluded by the lecture given by Prof. Victor Horsley, on "The Discovery of the Physiology of the Nervous System." The lecture was illustrated by a series of original lantern-slides, and was well received by a large and somewhat professional audience, who expressed their thanks, at the suggestion of Prof. Schäfer and Sir Robert Ball.

Tuesday was the only day of the meeting which opened with doubtful weather, inclined to being cold and showery. The unfortunate change culminated in the afternoon at the time of the large garden party in the Arboretum, and had the effect of thinning the attendance to some extent. Those who were present, however, found shelter from slight passing showers in the large tent which covered in the show of the Horticultural Society, and in the capacious refreshment-room; from both of these places the admirable music of the Royal Artillery band could be distinctly heard. The Committee of Recommendations, at their meeting in the afternoon, found it necessary to be economical in the grants made for research; the enrolment of 1661 members had produced only £1653, and this sum was less than that usually received. The list of money grants, however, which were recommended and were finally approved by the General Committee on the following day represent a total of £705. A reception at the Castle Museum brought the day to a close. Mr. Alderman Goldschmidt and Mr. Joseph Bright, as chairman and vice-chairman, respectively, of the Executive Local Committee, received the company. Entertainment was afforded by the string band of the Royal Artillery, and a series of interesting scientific objects were on exhibition. A special feature was the glass-blowing by Herr Zitzmann, of Wiesbaden, who had throughout the week displayed his skill in imitating old Venetian glass-work and in making glass scientific apparatus to large audiences in the chemical theatre of the University College.

The comfort of those attending the *conversazioni* and other general gatherings was secured in great measure by the membership being only an average one, and not unduly large. A larger membership would not only have added to the difficulties of the stewards, but also to the discomfort of those who attended the meetings. It may be safely asserted that the success of the work of the Association in no way suffered by the numbers not being large; whilst those who were playing the part of hosts in the town could the more readily cope with the demand on their kindly services. The number of official and other important members of the Association privately entertained reached nearly 400; and there remained some room both in private houses and in lodgings and hotels, so that the overcrowding frequently complained of in these gatherings was absent.

Of distinguished scientific men from different parts of our own country there was a good attendance; and amongst eminent foreigners who accepted the invitation to attend were the following:—Baron von Reinach; Dr. Meslans, Paris; Prof. Iddings, Chicago; Mons. A. Gobert, Brussels; Prof. Heger, Brussels; Mons. Gilson, Belgium; Dr. Brögger, Norway; Dr. Bock and Dr. Bohr, Copenhagen; Dr. Hertwig, Munich; Dr. Hildebrand, Stockholm; Dr. W. Einthoven, Leyden; Dr. Rothpletz, Munich; Dr. Mandello, Budapest; Dr. Renard, Gand; Mr. Cope Whitehouse, New York; M. de Liegeard, Paris.

On Wednesday little sectional business was transacted, except by the energetic geologists of Section C. In the afternoon the General Committee passed the awards of money towards scientific research, a list of which was given last week.

The business of the meeting was then brought to an end at the concluding meeting by the usual votes of thanks.

In the evening over a thousand members were entertained by the local committee in the Theatre Royal, and witnessed Mr. Wilson Barrett's company in the new play *Pharaoh*.

The concluding day, Thursday, was devoted to whole day excursions to "The Dukeries" (Sherwood Forest, Welbeck, Clumber, Thoresby, &c.), the Midland Railway Works at Derby, Chatsworth and Haddon, Charnwood Forest, Dovedale, Castleton, Matlock and Miller's Dale. The weather was all that could be desired, and the complete organisation led to everything passing off punctually and without a hitch.

The generally expressed opinion of the departing guests was that no meeting was comparable to the present one for enjoyment except that at Montreal. The workers seemed to be generally of opinion that in no direction had the gathering been so useful as in the discussions initiated in several of the sections, to which reference has been made in recent numbers of NATURE. Undoubtedly one of the greatest advantages derived by the annual gathering is the meeting of "researchers" from all parts for the interchange of ideas, and the making and renewal of acquaintance one with another. The impression apparently made on all who have been concerned in the meeting is that the British Association is by no means in a declining condition. It is instinct with life, and those of the inhabitants of Nottingham who have felt the vivifying effect of being brought into contact with many of the scientific pioneers of our time, will wish that the Association, which has stimulated their scientific ardour by its presence, may live to benefit other important centres for many years to come.

FRANK CLOWES.

NOTES.

IT is announced that the bust of the late Prof. John Marshall, which has been subscribed for as a memorial to him, will be handed over to the Council of University College on the occasion of the introductory lecture, by Mr. Bilton Pollard, at the opening of the session on Monday, October 2.

M. JANSSEN, writing to M. Bischoffsheim from the summit of Mount Blanc, on September 12, says that the Observatory has been fixed in its place, and all that now remains is to fit up the interior. It is hoped that observations will be commenced this autumn.

WITH much regret we record the death of Mr. Thomas Hawksley, the well-known civil engineer, on Saturday, September 23. Mr. Hawksley had for some years been at the head of that branch of his profession which deals with gas and water supply. It is said that more than 150 waterworks were constructed under his direction, besides a large number of important gasworks. He was born in 1807, and elected a Fellow of the Royal Society in 1878. In 1871 he was chosen as President of the Institution of Civil Engineers, and held that office for two years. The Institution of Mechanical Engineers elected him President in 1876-7, and he was the first President of the Gas Institute. In addition to these distinctions Mr. Hawksley possessed a number of decorations conferred upon him by various Sovereigns for services to science and to themselves. At the ripe old age of eighty-eight he passed away, leaving behind him a name which will be honoured for many years to come.

THE Right Hon. Lord Thring will, on Tuesday, October 3, distribute the prizes to the successful students of the Medical School of St. Thomas's Hospital. The distribution will take place at three o'clock, in the Governors' Hall.

AT a meeting of the Committee of the Sunday Society, at the Prince's Hall, on Tuesday, the date of Museum Sunday this year was fixed for November 26, when, as in November last, addresses are to be delivered in support of the Society's object, viz. the opening of museums, art galleries, and libraries on Sundays.

PROF. H. A. NICHOLSON will commence the Swiney Lectures on Geology on Monday, October 2, at the South Kensington Museum. His subject is "The Bearings of Geology on the Distribution of Animals and Plants."

THE Gilchrist trustees have granted the delivery of a course of science lectures at the Great Assembly Hall, Mile End Road, on alternate Thursdays, beginning this evening, when Prof. V. B. Lewes will discourse on "Our Atmosphere and its Relation to Life." The other lecturers will be Sir Robert Ball, Prof. Fleming, Rev. Dr. Dallinger, Dr. R. D. Roberts, and Dr. Andrew Wilson. The course will be in connection with the Bethnal Green Free Library.

A COURSE of twelve educational lectures on the principles of Commercial Geography applied to the British Empire will be delivered by Dr. H. R. Mill, at the London Institution, on Tuesday evenings, commencing on October 3. At the opening lecture, which is free, the plan of the course will be explained. Mr. H. J. Mackinder will follow Dr. Mill with a course on the relations between History and Geography.

THE following lectures will be delivered at the Royal Victoria Hall, Waterloo Bridge Road, during October:—"The Life and Work of Sir Richard Owen," by A. Smith Woodward; "A Total Eclipse of the Sun," by Prof. Thorpe; "Electrical Fishes," by Dr. W. D. Halliburton; and "The Compass in Iron Ships," by Prof. Reinold.

THE Dublin Water Committee has recently been carrying out experiments in rain-making. On the 20th inst. three dozen distress signals and one dozen rockets were fired into the air, and ten pounds of tonite were exploded on the ground. A copious fall of rain occurred shortly afterwards, especially on that part of the watershed between the Djouce and the Sugar Loaf Mountains. Whether the precipitation was directly caused by the fireworks is, however, a matter of opinion.

THE weather in these islands has recently undergone considerable change, owing principally to a deep depression which for several days lay between the Shetlands and Norway, causing northerly gales in Scotland, and snow in the northern parts of the kingdom. Frosts have occurred at night over Scotland and the central parts of England and Ireland, while in many places the daily maxima have fallen below 50°. Rainfall exceeding an inch in the twenty-four hours has occurred at several stations in Scotland, but in the midland and southern parts of England the weather generally has continued very dry. From the commencement of the year there is a deficiency in the amount of rain in all districts, amounting to nearly seven inches in the midland counties and south-west of England, and to more than nine inches in the west of Scotland.

THE Rev. S. Chevalier, S.J., Director of the Zi-Ka-Wei Observatory, has recently read a paper before the Shanghai Meteorological Society on the *Bokhara* typhoon which occurred in October, 1892. The typhoon originated on the 7th of October to the east of Luzon, and on the 10th passed very near to the south Cape of Formosa and, whilst crossing that island, wrecked in one night the Norwegian steamer *Normand* and the Peninsular and Oriental steamship *Bokhara*. Observations have been collected and collated for the whole area which came under the influence of the storm, and diagrams are given for selected stations to show the action of the barometer and the position of the typhoon each day from October 8th to 11th. The author considers that the occurrence of a high barometer cannot be taken as a satisfactory indication of a typhoon, as is sometimes asserted, and he gives considerable attention to testing the relation which existed between the occurrence of a high barometer and the typhoon which followed. The first intelligence of the typhoon reached Shanghai on October 8, when a telegram was received from Manila, dated October 7, reporting it to the south-east of Luzon. Mr. Chevalier is of opinion that the typhoon was situated to the north-east, and not to the south-east of Luzon, and he adds that the *Bokhara* left Shanghai with inaccurate information. The storm apparently had its centre about sixty-five miles to the north-east of Appari at 2 p.m. on the 9th, and it must have travelled directly towards the south Cape of Formosa, being about 130 miles distant at 9 p.m. At that time the *Bokhara* was outside the Channel, and had not yet entered into the gale. From the quick fall of the barometer and the veering of the wind from north-east to south-west in a few hours, it is evident both that the centre had passed very near the Cape, and that it had recurved towards the north and north-east, instead of continuing to the north-westward. The barometer on board the *Bokhara* when at its lowest was 29·15 inches, where it remained for several hours. On the evening of the 10th the vessel was quite unmanageable owing to the heavy wind and sea, and was cast on the reef before midnight. The paper contains much valuable data relating to the violent storms which occur from time to time in the China seas.

THE detection of particular pathogenic bacteria in water in the presence of numerous harmless water forms, involves the use of special methods requiring much care and skill in their application. Koch (*Zeitschrift für Hygiene*, vol. xiv. 1893) recently recommended for the isolation of the cholera organism in water the addition of one per cent. of peptone and one per cent. of common salt to 200 c.c. of the water under examination. The latter ingredient is added on account of Dunham's discovery that the cholera bacilli multiply very rapidly when more salt than usual is added to the culture material. The treated water is then incubated at 37° C. for periods of ten, fifteen, and twenty hours, and agar-plates poured at these several intervals, whilst a careful microscopic examination is made of the surface of the liquid. Any colonies resembling those of the cholera organism are isolated from the agar-plates, and are further tested for the indol reaction, as well as for the pathogenic action on guinea-pigs. Koch states that by means of this method he was able to identify the cholera bacillus in a number of waters submitted to him during the recent cholera epidemic in Germany. Quite recently another modification has been published by Arens, "Ueber den Nachweis Weniger Cholerakeime in gröszeren Mengen Trinkwassers." (*Münchener med. Wochenschrift*, 1893, No. 10.) The suspected water is first rendered distinctly alkaline by the addition of 1–1·6 c.c. of a ten per cent. solution of caustic potash to 200 c.c. of the water, so that the latter contains ·05–·08 per cent. of KOH. This alkalised water then receives pancreas bouillon in the proportion of one to nine parts of the water. This bouillon is composed of broth obtained from the pancreas to which Witte's peptone is added, and the whole neutralised with carbonate of soda until a highly diluted portion yields a faint red colour with rosolic acid. The treated samples of water are then incubated and examined as described above. Arens claims that by means of this method cholera bacilli can be detected when present in such small numbers as 2 in 5 c.c. of water.

Two official maps of the geology of parts of Germany have been recently published; one of them, "Geognostische Uebersichtskarte des Königreichs Württemberg," has a scale $\frac{1}{600000}$. The strata are delineated with great minuteness, the subdivisions shown by colour and signs being as follows: 8 Quaternary, 10 Tertiary, 4 Cretaceous, 11 Jurassic, 18 Triassic, 4 Permian, 1 Carboniferous, 1 Devonian (?), 1 Archæan, 6 Igneous. The other map, "Geologische Uebersichtskarte von Elsass-Lothringen," by E. W. Benecke, has a scale $\frac{1}{500000}$. Although on a slightly larger scale, this map shows fewer subdivisions of the sedimentary series than does that of Württemberg; the crystalline rocks of the Vosges, &c., with their associated serpentines and limestones, are, however, carefully drawn. The low price at which these maps are sold is noteworthy—Elsass-Lothringen, 1 mark; Württemberg, 2 marks.

PROFESSOR CHARLES V. RILEY has reprinted, from the Third Annual Report of the Missouri Botanical Garden, the results of his observations, which have now extended over a period of twenty years, on the Pollination of *Yucca*. Every known species of *Yucca* is absolutely dependent, for its fertilisation, on the visits of a single species of insect, in all cases a species of *Pronuba*, a genus of small white moths belonging to the Tineina. The pollen cannot reach the stigmatic tube without artificial aid. The species which has been chiefly observed is *Yucca filamentosa*, which is pollinated by *Pronuba yuccasella*. The process is described in detail by which the female moth pierces the ovary, and deposits the egg in close proximity to an ovule. As soon as the ovipositor is withdrawn the moth runs up to the top of the pistil and thrusts the pollen, which she has gathered from other flowers of the species, into the stigmatic opening, and cross-fertilisation is secured. The larva is developed within the ovary, but the number of ovules destroyed in an ovary is never large, and does not practically affect its fertility. Every other species of *Yucca* has its own special fertilising species of *Pronuba*. *Y. filamentosa* is also abundantly visited by another moth, very similar in appearance to the *Pronuba*, the "bogus *yucca* moth," *Prodoxus decipiens*, which is apparently perfectly useless, and is not dependent on the fertilisation of the ovules for its subsistence. The paper is illustrated by ten plates, and concludes with a monograph of the three known species of *Pronuba* and the ten known species of *Prodoxus*, all named by Prof. Riley.

THE decomposition of any form of energy into two factors, one of which is of a constant magnitude, introduces certain simplifications into the theorems of thermodynamics and chemical physics which appear to merit some attention. Herr W. Meyerhoffer, in the *Comptes Rendus*, points out that the constant factor in the case of heat is not the entropy, as maintained by M. Le Chatelier, but the absolute specific heat, which has the dimensions of an energy divided by degrees of temperature. Entropy, on the other hand, is an energy divided by a number representing the number of degrees possessed by the heat at the time of its passage, and which Herr Meyerhoffer proposes to call the number of the isothermal. The confusion between entropy and absolute specific heat arises from the fact that the dimensions of temperature are at present unknown. Herr Meyerhoffer proposes to call the two factors of energy capacity and potential respectively. Then every transfer of heat will involve a change of two potentials, and the criterion of a reversible process will be the inequality of the two potentials. All the cycles invented since Carnot have always had the same function of transforming the variation of one potential into that of another of different nature. By means of this division of energy, most of the known stœchiometric laws can be reduced to one, thus:—The smallest particles of matter have, in a comparable state, the same capacity of energy. By going through the various forms of energy, Regnault's law concerning the specific heats of gases, and the laws of Dulong and Petit, Faraday, Eötvös, and Dalton may be severally obtained.

Mr. John Daniel has sent us an advance-proof of a paper on "Polarization, using a thin Metal Partition in a Voltameter." The investigation had its starting-point in an observation of Dr. L. Arons', who noticed that ordinary gold leaf, used as a partition in an H_2SO_4 voltameter, allowed a current of ·2 or ·3 ampere to pass without any visible development of gas upon the metal, which was pasted over a hole $1\frac{1}{2}$ c.m. in diameter, bored in a glass plate. The glass plate slid in grooves in a wooden frame, which was placed in the middle of the glass-voltameter. When platinium-foil (0·1 mm. thick) was substituted for the gold-leaf, there was a profuse escape of gas from the metal partition. Mr. Daniel has made similar experiments with partitions of gold, silver, aluminium and platinum of various thicknesses, and with various electrolytes, and has obtained for the different substances, values of the "critical thickness" above which polarization at the partition takes place, as well as some other interesting facts as to "critical current density," &c. He finds, for instance, that the "critical thickness" in good-conducting solutions of H_2SO_4, $CuSO_4$ and NaCl, is greater than ·00009 mm., but less than ·0004 mm., in the case of gold; while ·00015 mm., and ·002 mm. are the corresponding figures for platinum, with a current density of not more than 0·1 ampere per square c.m. of the metallic partition. Between these "critical limits" the polarisation for a given current increases with the thickness. In $CuSO_4$, all the plates except those below the critical thickness were destroyed by oxidation, and a similar effect was noticed in NaCl, in which gold and silver below the critical thickness were quite unaffected, while above it they could not be used on account of the chemical action.

Notes from the Marine Biological Station, Plymouth.—Last week's captures include the Ascidian *Ascidia mollis*. The tow-nets continue to yield the regular autumn forms, among which the Liphonophore *Muggiæa atlantica* and the larvæ of the Polychæta *Magelona* and *Terebella* have generally been plentiful. An interesting feature of recent tow-nettings has been the presence of numerous minute free-floating colonies of certain Didemnidæ. Young *Echini* and *Asterinæ* of this season's growth are now plentiful at a depth of five fathoms and in coralline tide-pools respectively. The following animals are breeding:—The Hydroid *Sertularella Gayi*, the Nemertine *Amphiporus dissimulans*, the Archiannelid *Histriobdella Homari*, and the parasitic Cirrhipede *Sacculina*.

The additions to the Zoological Society's Gardens during the past week include a Leadbeater's Cockatoo (*Cacatua leadbeateri*) from Australia, presented by Miss Mercy Grogan; a Common Quail (*Coturnix communis*) British, presented by Mrs. Mazelin; two Black-pointed Teguexins (*Tupinambis nigropunctatus*) a Crowned Snake (*Scytale coronatum*), a Tree Boa (*Corallus hortulanus*), a —— Snake (*Leptognathus nebulatus*) from Trinidad, W.I., presented by Messrs. Mole and Urich; two Hamsters (*Cricetus frumentarius*, white var.) European, a Black-headed Caique (*Caica melanocephala*) from Demerara, a Corean Sea Eagle (*Haliætus branickii*) from Corea, a Black-pointed Teguexin (*Tupinambis nigro-punctatus*), a Tree Boa (*Corallus hortulanus*), a Boddært's Snake (*Coluber boddærti*) from Trinidad, W.I., deposited; a Golden Plover (*Charadrius pluvialis*) British, purchased.

OUR ASTRONOMICAL COLUMN.

Nova (T) Aurigæ Spectrum.—In the current number of the *Astronomischen Nachrichten* (No. 3189) Mr. W. W. Campbell communicates his observations of the spectrum of Nova Aurigæ since its reappearance in August. At this time the continuous spectrum was very faint, the spectrum consisted of isolated bright lines, and the three brightest lines had the intensities and positions of the characteristic nebular lines, the result being that the spectrum of this new star was announced to be that of a planetary nebula. That this view has not been universally adopted is shown by Vogel's paper on the same star, and he inclines to the opinion that the bright lines are chromospheric, and that the brightest line is not the nebula line. In the present paper Mr. Campbell has made more visual and long exposure photographic observations of nebular spectra, and finds no less than five other lines which are in the spectrum of the new star. The nebulæ he uses here for comparison are: Orion, G.C. 4390, N.G.C. 7027, G.C. 4964, G.C. 4373, and in the photographs of their spectrum he obtains 12, 12, 7, 10, and 5 lines respectively that appear to him to be new. The tabulated list of lines brings out very clearly, that with the exception of the line 451, the identity of which is uncertain in these nebulæ, the Nova lines are matched perfectly in one or more of them, allowing for the fact that they (the Nova lines) were shifted about five-tenth metres (in August and November, 1892) towards the violet. The Nova spectrum, as Mr. Campbell says, "certainly differs no more from the nebular spectra than the nebular spectra differ from each other." As for the lines, 4857, 4336, 4098, and 396 are the well-known hydrogen lines; 5002, 4953, the first and second nebular lines, while all the others correspond well with the nebular lines. The presence of these four hydrogen lines and the chromospheric line 4472, strengthens, as he says, his argument, and he concludes with the words that "if the spectrum is not conceded to be nebular, I must ask what else we should expect in that spectrum if it were nebular?"

The Fireball of January 13, 1893.—In the *American Journal of Science* (vol. xlvi. September, 1893), Prof. H. A. Newton contributes a discussion of all the observations that were made of the large fireball that was observed in America in January last. The great interest attached to this fall lay in the fact, as previously mentioned in this column, that Mr. Lewis, of Ansonia, Conn., happened to obtain a very good picture of the trail as it passed in the line of sight of his instrument while he was photographing the comet Holmes. Prof. Newton seems to have taken great pains to have the information as accurate as possible, and has even had some of the observers cross-examined, so to speak, on many particular points. The plate on which the photograph was taken is 4 by 5 inches, and the meteor went nearly centrally across it, the photographed portion being about 19° long. Several stars of the tenth magnitude in the middle, and some of about the eighth, near the margin of the plate, are shown on the negative, so that some fairly good measurements of the position of the track have been procured. The co-ordinates of seven points of the trail have thus been measured, and a very slight curvature of the path is indicated by the results but not clearly proven, the curvature being caused, as suggested by Prof. Newton, by "the atmosphere's resistance of the irregularly shaped body." An enlarged print of the photograph (about 26 inches long) accompanies the paper. The striking feature of it is the irregularities of light on the path, and also its increase in frequency as the end of the plate is reached. This is due, as supposed, to a rotation of the stony mass, "more rapid at the end than at the beginning, and that the unequal amounts of burned material were thrown off according as a well burned or a raw surface was for the instant in front."

NITRO-METALS, A NEW SERIES OF COMPOUNDS OF METALS WITH NITROGEN PEROXIDE.

A remarkable new series of compounds, formed by the direct union of nitrogen peroxide with certain metals, and of a nature somewhat akin to that of the metallic carbonyls recently discovered and investigated by Mr. Mond and his co-workers, are described by MM. Sabatier and Senderens in the September number of the *Bulletin de la Société Chimique*. It was observed that when vapour of peroxide of nitrogen in a state of tolerable purity was allowed to stream at the ordinary temperature over metallic copper, cobalt, nickel, or iron, these metals being in the finely-divided and pure condition obtained by the recent reduction of their oxides by hydrogen, rapid absorption of the nitrogen peroxide occurred with the formation of definite compounds possessing properties of an exceptionally interesting kind. These compounds are solid non-volatile substances, unlike the metallic carbonyls in this respect, and are represented by the general formula M_2NO_2, where M represents either of the four metals mentioned. Their discoverers propose the name *metaux nitrés*, which perhaps may be conveniently rendered into English as *nitro-metals*.

When a quantity of copper, recently prepared by the reduction of copper oxide in the usual manner by means of a stream of hydrogen or of carbon monoxide, is exposed at the ordinary summer temperature (about 25° being the average temperature of the laboratory while MM. Sabatier and Senderens were conducting these experiments) to a current of the reddish-brown vapour of nitrogen peroxide, it becomes rapidly attacked and converted into a brown substance, considerable heat being at the same time evolved and a large proportion of the nitrogen peroxide absorbed. The brown solid substance produced is found to react with great energy with water, the reaction being accompanied by a copious evolution of nitric oxide, NO. At 30° reduced copper absorbs no less than a thousand times its volume of nitrogen peroxide. Upon analysis of the product it is found to contain about 74 per cent. of copper. A compound of the composition Cu_2NO_2 would contain 73·4 per cent. The nitrogen present was also determined directly, by heating with excess of copper in a stream of carbon dioxide, the nitrogen being measured over caustic potash in the ordinary manner; its amount was found to correspond closely with that demanded by the above formula.

In preparing nitro-copper care must be taken to free the nitrogen peroxide from traces of the vapour of nitric acid, for this acid decomposes the compound with energy, effervescence occurring and the green nitrate of copper being produced. To prevent the deleterious effects of traces of admixed nitric acid vapour the red fumes are allowed to pass first through a column of litharge and afterwards over phosphoric anhydride.

Nitro-copper is unalterable in dry air at ordinary atmospheric temperatures. When heated in pure nitrogen it is dissociated, a temperature of 90° being ample to effect the change; nitrogen peroxide is evolved together with smaller quantities of nitric oxide and nitrogen, and partially oxidised copper remains. One of the most useful properties of nitro-copper is that it may be used for the purpose of liquefying nitrogen peroxide; if a quantity is placed in one limb of a Faraday V-tube and heated, the other limb being cooled, the nitrogen peroxide liberated by the dissociation rapidly collects in the liquid form in the cold limb. If the tube is removed and allowed to stand a short time, re-absorption of the peroxide by the copper occurs. Water reacts with nitro-copper as above mentioned with considerable violence, pure nitric oxide entirely soluble in solution of ferrous sulphate being briskly evolved. The aqueous solution contains cupric nitrate and nitrite, and a sediment of pure copper remains. In moist air, therefore, nitro-copper rapidly deteriorates, becoming enveloped in red fumes and its surface turning green. Hydrogen is without action upon it in the cold, but when heated to 180° large quantities of ammonium nitrite and free ammonia are produced. Dry ammonia gas reacts at the ordinary temperature with some energy upon nitro-copper. White clouds of ammonium nitrate and nitrite and of moisture first make their appearance, then suddenly the mass becomes incandescent and more copious clouds of ammoniacal salts and steam are produced, the residue consisting of copper mixed with ammoniacal oxide of copper. Sulphuretted hydrogen likewise reacts at the ordinary temperature with nitro-copper, heat being evolved, water, sulphur, and a blue sulphide of copper being the products of the reaction.

It would thus appear that nitro-copper is of a kindred nature to the metallic carbonyls, the nitrogen peroxide being held in a similar manner to the carbon monoxide of the latter compounds, and capable of being liberated in a regular manner by the dissociation of the compound by heat. The substance may, in fact, be employed as a convenient means of storing nitrogen peroxide, with the certainty of being able to liberate it by a comparatively slight rise of temperature whenever it is desired to procure some for experimental purposes.

Metallic cobalt reduced from its oxide by means of hydrogen at a temperature below redness is only difficultly pyrophoric in air, not becoming incandescent on admission into air with anything like the readiness of iron. It burns energetically in the cold, however, in nitrogen peroxide. When the nitrogen peroxide vapour is diluted with nitrogen, the heat of the reaction is modified, and the formation of nitro-cobalt occurs in a regular manner, as in the case of copper. It is necessary in the case of cobalt to conduct the preliminary reduction in hydrogen in the same tube as is afterwards used for the preparation of the nitro-compound, in order to avoid re-oxidation of the metal, and it is advantageous to employ as low a temperature for the reduction as possible.

Nitro-cobalt is a black solid substance. Its reaction with water is very violent, but less nitric oxide is produced than in the case of nitro-copper. The rose-coloured solution contains mainly nitrate of cobalt, and a quantity of basic nitrite is found amongst the residual copper. When nitro-cobalt is heated in an atmosphere of nitrogen, a small quantity of nitrous fumes are first evolved, then almost immediately violent deflagration, accompanied by a flame of great brilliance, occurs. The same explosive deflagration occurs if, at the end of the preparation, the supply of diluting nitrogen is shut off before the nitrogen peroxide. When mixed with a combustible substance nitro-cobalt forms a dangerous explosive. If a small quantity wrapped in paper is introduced into an eprouvette filled with mercury at the top of which is a little water, a violent explosion at once results upon the arrival of the small paper packet at the surface of the mercury, owing presumably to the heat of the reaction of a portion of the nitro-cobalt with water causing sudden dissociation of the whole, the organic matter of the paper burning in the gaseous products of the dissociation.

Nitro-nickel is more difficult to obtain in a pure state, for cold reduced nickel reacts so vigorously with nitrogen peroxide that even when the latter is largely diluted with nitrogen a partial oxidation of the metal occurs. Actual incandescent combustion is, however, avoided, and a regular absorption of the peroxide vapour occurs. In a careful experiment a product containing 20 per cent. of NO_2 instead of the theoretical 28 per cent. was obtained. Nitro-nickel closely resembles nitro-cobalt; it is a black substance which reacts with water with evolution of nitric oxide, and which deflagrates with explosive force when heated in a current of inert gas.

Nitro-iron is still more difficult to isolate. When the peroxide is diluted with a very large excess of nitrogen, it is quickly absorbed by reduced iron up to a certain point, when the passage of more peroxide invariably brings about brilliant deflagration and consequent destruction of the product. There is ample evidence, however, that iron does form a nitro-compound of a similar interesting nature to that of the nitro-compounds of copper, cobalt, and nickel above described.

A. E. TUTTON.

PHYSICS AT THE BRITISH ASSOCIATION.

SECTION A met in the well-appointed lecture theatre of the Nottingham University College. Mr. Glazebrook had only just finished his presidential address when an incident occurred which was of interest as showing that members meant business, and were not disposed to allow the authority of the chair to be questioned. Perhaps the experimental work communicated was not of striking novelty or importance, but some of the informal communications and discussions—notably those on electrical theory, the connection between ether and matter, and the teaching of elementary physics—were of great interest, especially to teachers of physics. This was largely due to the active part taken by Lord Rayleigh, Profs. Fitzgerald, Carey Foster, Oliver Lodge, Rücker, and other leading physicists. The discussion occasionally tended to resolve itself into an exchange of ideas around the lecture-table, but as the ideas were for the most part interesting (and energetically expressed) members did not appear to object. At first there was an occasional grumble against Dr. Lodge's innovation of starting at 10 a.m., but the wisdom of the change was shown by the fact that the Section had generally to sit until 2 p.m.

At the first sitting on Thursday (September 14), after the President's address, the "Report of the Committee on Solar Radiation" was communicated. Observations have been made with a thermometer enclosed in a non-conducting case, an image of the sun being thrown upon the bulb. Simultaneous readings of screened thermometers within the case were also taken, and the excess of temperature noted from minute to minute. The thermometer has since been replaced by a thermo-junction, which works very sharply, the readings becoming steady in about six minutes, whereas with the thermometer twenty minutes are required. The readings were calibrated by comparison with an iron-copper junction, heated in paraffin oil and balanced against the actinometer couple. 1° F. was found to be equal to about thirty-six divisions. Another Committee gave detailed reports of magnetic work at the Falmouth Observatory. The other Committees submitted formal reports asking for re-appointment, in some cases with small grants of money.

Prof. G. F. Fitzgerald gave an interesting communication on "The period of vibration of Disturbances of Electrification of the earth." The period of oscillation of a simple sphere of the size of the earth, supposed charged with opposite charges of electricity at its ends, would be about $\frac{1}{17}$th of a second; but the hypothesis that the earth is a conducting body surrounded by a non-conductor, is not in accordance with the fact. Probably the upper regions of our atmosphere are fairly good conductors. In a Geissler tube air is a good conductor, and we know that when part of a gas is transmitting an electrical disturbance the rest of the gas in its neighbourhood becomes capable of transmitting such as well. Extending the analogy, we may assume that during a thunderstorm the air becomes capable of transmitting small disturbances. If the earth is surrounded by a conducting shell its capacity may be regarded as that of two concentric spheres, and is accordingly greater than that of a simple sphere, which would produce a corresponding change in the rate of oscillation. But at the same time the presence of currents in the outer air would alter the self-induction; and calculation shows that the net result is a comparatively slight change in the period of oscillation. If we assume the height of the region of the aurora to be 60 miles or 100 kilometres, we get a period of oscillation of 0·1 second. Assuming it to be 6 miles (or 10 km.) the period becomes 0·3 second. On the sun we might expect very much greater periods of oscillation, but these oscillations would not give rise to radiations. If alternating currents of the kind referred to really travelled north and south around the earth they would give rise to east and west alternating magnetic forces of periods between $\frac{1}{10}$ and $\frac{3}{10}$ of a second. Dr. Lodge has already looked for evidence of such magnetic forces, but on the assumption that the period would be $\frac{1}{17}$ second. The author has calculated what magnetic disturbances would be produced by given charges. A disturbance equal to $\frac{1}{10}$ part of the horizontal force of the earth would correspond to an electrostatic charge of 80 C.G.S. units per sq. cm. Such a charge would reduce the superficial pressure on the earth by an amount corresponding to a weight of 40 gm. per sq. cm. This does not sound probable, but we must remember that it would correspond to a most fearful magnetic storm. A charge of 8 C.G.S. units per sq. cm. would produce a variation of $\frac{1}{100}$ of H, and would not sensibly affect the barometer. The records of existing magnetic observatories are not sufficiently complete to admit of testing the other suggestions made in the paper. Prof. O. Lodge thought that the detection and observation of such magnetic disturbances was work that could only be done in a National Physical Laboratory. If the sun were a conducting body surrounded by a non-conductor, the period of an electrical oscillation upon it would be $6\frac{1}{2}$ seconds. He had hung up in his laboratory a needle and watched it for hours, but the only disturbances observed were due to trains and traffic. He pointed out that the electric vibrations of a molecule, calculated from its size, were more rapid than those required to produce light. He suggested the addition of a jacket like that which Prof. Fitzgerald assumed to exist around the earth; but would this prevent radiation?

The Moon's Atmosphere and the Kinetic Theory of Gases.—Sir Robert Ball has suggested that the absence of any atmosphere investing the moon is a simple and necessary consequence of the kinetic theory of gases. Prof. Liveing has applied this theory to interplanetary and interstellar space, with reference to the chemical constitution of planetary atmospheres. According to Sir Robert Ball the mean molecular speed of oxygen and nitrogen is less than the speed with which a body would have to be projected in order to leave the moon without ever returning; but in the course of collisions between the molecules they frequently attain speeds sufficiently great to enable them to overcome the moon's attraction, and thus escape from the moon's atmosphere. On the other hand, the speed required to permanently leave the earth is one which "it would seem that the molecules of oxygen and nitrogen do not generally ever reach," and therefore the earth retains a copious atmosphere. Mr. G. H. Bryan, in reading his paper on this subject, stated that no statistical calculations had hitherto been made with the object of testing these questions; he was not aware until his paper had been printed that explanations based on the kinetic theory had been suggested as far back as 1878 by Mr. S. Tolver Preston and Mr. Johnstone Stoney. Mr. Bryan has applied the theory to investigate that effect of varying temperatures upon the relative densities of oxygen and hydrogen in a permanent distribution under various conditions; he has also calculated the average number of molecules of gas to every one whose speed is sufficiently great to overcome the attraction of given bodies in the solar system, and gives tables showing the results. Thus for oxygen at 0° C., rather over one molecule in every *three billion* is moving fast enough to fly off permanently from the moon, and only one in every $2{\cdot}3 \times 10^{329}$ is moving fast enough to escape from the earth's atmosphere; while the sun's attraction, even at the distance of the earth, prevents more than one in every 2×10^{4910} from escaping. In the discussion which followed, Sir Robert Ball stated that the suggestion really did not originate with himself, but were familiar to him as having been discussed many years ago in a paper by Mr. Johnstone Stoney. Among celestial bodies the moon is unique in having no atmosphere. In the earth's atmosphere there is no free hydrogen. Stoney's theory accounts for these effects. On the other hand, in the case of big bodies like Sirius it is hydrogen, and essentially hydrogen alone, which forms their atmosphere.

Grinding and polishing of glass surfaces.—Lord Rayleigh stated that he had been investigating the nature of these processes, and gave a most interesting description of the results. He first pointed out that the process of grinding with emery is not, as is commonly supposed, a scratching process. The normal effect is the production of isolated detached pits—not scratches. The glass gives way under the emery; at the same time the emery gives way under the glass and suffers abrasion. An image seen through glass which has been finely ground (but not yet polished) has perfect definition. And so when the sun is viewed through a cloud the image is sharp as long as there is an image; even when the cloud thickens, the edge appears to be sharp until we lose the image altogether. A glass lens finely ground gives very good definition, but there is great loss of light by irregular reflection. To obviate this the lens is polished, and examination under a microscope shows that in the process of polishing with pitch and rouge the polishing goes on entirely on the surface or plateau, the bottom of each pit being left untouched until the adjoining surface is entirely worked down to it. It appeared interesting to investigate the amount of glass removed during the process of polishing. This was done both by weighing and interference methods, and the amount removed was found to be surprisingly small. A sufficiently good polish was obtained when a thickness corresponding to $2\frac{1}{2}$ wave-lengths of sodium light was removed, and the polishing was complete when a thickness corresponding to 4 wave-lengths was removed. Lord Rayleigh is of opinion that the process of polishing is not continuous with that of grinding, but that it consists in a removal of molecular layers of the surface of the glass. Grinding is easy and rapid, whereas polishing is tedious and difficult. The action of hydrofluoric acid in dissolving glass was also investigated, and was found to be much more regular—that is, has generally been assumed to be by chemists. It was found to be easy to remove a layer corresponding in thickness to half a wave-length of sodium light; and with due precautions as little as one-tenth of a wave-length.

Mr. W. B. Croft exhibited simple apparatus for observing and photographing interference and diffraction phenomena. No bench was used, but the various pieces of apparatus were mounted on the usual stands used for holding lenses, &c. One of these contained a thin aluminium plate with a needle-hole, or the slit of a spectroscope. On this the light of a lamp was focussed by means of a lens. As an observing eye-piece, the eye-piece of a Beck microscope was used and was placed about 2 ft. from the slit or point, the object being introduced between. The stands should be adjusted so that the light proceeds straight into the eye-piece. The whole of the special apparatus required need only cost a few shillings, and with this the usual phenomena of Fresnel's bi-prism, sharp edges, perforated zinc, &c., can be both seen and photographed. Mr. Croft exhibited an admirable series of slides photographed direct with the aid of his apparatus, including interesting examples of the bright central spot in the shadow of a small opaque screen (shot).

On Sun-spots and Solar Envelopes.—The Rev. F. Howlett gave an account of observations and records made by him during the last thirty years of sun-spots, &c., and stated that he had not on a single occasion been able to verify the assertions made in 1769 by Dr. Wilson with reference to the behaviour (through fore-shortening) of the umbra and penumbra as a sun-spot approaches the limb of the sun.

On Friday a report was submitted "On our Present Knowledge of Electrolysis and Electro-Chemistry." This was part of a report which was being drawn up by Mr. W. N. Shaw and Mr. T. C. Fitzpatrick. Many investigators have been engaged upon electrolytic work, but their observations have been published in scattered papers and expressed in a manner which makes comparison of them difficult. The present instalment of the report is the work of Mr. Fitzpatrick, who has at great pains collected all the available information on the electro-chemical properties of solutions in water and has compiled an exhaustive table showing the different chemical salts in solution. Data are given respecting conductivity, temperature coefficients, migration constants of ions (from which one can calculate the rate at which ions travel through solutions), fluidity (the inverse of viscosity), &c. As with falling objects so it is with ions; they travel more quickly through a limpid fluid than through a viscous one. This is just why acids conduct better than salts.

On the connection between the Ether and Matter:—Prof. O. Lodge made a further report as to experiments made with the same apparatus as that which he had described to the Section at the Cardiff meeting in 1891. Ever since Fresnel's time the question has been debated whether—(1) the earth carries with it the ether in its immediate neighbourhood, thus causing a disturbance, or (2) rushes through it, and it through the earth, each being independent and moving independently. Dr. Lodge has been endeavouring to settle this question by finding out whether a rapidly revolving steel disc (like a circular saw) exercises any drag upon the ether in its immediate neighbourhood. He uses two such discs of tough steel, about a yard in diameter, rotating in parallel planes an inch apart. He is now able to run the discs at the rate of 3000 revolutions per minute; but even at this high speed no effect is observed which can be attributed to any drag of the ether. He has also replaced the discs by an oblate spheroid of wrought iron with a deep channel or groove cut in it and wound with wire; but the rotation of this transversely magnetised mass (weighing about a ton) does not set the ether in motion.

A Mechanical Analogue of Anomalous Dispersion.—Mr. Glazebrook described a mechanical model which he had constructed to illustrate the theory of anomalous dispersion propounded by Sellmeyer, and developed by Helmholtz and Lord Kelvin. The model consisted of rows of balls connected to each other by elastic strings and connected to fixed beams by springs of varying stiffness.

Prof. Fitzgerald communicated a note on Prof. Ebert's method of estimating the radiating power of an atom, and stated that the results show that molecules have a complex structure, otherwise they would radiate very badly. Prof. Fitzgerald holds that the vibration of an atom is the mechanical vibration of a minute bit of the corresponding matter; and that the ionic charges by their corresponding vibrations excite the external radiation.

Lord Rayleigh gave the results of his investigations on the "Theory of Reflection from Corrugated Surfaces," and also, in the absence of the author (Lord Kelvin), read two papers "On the Piezo-Electric Property of Quartz," and "On a Piezo-Electric Pile." These were followed by two interesting communications on electro-magnetic work carried out under the direction of Prof. Hertz in Bonn.

On Electric Interference Phenomena.—Mr. E. H. Barton described experiments on phenomena somewhat similar to Newton's rings, but exhibited by electromagnetic waves in wires. The waves were generated by a Hertzian primary oscillator consisting of two discs of 40cm. diam. each connected by a wire 1m. long to small brass balls between which sparks passed. Opposite these discs, and about 30cm. distant, were two similar ones from which proceeded a pair of parallel copper wires 8 cm. apart and 160m. long. Along these the waves were propagated and the interference phenomena exhibited. The phenomena in question were produced by hanging sheets of tinfoil on the wires for a certain part of their length. Where the sheets hung the capacity and self-induction of the leads were changed, thus causing a partial reflection of the waves from the *beginning* of this *abnormal* part. But a *second* reflection occurs at the *end* of this part also. Thus interference phenomena were set up, and as the length of the abnormal part was gradually increased the intensity of the transmitted waves was found to periodically increase and diminish. Mr. Barton has recently given (Proc. Roy. Soc.) a theory of these phenomena with which the experiments are in fairly good accord.

On the Passage of Electric Waves through Layers of Electrolyte.—The method and apparatus used in this research were described by Mr. G. H. Yule in a communication to the Royal Society in June last, and an experimental curve was given in the same paper showing that the transmission of trains of electromagnetic waves through a layer of distilled water follows the same law as that of light through a thin plate, *i.e.* that the transmitted intensity varies periodically as the thickness of the plate increases. Similar curves were now given, using dilute solutions of zinc sulphate, alcohol, and a mixture of alcohol and water; in all cases the periodic character of the curve was very well marked. As the transmitted intensity attains its first maximum when the thickness of the layer is half a wave-length, the method may be used to determine dielectric constants. That found for water was 69·5, and for 95 per cent. alcohol 26·7—values agreeing roughly with the high values found by previous investigators.

Mr. J. Larmor referred to a familiar type of caustic curve, produced by reflection from a strip of metal bent into circular form. He pointed out that the source of light need not lie in the plane on which the caustic is thrown—the caustic preserves the same form whether the incidence is direct or indirect.

On Saturday the following papers (mainly of mathematical interest) were communicated:—"On a Spherical Vortex," by Prof. M. J. M. Hill; "Note on the Magnetic Shielding of Two Concentric Spherical Shells," by Prof. Rücker; "The Effect of a Long Tube as a Magnetic Screen," and "The Effect of a Hertzian Oscillation on Points in its Neighbourhood," by Prof. Fitzgerald; "The Magnetic Action of Light," by Mr. J. Larmor (Dr. Lodge characterised this as being perhaps the most suggestive communication made during the meeting, and expressed the hope that it would be further developed and printed); "A Special Class of Generating Functions in the Theory of Numbers," by Major MacMahon; "On Agreeable Numbers," by Lieut.-Col. Cunningham.

On Monday Mr. Horace Darwin exhibited and described the instruments used by the Committee on Earth Tremors. Prof. Milne presented the report of the Committee on the volcanic and seismological phenomena of Japan, and gave a most interesting account of the work done by himself and other observers in Japan.

The greater part of the sitting was taken up by a discussion on the teaching of elementary physics. This was introduced by Prof. Carey Foster, who exhibited and described some simple and cheap apparatus for teaching practical physics. The apparatus shown was well adapted for elementary class-work in heat and electricity. Mr. W. B. Croft followed with a paper in which he described the plan of science teaching at Winchester School, where, by an order of the Privy Council, science is compulsory for almost all the boys. The aim is to arrange for that which may be imposed on all as part of a good education—to supplement thought with the observing faculty. The scheme is also suited for those who may hope to become mathematical physicists and who should in boyhood devote themselves mainly to mathematics. For some boys science forms the best foundation of early education. Public schools are not generally adapted for these cases; but they can well be provided for by a liberal elasticity of system. Prof. O. Lodge read a paper in which Mr. A. E. Hawkins gave the results of his experience of science teaching in public schools, especially in Bedford School. He deprecated the influence of examinations on the teacher's work. Dr. Gladstone considered that apparatus should be not only cheap but simple. To use complicated apparatus was almost as dangerous as to depend upon blackboard work. He agreed with Mr. Buckmaster that too much work was usually expected from a science master. Mr. D. E. Jones emphasised the last point, and stated that instances had come under his notice where science masters had no time to prepare their experiments for class. The idea that science, unlike other subjects, ought to pay for itself, was much to be deprecated; it should not be neglected or abandoned in a school merely because it was costly. The teaching of physics as an educational instrument had not been sufficiently developed; and Continental schools were not much in advance of English ones in this matter. Mr. Jones gave an account of the system of teaching experimental physics as now carried out under Mr. Rintoul at Clifton School. Referring to the subsidising of science teaching in secondary schools, he pointed out that supervision of some kind must accompany public aid. If the evil effects of examinations were to be avoided, an efficient system of public inspection must be developed, and the inspectors should be men with experience of teaching work. Prof. Fitzgerald agreed with this; and Dr. Lodge expressed his regret that head-masters of schools could not be compelled to attend and listen to discussions such as this. The President, in concluding the discussion, said that an effort should be made to replace examinations by an intelligent system of inspection.

The last sitting was held on Tuesday the 19th. The President, as Secretary, submitted the report of the Electrical Standards Committee. This report defines the unit ohm as being the resistance of a column of mercury 106·3 cm. long, and of 14·4521 grammes mass at 0° C. The B. A. unit is equal to 0·9866 of the ohm thus defined. The French authorities had forwarded through M. Mascart four names which were proposed for the ohm of the 106·3 cm., and of these names the committee on the whole preferred "international." The resolutions respecting the electrical units passed at the Edinburgh meeting have now been accepted in Germany, France, Austria, Italy, and the United States, and throughout the British empire. Prof. Carey Foster said it should be known that the work of the Committee was really the work of the President (Mr. Glazebrook).

On Standards of Low Electrical Resistance.—Principal J. Viriamu Jones described the method of determining the ohm devised by Lorenz and used by Lord Rayleigh and subsequently by himself. The method consists in rapidly rotating a copper disc coaxially in the mean plane of a standard coil, the same current being led through the coil and through the low resistance which is to be measured. By varying the speed of rotation the difference of potential between the centre and the circumference of the disc can be made to counterbalance the difference of potential at the ends of the resistance. Prof. Jones pointed out that it is not only the most accurate method of measuring the ohm, but that it is especially suited for the measurement and production of very low resistances. Errors are necessarily produced in stepping down from a standard ohm, say by the potentiometer method, to a resistance of 1/1000 or 1/10,000 of an ohm. The Lorenz method is sufficiently simple and accurate to be adapted for the direct production of low resistances from a rotating disc and standard coil without going through the circuitous process of stepping up to a standard ohm and down again. The difficulty of making a good contact with the edge of the disc is avoided by using a tube with mercury running through it at constant pressure. Difficulties were encountered in using the electrically driven tuning-fork; for although it vibrated uniformly when once started, it was liable to a small change when stopped and started again. A series of experiments on a resistance of 1/2000 of an ohm was given in which the variation from the mean of the extreme values was only 1 in 12,000. Lord Rayleigh expressed his pleasure at the extraordinary accuracy now obtained by the method. In his own experiments the electrically driven tuning fork, instead of being stopped and started again, was kept on all day, and compared at the beginning with a free fork of the same frequency (128). In a recent paper Dorn has criticised the various methods used in the determination of the ohm, and has raised against Lorenz's method the objection that particles of iron in the disc might affect the result by altering the permeability inside the coil. This assumes that the presence of such particles would introduce a direct factor into the result, which would only be true if the whole space inside the coil were so filled.

Apparatus for Comparing nearly Equal Resistances.—Mr. F. H. Nalder exhibited a modified Wheatstone Bridge for comparing nearly equal resistances. In applying the Carey Foster method only a small portion of the usual metre bridge is brought into actual use, and in Mr. Nalder's modification only the part thus used (about 1 decim. long) is provided. This can be replaced by other wires of the same length but of different diameters and therefore resistances; of course the resistance per unit length in each of these is known. The comparison coils are wound in a single bobbin, so as to avoid temperature errors; these, and errors due to the thermo-electric effects, are materially reduced by the compactness of the whole apparatus. Dr. O. Lodge described a new form of galvanometer for physiological purposes. It was designed by himself and made by Messrs. Nalder Brothers. The nerve currents excited by stimuli are exceedingly feeble and, even with the so-called non-polarisable electrodes, the currents under investigation are frequently masked by other effects. Physiologists require an exceedingly sensitive ballistic galvanometer; but they appear generally to use needles which are far too heavy, and galvanometers which are too highly damped, and which manifestly cannot be so delicate as undamped galvanometers. The best form of galvanometer for their requirements is one which contains a very light needle built up of short pieces of highly magnetised steel wire and in which the coils are small and are wound up as close as possible to the needles. The instrument exhibited had four such coils and four needles, forming an astatic system suspended by a quartz fibre in a very weak field. Compared with the usual galvanometers of the same resistance its sensitiveness was at least twice as great. Prof. Boys has shown that excellent definition can be obtained from a small scrap of reflecting mirror; and Lord Rayleigh has shown that a pointer read by a microscope admits of just the same degree of delicacy as the mirror method. As biologists are accustomed to looking through microscopes, Dr. Lodge suggested that they might prefer to observe through a micrometer eyepiece a needle with a bee-sting as pointer. Prof. Fitzgerald suggested that the damping might be further reduced by hanging up the needle in a vacuous tube; and that the polarisations might be swept out by introducing capacities as in cable work.

A Simple Interference Experiment.—There is a well-known interference arrangement in which the object-glass of a telescope is covered by an opaque diaphragm containing two narrow slits. An observer looking through the telescope at a radiant point or slit parallel to the two narrow slits sees a bright central band of white light bordered by interference-bands. Lord Rayleigh had investigated the part played by the telescope in this arrangement, and found that the interference-bands can be equally well obtained by using a plain brass or cardboard tube, having at one end a single slit and at the other a double slit consisting of two fine scratches on a piece of chemically silvered glass about 1/100th of an inch apart. The President thanked Lord Rayleigh for introducing such a simple form of interference experiment, and said it should be more generally recognised that, inasmuch as the eye contains a lens and screen, we can frequently do without an observing telescope in optical experiments.

On Specula for Reflecting Telescopes.—Dr. A. Shafarik communicated the results of investigations which he has carried on since 1870 with the object of producing specula having greater tenacity than that of the Ross telescope. Silvered-glass mirrors produced by the Foucault method suffer rapid deterioration in the air of large towns. The addition of phosphorus is found to make bronzes harder and closer; and the addition of iron, nickel, or cobalt gives them a surprising degree of tenacity. In general the strongest alloys are those which contain the metals in atomistic proportions; and even a small deviation from this proportion appears to diminish the strength considerably. The process of grinding specula differs from that of grinding glass, for alloys are never homogeneous, they are full of crystals, as can be shown by partially dissolving out with acids. The relative tenacity of the Rosse speculum and of two other alloys is given below:—

R $= Cu_4Sn_1$	Strength	$= 1{\cdot}00$
ZN $= Cu_5Sn_1Ni$	,,	$= 6{\cdot}33$
D $= Cu_4Sn_1 + 4$ per cent Zn.	,,	$= 0{\cdot}52$

Several members pointed out that what was really required was a knowledge of the values of Young's modulus for the various alloys investigated, and that it was doubtful whether this was what the author referred to as "strength," or in what way the measurements had been carried out.

Prof. O. Lodge communicated a supplementary note on the ether. He had been asked how could dust polarise light if there was no mechanical connection between ether and matter? But on the electro-magnetic theory there was no difficulty, for light is not an ethereal oscillation but an electrical oscillation, and if the dust has different values of μ and κ from the ether it may affect the wave. Mr. Trouton stated that dust particles act as reflecting resonators with free periods. The President had to confess that he did not fully understand the sense in which Prof. Lodge used the word "mechanical," but considered that a modified mechanical theory (*e.g.* that of the quasi-labile ether) could explain all optical phenomena save those of electro-optics.

A discussion on "The Publication of Scientific Papers" was introduced by the reading of Mr. A. B. Basset's paper. Mr. Basset thinks it highly improbable that scientific societies of position and standing would consent to sink their individuality in order that arrangements might be made for the publication of all important papers in a central organ. The only feasible scheme seems to be the publication of a digest of papers by the co-operation of the various scientific societies; and if thought desirable, papers published in foreign countries might also be included. The development of a well-known periodical is an easier matter than the starting of a new one; and as many authors already send abstracts of their papers to NATURE, it might be worth while considering whether an arrangement could not be made with the proprietors of NATURE by which a supplemental number could be issued (say quarterly) containing a digest of the most important papers published during that period. Mr. J. Swinburne characterised the present system of publishing physical papers as being about as bad as it could be. Papers should be printed and circulated beforehand so as to leave time at meetings for useful discussions. He thought the Physical Society was the most hopeful body to look to, and advised the sending of all physical papers to it. Prof. Fitzgerald agreed with Mr. Swinburne that the publication of titles or indexes alone was unsatisfactory; it was like giving a stone to a man who asked for bread. Abstracts were better, for they gave a little bread with the stone, and he advised the translation of Wiedemann's *Beiblätter* into English. The *Philosophical Magazine* was the personal property of Dr. Francis, and even in the interests of science it was unreasonable to try to evict a man from his own property. The discussion was continued by Prof. Rücker, Prof. Carey Foster, and Lord Rayleigh; and the President in summing up said that the general opinion appeared to be that the matter should be considered by a committee of the Royal Society, if possible in conjunction with the Physical Society.

A new form of air-pump by Prof. J. J. Thompson was exhibited, in which two objects had been aimed at:—(1) to use sulphuric acid instead of mercury; (2) to make the pump self-acting and automatic.

Mr. F. T. Trouton made a communication on a peculiar motion assumed by oil bubbles in ascending tubes containing caustic solutions. A long glass tube was exhibited containing a bubble (about 3 inches long) of sweet oil in a very dilute solution of caustic potash. On inverting the tube the bubble begins to rise, and waves develop on its surface like the knots on a bamboo. These are unstable, and presently resolve into spiral waves which are more stable, because they leave spaces along which the solution can stream past the bubble. If the tube is inclined instead of inverted the bubble crawls up with a slow, caterpillar-like motion.

Dr. R. H. Mill gave a most interesting account of the relation between the temperatures of sea water and air in the Clyde sea area, and illustrated his remarks by an excellent series of slides. After a somewhat unintelligible communication by Mr. E. Major "On the disturbance of a fluid consisting of hard particles by a moving body, with special reference to the ether," the meeting closed with a hearty vote of thanks to the President.

CHEMISTRY AT THE BRITISH ASSOCIATION.

AMONG the advantages of the sectional meetings of the British Association are the opportunites they afford for discussions on scientific matters of special interest, and for the exhibition of experiments and specimens to a wider audience than is often available at the meetings of any single scientific society. The meeting of Section B at Nottingham will be chiefly remembered on account of the success of these two features, and it is to them that attention will be specially devoted in the necessarily brief account which follows.

The papers read on the opening day, after the President's address, were chiefly connected with the chemistry of the metals.

Dr. Gladstone gave an account of some tools and ornaments of copper discovered by Dr. Flinders Petrie and Mr. Bliss in Egypt and Palestine. From the chemical examination of some of these it is concluded that their necessary hardness was imparted by the presence of cuprous oxide.

In a paper by H. Harris and T. Turner a furnace used by the natives of Bengal for smelting iron was described. It is a small shaft furnace, about three feet high, and is capable of producing iron of great purity, from magnetic ore and native charcoal, without the addition of flux.

The Report of the Committee for obtaining an International Standard for the Analysis of Iron and Steel was read by T. Turner. The work of the British Committee is complete as far as the first four standards are concerned. A report, subject to slight revision, has been issued by the American Committee. Their results agree very well with those obtained by the English Committee. Standard 5 is held over for later investigation, after the work of all the committees is complete.

G. J. Fowler read a paper on the preparation and properties of Nitride of Iron. His results confirm those obtained by Stahlschmidt, according to which nitride of iron has a definite composition corresponding to the formula Fe_2N. It dissolves in acid according to the following equation:

$$2Fe_2N + 5H_2SO_4 = 4FeSO_4 + (NH_4)_2SO_4 + H_2$$

By means of this reaction the author, in conjunction with Mr. P. J. Hartog, has attempted to determine the heat of formation of the nitride. Agreeing experiments show it to be formed with evolution of about three calories.

Specimens of Cyano-nitride of Titanium obtained from Ferro-manganese were described and exhibited by T. W. Hogg. This substance has been found present, disseminated in microscopic crystals, in every specimen of high percentage ferro-manganese examined by the author. It can be obtained by elutriation of the carbonaceous residue, left after solution of the alloy in dilute hydrochloric acid, cupric chloride, &c., and has been identified by qualitative analysis, and by comparison with cyano-nitride of titanium obtained from the blast furnace.

On Friday the communications dealt chiefly with the chemical action of light, and the chemistry of the halogens.

Prof. Hummel read the Report of the Committee for investigating the action of Light upon Dyed Colours. Reds were the colours chiefly examined; of these the eosins were found to be the most fugitive. The great bulk of the fast reds belong to the azo-colours. It was especially pointed out that certain reds obtained from natural dye-stuffs are more fugitive than many artificial colours.

After the reading of this report, the President called upon M. Meslans, chief assistant to M. Moissan, to demonstrate the Method of Isolation, and the Properties of Fluorine. The experiments, which were followed with great interest by a large audience, were eminently successful. The apparatus used was the same as that already described in NATURE. On passing a current rather exceeding twenty-five amperes through the solution of potassium fluoride in hydrofluoric acid cooled by the evaporation of methyl chloride to $-23°$, fluorine was disengaged at the positive pole, its presence becoming evident by the strong smell of ozone. The combustions of silicon, boron, phosphorus, iodine and carbon in the gas, were shown with great success.

M. Moissan's apparatus for determining the density of fluorine was shown. After the vote of thanks to M. Moissan and to M. Meslans, proposed by Sir Henry Roscoe, and seconded by Prof. Thorpe, had been carried by acclamation, a telegram, at the suggestion of Sir Henry Roscoe, was despatched by the President to M. Moissan, congratulating him on the success of the experiments. A reply was afterwards received from M. Moissan regretting his inability to be present at the meeting.

Specimens of M. Moissan's artificial diamonds, and of the Carbide of Uranium which coruscates brilliantly on shaking the bottle containing it, were shown to the section.

Dr. S. Rideal described the results of his experiments to determine the Iodine Value of Sunlight in the high Alps. The experiments were made at St. Moritz in the Engadine, at a height of about 7000 feet, the method being exactly in accordance with that recommended by the Manchester Air Analysis Committee. From comparison of the results with some obtained in Manchester at the same time of year (viz., January), it appears that as much sunshine falls upon St. Moritz in one day as upon Manchester in ten. It is this large amount of sunshine doubtless which renders St. Moritz so favourable a health resort. It appears from some experiments made in the Alps by Prof. Dixon by and Dr. Kohn that above a certain height the amount of sunlight as determined by the liberation of iodine does not increase.

The Report of the Committee on the Action of Light on the Hydracids of the Halogens in the presence of Oxygen was read by Dr. A. Richardson. The committee have been investigating the conditions necessary to start the decomposition of hydrochloric acid in presence of oxygen. Experiments show that the presence of metallic salts is of great influence in this respect; the action of metallic chlorides is being especially studied.

The Expansion of Chlorine and Bromine under the influence of Light was shown on the screen by Dr. Richardson. For the success of the experiment it is necessary that the surface tension between the liquid, used as indicator of the expansion, and the tube in which it moves, should not be great.

Some interesting experiments made to determine the Rate of Evaporation of bodies into Different Atmospheres were described by Dr. Phookan. From the results obtained with naphthalene, it appears that vapours behave quite differently to gases in the manner in which they affect the rate of evaporation of this substance into them.

At the Monday sitting, Prof. P. Frankland read a paper introducing a Discussion on the Present Position of Bacteriology, more especially in its relation to Chemical Science. Prof. Frankland said that the present science of bacteriology really dated from the discovery, some twelve years ago, of methods for obtaining pure cultures. Since then the changes which have taken place have been chiefly in the methods employed for the recognition of bacteria. Microscopical characteristics, even when they have been brought out by mordant staining, have been found to be insufficient for this purpose. This was illustrated by the case of the cholera spirillum, as much difference existing between the different specimens of this spirillum, as between it and totally different species. Morphological have consequently been obliged to give way to chemical and physiological tests. Chemical tests being as yet few in number are apt to be treacherous, but they are capable of considerable extension. The typhoid bacillus, *e.g.*, will give no reaction with indol, the characteristic of the cholera bacillus, nor will it ferment glucose, but it will coagulate milk. With regard to the chemical products of the action of organisms the following questions suggest themselves:—Does the same substance yield different products with different bacteria? Do the same bacteria give rise to the same products with different substances?

Experiments with pure cultures have shown that one and the same bacillus will give identical products with such chemically related bodies as glycerol, arabinose, mannitol, &c. It appears probable that fermentability is due to the power possessed by a set of substances of yielding the same intermediate body which will give identical end products in all cases. This may explain why only those sugars which contain three carbon atoms or a multiple of three in their molecule appear to be fermentable.

The production of all three varieties of lactic acid by fermentation of glucose by different organisms has been accomplished. The mechanism of their formation was discussed in the light of Emil Fischer's formulæ for the glucoses.

The problems of selective fermentation were next dealt with, the cause of which was to be sought for in the slight differences of solubility &c., shown by active substances, when in combination with optically active isomeric bodies. One isomer is not found always to be quite unfermentable; in some cases both isomers can be destroyed if time be allowed, one, however, always disappearing first.

Of great interest is what may be termed educational culture, by means of which new characteristics may be artificially impressed upon an organism. A species of bacillus, morphologically identical with anthrax, but totally incapable of producing spores, may be obtained by cultivation of true anthrax in broth containing certain salts, such as potassium dichromate, or nitrate. The new characteristics will even persist after passage through the bodies of animals. On the other hand, by various means the virulence of pathogenic organisms can be greatly increased, though it has not been found possible to produce pathogenic from non-pathogenic organisms. It becomes probable, therefore, that naturally occurring bacilli will acquire new characteristics according to alterations in their condition of growth. The occurrence of non-toxic associated with, and morphologically identical with certain toxic organisms, *e.g.* those of diphtheria, anthrax, cholera, and typhus, is suggestive in this connection.

It is possible that ærobic organisms may become so far modified as to be active in absence of air. Much study is wanted in this direction, which affords special opportunities for observing the conditions of evolution among simpler forms of life.

The application of bacteriology to hygienic matters was next dealt with, with special reference to the bacteriological examination of water.

Finally, the disinfecting action of light under different conditions was spoken of. The generation of hydrogen peroxide, from air and moisture, under the influence of light, discovered by Richardson, would seem to play an important part in this action of sunlight, and the problem partly resolves itself into the study of the conditions of formation of this substance. The effect of different salts in modifying the bactericidal effects of sunlight was touched on, and in conclusion the necessity was urged upon chemists of a knowledge of biology and botany, to enable them to carry on bacteriological work, for which the first necessity had now become profound knowledge of chemistry and chemical methods.

In the course of the discussion, which owing to the length and comprehensiveness of the paper was not prolonged, Prof. Burdon-Sanderson advocated the establishment of an institute for research where chemists, biologists, and pathologists could mutually assist one another. It was resolved that, with his permission, Prof. Frankland's paper should be published in full.

The following papers were read in connection with the subject of discussion, viz., "Remarks on the Chemistry of Bacteria," by R. Warington, F.R.S.; "Fermentation in connection with the Leather Industry," by J. T. Wood; and "Some Ferments derived from Diseased Pears," by Dr. G. Tate.

On the Tuesday morning, Prof. H. B. Dixon opened what proved to be a most interesting discussion on Explosions in Mines, with special reference to the Dust Theory.

Opinions on this subject may be grouped under three heads:—

(1) That although it is possible to stir up and ignite a cloud of dust, the flame dies out and is not explosive; *i.e.* that a mixture of coal-dust and air *per se* is not explosive. This is the view held by Mallard and Le Chatelier.

(2) That, although a mixture of coal-dust and air *per se* is not explosive, a very slight addition of fire-damp, insufficient to be recognised by the Davy lamp, will render the mixture explosive. This view is supported by the experiments of Abel.

(3) That a mixture of fine coal-dust and air is *per se* explosive, and that the explosion once started in such a mixture can be propagated as far as the mixture extends.

Prof. Dixon then gave a brief history of the subject, dealing chiefly with the characteristic features presented by certain great mine explosions, and the experiments and results of the committees in different countries who have studied the question. The explosion in the Seaham Colliery in 1880 was specially dealt with. By means of a diagram it was shown that the only portions of the mine untouched by the explosion were those which were damp, and therefore free from dust. It was impossible to explain the method of propagation of this explosion otherwise than by the dust theory. Mr. Hall's experiments in 1891, in which a cannon was fired at the bottom of an old shaft in which coal-dust was suspended, were described, and photographs of some of the explosions shown. In some cases explosions could be brought about by these means, in others not, suggesting that the explosion was largely dependent on the character of the coal-dust. In conclusion, the importance of carefully testing for low percentages of fire-damp was pointed out, and also the possible advisability of using the fuses containing ammonium nitrate, recommended by the French Commission, on account of their low temperature of detonation.

At the conclusion of Prof. Dixon's address, Prof. Clowes exhibited his portable safety lamp, with hydrogen attachment for delicate gas-testing, described in the Proceedings of the Royal Society, vol. lii.

Mr. Galloway followed with a vigorous defence of the coal-dust theory. The dusty mines are always the deep mines which, owing to their greater warmth, are dry. In no mine of a less depth than 600 feet has any great explosion occurred. In damp mines explosions are limited in their area, while in dry mines they may ramify sometimes for a mile or so. In his opinion the experiments which had given rise to the belief that stone dust could convey explosions should be repeated. It was to be noted in drawing conclusions from laboratory experiments, that the conditions obtaining in the mine were more favourable to the production of explosions, the temperature being higher and the air drier and denser. In conclusion he showed that the anticipated evils resulting from watering the mine do not occur.

Mr. Hall, in the course of his remarks, said the higher the quality of the coal, the greater was the liability to explosion. He hoped that it had been proved to the satisfaction of practical people that coal-dust and air alone were competent to produce explosion.

Prof. Thorpe said that in an explosion caused by flour-dust, which had reduced a mill to a heap of dislocated bricks, he had received an object lesson, which had quite converted him to the coal-dust theory. Experiment had shown him that coal-dusts varied greatly in their capacity of exploding; some will not explode under any conditions, while others he could at any time explode with certainty.

Mr. Stokes declared himself in favour of the second of the three opinions mentioned by Prof. Dixon. It should not be concluded that large amounts of gas could not rapidly accumulate in pits. In one mine, in which for four years no gas had been found, an evolution of gas took place which in twenty-five minutes was sufficient to fill the workings. The lamps being good, no explosion took place; had it done so, all the evidence would have been in favour of its origin being due to coal-dust. He looked for remedial measures in improved explosives and safety-lamps, rather than in watering, which he considered insufficient to more than moisten the surface of the dust, unless carried to an impracticable extent. Others having spoken, mainly in favour of the coal-dust theory, Prof. Dixon, in reply, said that he was glad that all mining engineers now seemed to recognise the dangerous character of coal-dust.

After the above discussion, Prof. Smithells showed by experiment that iodine vapour will glow on heating, supporting his contention that the luminosity of flame may be due to incandescent gas.

The papers on organic chemistry read at Nottingham were very few, viz.—"On the Red Colouration of Phenol," by Dr. C. A. Kohn; "On the Salts of a new Sulphurea Base," and "On Citrazinic Acid," by W. J. Sell and T. H. Easterfield; and "On Ethylbutane Tetracarboxylate and its Derivatives," by Bevan Lean. In the course of the latter investigation two isomeric modifications of di-benzyl adipic acid have been obtained. The Report of the Committee on Isomeric Naphthalene Derivatives was read. The work done has been chiefly in connection with the orientation of mixed nitro and halogen derivatives.

The following pieces of apparatus were described, viz.—An Apparatus for Extraction for Analysis of Gases dissolved in water, by Edgar B. Truman, and a new form of Bunsen and Roscoe's Pendulum Actinometer, by Dr. Richardson and J. Quick.

GEOLOGY AT THE BRITISH ASSOCIATION.

OUT of the sixty papers contributed to this year's meeting of Section C. a considerable number, as might have been expected from the personal influence of the President, Mr. Teall, were on subjects connected with Petrology. Amongst this series, two of the most important were read by the eminent foreigners Prof. Brögger and Prof. Iddings, who had come over especially to attend this meeting. Next in number were the papers on Glacial Geology. The other papers group themselves into those on Local and Triassic Geology, Palæontology, Foreign Geology, and Vulcanology.

"On the Genetic Relations of the Basic Eruptive Rocks of Gran (Christiana region)" by Prof. W. C. Brögger.—This paper dealt with a series of eruptive bosses and laccolites forming a line of hills, of which the chief, in order from north to south, are (1) Brandberget, (2) Sölvsberget, (3) Dignæs. The main rock type in these bosses was called by the author Olivine-gabbro-diabase. It is basic (43 per cent. SiO_2) in 1, rather less basic (47 per cent.) in 2, and somewhat acid (49 per cent.) in 3; the more basic rocks were erupted first, then the less and less basic in order from north to south. From the intimate connection of the minerals in the different types, and the occurrence of all intermediate varieties, it was proved that these rocks had segregated in succession from a magma whose average composition was not unlike tha of the rock of Sölvsberget. The gradation in chemical composition produced a similar gradation in the mineral percentages, the felspar increasing from 12–64 per cent., and the pyroxene diminishing from 67–10 per cent. in a southerly direction. The author briefly stated that the contact metamorphism due to these plutonic rocks was quite different in character from that produced by a neighbouring mass of quartz-syenite on the same group of sedimentary rocks.

The eruptive bosses are accompanied by a great series of dykes and sheets of lamprophyric character, and varying from Camptonite to Bostonite. The author brought forward a quantity of evidence to prove that (1) these two extreme types, with silica percentages ranging from 40–56, had been derived from the same magma; (2) that 9 parts of Camptonite and 2 of Bostonite (about the proportion observed in the field) would give a magma of the composition of the Olivine-gabbro-diabase of Sölvsberget; (3) that these lamprophyric dykes had been derived from the same magma as the plutonic rocks; and (4) that the differentiation had been effected while the magma still remained fluid. It was further shown that the differentiation was probably due to the migration of less soluble constituents to the cooling margin, that the Camptonites had a composition closely allied to that of the brown hornblende of the area, and that while the essential cooling of the plutonic rocks had taken place in the eruptive bosses themselves, the dyke rocks had segregated before extrusion.

A subsidiary differentiation has taken place in some of the plutonic rocks, giving rise in the more basic Brandberget to a pyroxenite (with 95 per cent. of pyroxene) and augite-diorite, and in the less basic Sölvsberget to pyroxenite and Labrador-porphyrite.

Other points of importance to be noted were: (1) That under different physical conditions not only various mineral aggregates, but rocks of varying chemical composition had resulted from the crystallisation of the same magma; (2) that similar products result in this case from the segregation of an Olivine-gabbro-diabase magma, as have elsewhere been derived from a magma that has produced nepheline-syenites; (3) that the direction of segregation according to laws of crystallisation throws considerable light in the order of volcanic eruptions from neighbouring centres.

"On the Dissected Volcano of Crandall Basin, Wyoming," by Prof. J. P. Iddings. This paper was divided into a strictly petrological portion, and one dealing more broadly with the features of the area, and illustrated by slides brought over for the purpose by Prof. Iddings. The palæozoic and mesozoic deposits, almost unbroken up to the Laramic, had been disturbed and eroded before the outbreak of this volcano, now represented by lavas and breccias, penetrated by radiating dykes, and a core of crystalline rock, which is surrounded by a chaotic mass of scoriaceous breccia and massive flows. Erosion has removed at least 10,000 feet from the summit of the volcano, and has cut 4000 feet deeper into the valleys on either side of the centre. The lower breccia contains several varieties of andesite, the upper is chiefly basaltic, which is also the character of the chief massive flows. The dyke rocks are on the whole more crystalline, and contain biotite to the almost total exclusion of the olivine of the lavas and breccias. The core is chiefly of gabbro, which, however, passes into diorite, and even to aplite; these highly acid rocks appear to be amongst the latest of intrusions, but are cut by a few dykes of lamprophyric basic rock, which are also represented in the flows outside the core. The author's investigations show that under different circumstances totally different mineral aggregates arise from the cooling of the same magma. The basalts containing plagioclase, augite, olivine, magnetite, and sometimes hypersthene, the gabbros, plagioclase, augite, hypersthene, and biotite, besides some magnetite, orthoclase, and quartz, with or without hornblende. Further, the coarseness of crystallisation in the core and dykes seems to have been more influenced by the temperature of the surrounding rock than by the pressure to which they were subjected.

"On Structures in Eruptive Bosses which resemble those of ancient Gneisses," by Sir Archibald Geikie. He thought Lehmann's theory of the dynamical origin of foliation might explain granulitic gneisses with thin folia extending uniformly over a large area, but was inadequate to explain coarsely banded masses of irregular composition. These were better compared with the structures visible in the deeper parts of eruptive bosses in which minerals were segregated into bands, often parallel, and containing one prominent mineral in large crystals. Pegmatite veins, traversing not only massive unfoliated rocks, but the segregated bands, also occurred. These structures were best seen in ancient plutonic masses, but had also been lately observed by the author in the recent volcanic rocks of the Western Isles of Scotland.

On "Berthelot's Principle applied to Magmatic Concentration," by A. Harker. The paper deals with that type of concentration in which an igneous rock-magma, supposed originally homogeneous, has been differentiated by accumulation of the more basic ingredients in the cooler marginal part of the liquid. The author tries to find a physical cause for this action by comparing such a magma with a *saturated* saline solution, and applying Berthelot's "principle of maximum work" or the cognate one of "most rapid degradation." The migration of the least soluble ingredients to the part of the liquid most easily saturated would determine crystallisation, the process which in the case supposed would give the most rapid evolution of heat.

On "The Igneous Rocks of Barnavave, Carlingford," by Prof. W. J. Sollas. The white granophyre of this tract is intrusive into a black gabbro, in dykes of all sizes down to the most minute films and specks amongst the constituents of the latter rock. The result of this intimate intrusion is to convert the gabbro locally into a quartz gabbro, whilst the granophyre is loaded with fragments varying from large masses to crystal dust derived from the fracture of the gabbro, thus becoming a hornblendic granophyre. These intermediate rocks have been made out of a mixture of acid and basic constituents. The same author gave an analysis and microscopical description of an intrusion of Amphibolite at Glendalough, which, at its margin, had been transformed into Quartz-mica-diorite by the action of veins which were filled with potash felspar in the hornblende rock, but with quartz in the adjacent schists. Both these papers were well illustrated by lantern slides. Prof. Sollas also exhibited some pebbles from an ancient consolidated beach at Sandymount, co. Dublin, which had impressed one another on account of the perpetual jarring of the tram-cars running over them. He thought it was likely that earth tremors had had considerable influence in producing the similar pittings in Triassic pebbles. Bearing on this subject Dr. V. Ball showed incised bones and antlers from Irish peat-bogs, the cuts on which were due to pressure and tremors passing through the bog.

There were two papers, by Mr. W. W. Watts, on Irish petrology; one, "On a Hornblende-Pikrite intrusive in Cambrian Rocks at Greystones, co. Wicklow," described a rock consisting mainly of green and colourless hornblende enclosing grains of olivine, now converted into a mineral-like colourless amphibole; and another, "On the Perlitic Quartz Grains in Rhyolite of Sandy Braes Quarry in Antrim," in which the porphyritic quartz grains exhibited a series of concentric cracks, perlitic in character, the bulk of which were confined to the quartz crystals, but some of which traversed quartz and matrix alike.

"On Augen-Structure in Relation to the Origin of Eruptive Rocks and Gneiss," by Mr. J. G. Goodchild. Passing over that type of this structure more properly named phacoidal, the author confined himself to those "eyes" of minerals which have grown *in situ* in the rock where they occur. In cases where the original rock contained the necessary material for the formation of the "eyes," a rise in temperature or relief in pressure sufficient to enable the less refractory minerals to aggregate, but not sufficient to alter the chemical and physical state of the matrix, appears to have been all that is necessary. In other cases the author suggested that the necessary alkalies for the formation of such substances as secondary felspars may have been derived from the inner zones of the earth's crust.

A very useful and well-illustrated paper was read by Mr. Arnold-Bemrose, "On the Derbyshire Toadstone." There are two, at least, and may even be three or four, beds of olivine dolerite associated with tuffs. The rock is columnar and spheroidal, and may frequently be met with in an undecomposed state when the augite occurs in grains or ophitic plates containing felspar or olivine. There appears to be no foundation for the supposition that the toadstone contains no lead ore. All these rocks are surface lava flows.

Messrs. Howard and Small divide the igneous rocks of South Pembrokeshire into a northern group of rhyolites associated with quartz diorites and granites, often gneissose in character, and with epidiorites and hornblende schists, and a southern group at Musclewick Bay, consisting of porphyrites and dolerites in connection with a rock like a soda felsite. The authors are unable to fix the age of the rocks, but think the evidence goes to show that the rocks are, at the earliest, of Post-Silurian date.

Amongst the local papers, one by Prof. Clowes was of considerable interest. In it he showed the rock of which Bramcote and Stapleford hills and the Himlack stone were composed, was cemented by barium sulphate present occasionally in such quantity as to make 50 per cent. of the whole rock. Sometimes the crystalline cement was evenly distributed in minute crystals, but at others it was aggregated into patches which made the rock weather unevenly, so as to produce the so-called "pebble sand-beds." The author had no evidence of the form in which the cement was originally deposited—whether as carbonate or directly as sulphate.

Prof. E. Hull pointed out that the Nottingham water supply was derived from the Bunter sandstone, which was underlaid by the impervious Permian marls. Allowing that 20 out of 30 inches percolated into the sandstone, he calculated that the area of its outcrop from Worksop to Nottingham (120 square miles) must receive 40,000,000 gallons, all of which tends to flow eastwards. From the three stations about $5\frac{1}{4}$ million gallons were pumped daily. In a note on "The Borings at Netherseal Colliery," Prof. Hull determines the lowest rocks reached under Trias and Coal Measures at a depth of about 770 feet from the surface, as grits, sandstones, and quartzite, and attributes to them a Lower Cambrian age.

A number of more or less local papers relating to the new red sandstones were grouped together. Prof. Lapworth gave a general account of the subdivisions, distribution, and thickness of these rocks in the Midlands. Mr. Irving followed with a *résumé* of his researches for twenty years into the younger red rocks, referring to the classing of the Devonshire igneous and lower stratified red rocks as Permian in the recently published index maps of the Geological Survey. Mr. Metcalfe gave a note on the Gypsum deposits of Notts and Derbyshire. Baron von Reinach and Mr. Ussher recorded the discovery of Upper Magnesian limestone shells at Bulwell, and Messrs. Kendall and Gray showed that the presence of Permian marls at Stockport destroys the supposed evidence of unconformity there between the Permian and Trias.

After a brief discussion on Geological Education, Tuesday was devoted to glacial papers and discussion. Mr. Dugald Bell read an abstract of a most careful and important investigation into the shell-bearing clays of Clava in Nairn. The section in descending order, proved by excavation and boring, is as follows:—

	Feet.
(1) Surface soil and sandy boulder clay	43
(2) Fine sand	20
(3) Shelly blue clay with stones in lower part ...	16
(4) Coarse gravel and sand...	15
(5) Brown clay and stones	$21\frac{1}{2}$
(6) Solid rock, Old Red grit	

The highest part of the shelly clay is $503\frac{1}{2}$ feet above sea level, and the deposit appears to be continuous for a distance of 190 yards. It contains far-travelled, well-rounded stones (one must have come at least twelve miles) associated in different proportions from those in the overlying boulder clay or underlying gravel. The shells are mainly littoral, though some may have lived at depths not greater than twenty fathoms; although not intensely arctic, they indicate a colder climate than the present. The shells are well preserved, neither rubbed nor striated, and the deposit is a true marine silt, which if not *in situ* must have been transported in mass. The direction of ice flow being from south, or a little west of south, shows that the ice did not pass over any existing sea-bed before reaching Clava, and if the clay was carried from Loch Ness a submergence is postulated by the marine fauna there. The majority of the committee consider the evidence sufficently strong to prove a submergence to the extent of 500 feet, and they think the passage of ice to form the upper boulder clay would be sufficient to cause the cracking of the shelly clay and the crushing of certain of the shells. Detailed reports and lists of organisms are given, and a "minority report" on the evidence bearing against the view put forward above. Mr. Bell, in a paper, commented on shelly clay and gravel extending along the east coast of Aberdeenshire from the sea level up to about 300 feet, and endeavoured to explain it by the formation of lakes owing to the blocking of transverse valleys by the passage of ice across their mouths. In another paper the same author connected the granite boulders found in the Clyde Valley about Glasgow and Gourock with the mass of plutonic rocks occurring between the heads of Lochs Fyne and Lomond, and supposes them to have been brought by ice coming through Loch Fyne and Holy Loch, Loch Sloy, Loch Long, and the Gareloch, and in much smaller numbers by Loch Lomond.

Prince Kropotkin summed up his knowledge in the general glaciation of Asia. The Lowlands and Steppes, under 2000 feet in height, do not appear to have been glaciated; but all the mountain ridges rising over the steppes, the great border ridges like the Tian Shan, and the Alpine tracts fringing the plateau were covered with immense glaciers, which descended to within 1000 feet of the sea level. The Vitim Plateau, the N.W. Mongolia Plateau, the Pamirs, and the Great Khingim were extensively glaciated. The southern portion of the High Plateau, however, yields only indirect and not conclusive evidence of glaciation.

Prof. Sollas exhibited a large map, and gave an account of the Esker Systems of Ireland. Eskers have always been difficult to explain, and the best explanations have called in deposit by rivers; the difficulty has been to account for the disappearance of their banks. Prof. Sollas suggests that the sustaining walls may have been of ice, and that eskers are practically "casts of a glacial tunnel in gravel and sand." The eskers of Ireland are like rivers in their windings, and in the reception of tributaries at an acute angle. Deducing from the eskers the ancient drainage system of the Irish glaciers we find a smaller set draining from the glaciers of Sligo and Roscommon, and a much more important set, embracing the whole central plain, escaping by the valley of the Liffey

Mr. C. A. Lindvall, of Stockholm, reviewed the principal theories to account for the origin of the glacial period, and proposed to account for it by the partial submergence of Northern Europe to form an archipelago, through which escaped the cold ice-bearing currents from the Arctic Ocean. The author further endeavoured to show that the drifting of pack ice is sufficient to account for the striation, eskers, boulders, and other glacial signs in Scandinavia, Switzerland, and Scotland.

Prof. Bonney read a paper which gave rise to brisk discussion, in which Sir H. Howorth, Mr. Lamplough, Mr. Kendall, and others took part. He denied that there was any proof of considerable ground moraines in connection with existing glaciers, that glaciers were potent encavators, and that there was any evidence to show that ice had the power to scoop loose material from a sea-bed and pile it up from above the water-level; he suggested that boulder-clays like those of Britain, so different from Swiss moraines, may have had more than one origin.

Messrs. Abbott and Kendall have found shell middens with *Cardium edule*, a sheep's tooth, bird bones, and charcoal, at "The Quinta," on Penmaenmawr, and in the Aber Valley; they consider them due to human agency. Mr. Cameron described a mass of chalk, about a mile long, embedded in boulder clay at Catworth, in Huntingdonshire. Mr. De Rance concluded that the rock valleys of Lancashire and Cheshire were scooped by fluviatile agency when the land stood 300 feet higher than at present, and many of them are now choked with glacial detritus extending far into the Irish Sea. The so-called inter-glacial gravels do not occur on one horizon, and often several such beds are passed through in succession; they are regarded as having been partly formed in freshwater lakes and partly under the ice.

In the subject of palæontology three reports were presented. Prof. T. Rupert Jones described two species and two varieties of *Phyllopoda*, and made corrections, suggestions, and criticisms of other work; Mr. Laurie and Mr. Smith Woodward reported that progress was being made in working out the Eurypterids of the Pentlands, and in the registration of type specimens of fossils respectively. Dr. Traquair recorded *Cephalaspis* (*C. magnifica*) for the first time from the Orcadian area of the Old Red Sandstone; the cranial shield of this form, the largest known, is not less than 8½ inches in length. Mr. E. T. Newton gave a concise account of the Reptilia of the British Trias, including a notice of two entirely new forms, one related to *Stagonolepis*, the other a form intermediate between the crocodiles and dinosaurs. Mr. R. B. Newton recorded the first known shells from the English Keuper, discovered by Mr. Brodie and Mr. Richards in the marl of the Upper Keuper Sandstone of Shrewley, Warwickshire. They are referable to new species of the genera *Thracia*, *Goniomya*, and *Pholadomya*, and are associated with *Acrodus* and *Estheria*. Prof. Sollas gave a careful and illustrated description of the minute anatomy of *Monograptus priodon*, gathered from exceptionally perfect specimens; three layers are visible, the middle one being reticulated and thickening out to form the virgula and at the free edges of the thecæ. Mr. Montagu Browne referred several bones and teeth of *Termatosaurus albertii*, and of undetermined species of *Plesiosaurus*, to *P. rostratus* (Owen), from the Rhætic; he considered that the teeth of several species of *Saurichthys* would have to be divided between fish and labyrinthodonts; he also recorded the discovery of *Ceratodus* from the Rhætic.

In a clear and well illustrated paper by Mr. Walcot Gibson "On the Geology of Central East Africa" there is a description of the fringing reef bordering the land at Mombasa, succeeded by inland reefs rising up to 100 feet; the latter rests on a sedimentary series containing ammonites and ichthyosauria, and in turn resting unconformably on a great metamorphic series of gneisses, schists and intrusive granites, which occupy an area of fully two-thirds of Central East Africa. The remainder of the country is formed of recent volcanic rocks, forming great cones like Kilimanjaro, or arranged in lines running north and south. Most of the volcanoes are dormant or extinct, and none appear to be of great geological antiquity. Mr. R. D. Oldham exhibited geological maps of India on the scales of 96 and 32 miles to the inch, showing the recent work of the Geological Survey of that country; the smaller-scale map is to be published with the "Manual of the Geology of India." Mr. Myres showed that the fundamental rocks at Caria were crystalline, quartzose, and felspathic rocks with obscure foliation, traversed by dykes and necks of two ages, one pre-Cretaceous, which have supplied the volcanic rocks underlying the great mass of Cretaceous limestone, and the other from which the Tertiary volcanoes proceeded. The Cretaceous rocks were eroded before the deposit of the Tertiary shore beds, which pass away laterally into limestones; these beds are roughly correlated with those of Rhodes and Crete. Galena, pyrolusite, and a cobalt mineral are found in the ancient rocks.

Amongst the other papers it is only necessary to notice the following briefly:—Mr. Fowler described a fault at Cinder Hill, which causes greater displacement in the Carboniferous than in the overlying Permian rocks. Dr. Hicks pointed to the fragment in basal Cambrian rocks as indicating older series in Wales; Mr. Fox noted the wide extension of radiolarian chert in Cornwall; Mr. Bolton gave an account of the Skiddaw slates of the north of the Isle of Man, which had yielded rare trilobites and *Dictyonema*; Mr. Woodward's discovery of a bed of iron-ore on the horizon of the Cleveland iron between the middle and upper Lias of Raasay; Prof. Herdman's note on a consolidated shelly sand-bed from the bottom of the Irish Sea; Prof. Milne's illustrated account of volcanic and earthquake phenomena in Japan; Dr. Johnston Lavis's record of the condition of Vesuvius during the year, and his interesting note on the production of emerald-green augites by the action of enclosed particles of quartz and quartzite on a lava of Stromboli; Mr. Jeffs' list of geological photographs (140 in number) received during the year; Mr. De Rance's report on the circulation of underground water; and Mr. Kendall's report on erratic blocks, including the detailed survey of boulders in some considerable areas of the North of England.

In addition to the papers above reviewed, Section C took part in two discussions with other sections, and held one on its own ground. Mr. Topley, Prof. Bonney, Dr. Ball, Dr. Roberts, and Prof. Lapworth were the chief speakers on the limits of geology and geography; Prof. Sollas, Prof. Bonney, and Dr. Rothpletz, on the subject of coral reefs. The discussion on geological education was led by Prof. Cole, in a lucid paper on "Geology in Secondary Education," in which he advocated that, as a branch of history, geology should be taught to all secondary students. He advocated practical teaching so far as possible, and especially an acquaintance with the life history of the globe. Prof. Lebour, following, insisted on the careful selection of subjects in professional education and on the importance of making every part of the teaching as practical as possible, and encouraged experiments and field work, which he thought might very well be aided from the County Council's Technical Education Grant. These ideas were enforced by a number of subsequent speakers.

A word must be given to the series of photographs exhibited by the Photographs Committee, of which, however, only a small selection could be shown, those exhibited by the Scottish Geological Survey, and the specimen slides and maps to illustrate papers and discussions, kindly lent by Prof. Sollas, Messrs. Teall, Topley, Johnston Lavis, Gregory, and many others. This exhibition, if it can be continued with increased facilities at subsequent meetings, promises to become one of the most important features of the section's meeting

EVOLUTION AND CLASSIFICATION.[1]

As we have gathered up the scattered masses of botanical knowledge, laboriously wrought out by many isolated workers, and attempted to fit them together into a consistent whole, which should outline the structure of the temple Botany, we have found that the workmen have not always followed the same architectural plan, and have often used different units of measurement. With the increasing specialisation so noticeable year by year there is a corresponding lack of coordination of work. To this lack of coordination, this want of unity of measurement, this misunderstanding of plan, we can no longer close our eyes, and I therefore feel free to invite your attention to the following somewhat summary discussion of the causes of the present unsatisfactory condition, in the hope that we may thereby be enabled to see how we may make some improvement.

All botanical knowledge finally culminates in some kind of classification. The facts of histology, morphology, and physiology are of great biological importance, but the greatest of all biological facts is that the world is peopled with living things. We may group and arrange in orderly sequence the histological facts of the science; we may do likewise with the facts which the morphologist has discovered; we may make a classification of all the known physiological facts; but beyond and above these lies the greatest grouping of all—the grouping in orderly sequence of the organisms themselves whose histology, morphology, and physiology we have studied.

It is now a full third of a century since a great light was first turned upon all biological problems by the formulation of the doctrine of evolution by the master-mind of Darwin. In its light many puzzles have been solved, and many facts hitherto inexplicable have been made plain. We now know what relationship means, and we have given a fuller meaning to the natural system of classification. From the new point of view a natural classification is not merely an orderly arrangement of similar organisms. It is an expression of genetic relationship. Furthermore, in the light of evolution we now see the meaning of many reduced structures whose significance was formerly not at all—or but vaguely—understood. We have become familiar with the fact that degradation is a prominent factor in the vegetable kingdom. Evolution has by no means always involved an advance in structural complexity. Often this catagenesis is a result of parasitism or saprophytism, as is so well illustrated in the "fungi," where the degradation has gone so far that their relationship has to a great degree been obscured.

But there are also many cases of a catagenesis not due to a dependent habit in which we have evidence of a simplification from a more complex structure. Thus in the willows and poplars, where we have a raceme of very simple flowers, each consisting of a single ovary, or one to many stamens, it is readily seen that this simplicity is not primitive. The ovaries are not single carpels, but are composed of two or three united. The flower of the willow is simple by a degeneration from a higher type—probably a tricarpellary or pentacarpellary type—by the loss of its floral envelopes and stamens or pistils.

Every naturalist should be as familiar with these illustrations of evolution by simplification as he is with those of evolution by complication. In the growth of the great tree of life, while the development has been most largely in an upward direction, so that the great body of the tree has risen far above its point of beginning, there are yet multitudes of twigs and branchlets which droop downward.

I need not now, before a body of scientific men, speak of evolution as an hypothesis; for we know it as a great biological fact, about whose existence there is no shadow of doubt. A natural classification will conform strictly to the lines of evolution, it will be in fact a clear exposition of the successive steps in its progress. In such a classification the primitive forms will precede the derived ones, and the relation of the latter will be positively indicated. Moreover, in such a system there will be no confusion between the primitively simple forms and those which are so by derivation.

An examination of our common systems shows them sadly deficient in the essentials of a scientific classification. This is particularly true of the treatment of the flowering plants at the hands of English and American botanists. Nothing could show better the conservatism of botanists than the fact that for a third of a century after the general acceptance of the doctrine of evolution they are still using so crude an arrangement of the group of plants with which they are most familiar.

I may assume that it is well known to nearly all of us that the prevailing arrangement of the Dicotyledons does not represent the later views of any of the systematists. The fact is that the systematic disposition of the higher plants is at present a make-shift, maintained by conservatism, and a reverence for the time-honoured work of the fathers. It is unscientific to let our practice drag behind the present state of our knowledge: it is far more so for us to cling to the opinions of our fathers, through mere reverence, long after we know them to be untenable. It is not to the credit of our science that for a second time she has persistently held to a system through such considerations. For thirty or forty years after a natural system had been constructed by Jussieu, botanists as a body still adhere to the artificial system of Linne. Now, sixty years later, we find ourselves faced with a problem similar to that which Lindley, Torrey, Beck, and Gray met. History repeats itself with such exactness that, with the change of a word here and there, the arguments *pro* and *con* then used may be used to day. The system of Jussieu and DeCandolle is now as much a clog and a hindrance to the systematic botany of the higher plants as was that of Linne sixty years ago, and now as then it is the spirit of conservatism and of veneration for time-honoured usage which maintains the incubus.

Manifestly a system of classification which conforms to and is based upon the doctrine of evolution must begin with those forms which are primitive, or which as nearly as may be represent primitive forms. Since the flower is a shoot in which the phyllomes are modified for reproductive purposes, that flower in which the phyllomes are least modified must be regarded as primitive, while that in which there is most modification must be regarded as departing most widely from the primitive type. The simple pistil, developed from a single phyllome, is primitive and lower, the compound pistil is derived and higher. The several seeded compound ovary must be lower, and the compound ovary with but one seed must be higher. Separate stamens are primitive, united stamens, whether the union be with one another or with other structures, must be derived and consequently higher. So, too, when all parts of the flower are separate it is a primitive condition, and when they are united it is a derived structure.

Applying these principles to the flowering plants it becomes evident that in the Dicotyledons either the Apetalæ or the Polypetalæ must furnish our starting point. The Gamopetalæ are universally admitted to be higher than the groups just mentioned, and certainly do not contain the sought for primitive types. Even a hasty examination of the thirty-six apetalous families shows that they are, at least to a very large extent, derived from the Polypetalæ by the abortion of some parts and the entire omission of others. It will not be difficult to determine that the Ranales must take rank below all other Polypetalæ, in the sense of representing more nearly than any other group the primitive Dicotyledons.

The attempt to make a natural system by linking family to family in a long undulating chain, by concatenation, is unscientific because it absolutely fails to conform to the law of evolution. We must abandon the old classification and attempt one which in the light of evolution is rational. Let us not cling to the old because it is inconvenient to change, let us not cling to it through a mistaken reverence for the practice of the fathers, let us not cling to it as long as a flaw may be found in a new system. Science is ever abandoning the old when the old is no longer the true; it tears down the work of years when that work no longer represents the truth; and it dares to reach

[1] Abstract of Annual Address before Section G (Botany) of the American Association for the Advancement of Science. By C. E. Bessey, President of the Section.

out and frame a rational system even though some parts of it for a time rest upon hypothetical grounds.

A REVISED ARRANGEMENT OF THE BENTHAMIAN "SERIES" OF FLOWERING PLANTS.

Monocotyledons.

Apocarpæ.
Coronarieæ.
Nudifloræ.
Calycinæ.
Glumaceæ.
Hydrales. (Hydrocharideæ).
Epigynæ.
Microspermæ.

Dicotyledons.

Polypetalæ.

Thalamifloræ (including the apetalous Curvembryeæ, Micrembryeæ, and "Ordines Anomali," and the Euphorbiaceæ and Urticaceæ, &c., of the Unisexuales).
Discifloræ (including the apetalous Daphnales and the Juglandaceæ and Cupuliferæ, &c., of the Unisexuales).
Calycifloræ (including the apetalous Aristolochiaceæ and Cytinaceæ).

Gamopetalæ.

Heteromeræ.
Bicarpellatæ.
Inferæ.

SCIENTIFIC SERIALS.

American Journal of Science, September. — Fireball of January 13, by H. A. Newton (see p. 524).—On a photometric method which is independent of colour, by Ogden N. Rood. This is not based, like most previous methods, upon the comparison of the luminosities of two adjacent surfaces, but upon the shock that is produced upon the retina by a change of intensity of light. If one-half of a rotating disc reflects less light than the other by 1–50th of the whole amount, with appropriate rates of rotation a faint flickering will be noticed. This flickering disappears if the two halves have the same degree of brightness, whatever may be their colours.—On the oscillations of lightning discharges and of the Aurora Borealis, by John Trowbridge. Photographs were obtained of sparks having both great electromotive force and great quantity, produced by an alternating machine giving from 300 to 400 alternations per second, with the aid of a step-up transformer and an oil condenser. The oscillations were investigated by Feddersen's rotating mirror method. The sparks were about 2 cm. long, and the interval between two successive oscillations was one hundred-thousandth of a second. On each of the photographs reproduced some ten or twelve oscillations can be counted. The discharge is seen to follow exactly the same path three times in succession. After that it assumes the character of a brush discharge. By intercalating a non-inductive water resistance and a vacuum tube between the terminals of a suitable transformer it is possible to imitate exactly the phenomena observed when a vacuum tube is held in one hand while the other hand grasps the terminal of the transformer. In observing the striæ and waving columnar form of the light excited in this manner in tubes filled with rarefied gases, one is led to believe that the stratified form of the Aurora Borealis is produced in a similar manner.—On the estimation of chlorates and nitrates, and of nitrites and nitrates in one operation, by Charlotte F. Roberts. By means of the apparatus for the estimation of nitrates previously described, chlorates and nitrates together may be estimated. They are treated with manganous chloride, and the resulting gases are passed through potassium iodide and then into a Hempel's burette. The amount of nitric oxide, gives the amount of nitrate present, and the chlorate is estimated by deducting from the total chlorine liberated that due to the reduction of the nitrate.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, June 15.—Dr. Armstrong, President, in the chair.—The following papers were read:—Contributions to our knowledge of the aconite alkaloids. Part vi. Conversion of aconitine into isaconitine, by W. R. Dunstan and F.H. Carr. On heating the hydrobromide of the highly poisonous aconitine it is converted into the corresponding salt of its non-poisonous isomeride, isaconitine.—Part vii. Some modifications of aconitine aurichloride, by W. R. Dunstan and H. A. D. Jowett. Aconitine aurichloride may be obtained in three different physically isomeric modifications, melting at 135·5°, 152°, and 176° respectively.—Note on the stereoisomerism of nitrogen compounds, by S. U. Pickering.—A study of the properties of some strong solutions, by S. U. Pickering. The depressions of the freezing points of water, acetic acid, and benzene, by a number of organic non-electrolytes, indicate in all cases the formation of compounds of the solvent with the dissolved substance.—Studies on citrazinic acid, by W. J. Sell and T. W. Easterfield. The authors propose provisional formulæ for citrazinic acid and a number of allied compounds as the result of their work on the subject.—The essential oil of hops. Preliminary notice, by A. C. Chapman. A dextro-rotatory sesquiterpene $C_{15}H_{24}$, is obtained by the steam distillation of hops.—The sulphides and polysulphides of ammonium, by W. P. Bloxam. The author has obtained a number of crystalline double ammonium sulphides of the general formula $(NH_4)_2S, xNH_4\cdot SH$.—Sarcolactic acid obtained by fermentation of inactive lactic acid, by P. Frankland and J. MacGregor.—Hexanitroanilide, by A. G. Perkin.—The constituents of the Indian dye-stuff kamala, I., by A. G. Perkin. On extraction with ether, kamala yields rottlerin, $C_{11}H_{10}O_3$, isorottlerin, two resins $C_{12}H_{12}O_3$ and $C_{13}H_{12}O_4$ and a small proportion of a yellow colouring matter.—A quantitative method of separating iodine from chlorine and bromine, by D. S. Macnair. The method is based on the fact that, when treated with chromic acid mixture, silver iodide is converted into the iodate whilst silver chloride and bromide are converted into the sulphates.—Note on a form of burette for rapid titration, by L. Garbutt.—The use of sodium peroxide as an analytical agent, by J. Clark. By heating powdered minerals with sodium peroxide, the arsenic and sulphur may be rendered soluble.—Stibiotantalite, a new mineral, by G. A. Goyder.—The colouring matter of *Drosera Whittakeri*, II., by E. Rennie. The author has extended his previously published work on this subject.—Preparation of mono-, di-, and tri-benzylamine, by A. T. Mason. Mono-, di-, and tri-benzylamine respectively may be obtained as the chief products of the interaction of benzyl chloride and ammonia, by varying the quantity of the latter.—Piazine (pyrazine) derivatives, II., by A. T. Mason.—Piazine derivatives, III., by A. T. Mason and L. A. Dryfoos. In these two papers the authors describe a number of new substituted piazines and their dihydrides.—Condensation products from ethylenediamine and derivatives of acetoacetic acid, IV., by A. T. Mason and L. A. Dryfoos.—Studies of the oxidation products of turpentine, by S. B. Schryver. The author assigns to terpenylic acid the formula

$$\begin{array}{r} CH_2\cdot CO\diagdown \quad \\ \cdot \qquad\quad >O \\ COOH\cdot CH_2\cdot CH\cdot CMe_2\diagup \quad \end{array}$$

—Addendum to note on the nature of depolarisers, by H. E. Armstrong.—The molecular complexity of liquids, by W. Ramsay and J. Shields. The authors deduce the molecular weights of liquids from their surface tensions.—The preparation of active amyl alcohol and active valeric acid from fusel oil, by W. A. C. Rogers. By repeatedly heating fusel oil with fuming hydrochloric acid, pure laevo-rotatory amyl alcohol ($[\alpha]_D = -5·2°$) is obtained; by oxidising the alcohol, active valeric acid may then be prepared.—On the occasion of the Rothamstead jubilee, July 29 last, an address was presented to Sir J. Lawes and Dr. Gilbert by the President and Council of the Chemical Society.

PARIS.

Academy of Sciences, September 18.—M. de Lacaze-Duthiers in the chair.—On the teeth of hyperboloidal gearing, by M. H. Resal.—The shooting stars of the month of August, 1893, observed in Italy, by P. François Denza. Reports received from members of the Meteorological Association in all parts of Italy show that the August showers were observed under comparatively favourable conditions. The number of meteorites observed grew progessively from the first to the eleventh of the month, and the phenomenon exhibited on the latter date a greater brilliancy than usual. The maximum took place earlier than in previous years, and the greater density of the shower indicates a corresponding increase in the density of the meteorite swarm. The principal radiant was near η Persei, about R.A. 44°, Decl. + 55°. The steady annual displacement of the Perseid radiant and the unusual brilliancy of the swarm makes an interesting subject for future observation.—Circles or spheres "derived" from an envelope, plane or solid, of any class, by M. Paul Serret.—On the periodical maxima of spectra, by M. Aymonnet. It may be assumed that luminous waves comprising an exact number of molecular ranges are propagated with less friction than waves producing nodes in the molecules themselves. If, between two given limits, the incident radiation is sufficiently complex and intense, and the solid transmits all the maximum waves possible, these will, in the normal spectrum, differ in wave-length by twice the product of the index of refraction into the sum of the molecular diameter at absolute zero, its expansion at the given temperature, and its lengthening or shortening in the direction of propagation under the influence of the wave.—On the development of the pancreas in Ophidia, by M. G. Saint-Remy. The earliest stage observed in the snake, corresponding, as far as the pancreas is concerned, to the fifth day in the development of the chicken, shows distinctly the three markings, one dorsal and two ventral, observed in some other vertebrates. The ventral markings are completely isolated from the intestine, and detach themselves from the hepatic canal, forming two clusters of acini on the two sides. The dorsal marking, which is very voluminous, lies to the right of the duodenum, with which it communicates by a broad canal. It was this that was previously observed. The close connection between the hepatic canal and the pancreas is easily understood by observing the development of the latter from the three markings referred to.—On the coccidia of birds, by M. Alphonse Labbé. In the course of researches on parasites of the blood of birds, conducted at Roscoff, the presence of an intestinal coccidium, probably unknown hitherto, was verified in a large number of aquatic birds. It is a very small tetraspore coccidium with exogenous development. The pyriform capsule is not larger than 16 or 18 μ by 14 or 16 μ. An interesting characteristic is the frequent presence of two bright granules at the micropylar extremity. The presence or absence of polar granules in *Coccidium Roscoviense* appears to be determined by the culture in which the cysts were developed.—Vegetable anatomy of *Ataccia Cristata*, Kunth, by M. C. Queva.

SYDNEY.

Royal Society of New South Wales, June 7.—Prof. T. P. Anderson Stuart, President, in the chair.—The following papers were read:—Flying machine motors and cellular kites, by Lawrence Hargrave.—Notes and analysis of a metallic meteorite from Moonbi, near Tamworth, N.S.W., by John C. H. Mingaye.—Plants with their habitats, discovered to be indigeneous to this colony since the publication of the "Handbook of the Flora of New South Wales," by Charles Moore.—On the whipworm of the rat's liver, by T. L. Bancroft.—Small whirlwinds, by H. C. Kiddle.

July 5.—Prof. T. P. Anderson Stuart, President, in the chair.—The following papers were read:—On the languages of the New Hebrides, by Sidney H. Ray.—On an approximate method of finding the forces acting in magnetic circuits, by Prof. Threlfall.—Unrecorded genera of the older tertiary fauna of Australia, including diagnoses of some new genera and species, by Prof. Ralph Tate.

DIARY OF SOCIETIES.

LONDON.

WEDNESDAY, OCTOBER 4.

ENTOMOLOGICAL SOCIETY, at 7.—On the Cost and Value of Insect Collections: Dr. D. Sharp, F.R.S.—On the Ants of the Island of St. Vincent: Prof. Auguste Forel.—Description of a New and Remarkable Sub-family of the Scolytidæ: Walter F. H. Blandford.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—University College, Bristol, Calendar for the Session 1893–94 (Bristol).—The Miner's Handbook: Prof. J. Milne (Lockwood).—Elementary Lessons, with Numerical Examples in Practical Mechanics and Machine Design, new edition: R. G. Blaine (Cassell).—The Orchid Seekers: A. Russan and F. Boyle (Chapman and Hall).—On Sewage Treatment and Disposal: T. Wardle (J. Heywood).—The Cholera Epidemic of 1892 in the Russian Empire: Dr. F. Clemow (Longmans).—Proceedings and Transactions of the Royal Society of Canada, 1892 (Ottawa, Durie).—A B C Five-Figure Logarithms for General Use: C. J. Woodward (Spon).—Our Household Insects: E. A. Butler (Longmans).—The Essentials of Chemical Physiology: Dr. W. D. Halliburton (Longmans).—The Art of Projection and Complete Magic-Lantern Manual: An Expert (Beckett).—Songs in Springtime, 2nd edition; J. C. Grant (E. W. Allen).—Notes on Some of the More Common Diseases in Queensland in Relation to Atmospheric Conditions, 1887–91: Dr. D. Hardie (Brisbane, Beal).—Charts for ditto (Brisbane, Beal).—Manual of the New Zealand Coleoptera, Parts 5, 6, 7: Captain T. Broun (N.Z., Wellington, Costall).—An Examination of Weismannism: Dr. G. J. Romanes (Longmans).—The Science of Mechanics: Dr. E. Mach, translated by T. J. McCormack (Watts).—A Course of Practical Chemistry or Qualitative Chemical Analysis, 8th edition: W. J. Valentin, edited and revised by W. R. Hodgkinson (Churchill).—Drum Armatures and Commutators: F. M. Weymouth (*Electrician* Company).—Handbuch der Palæontologie, I. Abthg., Palæontologie, iv. Band, 2 Lief: K. A. Zittel (Williams and Norgate).—Traité des Gîtes Minéraux et Métallifères, 2 vols.: E. Fuchs and L. de Launay (Paris, Baudry).—Abnormal Man, being Essays on Education and Crime and Related Subjects: A. MacDonald (Washington).—British Commerce and Colonies: H. de B. Gibbins (Methuen).—The Chemistry of Fire: M. M. P. Muir (Methuen).—A Manual of Electrical Science: G. J. Burch (Methuen).—A Treatise on the Kinetic Theory of Gases, 2nd edition: Dr. H. W. Watson (Oxford, Clarendon Press).—A Handbook of the Destructive Insects of Victoria, Part 2: C. French (Melbourne, Brain).—Glasgow and West of Scotland Technical College Calendar for Session 1893–94 (Glasgow).—Sécheresse, 1893, ses Causes, Principes Généraux de Météorologie, l'Abbé A. Fortin (Paris, Vic et Amat).—Blackie's Junior School Shakespeare; King Henry V.: W. Barry (Blackie).—Blackie's Science Readers, No. VI.: Rev. T. Wood (Blackie).—Hand und Hilfsbuch zur Ausführung Physiko-Chemischer Messungen: Prof. W. Ostwald (Williams and Norgate).—Text-book of Biology; Part 2, Invertebrates and Plants: H. G. Wells (Clive).—Certain Climatic Features of the Two Dakotas: J. P. Finley (Washington).—The Industries of Animals: F. Houssay (W. Scott).—Utility of Quaternions in Physics: A. McAulay (Macmillan).—Pubblicazioni della Specola Vaticana, fasc. 1 and 2 (Roma).

PAMPHLETS.—A Guide to Stereochemistry: A. Eiloart (N.Y., Wilson).—The Caradoc Record of Bare Facts, 1892 (Shrewsbury).—Cremation and Cholera; Sir S. Wells (London).—The Prevention of Preventible Disease: Sir S. Wells (Glasgow).—Abstract of the Proceedings of the Linnæan Society of New York for the Year ending March 1, 1893 (New York).—On the so-called Bugonia of the Ancients, and its Relation to Eristalis Tenax, a Two-winged Insect: C. R. Osten-Sacken (Firenze, Ricci).—Catalogue of the Minerals of Tasmania, with Notes on their Distribution: W. F. Petterd (Hobart, Grahame).—The Glacier Epoch of Australasia: R. M. Johnston.—Abhandlungen zur Landeskunde der Provinz Westpreussen, Heft 5, Die Tucheler Haide, &c.: R. Schütte (Danzig, Bertling).—Notes on Marine Laboratories of Europe: B. Dean.

SERIALS.—Engineering Magazine, September (New York).—Insect Life, Vol. v. No. 5 (Washington).—The American Naturalist, August (Philadelphia).—Verhandlungen des Deutschen Wissenschaftlichen Vereines zu Santiago, Chile, ii. Band, 5 and 6 Heft (Berlin, Friedländer).—American Journal of Science, September (New Haven).—Journal of the Franklin Institute, September (Philadelphia).—Quarterly Journal of Microscopical Science, September (Churchill).—Economic Journal, September (Macmillan).—Timehri, June (Stanford).—Proceedings of the Liverpool Geological Society, Session 34, Part 1, Vol. vii. (Liverpool).—Transactions of the Academy of Science, St. Louis, Vol. vi. Nos. 2 to 8 (St. Louis).

CONTENTS.

THURSDAY, OCTOBER 5, 1893.

THE STUDY OF DIATOMS.

An Introduction to the Study of the Diatomaceæ. By Frederick Wm. Mills, F.R.M.S. With a Bibliography by Julien Deby, F.R.M.S. (London and Washington: Iliffe and Son, 1893.)

FEW forms in the organic world have been the subjects of such close, constant and varied study as the Diatoms. Their minuteness, their exquisite modes of growth, development and multiplication in the living state, and the beautiful refinement of symmetry and delicacy of surface chasing in their dead siliceous remains, have made them the special objects of interest, admiration, and often of serious study and research from certainly the dawn of this century until now. But there are few studies of living objects, at least of those that are extremely minute, that show more clearly that the real difficulties presented by them are understood only by those who thoroughly study them. It is the expert who knows how little is known concerning this most interesting if lowly group.

If no other purpose were served by this book, it would in a popular manner make this manifest.

There can be no serious doubt that much of the value that will attach to it as an "Introduction" is due to the very accessible and useful form in which Mr. Julien Deby's "Bibliography relating to Diatomology" has been presented to the student. The work consists of 240 pages; of these only forty-two are devoted to an exposition of the nature and habits of the Diatoms proper. There are three chapters relating to the collecting, the mounting, and the microscopical examination of these forms; but the forty-two pages are supposed to tell us all of importance that is known concerning these beautiful Algæ. Yet the Bibliography is enormous and includes the work and judgments of some of the leading naturalists of our century.

As this volume only aims at being an "introduction" to the study of these organisms, we have no right to anticipate exhaustive treatment in any branch of the subject; but we do not hesitate to affirm that the aim of its author would have been more efficiently reached had certain parts of his subject received a more liberal treatment.

No doubt the Bibliography opens to the amateur and the student almost every channel of knowledge, and will prevent him from attempting to repeat work already done, or from exhausting himself on work that it is at present more or less vain to attempt. But it would have been a great advantage to have seen in a concise form much that has been done in recent years.

Thus we find less than three pages devoted to the "Structure" of Diatoms; what is said is interesting and accurate; but, even remembering the aim of the author, we cannot consider it sufficient. It is quite true that no great generalisation of diatom structure has been arrived at; and we venture to think that much time and patient labour must be spent before it will be; nevertheless, during the last ten years some admirable glimpses at the wonderful architecture of these minute siliceous frustules have been obtained, showing that these silicified cases are not merely formed of two symmetrical valves united to one another by means of two embracing rings which constitute the connecting zone or girdle, and making together an elegantly carved box in which the species may be reproduced, but showing also that the most complete structural principles are embodied in their internal and external construction.

These are certainly not complete studies; but they do exactly what the zealous amateur wants: show the paths along which profitable study may be pursued.

This will apply with even greater force to the almost new branch of diatom work done in regard to "secondary structure" in the siliceous frustule. To those for whom this Introduction could be alone intended, few things could have a larger interest than this.

The nature of the extremely delicate "markings" of diatoms has been so zealously pursued by amateurs and microscopists generally, that it has brought upon them the frequently merited reproach of "Diatomaniacs." None the less it will be by the study of the perforations and physical constitution of the siliceous frustules that we shall ultimately obtain a true knowledge of their modes of motion, and even some aspects of their physiology. It would hardly have been supposed by those who wholly neglect, or even despise the study of the "markings" of diatoms that the wonderful "secondary structure" now demonstrated in many of these frustules had any existence. It may now, however, be taken for granted that every efficient manipulator possessed of a good microscope has demonstrated that, *e.g.*, *Coscinodiscus asteromphalus* is not only covered on its valves with the beautiful areolæ so long and so well known, but that these areolæ are in their turn delicately areolated. The coarse areolations so long familiar to us are for the most part approximately circular in outline; but inside these is a most delicately perforated membrane; and that this is related to the functions of the diatom there can be but little doubt.

Again it may be stated that these studies are incomplete; that is so; and, moreover, they require good instruments, and good manipulation of them, for satisfactory results; but we believe that it is such matters that the leisured amateur and the young student are most desirous of knowing in order to find suitable lines for profitable study.

It is true that the very remarkable work of Dr. Flögel on diatom sections, and some of his modes of operation are referred to, but these represent a far higher and more unusual class of research. The most elementary student should know something concerning them, and they are wisely referred to in this volume; but they do not compensate for the absence of efficient reference to the class of work we allude to.

The movement of diatoms receives careful treatment in this treatise; we believe, nevertheless, that more recent results might with profit have been referred to. The subject is in many senses one of the most difficult in the range of Biology. The three principal explanations, viz. endosmatic and exosmatic currents, the pre-

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sence of cilia, and the existence of a pseudopodic extrusion of hyaline protoplasm, are carefully given. The author wisely inclines to the last. It is certain that one of the results of the use of apochromatic objectives during the last three or four years has been to enable us to demonstrate that not only are there perforations in the siliceous tests of the diatoms, but that in the raphé of some Naviculæ and kindred forms, there is a "great" perforation, which runs tube-like from the apices of the frustule to the central nodule; and this may be readily seen to lend itself to the pseudopodic extrusion and withdrawal of protoplasm; and we commend the study of the possibility of this to microscopists. Delicate stains may be used that will not immediately destroy the organism, and that will tend to make the "hyaline protoplasm" at least more manifest. But in this connection the work of Bütschli and Lauterborn cannot be neglected, Making *Pinnularia nobilis* the subject of research, they specially directed attention to its mode of motion. The motion in diatoms is of a peculiar kind, being frequently a series of jerks which carry forward the frustule in the direction of its length, and often carry it back along the same path. Yet the motion may be smooth and equable.

Bütschli conceived the idea of placing under the thin covering glass, laid upon the top of the water in which he was microscopically studying the *Pinnularia*, a minute drop of Indian ink. This in its ultimate particles is, of course, not soluble. Its extremely fine granulation was therefore of great value, for by means of the enormous multitude of these black granules he affirms that he was able to see an extremely fine thread, which was directed backwards. This, he contends, was a protoplasmic filament, but so fine, and, as we apprehend, so near in its refractive index to that of water, that it is otherwise invisible.

This filament, it is stated, is formed by jerks, and the diatom was simultaneously moved in the opposite direction; while at times the filament appears to be retracted.

That these results are of value, there can be no doubt, and they open a line of study that may be most profitable.

Mr. Mills has adopted the method of classification for the Diatomaceæ which for the present may fairly be considered the best; but we can but fervently hope that a series of detailed discoveries will at no very distant date make such generalisation possible as will superinduce a great simplification in this direction.

There is a very useful chapter on Mounting Diatoms, and some excellent teaching on the microscopic examination of these forms; and the whole is rendered complete by a chapter that will greatly aid the beginner, on "How to Photograph Diatoms."

We welcome this book; it will occupy a distinct place in the literature of the subject in our language at present, and will, we hope, make the way for a greatly enlarged and amplified second edition. There is much to praise in the volume, and what we have endeavoured to point out as deficiencies we do not treat as defects. The subject is so large that an author may well pause and wonder at what point an "Introduction" to such a subject should halt in details. But we think that what has been given will open the way for very much more, and hope that Mr. Mills may be called upon and induced to provide it.

We note some printer's errors in the book. It will suffice to call attention to page 6, where a period at the end of the second line destroys the sense; to the word "rhizopodo" for "rhizopodia" on page 13; to the wrong spelling of an author's name, as in the foot-note on page 5, and to a reference to "northern microscopic" for "northern microscopist" on page 159. D.

THE PROPAGATION OF ELECTRIC ENERGY.

Untersuchungen über die Ausbreitung der Electrischen Kraft. Von Dr. Heinrich Hertz. Pp. 295. (Leipzig: Johann Barth.)

A DISCOVERER'S own account of his work is always of interest, and when it is an epoch-making work and the account so clear and well described as to be intelligible to all, it deserves the most careful attention, and should be studied by all who feel any interest in the subject. Dr. Hertz's account of his discovery of the propagation of electric energy is eminently a work of this kind. The subject is of immense importance; the work described is of the highest order of experimental investigation; the results attained have contributed more than any other recent results to revolutionise the view taken by the majority of scientific workers as to the nature of electromagnetic actions. It is to be hoped that a translation of this account of one of the greatest advances in our knowledge of nature will soon be in the hands of all who care to learn how the functions of the ether have been raised from obscurity into light, from being in the opinion of many a pious belief to be the momentous question of the hour. Prof. Hertz gives in his introduction an interesting account of the steps by which Maxwell's theory may be connected with the older theories. These latter supposed action at a distance pure and simple, and postulated two fluids, &c., &c. They neglected the intervening medium. The second step was to introduce the medium as performing some function when it was a material medium, but still to retain the positive and negative electricities acting across the space from molecule to molecule. This was practically Mossotti's theory as to the properties of the dielectric founded on Poisson's theory of magnetic induction. M. Poincaré seems to have got to about this stage, or perhaps a little further. The third stage was to transfer the molecular action to the ether, but still to consider it as due to electrical fluids attracting and repelling one another, producing the etherial stresses. The fourth stage was to see that these attractions and repulsions of electrical fluids are quite superfluous, and to attribute the whole phenomenon to stresses in the ether set up by straining it. In this last stage there is no room for an electrical fluid with attracting and repelling properties and accordingly it is suppressed. What the structure of the ether may be which is strained, and thereby electromagnetic stresses produced, is still unknown, and consequently the nature of the strain is unknown. It certainly differs from the ordinary straining of a solid in two important respects. In the first place, the mechanical stresses are proportional to the squares of the quantities that represent the strains; and in the second place, they depend on the absolute strain, and not on the relative displacement of the parts of the medium. Solid structures can be invented that have laws of this kind. The change of longitudinal stress in a stretched string is proportional to the square of the transverse displacement, and, if the ends of the string are fixed, this stress depends on the absolute value of the displacement. Upon a foundation of a somewhat similar kind a theory as to the structure of the ether being like a solid in tension may be founded, which gets over many of the difficulties of the simple elastic solid theory of the ether. We are, however, still a good way off any really satisfactory theory as to the structure of the ether, but the leading idea of Maxwell's theory, that electromagnetic attractions and repulsions are due to some sort of strain in the ether, is the direction in which scientific men are at present seeking for a dynamical explanation of electromagnetism and for a structure of the ether. Prof. Hertz, however, seems content to look upon Maxwell's theory as the series of Maxwell's equations. This is hardly fair. Maxwell has done much more than produce a series of equations that represent electromagnetic actions. Weber and Clausius went very close to that without revolutionising our ideas as to the nature of these actions. Any exposition of Maxwell's theory which does not clearly put before the reader that energy is stored in the ether by stresses working on strains, is a very incomplete representation of Maxwell's theory. The bulk of Prof. Hertz's work is, however, not concerned with any theory, but with the practical study of electromagnetic propagation along conducting wires and throughout space. This is the work for which Prof. Hertz is so justly famous, and on account of which Hertzian oscillators, Hertzian receivers, Hertzian waves have become in the few years since 1888 the objects of universal attention. No physical experiments since those by which Joule founded the theory of the conservation of energy have produced as great an effect on science as these experiments here described by their author. The subject is brought down to last year, and the experiments of others are mentioned and discussed. In this connection it may be worth while remarking that the observation that the waves emitted by a Hertzian oscillator are of all sorts of wave-lengths was clearly stated by Prof. Hertz himself when he explained how rapidly they died out. For what is a rapidly dying out oscillation except a Fourier series of all sorts of waves? There is consequently no essential difference between these two statements. The first states more than the second, for it explains the character of what in the other statement is described by the vague term, "all sorts of waves."

The whole work is most interesting, and well deserves the best attention of all interested in the greatest scientific advance of the last quarter of the nineteenth century, a century that has seen thermodynamics founded by Carnot and Clausius, conservation of energy by Joule, bacteriology by Pasteur, the origin of species by Darwin, and the functions of the ether by Faraday, Maxwell, and Hertz.

OUR BOOK SHELF.

Helps to the Study of the Bible. By Henry Frowde. (London, 1893.)

THE publisher of this useful volume of *Helps* is to be congratulated on the production of a work which is far in advance of any other book of the same kind published in England. It consists of six parts, which comprise a brief history of the Bible and its most ancient versions, including terse remarks on its canon and authenticity; a summary of the contents of the books of the Old and New Testaments; an account of the Apocrypha, together with historical and chronological notices of the period; a series of chapters on the history, geography, geology, botany, zoology and ornithology of the country of Palestine, on the Jewish Calendar, weights, measures, money and time, and on the musical instruments of the Bible; and a concordance, atlas, list of obsolete English words, glossary of antiquities and customs, &c., referred to in the Bible. The book represents the collected learning of many eminent specialists and scholars, arranged in a handy form and most convenient for reference. The evidence relating to Bible history which may be derived from the recently established sciences of Assyriology and Egyptology, is illustrated by a series of beautiful plates, which cannot fail to be appreciated by every thoughtful reader of the Bible, and are worth more for purposes of explanation than many dissertations could ever have been. In the first plate the connection of the Hebrew alphabet with the hieratic writing of Egypt is shown, and from this we are led to the Latin and Greek alphabets and to the Rosetta and Moabite Stones. Facsimiles of the oldest Hebrew and Syriac MSS. of the Bible are next given, together with specimens of the text of the Vaticanus, Sinaiticus and Alexandrinus codices. The funeral customs of the Egyptians are explained by reproductions from bas-reliefs, papyri, &c., and from the monuments of Assyria and Babylonia a large number of important illustrations have been selected to throw light upon the various occasions upon which the Israelites came in contact with the "great king." The busts of the Roman emperors referred to in the New Testament, and the Temple of Diana, are the subjects of the plates inserted to illustrate the New Testament. At the foot of each plate is a brief description, which, we must hope, may in some cases be lengthened in future editions of this excellent book.

Differential Calculus for Beginners. By Joseph Edwards, M.A. (Macmillan and Co., 1893.)

MR. EDWARDS has put together in a handy form for schoolboys the elementary parts of his large treatise on the Differential Calculus. The subject is here presented in a clear and interesting manner for beginners, and it is to be hoped that the book will be useful in leading to a more general study of this indispensable subject than has hitherto been customary in this country.

The French schoolboy learns the elementary ideas as part of his Algebra, but with us it has been thought right that "calculus dodging" should precede the study of the calculus itself, under a mistaken application of the proverb—*Principiis enim cognitis, multo facilius extrema intelligetis.*

Geometrical applications are very judiciously introduced at an early stage, but considering that the first differential coefficient invented was for the expression of a Velocity, these applications would be rendered more instructive by the introduction of the notion of Time as the primary independent variable.

But "this is Dynamics" the schoolmaster will say, and so must be kept separate by a sort of water-tight bulkhead.

G.

LETTERS TO THE EDITOR.

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

The Thieving of Assyrian Antiquities.

1. HAD I known that after having dissected my reply to the article entitled "Thieving of Assyrian Antiquities," which appeared in NATURE of the 10th ultimo, you had intended to add further objectionable remarks to it, I should have certainly declined to have had it published.

2. You seem, even now, to ignore the judgment of the High Court of Justice in the slander case of "Rassam *v.* Budge," and volunteer your own version of the story with which you have been supplied.

3. May I ask where you have found it reported about the evidence of the British Museum accountant and Sir Henry Rawlinson's deposition regarding the fragments of the national collection? If you have obtained your information from the latter's deposition that was certainly not revealed in the Press, and if it was supplied you by men who had no business to do so, then in fairness you ought to have quoted the other parts of the evidence. As for the "accountant," no paper reported what the Principal Librarian wanted him to say, and that was for a very good reason, because the Judge did not consider his evidence of any use, seeing that no one had disputed the purchase by the authorities of the British Museum, of Babylonian antiquities before I began my researches in Southern Mesopotamia, at the time when I was there and afterwards.

4. With regard to the cock-and-bull story about the bas-reliefs which are alleged to be at "Comford Hall," if you had said in your article, above referred to, that they *existed* in a private house in England, *instead of asserting that they were obtained by purchase*, I would have surprised you with further revelations that such "slabs" do exist in other houses in England and in different parts of Europe and America. Even half of the sculptures I had discovered in Assur-beni-pal's palace in 1853, belonging *legitimately* to the national collection, have been squandered, and part of them are now in the bottom of the Tigris.

5. As you seem to have allowed yourself to be imposed upon by malicious men who are not brave enough to put their names to the information with which they have supplied you, I must now close my correspondence, as it seems to me that your journal is not a proper channel through which justice can be obtained.

H. RASSAM.

6, Gloucester-walk, Kensington, W. September 23.

[THE above letter calls for some additional "remarks." We trust Mr. Rassam will find them less "objectionable" than the former ones.

1. The dissection to which reference is made consisted only of omissions of personal attacks, not even courteously worded, which moreover had nothing to do with the question of importance to the public.

2. Mr. Rassam is not happy here in his expressions. Nothing was stated in our article which was not openly stated in Court.

3. He is still less happy here. In his last letter he wished to make our readers believe that Sir H. Rawlinson's opinion on the "rubbish" Mr. Rassam had sent home was not stated in Court, and had been obtained by us in some improper way from the British Museum. In our "objectionable remarks" we charitably suggested that he had *forgotten* Sir H. Rawlinson's deposition containing this opinion was read in Court. It now seems that Mr. Rassam had not forgotten it in the least.

With regard to the accountant; the counsel for the defendant did say what the accountant was to prove, and the Editor does not see what the Principal Librarian had to do with it.

4. Why does Mr. Rassam take the trouble to misquote us by writing "Comford" instead of "Canford," and then to put his misquotation in inverted commas? The "story of a cock and bull," which we took from one edition of Murray's Guide is repeated in more detail in a later one, and even the name of the donor is mentioned, Sir A. H. Layard.

The more "revelations" Mr. Rassam can supply; the more he can show that property "belonging *legitimately* (the italics are Mr. Rassam's) to the national collection" has been squandered; the more reason there is for the inquiry to which we have pointed.

5. Requires no comment except that not a single inaccuracy on our part has been established.—ED. NATURE.]

Vectors and Quaternions.

I WISH to make some observations in reply to the letter of Prof. Knott which appeared in NATURE (June 15, p. 148). For my part I have nowhere condemned the system of Hamilton and Tait as "unnatural" and "weak"; on the contrary, I have always spoken of it with respect and admiration. To appreciate its value and high place in analysis it is not necessary to be blind to its imperfections and limitations. As to whether my work is mere innovation and a recasting of quaternion investigations, I leave to the judgment of those who read my papers. I wish merely to remark that Prof. Knott says nothing about exponentials, and that he has not pointed out what quaternion investigations are recast in my paper on "The Fundamental Theorems of Analysis Generalised for Space." It is the duty of a critic to state correctly and fully the principles which he criticises; this has not been done; my position has been misrepresented. It may aid the scientific discussion of this matter if I state briefly the principal positions I have taken, and the replies that have been given.

I have said that the quaternion notation can be improved. As regards notation, Hamilton himself was an innovator, and in his writings he apologises for the introduction of the strange symbols S, V, T, K, U, I, &c. My aim has been to generalise as much as possible the notation of ordinary analysis, as it is desirable to have one harmonious algebra, with easy transition from line algebra to plane algebra, and from plane algebra to space algebra. Prof. Tait himself has said in one of the prefaces to his treatise that a revolution in the matter of notation must ultimately come; but I infer from the ecstacy of his admiration, that Prof. Knott considers it part of the original brightness of the Archangel.

I have said that the quaternion definitions are not all that can be wished for; I have pointed out what appear to be defects, and I have attempted to remove them. According to Prof. Knott, "the quaternion originally defined as the quotient of two vectors, can also be represented as the product of two quadrantal versors." I reply that what is wanted is not an original or temporary definition of "quaternion," but one that will stand throughout; that in strains we have a quotient of two vectors which is not a quaternion, but a dyad; that we do not ask for a representation, but a definition; and that the representation indicated involves the idea of a versor, which, leaving out a mere multiplier, is the very thing to be defined. Further, the following questions may be asked: If by a quaternion is meant the quotient of two vectors, how can the product of two vectors be a quaternion? We have also the nice distinction that a quaternion may be represented by the product, but not by the quotient, of two quadrantal versors. It is certain that the product and the quotient of two quadrantal versors are quantities of the same kind; if the one is a quaternion, so is the other.

I have said that some of the fundamental principles of quaternions require to be corrected, especially the one which identifies versors with vectors. I have said that if α denote a unit-vector, then $\alpha^2 = 1$, not $= -1$. It is not a bare assertion that "to my mind" it appears so; a reason is given. Let a body of mass, m, have at any time a linear velocity whose rectangular components are a along the axis of i, b along j, and c along k; the kinetic energy of the body is $\frac{1}{2}m(ai + bj + ck)^2$, that is, $\frac{1}{2}m(a^2 + b^2 + c^2)$, not as quaternionists would have it, $-\frac{1}{2}m(a^2 + b^2 + c^2)$. The convention involved is one that pervades the whole of analysis, namely, that the product of two lines having the same direction is positive, while the product of two lines having opposite directions is negative. As kinetic energy is a square, the two lines must always have the same direction.

I have said that if $\alpha^{\frac{\pi}{2}}$ denote a quadrantal versor, then $\left(\alpha^{\frac{\pi}{2}}\right)^2 = \alpha^{\pi} = -1$, and that Hamilton's rules apply to versors, not to vectors. Prof. Knott says that I advocate a system which loses the associative principle and gains nothing but a positive sign and an undesirable complexity in transforming by permutations. Readers of NATURE will be surprised to learn that I advocate nothing of the sort. What I do advocate is to treat vectors as vectors, and versors as versors, and I show that the products of versors differ essentially from the products of vectors in that the associative rule applies to the former, but not to the latter. Prof. Knott justifies the treatment of quadrantal versors as vectors, because they are compounded according to the parallelogram law. It is true that the components of a quadrantal versor are so compounded, because every versor involves an axis; but the minus comes in, not on account of the axis, but on account of the angle of the versor, the very element which differentiates it from a vector.

I have said that $\nabla^2 = \frac{d^2}{dx^2}+\frac{d^2}{dy^2}+\frac{d^2}{dz^2}$ is more consistent with analysis than $\nabla^2 = -\left(\frac{d^2}{dx^2}+\frac{d^2}{dy^2}+\frac{d^2}{dz^2}\right)$, and I have remarked that in works on mathematical physics, even in Kelvin and Tait's "Natural Philosophy," the minus was dropped. A sign that can be so readily dropped has probably got no good reason for its appearance. In reply, Prof. Knott says that "when $\nabla^2 v$ occurs in ordinary non-quaternion analysis, it is used in the sense of the *tensor*, for only as such can it come in." This explanation does not explain; for "the name *tensor* is applied to the *positive* number which represents the length of a line" ("Hamilton's Elements," p. 164). Now the ordinary analysis is not limited to signless quantities, but embraces quantities which may be positive or negative. Why then is the minus dropped in an analysis where sign is essential? I asked for a proof of the principle that $\nabla(\nabla\omega) = \nabla^2\omega$; it is replied that "in quaternions there is no doubt whatever." Are we permitted, then, to doubt it as a truth in ordinary analysis, being true only in quaternions? If it is a matter of convention, no one desires two contradictory systems of analysis; if it is a matter of truth, it cannot be true "in quaternions" and not in ordinary analysis.

I have said that the rule $ij = k$ expresses what is true in space of three dimensions. Prof. Knott asks: "If a vector cannot be a versor in product combinations, what is the signification of the equation $ij = k$?" Let us first of all remove every ambiguity from the equation. We have then in all three cases: first, i and j both quadrantal versors; second, i a versor and j a vector; third, i and j both vectors. To distinguish between a quadrantal versor and a vector, let the former be denoted by $i^{\frac{\pi}{2}}$. Then $i^{\frac{\pi}{2}} j^{\frac{\pi}{2}} = -k^{\frac{\pi}{2}}$ means the forward order being taken, that a quadrant round i followed by a qudrant round j is equivalent to a quadrant round the opposite of k. Again, $i^{\frac{\pi}{2}} j = k$ means that the vector j, when turned through a quadrant round i coincides with k. Finally, ij means the unit of directed area which has i for base and j for altitude; for some purposes it may be represented by k on the principle that the axis of a plane may be specified by the axis which it wants; but at p. 92 of "The Principles of the Algebra of Physics," I have shown that the several types of products of vectors may be formed independently of that principle. Prof. Knott states that he fails to see what physical considerations have to do with mathematics of the fourth dimension. It is evident, however, that his perception cannot be taken as a criterion of truth, for every type of product of four vectors is geometrically real excepting the one which supposes them all independent of one another.

I have said that the rules for differentiation are much simplified when vectors and versors are not confounded. In proof of this I invite comparison.

I have said that the principles of quaternions can be greatly extended. In my papers will be found for the first time the extension of space analysis to logmarithmic spirals and to hyperbolic trigonometry. The connection of the latter with non-euclidean geometry is also pointed out. As further evidence of the fruitfulness of my notation and principles I may mention that I have just read before the Mathematical Congress assembled at Chicago two papers—one on "The Definitions of the Trigonometric Functions," the other on "The Principles of Elliptic and Hyperbolic Analysis." These papers give the trigonometry of the elliptic and hyperbolic surfaces.

As regards Prof. Knott's closing quotation from "Paradise Lost," I feel like the Senior Wrangler who, having read through the poem, remarked that it was all very pretty, but he didn't quite see what it proved. I close with a quotation which is from as good a book, and possesses more logical force: "Ye shall know them by their fruits. Do men gather grapes of thorns, or figs of thistles?" ALEXANDER MACFARLANE.

Chicago, Ill., August 26.

Astronomical Photography.

THE letter from Lord Rayleigh in your issue of August 24, on the subject of "Astronomical Photography," will, it is to be hoped, elicit some information from photographic experts.

Meanwhile, accepting what Lord Rayleigh says as to the present possibilities in the preparation of plates, I fail to see where any considerable saving is to be effected in the cost of the apparatus, as he appears to suggest.

For astronomical photography a pair of telescopes are required. The larger of these is employed to take the photographs, and the smaller acts as a guider. Supposing that plates could be obtained which were acted upon by visual rays, while comparatively insensible to the violet and ultra-violet light, this would simply mean that both the objectives would have to be made visually perfect, instead of having one of them as heretofore corrected for violet and ultra-violet light. A photographic objective is no more costly than a visual one of the same aperture; and as to mounting clockwork and dome, there could be no difference in expense.

Of course, if the necessity for a separate guiding telescope could be avoided by the adoption of Lord Rayleigh's suggestion, there would in general be some saving of expense; it should, however, be noted, that even when reflectors are employed for taking the photographs, it has not been always found desirable to dispense with the guiding telescope, though in this case, of course, the question as to the nature of the plates cannot arise at all.

In the particular instance of the instrument now proposed for Cambridge, the guiding telescope is already to hand in the shape of the present Northumberland instrument.

It is certainly easier to test the qualities of an objective corrected for visual rays than for photographic rays (if I may still use language which Lord Rayleigh has pointed out as incorrect). On this account it would, therefore, be desirable to have plates such as he refers to, rendered available for astronomers engaged in photographic work. ROBERT S. BALL.

Observatory, Cambridge, September 12.

P.S.—Sir Gabriel Stokes, after reading the above, writes: "I would ask whether in an orthochromatic plate the blue and violet are impressed more feebly than the rays which are visually the brightest. It may be so, but I do not happen to know whether it is."

The Constellations of the Far East.

WITH regard to the questions asked by "M. A. B." about the grouping of stars into constellations (NATURE, August 17), I venture to answer the last two, which the limited knowledge of an Oriental may partly meet, hoping thereby to interest some of your readers.

I do not consider that each race necessarily relies on its own plan in the fabrication of constellations. The Coreans and Anamese are said to be still adhering to the Chinese system, and till lately the Japanese were doing so. It is strange to find the latter, replete with so peculiar mythology, on which the national claim for high ancestry rests, possessing very few vernacular constellations.

Undoubtedly the Chinese system is of peculiar aspect. A name is given to a "Seat," which is sometimes a single star, but in general a group of stars, varying in number from two to twenty or thirty; and in one group, the Imperial Body-guards, they amount to forty-five. Occasionally the same stars are at once named collectively and individually; thus, the first seven stars of Ursa Major are grouped into Peh-tau or the North Ladle, of which the scoop consists of Shu α, Siuen β, Ki γ, and Kiuen δ, and the handle of Yuh-hang ϵ, Kai-yang ζ, and Yau-Kwang η. With Polaris as the centre, the heavens are radiantly divided into the twenty-eight "Inns" of unequal breadths, each division being denominated after its typical constellation, besides enclosing numerous Seats subordinate to the latter.

The fundamental idea of the plan is enigmatically expressed thus: "Sing (the star) is Tsing (the spirit)." Its solution continues: "Its body grows on the earth, and its spirit is perfected in the heavens." Consequently, various worldly facts and acts that have occupied the Chinese attention, not excepting some now quite forgotten, remind us of their past existence by means of the stellar and constellar names fashioned after them from fancied resemblances or analogies.

How closely this association of the heavenly and worldly phenomena was made, a few examples will suffice to show. The Bow-and-Arrow, though apparently separate, formed but one group, because an archer could perform well without an assistant; but, on account of the supposed impossibility of one's pounding, without an attendant to the mortar, the Mortar was distinct from the Pestle. Imitating the civil institutions of old times, Polaris, entitled the Emperor of Emperors, and his Empress, Imperial Heir, &c., constitute "Ché-wi Palace," with thirty-two subservient Seats, mostly named after officials. Besides, the four "Imperial Thrones" are established, one of which is surrounded with seventeen dependents, chiefly with the names of court-buildings in "Tai-wi Palace," while the other, amidst the "Celestial Emporium" has its seventeen subjects, named after provinces, market buildings, and measures.

For contriving the applications of the plan, the following methods seem to have been observed:

(1) Number, *e.g.* the Five Princes, Four Councillors.

(2) Magnitude, *e.g.* the Squire Captain, set apart from the Squires.

(3) Form, *e.g.* the Canopy, Celestial Coin, Ascending Serpent.

(4) Relation of positions, *e.g.* the Deep Water, Celestial Hook, and Celestial Pier, entirely and partly in, and along the Celestial River (the milky-way).

(5) Direction of the Compass, *e.g.* the South Gate, North Pole.

(6) Colour, *e.g.* Excrementum.

The objects and attributes resorted to for modelling the stars and constellations may be classified as follows:—

(1) Heavenly Bodies, *e.g.* the sun, moon, milky-way.

(2) Meteorological phenomena, *e.g.* thunder and lightning.

(3) Topographical Divisions, *e.g.* the field, tumuli, park, pond.

(4) Civil Divisions, *e.g.* Tsin (a province), Chang-sha (a shire).

(5) Animals, *e.g.* the dog, wolf, fowl, fish, snapping-turtle.

(6) Agricultural Products, *e.g.* bran, hay, gourd, cereals.

(7) Parts of Body, *e.g.* the tongue, penis.

(8) Human Actions, *e.g.* the cry, weep, slander, punishment.

(9) Family Relations, *e.g.* the son, grandson, adult, old man.

(10) Occupations, *e.g.* the farmer, weaving-woman.

(11) Buildings and Departments, *e.g.* the castle, granary, kitchen.

(12) Implements, Furniture, &c, *e.g.* the lock, drum, bell, bed, ship.

(13) Titles and Officials, *e.g.* the feudatory, ministers, generals.

(14) Heroes, *e.g.* Fu-yeh, Tsau-fu.

(15) Philosophical and Theological Notions, *e.g.* positiveness, virtue, prodigy, fates, fortune, wrong, &c.

As far as I could expound, the system implies certain peculiarities. First, it preserves some abstract notions, thus pointing the way towards investigations on the early Chinese speculations. Secondly, portions of the system severally harmonise with the conditions of the Chinese social system that existed for many centuries before the dawn of the Han dynasty (*circa* 200 B.C.), when it seems certain that the nomenclature was well-nigh finished. In the third place, I may mention that after careful revisions of the whole list containing more than three hundred names of the Seats, I have found but two that have had any reference to the sea, viz., "South Sea" and "East Sea," the rather vague notions of old usage indicating some uncivilised territories; and with this only exception there occur no names of marine beings such as Cetus, Delphinus, and Cancer. This fact probably justifies a historical theory that locates the cradle of Chinese civilisation on a land distant from the seas.

I do not know precisely what system is current among the Indians of the present day; but assuredly at least once they made use of their own plans, and mapped out the heavens into the twenty-eight divisions, each division with its typical constellations and their subordinates, as is often alluded to in the Buddhist writings of the North. The equality of number of the divisions in the Chinese and Indian systems is striking; but evidence favours the belief in their sporadic growths and analogous development. The Chinese records of the typical constellations date farther back than the epoch of their intercourse with the Indians; in fact, the Indian constellations, as is obvious from their mythic apotheoses and the articles of sacrifice, including such abomination to the Buddhist as blood and bird's-flesh, are essentially of Brahmanical type, and thus proclaim their priority in existence to the event of the Buddhist mission to China, which marks the era of the mutual acquaintance of the two nations.

When we see in the old Chinese works on Indian names, those of the Indian typical constellations, such as Rivata, Kamphilla, &c., not literally interpreted, but merely identified with those of the Chinese, such as Shi, Fang, &c., every two divisions of corresponding order seem to have had extents almost coinciding in the two systems.

Twan Chin-shi (*circa* 800 A.D.), a Chinese Pliny, in his "Miscellanies" has left us an extract from Indian records, registering the objects with which the Indians used to associate the forms of some typical constellations of their own. Of the Chinese typical constellations, the original resemblances or analogies can still be traced, through their names and characters, with the help of the descriptive remarks in cases of difficulty. Replying upon these authorities, I will now proceed to compare the cited objects of alleged resemblances or analogies, in order to see whether and how the fancies of the two nations converge into or diverge from one another, in the establishment of one most conspicuous, and thence typical constellation, out of the stars scattered over a division almost identical in the two systems.

Chinese names.	Remarks.	Objects of Indian fancy.
1. Niu (Taurus).	The bull with horns.	The head of a bull.
2. Wí (the Tail).		The tail of scorpion.
3. Liú (the Willow).	Curved, with a tip bent, like the willow (twig). In Chinese astrology, this is the patron of the snakes.	The serpent.
4. Wei (the Stomach).	The legs of a vessel for cooking.	Same.
5. Su (the Horn of Scops).		The head of deer (with antlers).
6. Kí (the Winnowing fan).		The horns of cattle.
7. Tsing (the Well).		A footprint.
8. Kwei (the unsettled).	Its character, combined with that for "foot," forms one for "kneeling," and its original hieroglyphic represents "one kneeling"; hence it is probably of analogous plan with Hercules (kneeling).	The dimple of woman.
9. Kwèi (the Ghost).	The coffin (with corpse).	The Saint's Breast.
10. Pih (the Handle-net).		A hat.
11. Sing (the Star).	The hook.	The river-bank.
12. Fang (the Screen).		Beads of head-dress.

It appears from the above comparisons that sometimes quite analogous or even identical plans might sporadically grow among distinct nations, probably due to the pronounced readiness to be grouped afforded by the stars of not very different brightness and relatively situated in a manner which at once suggests a definite outline.

In conclusion, I should be inclined to state that the peculiarity, in cases where it exists, can no doubt be of great value to students of sociology, as it may help to some extent towards the attainment of various important discoveries. For instance, a Chinese constellation, Nü, or the Woman, is described as very much simulating Ki, or the Winnowing Fan; and this might be closely connected with the frequent occurrence in Chinese works of a figurative phrase, "to serve the fan and broom" in the sense of "getting married." On the other hand, as to the merit of its use for ascertaining the race-affinity, my opinion must be somewhat negative, for, while instances are not wanting of such remarkable analogies among such heterogeneous nations as the Chinese and Indians, the subject is decidedly one of those social acquirements of highly transmissible nature, its present features being more the result of the national intercourse than that of the race-affinity.

KUMAGUSU MINAKATA.

15 Blithfield Street, Kensington, August 31.

Mr. Love's Treatise on Elasticity.

HAVING now returned to England, I have had an opportunity of examining my paper on wires (Proc. Lond. Math. Soc. vol. xxiii.), and I find that the discrepancy between my results and those given by Mr. Love, on p. 169 of his book, is due to a slip in my own work. On comparing my equations (11 and 15), it will be seen that in the latter equation the term $-\rho(\sigma p - \sigma r \cos\theta)^{-1}dw'/d\theta$ has been omitted. The value of w' is correctly given by equation 31, and when the omitted term is inserted in equation 32, the resulting value of g will be found to lead to values of the couples identical with those given by Mr. Love.

As I am strongly of opinion that the best way of constructing a satisfactory theory of shells and wires is to use the method of expansion, coupled with the hypothesis that all stresses which vanish at the surface may be treated (to a certain degree of approximation) as zero throughout the substance of the shell or wire, I am exceedingly glad to find that the apparent discrepancy is due to a small slip in my work, and not to any defect in the principles upon which the investigation is based. The question as to the values of the couples may now be considered to be completely settled.

A. B. BASSET.

September 28.

New Caledonian Pottery.

I AM extremely anxious to be informed on a little matter, and you are my only resource. In the *Journal of the Anthropological Institute*, August, 1893, vol. xxiii. page 90, Mr. J. J. Atkinson describes the making of New Caledonian pottery. The ingenious device of the pebble as a pivot is interesting. But Mr. Atkinson always says *he*. Do the men make pottery in New Caledonia, or is this a case of what the country school teacher termed the men embracing the women?

Washington, September 17. OTIS T. MASON.

SCIENCE IN THE MAGAZINES.

AMONG the articles of scientific interest in the magazines received by us, is one in the *Contemporary Review*, in which Prof. Weismann replies to Mr. Herbert Spencer's attack upon his views as to the distinction in the Metazoa between somatic and reproductive cells, and on the immortality of the latter, and of unicellular organisms. With regard to the experiments that have been made with a view to proving the occurrence of telegony, Prof. Weismann says:—

Herr Lang, of Stuttgart, has for twenty years experimented with dogs, without, however, ascertaining "a single fact that could be made use of for the advancement of the infection theory." Of course, in such a case negative results prove nothing; and the attempt must be made to determine the truth by new experiments. But as hitherto there have been no positive results from the observations that have been made; and as the most competent judges, namely, breeders who have a scientific knowledge, such as Settegast and Nathusius, and the late head of the Prussian Agricultural Station at Halle, Prof. Kühn, spite of their extensive experience in breeding and crossing, have never known a case of telegony, and therefore have great doubt as to its reality; it seems to me that *according to scientific principles, only the conformation of the tradition by methodical investigation, in this case by experiment, could raise telegony to the rank of a fact.*

In "A Note on Panmixia," Dr. Romanes attempts to remove any doubt that may exist in Mr. Spencer's mind as to whether Panmixia is a *vera causa* of degeneration, by showing that there are not excessive *plus* variations of an organ. Mr. Spencer had said, "If there are not excessive *plus* variations, the hypothesis of Panmixia is valid"—*ergo*, accepting Dr. Romanes' proofs, the doctrine is triumphant.

Mr. Robert H. Scott writes on "Weather Forecasts" in the *New Review*. He describes the difficulties that beset the weather prophet on all sides, and the various proposals that have been made for gathering in information which would increase their trustworthiness. Some of the proposals, *e.g.* the mooring of signal-ships in mid-Atlantic, are purely visionary, and intelligence directly received from stations in the United States or Canada is practically useless, for the condition of the atmosphere is constantly changing, and the rates at which storms cross the Atlantic vary considerably. The fact that the storms that visit us pass to the northward of the Azores would render those islands of little use to the Meteorological Office, even if a cable were laid to them; and all anticipations as to the advantages to be derived from mountain observatories remain unfulfilled, according to Mr. Scott. However, an examination of the results of forecasts prepared at 8 p.m. from 1879 to 1891 is fairly satisfactorily. Taking the eleven districts of Great Britain and Ireland, for which forecasts are made, it appears that, during the period mentioned, an average of 45·5 per cent. of the forecasts were entire successes, and 34·8 partial, thus giving a total of 80·3. Of the failures, an average of 6·6 per cent. were total and 13 per cent. partial. England (South) showed the highest rate of fulfilment, viz. 85 per cent., counting entire and partial successes together. "The least successful districts are, in order of their figures, the West of Scotland, the South of Ireland, and then the North of Ireland, and the North-west of England. The least successful forecasts are therefore our exposed west and north-west coasts."

Other articles of a scientific character in the *New Review* are: "Are we Prepared to Resist a Cholera Epidemic?" by Mr. Adolphe Smith, and "The Increase of Cancer," by Mr. H. P. Dunn.

Under the title "Atoms and Sunbeams" Sir Robert Ball gives, in the *Fortnightly Review*, a description of Helmholtz's shrinkage theory of the maintenance of the sun's heat, with particular reference to the "precise *modus operandi* by which, as the active potential energy vanishes, its equivalent in available heat appears." "Electric Fishes" is the subject of an article by Dr. McKendrick, and in it we find the investigations carried out by Fritsch, Bois-Reymond and Sachs, Burdon-Sanderson, and Gotch explained in an interesting manner. Before describing the minute structure of individual electrical organs the author makes the following remarks:—

About fifty species of fishes have been found to possess electrical organs, but their electrical properties have been studied in detail only in five or six. The best known are various species of *Torpedo* (belonging to the skate family), found in the Mediterranean and Adriatic Seas; the *Gymnotus*, an eel found in the lagoons in the region of the Orinocco, in South America; the *Malapterurus*, the rääsh, or thunderer-fish, of the Arabs, a native of the Nile, the Niger, the Senegal, and other African rivers; and various species of skates (*Raia*) found in our own seas. It is curious that the Nile is rich in electrical fishes, several species of pike-like creatures (*Mormyrus* and *Hyperopisus*) possessing electrical organs the structure of which has been quite recently investigated by Fritsch. The electrical fishes do not belong to any one class or group, and some are found in fresh water, while others inhabit the ocean.

Two distinct types of electrical organs exist. One is closely related in structure to muscle, as found in the torpedo, gymnotus, and skate, while the other presents more of the characters of the structure of a secreting gland, as illustrated by the electric organ of the thunderer-fish. Both types are built up of a vast number of minute, indeed microscopical, elements, and each element is supplied with a nerve fibre. These nerve fibres come from large nerves that originate in the nerve centres—brain, or spinal cord—and in these centres we find special large nerve-cells with which the nerve fibres of the electric organ are connected, and from which they spring. We may, therefore, consider the whole electric apparatus as consisting of three parts: (1) electric centres in the brain or spinal cord; (2) electric nerves passing to the electric organ; and (3) the electric organ itself. It must not be supposed, however, that the electricity is generated in the electric centres, and that it is conveyed by the electric nerves to the electric organ. On the contrary, it is generated in the electric organ itself, but it is only produced so as to give a "shock" when it is set in action by nervous impulses transmitted to it from the electric centres by the electric nerves.

The *Humanitarian* contains a revised form of the paper on "Cremation" read at the Edinburgh meeting of the British Institute of Public Health by Sir Spencer Wells.

Mr. Geoffrey Winterwood writes on "Mars as a World" in *Good Words*, his article being based in the main upon Camille Flammarion's recent work on Mars and its conditions of habitability. The article is brightened by nine excellent illustrations. "The Cold Meteorite" is the title of a poem by Mr. W. R. Huntingdon in the *Century Magazine*. The meteorite is thus apostrophised:—

"far better 'tis to die
The death that flashes gladness, than alone
In frigid dignity to live on high;
Better in burning sacrifice be thrown
Against the world to perish, than the sky
To circle endlessly, a barren stone."

HYDROPHOBIA STATISTICS FOR 1892 *AT THE INSTITUT PASTEUR.*

An account of the anti-rabic vaccinations undertaken last year in the Pasteur Institute in Paris has been recently published (*Annales de l'Institut Pasteur*, vol. vii. p. 335, 1893). From the statistics here given it appears that no less than 1790 persons underwent this treatment during the past year in Paris alone, and that out of these only four subsequently died from rabies. In 600 of these cases the bites were attributed to animals suspected of suffering from hydrophobia at the time, but in all the others the certainty was established by subsequent veterinary examination, as well as by the death from rabies of other animals bitten by the animal in question.

Since the beginning of the Pasteur treatment in 1886, the mortality from bites on the head after treatment is stated as 1·48 per cent., from wounds on the hands 0·55, and 0·24 per cent. from bites on the limbs.

Thus by far the most serious cases are those in which the head is attacked, and it is pointed out how unfortunate is the delay which frequently occurs between the wound and the arrival of the patient for treatment, the interval militating most seriously against the success of the subsequent inoculations.

The following table indicates the nationality of the patients admitted to the Institute during the past year:—

England	26	Russia	1
Belgium	11	Switzerland ...	3
Egypt	12	Holland	14
Spain	14	India	9
Greece	19	France and Algeria	1584
United States ...	1		
Portugal	96		

Algeria is specially mentioned as being amongst those districts from which the largest number of cases are yearly sent to the Institute.

Last year a patient came from Madeira, rabies having been imported for the first time into the island by a dog from Portugal.

A most unusual occurrence is drawn attention to, viz. the death of a patient, a young Englishman, treated in 1887, and who died last year, five years therefore later, of rabies. Such an exceptional case has not been met with since the commencement in 1886 of the anti-rabic inoculations, which up to the present number 12,782.

Taking the average of cases received during the past six years, rabies appears to reach a maximum in the spring and a minimum in the autumn.

NOTES.

The Harveian Oration will be delivered by Dr. P. H. Pye-Smith, at the Royal College of Physicians, at four o'clock on Wednesday, October 18.

The vacancy in the Mineralogical Department of the British Museum, occasioned by the death of Mr. Thomas Davies, has been filled by the appointment by the trustees of Mr. Leonard J. Spencer, of Sidney Sussex College, Cambridge, who gained the first place at the competitive examination.

Through the munificence of Mr. F. Duncane Godman, F.R.S., a botanical exploration of the island of St. Vincent was made by Mr. Herbert H. Smith and Mr. G. W. Smith in 1889 and 1890. The plants then collected, and those from St. Vincent previously in the Kew Herbarium, have now been arranged, and the resulting catalogue constitutes the *Kew Bulletin* for September (No. 81). All the 977 plants collected by the Smiths are included, whether indigenous or naturalised, and, in addition, 179 flowering plants and 24 ferns not collected by them. We read that, "with regard to the general distribution of the indigenous plants, the principal points are the wide geographical range of the majority, and the smallness of the endemic element, conditions that obtain throughout the whole chain of islands from Tobago to the Virgin group, which are in striking contrast to the proportions of the endemic element in Cuba and Jamaica. . . . . The fern vegetation is very rich and varied, and, in relation to the area, far in excess as to number of species to that of New Zealand, which is generally regarded as one of the most highly concentrated."

We learn from the *Pioneer Mail* that Mr. Dallas, Assistant Meteorological Reporter to the Government of India, leaves shortly for Madras, in order to assist the authorities in starting a daily weather report in that Province.

Dr. Henry B. Ward, of Michigan University, has been appointed Associate Professor of Zoology to the University of Nebraska, Lincoln, Nebr.

Dr. E. Symes Thompson will lecture upon the voice, at Gresham College, Basinghall Street, on October 10, 11, 12, and 13. The lectures are free to the public, and commence each evening at six o'clock.

A very brilliant meteor was seen about 9.45 last night at Leicester (says the *Times* of October 2). It seemed to burst from near the zenith, and proceeded towards the western horizon, increasing very rapidly in brilliancy, until the ground and atmosphere were lit up so that objects in the landscape could be clearly seen at a long distance for several seconds. Mr. H. Cook, of the Birmingham and Midland Institute, says that the meteor was also seen at Neen Sollars, near to Cleobury Mortimer, Salop, at the above-mentioned hour.

Dr. O. Loew, of Münich, well known for his investigations of the nature of protoplasm in connection with Dr. T. Bokorny, has been appointed Professor of Agricultural Chemistry in the University of Tokio, Japan; and Dr. D. Brandis, a fellow of our Royal Society, Professor of Forestry in the University of Bonn.

In two recent numbers of the *Botanisches Centralblatt* is a detailed account, by Dr. F. v. Herder, of the Herbaria and Botanical Museums in St. Petersburg. Of these, five in number besides private collections, the richest and most important are those of the Imperial Academy of Sciences and of the Imperial Botanical Garden.

THE Natural History Society of Danzig has offered a prize of 1000 marks for the best essay on the best means of producing and spreading fungus-epidemics for the destruction of insects injurious to the forests in Western Prussia. The essays must be written in German or French, and are to be sent in before the end of the year 1898.

The numbers of the *Œsterreichische Botanische Zeitung* for August and September contain interesting reports of the botanical excursion of Dr. E. von Halácsy in the Pindus range in Greece, and of that of Dr. J. Bornmüller in Persia. Dr. Bornmüller describes the flora of the neighbourhood of Bushire in March as being especially rich and beautiful.

A SUBTROPICAL botanical laboratory has been established at Eustis, Florida, under the direction of Prof. Swingle. The diseases of fruits belonging to the *Aurantiaceæ* are a special subject of investigation.

THE singular swarms of flies observed by Mr. R. E. Froude at the end of May last, and described by him in these columns (vol. 48, p. 103 and p. 176), have also been seen at Muskegon, Michigan, by Mr. C. D. McLouth. Writing from that city to *Science* of September 15, Mr. McLouth says that on the evening of June 26 the fire brigade was called to two of the highest buildings, the alarms being caused by an appearance as of smoke issuing from the pinnacles of the towers. In both cases the appearance was found to be caused by clouds of insects. Some insects afterwards captured and supposed to be identical with the swarmers were found to be Neuropters.

THE fiftieth volume of the *Verhandl. des Naturhistor. Vereins der preuss. Rheinlande* contains numerous short notices on various subjects, and three important memoirs:—B. Stürtz, on star-fishes, giving a bibliography of recent and fossil forms, notes on classification and distribution, and descriptions of three new species; a continuation of the monograph, by A. Hosius, on the Foraminifera of the Miocene; and a paper by H. Laspeyres on the nickel ores and minerals of the Rhenish rocks, giving numerous analyses and crystallographic notes.

MR. G. CHRISTIAN HOFFMANN has prepared an excellent catalogue of Section I. of the Museum of the Geological Survey of Canada. It embraces the systematic collection of minerals and the collections of economic minerals and rocks and specimens illustrative of structural geology. Reference is facilitated very considerably by four very full indexes. The first of these is an index to the cases containing the minerals; the second to the numbers borne by the specimens; the third to mining districts, areas, camps, locations and claims, mines, quarries, and pits, and the fourth to subjects. Since all the specimens are from Canadian localities, Mr. Hoffmann's catalogue may be taken as a representation of the mineral resources of the Dominion.

THE modifications in the physiological character of micro-organisms which may be produced by either natural or artificial means, and which may, moreover, become inherited and permanent, is one of the most fascinating subjects in bacteriology. But it opens up a problem of much importance in the identification of bacteria, for the characteristic appearance may become so modified that its original parentage is with difficulty recognised. In this connection the production of a race of *sporeless* anthrax, endowed with the same virulent properties, resembling also microscopically the original form, is of particular interest. Such "asporogène" anthrax was first produced by Chamberland and Roux, through the addition of small doses of potassium dichromate to broth infected with anthrax-blood. By this means a generation of anthrax bacilli was obtained in which the power of producing spores was permanently destroyed. Since the publication of the above, "asporogène" anthrax has been obtained by other investigators, whilst Lehmann came upon such a variety quite accidentally in an old gelatine culture. Still more recently (*Le Bulletin Méd.* p. 293, 1892), Phisalix has succeeded in producing sporeless anthrax by the continuous and successive cultivation of anthrax bacilli at 42° C. For the original infection the blood of a sheep dead of anthrax was taken, and portions of this culture were transferred to a second culture, and also kept at 42° C., this process being continued for twenty-five generations covering a period of five months. The twelfth generation already yielded a variety incapable of producing spores except on being first passed through the body of a mouse, but the fourteenth generation had established a race permanently incapable of producing spores. These asporogène cultures, however, unlike those of Chamberland and Roux, suffered an attenuation of their virulent properties, and the descendants of the twentieth generation were absolutely harmless as regards animals. The possibility, therefore, of pathogenic microbes losing their virulence, or of harmless saprophytes being trained up to acquire pathogenic properties, is one which must without doubt be taken into consideration; and when we remember that sunshine alone may produce such modifications in the physiological characters of microbes as to permanently deprive certain pigment-producing bacteria of this property, and raise up instead a colourless race (Laurent), the indulgence of this possibility becomes yet more within the bounds of legitimate conception.

THE Meteorological Reporter to the Government of India has published No. 5 of *Cyclone Memoirs*, containing an elaborate and valuable discussion, accompanied by twenty-five plates, of three cyclones in the Bay of Bengal and Arabian Sea during the month of November, 1891. The first storm, called the Port Blair cyclone, originated in the Gulf of Siam on October 29 and 30, and caused great destruction of life and property in the South Andaman Island. It is the first large storm for which there is conclusive evidence that it originated outside the area of the Bay of Bengal, and owing to its rapid recurvature several ships encountered the storm twice; it was probably owing to this that the pilot vessel *Coleroon* foundered. An examination of the storms which have occurred since 1737, shows that not more than three or four of them could possibly have advanced across the Malay Peninsula into the bay. The second storm originated on the 1st and 2nd, between the Maldives and the Travancore coast, and is said to be the most violent that has been experienced in Minicoy for the past quarter of a century. This storm is the more interesting from the fact that exact information is rarely obtained of the birth of such a disturbance in the neighbourhood of the equator. The predominant feature was the excessive amount of rainfall, which was quite as exceptional as the storm itself. The third storm originated in the south-east of the bay, on the 19th and 20th; it was remarkable only for its track, as it advanced by a curved path into Central Burma, instead of to the coast of Madras, as usual. The tracks of this and of the first storm show certain abnormal conditions to have existed during the whole of the month. All the disturbances were generated in the humid south-west monsoon current, and were apparently not due to any mechanical action between two opposite air currents. Mr. Eliot states that rainfall appears to be the dominating factor in all large cyclones in India, and that this or aqueous vapour was the chief agent in determining the origin and motion of the three storms above referred to.

A REMARKABLE case of resuscitation of an optical image is described from personal experience by Prof. T. Vignoli in a paper recently communicated to the *Reale Instituto Lombardo*. On the morning of July 3, after a railway journey in a bright sun, and two days' walk in a suffocating heat, he happened to be in a room with several other persons, and during conversation looked at a balcony bathed in bright sunlight, but without taking any special interest in it. The balcony was decorated with trellis-work and ivy. Flowering creepers were arranged in vertical columns, each column being crossed below by the iron bars of the balcony, and above by sticks supporting the plants. A cage with birds hung up in the middle. Two days afterwards, very early in the morning, the professor was in bed, but perfectly awake, and in ordinary health, when, to his astonishment, he saw on the ceiling, by the light coming through Venetian blinds of two large windows, an exact reproduction, in all its colours and details, of the balcony referred to. The phenomenon lasted long enough to permit some detailed investigation. On closing the eyes, the image disappeared, to appear again when they were opened. It was unaffected by regarding it with each eye alternately. A finger placed between the eye and the image intercepted it in the same manner as it would any ordinary object; in short, the phenomenon obeyed all the optical laws of vision. And not only was the cage of birds reproduced, but also its swinging motion noticed before. Prof. Vignoli argues that this cannot have been a case of ordinary hallucination, since the latter is unaffected by the opening or closing of the eyes, and is practically limited to occasions of abnormal health or disturbed state of mind. It must be regarded as an outward projection of a recollected image, though the mechanism of this projection does not appear to be well understood by the professor himself. A case such as this, of what the German psychologists would call *wach-traum*, merits the attention of those interested in psycho-physics.

The current number of the *Electrical Review* contains a description of some of the latest appliances in "electric heating" for domestic use. In the cookery experiments at the Crystal Palace last year the efficiency obtained was, as a rule, very small, and the wires used in the apparatus were soon destroyed. Mr. Binswanger, of the General Electric Company, claims to have got over both these drawbacks, as well as that of the difficulty of insulation. Instead of wrapping the wires in asbestos, mica, &c. (under which conditions they rapidly oxidise), or clothing them with enamel (which cracks at high temperatures), a cement is applied in a cold state, which is said to insulate well without cracking, even at very high temperatures. The "electric kettle" has a copper bottom resting on a double layer of silicate cement, between the two parts of which the copper wires carrying the current are arranged. The 1 pint size takes 3 amperes at 100 volts to raise the water to boiling, and as the time required to raise a pint of water from 15° C. to 100° C. by an expenditure of 1000 watts is 3·7 minutes, this kettle, which is a "300-watt kettle," will take 12 minutes to boil 1 pint. With electricity at 4d. per unit, the cost of boiling the pint of water would be approximately one farthing, which is, of course, much dearer than gas. Stew-pans, ovens, and "radiators" for heating rooms are also made, as well as frying-pans and gridirons, in the two last-named of which greater economy is practicable than in the other cases, as the heat can be produced in the exact spot in which it is wanted. Altogether it is evident that although the use of "electric heating" for domestic culinary purposes is not yet in its really practical stage, it is well on the way there.

In the course of an interesting series of articles in *Electricité* on the "Electric Lighting of Trains," we find the following figures given as a comparison between the cost of oil-lamps and electric lights. The system under discussion is that of accumulators carried in the train and charged at fixed charging stations. The total expense of an electric-lamp in a first-class carriage, including interest on capital, &c., comes out at 0·0289 francs per "lamp-hour," while an oil-lamp (of only 7-candle power) comes to 0·38 francs per hour, while in the second and third class carriages, where more lamps are run off the same battery, the comparison is still better in favour of the electric system.

A catalogue of works on Phanerogams, alphabetically arranged in genera, has been issued by Messrs. Dulau and Co.

Two pamphlets by Sir Spencer Wells have been sent to us—one, "The Prevention of Preventible Disease," is a lecture delivered in Glasgow in May last, and the other, "Cremation and Cholera," is reprinted, with additions, from the *Forum* for February, 1893. They both deserve a wide circulation and attentive reading.

Messrs. Cassell and Co. have just published a new edition of "Elementary Lessons with Numerical Examples in Practical Mechanics and Machine Design," by R. G. Blaine. The book has been to a large extent rewritten, and contains a good deal of additional matter, an attempt having been made to bring the work up to date.

There is little of scientific value in Mr. Phil Robinson's latest volume—"Some Country Sights and Sounds" (Unwin). The author, however, writes pleasantly enough on a variety of topics more or less to do with the country.

We have received a volume containing the meteorological observations made at the Adelaide Observatory and other places in South Australia and the northern territory, during the years 1884–5, under the direction of Sir Charles Todd, F.R.S.

A new edition (the eighth) of Valentin's "Course of Practical Chemistry, or Qualitative Chemical Analysis," edited and revised by Prof. W. R. Hodgkinson, has just been published by Messrs. J. and A. Churchill. A few additions have been introduced into the work, including an extra chapter, in which quantitative operations are dealt with.

The June number of *Timehri*, the journal of the Royal Agricultural and Commercial Society of British Guiana, has just appeared, and contains articles on "The Seasons in Guiana," "Notes on a Journey to a Portion of the Cuyuni Gold Mining District," and "Amateur Insect Collecting in British Guiana," occasional notes, reports of the society's meetings, &c. It may be obtained in London from Mr. Stanford.

Messrs. Blackie and Son have just published an attractive little book entitled "Animal and Plant Life," by the Rev. Theodore Wood. The book is the sixth number of a useful series of science readers adapted for use in elementary schools.

"Weissmann's Theory of Evolution" (1893) is the title of an article by Prof. Romanes in *The Open Court* of September 14. Prof. Weismann's recent modifications of his sequent theory of evolution are the chief points discussed.

A list of Coleoptera, prepared by Mr. James Edwards, and forming Part XII. of the "Fauna and Flora of Norfolk," has been reprinted from the Transactions of the Norfolk and Norwich Naturalists' Society (Vol. V.), and issued separately.

Under the title "Les Moteurs à Gaz et à Pétrole" (Gauthier Villars), M. Paul Vermand gives an excellent summary of the present state of knowledge of atmospheric motors. The volume belongs to the Aide-Mémoire series. Another work in the same series that has recently been received is "Décoration Céramique au Feu de Moufle," by M. E. Guenez.

Messrs. Methuen and Co.'s Commercial Series, "intended to assist students and young men preparing for a commercial career, by supplying useful handbooks of a clear and practical character, dealing with those subjects which are absolutely essential in a business life," has received an addition by Mr. H. De B. Gibbins, entitled "British Commerce and Colonies."

A SECOND edition of Mr. J. R. Ainsworth Davis' "Elementary Text-book of Biology" (Messrs. Charles Griffin and Co.) having been called for, the book has been thoroughly revised and much enlarged, and a number of illustrations have been added. Part II. (Animal Morphology and Physiology) has had its value enhanced by the addition of a chapter on the Distribution of Animals.

MESSRS. WHITTAKER's library of popular science has received an addition in the form of a volume entitled "Electricity and Magnetism," by Mr. S. R. Bottone. The illustrations in the book are a little coarse, but are just what a teacher requires to elucidate the text. Mr. Bottone is evidently at home in his subject, and he knows the way to present it to the general reader.

DR. J. W. GREGORY has conferred a benefit upon students of petrography by translating the "Tables for the Determination of the Rock-Forming Minerals," prepared by Prof. F. Lœwinson-Lessing. The tables of Rossenbach and Michel Lévy and Lacroix leave nothing to be desired in the matter of completeness, but they are of little use to the elementary student for purposes of identification. By means of the synoptical tables, however, the commoner rock-forming minerals can easily be determined when their characters have been microscopically observed. A very suitable introduction to the tables is a description of the petrological microscope, by Prof. Grenville A. J. Cole. Messrs. Macmillan are the publishers of the translation.

THE October number of *Natural Science* is of unusual interest. Among the articles are the following: "The Effect of the Glacial Period on the Fauna and Flora of the British Isles," by G. W. Bulman; "Some Recent Researches on the Habits of Ants, Wasps, and Bees," by George H. Carpenter; and "The Recent Plague of Wasps," by Oswald H. Latter. Dr. C. Herbert Hurst theorises upon "The Digits in a Bird's Wing," and Mr. J. T. Cunningham upon "The Problem of Variation." In addition there are numerous notes and book-notices.

AN investigation of the composition and properties of the dangerously explosive iodide of nitrogen has been carried out by Dr. Szuhay in the laboratory of the University of Buda-Pesth, and an account of his interesting experiments is contributed to the latest publication of the *Berichte*. A large number of investigators have previously attacked this somewhat fascinating subject, but the knowledge hitherto accumulated has been insufficient to enable us to express with certainty its composition. One of its properties, its unparalleled readiness to explode with or without provocation, has been so much to the fore as to almost entirely exclude investigation of its more important, although less sensational, chemical properties. One variety of the substance, which was obtained by Dr. Szuhay by adding ammonium hydrate solution to powdered iodine, was found to be so pre-eminently disposed to detonative decomposition that it frequently exploded even under water, and if it were successfully transferred while wet to a filter it exploded upon the passage of the first draught of air. An attempt to ascertain its composition by careful decomposition with sulphurous acid resulted in the complete pulverisation of the containing vessel. Iodide of nitrogen was first prepared by Curtois by mixing alcoholic solutions of iodine and ammonia. He considered it to be the tri-iodide NI_3, an opinion which was subsequently shared by Gay Lussac. Millon and Marchand afterwards expressed the view, unsupported, however, by experimental evidence, that it contained hydrogen, and might be represented by the formula NH_2I. More recently Bineau, and in this country Dr. Gladstone, have adduced more trustworthy evidence, from its mode of decomposition by an aqueous solution of sulphuretted hydrogen and by sulphurous acid, that this extraordinary substance does indeed contain hydrogen, but only to the extent of one atom, its constitution being NHI_2. Bunsen, however, subsequently communicated to the *Annalen* the view that iodide of nitrogen consists of NI_3, but that according to its mode of preparation it contains more or less ammonia. Finally, Stahlschmiedt has brought forward the further hypothesis that when an alcoholic solution of iodine is mixed with aqueous ammonia the substance NI_3 is produced, but that when alcoholic ammonia is employed the product possesses the composition NHI_2. The result of all this conflicting testimony has been to leave the question of the composition of iodide of nitrogen an open one.

IODIDE of nitrogen was prepared by Dr. Szuhay, after investigating most of the methods hitherto described, by adding excess of aqueous ammonia to a concentrated solution of iodine in potassium iodide. It is thus obtained in the form of a very fine powder, which was found to be capable of safe purification by washing with a dilute solution of sodium sulphate. It is requisite to protect the filter from draughts of air which are liable to induce explosion. The purified substance, of course in a moist condition, as it cannot be dried without explosion, was analysed by decomposition with a solution of sulphurous acid of known strength and estimation of the amount of iodine and ammonia in the solution. Its composition was indubitably proved to be NHI_2, thus confirming the earlier work of Dr. Gladstone and of Bineau. This conclusion is powerfully supported by the fact that Dr. Szuhay has been able to prepare a silver derivative of the compound by replacing the hydrogen atom by silver. This silver compound is readily obtained by adding powdered oxide of silver or an ammoniacal solution of silver nitrate to iodide of nitrogen suspended in water. It is a black flocculent substance which is quite as explosive as iodide of nitrogen itself. When carefully dried the least rise of temperature provokes explosion. It also detonates upon being struck or even when brought into gentle friction with any other substance. When warmed under water, or when treated with dilute acids it is quietly decomposed, silver iodide being deposited, free iodine liberated, and free nitrogen escaping with effervescence. The relative amounts of these products of decomposition conclusively prove the compound to possess the composition $AgNI_2$. Moreover, considerable evidence is also adduced to show that potassium, sodium, and barium replacement compounds are capable of existence in solution. The existence of the compound HNI_2 is thus fully demonstrated, and whether or not the compounds NI_3 and NH_2I are likewise capable of formation under different experimental conditions is a question which doubtless further work will elucidate. It is not unworthy of notice that there is a considerable amount of resemblance between this extraordinarily explosive substance and the similarly distinguished azoimide $H-N\Big\langle\begin{matrix}N\\ \|\\ N\end{matrix}$; for both contain the imido group NH the hydrogen of which is capable of being replaced by silver and other metals, and both appear in consequence to be endowed with a somewhat acid nature by the two atoms of negative iodine in the one case, and the negative diazo-nitrogen group in the other.

NOTES from the Marine Biological Station, Plymouth.—Last week's captures include the Annelids *Myrianida maculata* (one of these with a chain of buds), *Sphærodorum peripatus* and *Siphonostoma uncinatum*, the tubicolous Gephyrean *Phoronis* *hippocrepia*, and the Decapod Crustacean *Athanas nitescens*. The floating fauna has presented hardly any appreciable change: numbers of young *Geryonia appendiculata*, some Margelid medusæ and swarms of *Obelia*, have formed the chief Cœlenterate element. *Noctiluca* is generally present in fair quantity. The Ascidian *Ciona intestinalis* is now breeding.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*) from India, presented by Mr. Duncan Mackintosh; two Lions (*Felis leo*, ♀♀ jew.) from Somaliland, presented by The Lord Delamere; four Long-fronted Gerbilles (*Gerbillus longifrons*) from Tunis; two Long-tailed Field Mice (*Mus sylvaticus*) from France, presented by Mons. Albert de Lautreppe; a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Mr. H. Rich; two White Storks (*Ciconia alba*) European, presented by Mr. Walter Winans, F.Z.S.; an Adelaide Parrakeet (*Platycercus adelaidæ*) from Australia, presented by Mrs. Waterhouse; two Common Sheldrakes (*Tadorna vulpanser*) from Scotland, presented by Mr. Francis Alexander; three Dwarf Chameleons (*Chamæleon pumilus*) from South Africa, presented by Mr. Henry Beamish; an Alligator (*Alligator mississippiensis*) from Florida, presented by Mr. H. Venn; a Serval (*Felis serval*), a Cape Crowned Crane (*Balearica chrysopelargus*), a Secretary Vulture (*Serpentarius reptilivorus*), a Black-winged Kite (*Elanus cæruleus*) from South Africa, a Grey Squirrel (*Sciurus cinereus*) from North America, deposited; three Viscachas (*Lagostomus trichodactylus*), a Hairy Armadillo (*Dasypus villosus*), two Ypecaha Rails (*Aramides ypecaha*), a Great Grebe (*Æchmophorus major*) from South America, a Prêtrés Amazon (*Chrysotis pretrii*) from Brazil, purchased; four Indian Wild Swine (*Sus cristatus*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ON THE PARALLAX OF THE PLANETARY NEBULA B.D. + 41°.4004.—During the summer of 1892 Dr. J. Wilsing began a series of photographs of Webb's planetary nebular B.D. + 41°.4004, using the new photographic refractor of the Potsdam Observatory, with the intention of determining the parallax. In the current number of *Astronomische Nachrichten* (No. 3190) he gives an account of the measurements made. The undertaking seems to have been especially difficult on account of the numerous errors that were liable to arise, and also to the lack of sharpness of the image of the nebula on the photographic plate. From June 1892 to June 1893 he obtained thirty-four plates with two exposures on each of eight minutes duration, and they were all measured with the Repsold's measuring apparatus, a description of which instrument is given in vol. v. of the Publications of the Potsdam Astrophysical Observatory. Six stars were used for comparison, and the distance of the nebula was measured from two of these stars, the others being used for finding the value in seconds of arc of the measured distances, &c. The distances measured show a distinct decrease, as will be gathered from the following table, when N. 3 and N. 6 denotes the distances from the two companion stars respectively:—

1892-93.	N. 3.	N. 6.	Wt.
	′ ″	′ ″	
June 25	7 24·53	13 9·72	$\frac{2}{3}$
July 13	24·40	9·77	1
Aug. 8	24·53	9·56	$\frac{1}{3}$
Sept. 23	24·42	9·71	$\frac{1}{3}$
Oct. 18	24·43	9·61	1
Nov. 10	24·23	9·60	$\frac{4}{3}$
Jan. 2	24·32	9·43	$\frac{1}{3}$
June 5	7 24·56	13 9·61	$\frac{1}{3}$

Assuming the nebula distances from these stars as 7′ 24″·40 + 13′ 9″·60 for 1892·0, the position, corrections, relative yearly proper motions, and the relative parallaxes, when taken into account, gave the following numbers for the equation, observed—calculated

O – C.

N. 3.	N. 6.	N. 3.	N. 6.
″	″	″	″
+ 0·05	+ 0·05	+ 0·06	– 0·05
– 0·07	+ 0·06	– 0·13	+ 0·01
+ 0·08	– 0·11	– 0·05	– 0·08
+ 0·02	+ 0·03	0·00	+ 0·05

The negative relative parallax thus obtained shows, as Dr. Wilsing in his concluding remarks says, that the distance of Webb's nebula from the sun cannot be assumed in any way to be less than the distances of both the eleventh-magnitude comparison stars.

SOLAR AND LUNAR EPHEMERIS FOR TURIN.—In vol. xxviii. of the *R. Accademia delle Scienze di Torino*, Dr. Alberto Manaira contributes the ephemerides of the sun and moon which he has calculated out for the horizon of Torino for the year 1894. For each day of the month throughout the year he gives the time of rising, meridian passage, and setting of the sun and moon. Brief reference is also made to the eclipses visible in that year, giving the time (mean time Rome) of the chief contacts.

GEOGRAPHICAL NOTES.

THE *Mouvement Géographique* publishes a sketch map of Dr. Baumann's exploration to the north-east of Lake Tanganyika, in the country of Urundi. He has traced out the head waters of the Kagera, which take their rise close to Tanganyika and flow down the long slope to the Victoria Nyanza, being thus the ultimate source of the Nile, if it is possible to apply that name to any of the streams which feed Lake Victoria. The mountains between the basin of the Kagera and that of the Rusiji are called by the Warundi *Misozi a Mwedi*, or Mountain of the Moon. Some of the summits were apparently abou 10,000 feet above the sea. The Rusiji River, which flows int Lake Tanganyika at its northern end, is represented provisionall as flowing from the reported Lake Oso, which receives the drainage from the southern slopes of the Mfumbiro mountains, the north slope of which drains to Lake Albert Edward. If this topography turns out to be correct, the Mfumbiro range forms the only barrier across the great meridional furrow which runs from the Mediterranean to the Zambesi, and includes Lakes Albert, Albert Edward, the possible Oso, Tanganyika, and Nyasa.

MR. H. F. B. LYNCH, with his brother and a Swiss guide, succeeded, after seven and a half hours' climbing, in making an ascent of Mount Ararat, on September 19, and promises some interesting information regarding his observations on his return to this country. He took some photographs of the mountain scenery.

PRINCE KRAPOTKIN publishes his address on the Teaching of Physiography, given at the Teachers' Guild Conference at Oxford, in the October number of the *Geographical Journal*. He deprecates the exclusive use of the *Heimatskunde* in introducing children to the study of the earth, and approves rather of teaching geography by considering the earth as a whole, insisting, however, on the importance of personal work by the scholars in their own neighbourhood to extend and give reality to theoretical teaching.

AN interesting history of the mapping of the state of Missouri, by Mr. Arthur Winslow, assisted by Mr. C. F. Marbut, has been published in the Transactions of the Academy o Sciences of Missouri. Starting with the dictum that the civilisation of a people is proportional to the accuracy with which their country is mapped, Mr. Winslow traces the gradual improvement of the maps of Missouri in a readable way. He gives rough sketches of the more interesting early maps. Franquelin's map of 1688 is the first on which the name "Missourils" appears, but the river to which the name was applied is very imperfectly drawn. In Sinex's map of 1710 the position of the Mississippi is shown nearly sixty miles too far west, and the mouth of the Missouri twenty-five miles too far north. In du Pratz' map of 1763 the error in both directions is doubled. Lieutenant Ross, of the British Army, in 1765 made a survey of the Mississippi, accurate as to latitudes, but wrong in longitude. The first really effective survey was that of Messrs. Lewis and Clarke in 1804–1806. In 1815 Land Office surveys were commenced. After the admission of the State to the Union in 1820 more accurate surveys were required to fix the boundary lines, but these had to be rectified in 1850, when serious discrepancies were found. Really trustworthy surveying was only begun when the Coast and Geodetic Survey commenced a triangulated line across the state in 1871. The Mississippi and Missouri River Commissioners subsequently rectified the mapping of the rivers, and now the topographical survey of the State is being carried out by the U.S. Geological Survey, which has executed maps of one-third of the area on the scale of about two miles to the inch. The Missouri Geological Survey also makes a topographical map of selected parts of the State on the scale of about one mile to the inch.

THE OBSERVATORY ON MOUNT BLANC.

AS briefly announced in our Notes last week, Dr. Janssen has recently visited the observatory on Mount Blanc. In the current *Comptes Rendus* he gives an account of the expedition from a scientific point of view, and the following is a translation of his description:—

We left Chamonix on September 8, at 7 a.m., and arrived at the summit on September 11, at 2.30 p.m. The observatory was then in front of us. This construction has several floors, of which the framework, formed by large and massive beams crossed in all directions in order to ensure the rigidity of the whole, produces a deep impression upon the mind. One wonders how it has been possible to transport the edifice to this altitude and fix it on the snow. However, if the conditions offered by the hard, permanent, and little mobile snows of the summit are carefully considered, it is soon recognised that the snows are able to support very considerable weights,[1] and that they will be only slightly amenable to displacements, which will render it necessary to straighten again the construction which has been fixed upon them.

On my arrival I made a rapid survey, and saw that the construction had not been sunk in the snow as much as I had stipulated of the contractors. I do not approve of this. My guides and myself then took possession of the largest underground room. I intended at first to fix the instruments for enabling observations to be commenced immediately, and the provisions were left on the Rocher-Rouge. This circumstance put us in a state of perplexity, for the weather suddenly became very bad, and we had to remain two days separated from the stores. The storm lasted from Tuesday until Thursday morning. Beautiful weather then set in, and I was able to begin the observations.

The observations have for their principal object the question of the presence of oxygen in the solar atmosphere. The Academy knows that I worked at this important point during my ascensions to the Grands-Mulets (3050 metres) in 1888, and at M. Vallot's observatory in 1890.

But the novelty of the observations of 1893 lies in the fact that they have been effected on the very summit of Mount Blanc, and that the instrument employed is infinitely superior to that of the two preceding ascensions. At the first, in fact, a Duboscq spectroscope incapable of separating the B group into distinct lines was employed, while the instrument about to be employed at the summit of Mount Blanc is a grating spectroscope (the dispersive piece of which I owe to the kindness of Rowland), with telescopes having a focal length of 0·75 and showing all the details of the B group. This circumstance is of considerable importance, for it may lead to the discovery, in the constitution of the group in question, of valuable elements for measuring in some way the effects of the diminution of the action of our atmosphere as one ascends into it, and, accordingly, to determine whether this diminution corresponds to total extinction at its limits. In fact we shall learn whether or no the double lines which make up the B group diminish in intensity as their refrangibilities diminish; that is, as their wave-lengths increase.

This circumstance may perhaps be employed with profit, if not to measure, at least to observe the diminution of the action of the selective absorption of our atmosphere. It has been ascertained that the most feeble doubles fade away one after the other as the atmosphere is ascended, that is to say, as the absorbing action is diminished. Thus, under ordinary circumstances, at the surface of our seas or upon our plains, thirteen or fourteen doubles can be seen, not reckoning that which is known as the head of B.

But even at Chamonix, that is at an altitude of 1050 metres, the thirteenth double is very difficult to make out, and at the Grands Mulets (3050 m.), it is only possible to see from the tenth to the twelfth, while at the summit of Mount Blanc I could hardly go beyond the eighth.

It is not to be supposed that we establish a proportionality between the numerical diminution of the doubles and that of the atmospheric action. The law is evidently of a much more complex character. But this diminution, especially when considered in connection with the experiments made with tubes full of oxygen, and able to reproduce the series of atmospheric phenomena to which we have referred, is sufficient for us to conclude that the B group would totally disappear at the limits of our atmosphere. It is remarkable, however, that if we take the co-efficient 0·566 that represents the diminution of atmospheric action at the summit of Mount Blanc according to barometric pressures $\left(\frac{0·43}{0·76} = 0·566\right)$ and multiply it by thirteen—the number that represents the doubles clearly visible on the plain—we obtain 7·4 as the result; that is to say, very nearly the number (8) doubles that can be seen by me on the summit of Mount Blanc.

This result is certainly remarkable, but I repeat that, in my opinion, it is only by the comparison with tubes reproducing the same optical conditions as nearly as possible, that any definite conclusions will be obtained. These comparative experiments have already been commenced in the laboratory of Meudon Observatory, and they lead to the same result, viz., the disappearance of the groups A, B, and α at the limits of the atmosphere. On account of the importance of the question, however, the experiments will be repeated and completed.

The question arises as to whether the high temperatures to which solar gases and vapours are subjected are not capable of modifying the power of selective absorption, and particularly whether the absorption of oxygen which takes place in the sun's atmosphere would not be altogether different from that indicated by the experiments which have been made at ordinary temperatures.

I have already instituted experiments with the idea of replying to this objection. I shall give an account of them to the Academy in due course, but I may say that the absorption spectrum of oxygen, either the line spectrum or the unresolvable bands, do not appear to be modified in an appreciable manner when the oxygen is raised to temperatures of about 400 or 500 degrees.

On the whole, I think that observations made on the summit of Mount Blanc give a new and much sounder foundation to the study of the question of the purely telluric origin of the oxygen groups in the solar spectrum, and lead to the conclusions previously stated.

Independently of these observations I have also given some attention to the transparency of the atmosphere of this almost unique station, and to the atmospheric phenomena which are included in such an extensive view, and across such a great thickness. I shall speak of this on a future occasion.

The observatory, of course, is not completed. There yet remains much to be done independently of interior arrangements and the installation of the instruments; but the great difficulty has been overcome, for we are free to work, and no longer have to reckon with the snowstorms; the rest will follow in due course.

I hope that the observatory will soon be able to offer a much more comfortable sojourn than I have had there; but that will depend upon the weather. Be this as it may, I regret nothing. I strongly wished to see our work in position, and still more fervently desired to inaugurate it by observations which are ever in my mind. I am fortunate at having been able to realise my desires in spite of some difficulties.

IRON AND STEEL INSTITUTE.

A VERY successful meeting of the Iron and Steel Institute has just been held in Darlington, commencing on Tuesday, September 26. The President, Mr. E. Windsor Richards, occupied the chair There was a very good list of papers,

[1] See *Comptes Rendus* for an account of experiments made at Meudon on the resistance of slightly compressed snow.

eleven in all, as follows:—On the Manufacture of Basic Steel at Witkowitz, by Paul Kupelwieser; on the Waste of Fuel, Past, Present, and Future, in Smelting Ores of Iron, by Sir Lowthian Bell, F.R.S.; on Iron and Steel at the Chicago World's Fair, by H. Bauerman; on Iron and Steel Wire, and the Development of its Manufacture, by J. P. Bedson; on the Sampling of Iron Ore, by T. Clarkson; on the Tudhoe Works of the Weardale Iron and Coal Company, by H. W. Hollis; on the Lührig Coal Washing and Dry Separation Plant at the North Bitchburn Coal Company's Randolph Pit, by James I'Anson; on Carbon in Iron, by Prof. Ledebur (Freiberg); on Suggested Improvements in connection with the Manufacture of Steel Plates, by William Muirhead; on the Last Twenty Years in the Cleveland Mining District, by A. L. Steavenson; on the Production of Wrought Iron in Small Blast Furnaces in India, by T. Turner.

Mr. Kupelwieser's paper was first taken, and gave an interesting account of the basic process, which the author has introduced with considerable success at Witkowitz. It is of course well known that the cheapest process of steel manufacture is that carried out with the Bessemer converter; the Siemens furnace comes next. Although the basic process was originally devised for the use of the Bessemer converter, it has had considerable application with the open-hearth furnaces. The basic process is, however, dearer than the old acid system of manufacture, and some of the most beautiful mild steel produced is made in the open-hearth furnace with a basic lining. The latter, again, is more costly than the old acid lining, and we have therefore the following gradations as to cost:—First, the acid Bessemer, or original process; next, the basic Bessemer; then the acid open-hearth, and finally the basic open-hearth; the latter being the dearest of the four. It is obvious therefore, that when circumstances permit it, that the Bessemer converter should be used in place of the open-hearth, but there is an objection to the Bessemer converter in the fact that it acts so much more quickly; the slower working open-hearth furnace giving time for tests to be made, and the product is consequently more certain. Mr. Kupelwieser has introduced a combined process in Witkowitz, which many members of the Iron and Steel Institute saw in work, when the Institute meeting was held in Austria. The pig-iron obtained in Witkowitz contains too much phosphorus for use in the ordinary Bessemer process, while it does not contain sufficient phosphorus for the basic process. As a further complication, a supply of cheap scrap was not obtainable at the works. The way in which the author got over his difficulties is highly ingenious, and is well worth study by English steel-makers. The pig-iron is run from the blast furnace into the ladle, and transferred immediately to the converter, which has an acid lining. The blast is then turned on, and the blow kept up till the pig-iron is de-siliconised: an operation that requires about five or six minutes to perform. The silicon being removed, manganese and a considerable amount of carbon remain; the metal is poured into a ladle, and taken to the open-hearth furnace, where the process of steel-making is completed. This method of operation has the great advantage that the molten metal, when run into the open-hearth furnace, which is basic lined, does not destroy the lining, as it has become completely de-siliconised. The time required for working the charge is considerably diminished, and the amount of iron taken up by the slag is said to be less, as also are the expenditure of fuel and cost of wages. We do not propose following the author into his figures as to the cost of production, but the balance in favour of his method is 10*s.* per ton as compared with the cost of conversion in the open-hearth furnace from the commencement, whilst it is said to be no dearer than the basic Bessemer process when carried out on a large scale. Perhaps the chief point of interest to English steel-makers is the working of the metal from the blast furnace direct; a thing which has of course often been considered by steel-makers in all parts of the world. It is always difficult, and often fallacious, to make comparisons unless the whole conditions on both sides be similar, and it is certain that those conditions existing at Witkowitz have not their exact counterpart in this country. It is not surprising, therefore, to find that during the discussion of the paper high authorities differed. Mr. James Riley did not by any means approve of the author's suggestions; basing his objection principally on the waste that would take place in the process. On the other hand, Mr. Snelus and Mr. Whitwell—both high authorities—supported the author. There is of course the undeniable 10*s.* a ton, which is sufficient vindication of the process as carried out in Witkowitz. Whether the 10*s.* would still be to the good in English steel works, is a matter that is open to question.

Sir Lowthian Bell next read a paper on the waste of heat, past, present, and future, in smelting iron ores. This contribution was largely of a historical nature. Its scope is sufficiently indicated by the title, and it would be a useful intellectual exercise for students to follow its reasoning.

Mr. Bauerman's paper on the iron and stsel exhibits at the Chicago Exhibition was of the usual nature of such papers. The principal wonders to be seen were referred to by the author, but it is unnecessary for us to follow him in his description. The same remark applies to Mr. Steavenson's paper, with the reading of which the first day's sitting was brought to a close. In the afternoon a very instructive and pleasant excursion was made to the Weardale Steel and Iron Company's works at Spennymore, where members had an opportunity of seeing the gigantic operation of cogging and rolling ingots, which are characteristic of the modern steel works.

The first paper taken on the second day's sitting was Prof. Ledebur's contribution on carbon in iron. This met with a mixed reception, the opinion of some members appearing to be that it was hardly worthy of the time allotted to it, although international courtesy forbade them blankly saying so. We think such an opinion can only be due to a cursory study of the paper, which appears to be one of considerable value, and especially suitable for the Transactions of the Institute. There is some controversial matter in this memoir, but its value is that it brings together in a very compact form many of the leading facts involved in the subject upon which it treats, and although there is not much in it that is new—in fact, the matter consists of that already known—yet many of the details are, as was stated by Mr. Hadfield, the result of the author's own research. The paper is well worth the consideration of metallurgists, and we think there are few who would not benefit by their memories being refreshed, even if the facts were not altogether new. Prof. Ledebur holds that there are four states of carbon in iron. The first is the graphitic state; the second, that which the author described as the temper-carbon; the third is a carbide carbon or cement carbon; and the fourth hardening carbon. It will be evident that in stating this the author opened up matter largely of a controversial nature, and in the discussion which followed, Mr. Snelus, Mr. Hadfield, Prof Roberts-Austen, Mr. Stead, Sir Lowthian Bell, Prof. Thomas Turner, and Mr. Edward Riley took part. It is unnecessary to say that with all these gentlemen engaged in the discussion there was some clashing of opinion. Mr. Hadfield stated a most interesting fact, in that from a malleable iron casting he had obtained three per cent. of graphitic carbon; but we believe the casting showed all the physical qualities of having been well annealed. The result is of course not difficult to conceive, but the fact is none the less of interest. The action of silicon in regard to carbon in steel also occupied the attention of the meeting during this discussion, but we did not notice that any new facts were brought forward.

Mr. Bedson's paper on iron and steel wire was a very able contribution on a most interesting subject. The author is of the fourth generation of wire-makers, the business in which he is engaged having been handed down to him from his great-grandfather; whilst his father added some of the most important improvements to the machinery and process of wire manufacturing. The immense superiority of basic steel over that produced by the acid process was strongly insisted upon by the author; a fact which called forth some rather sharp remarks from Mr. James Riley, who protested against the acid Siemens steel being left unmentioned, as by far the greatest quantity of steel wire was manufactured from that metal. Mr. Bedson's paper was a long one; but if it had been even more extended, his audience would not have objected to it. For our own part, we should have been glad to have seen some mention made of the extraordinary tenacity in steel produced by drawing into wire.

The next paper taken was that of Mr. William Muirhead. Unfortunately this contribution was written in such a way that the author's meaning was somewhat obscure. From the wording of the paper we gathered that Mr. Muirhead would abolish the cogging process by which the ingot is broken down in rolls to manageable dimensions for rolling. This operation was originally performed by the steam hammer, and the cogging rolls were undoubtedly a great improvement, enabling work to be done with more expedition and greater cheapness. The author in his paper certainly advocated abandoning both hammering and cogging. In his paper he said, "Cogging, as it is at present carried on, with its consequent reheating, is a cumbersome, almost an ugly operation, and from the arguments I have endeavoured to adduce, an unnecessary one. How much smarter and cheaper it will be to take the ingots and roll them right off into plates, and I commend this to your earnest attention." Yet in the discussion which followed, Mr. Muirhead said that he did not in his system do without cogging. The point is one of considerable importance, and, Mr. Muirhead's position as the manager of an important steel-producing plant commands for him attention. If the same results can be got from the ingot without cogging and reheating, undoubtedly a great step in advance will have been taken; but the majority of steel-makers—perhaps we might say all, with the exception of Mr. Muirhead—think that cogging or hammering is a necessary though expensive process. Of course, if the author can show that he is right, and the rest of the steel world wrong, he will have performed a signal service to the industry. If we were the owners of steel works, however, we should prefer the experiments to be carried out by other manufacturers. It may be added that what is known as the direct process of rolling is not a new thing, and for Mr. Muirhead to succeed he will have to introduce some entirely fresh element into his procedure.

The last paper read at the meeting was Mr. Clarkson's contribution, in which he described his ore sampling machine. It would seem a small matter, at first glance, to sample ore, but it is by no means an easy thing to do. The variations in quality or composition are arbitrarily distributed, and it may easily be that a sample made up from portions from several different positions in the mass to be sampled, may not be a fair representation of the whole. Machines have been before used, by means of which small portions of a falling mass of ore may be abstracted at regular intervals. It would be difficult to describe this device without the aid of diagrams, but it may be stated that though they appear to work fairly and equitably at first sight, they are in reality partial in their selection. Mr. Clarkson has brought a trained mind to bear upon this subject, and has produced a really scientific instrument. The mass of ore is caused to fall in an annular stream, descending into a hopper, which is made to revolve at great speed. By a suitable mechanism small portions of the ore are abstracted at regular intervals, and from the fact that the falling mass takes the form of an annulus in place of a solid stream, the tendency of certain qualities to gather in the middle of the stream is obviated. A small-sized apparatus was shown in the theatre, and the author was able to practically demonstrate the accuracy with which it worked, so far as the exact percentage of the material abstracted from the whole was concerned. The demonstration, it may be said, was perfectly successful. The apparatus has another useful field in distribution of a mass into equal parts, so that by it a number of bottles or boxes can be filled without the tedious process of weighing being gone through, and yet each receptacle will have its due share of the material. The error of the ore separator is less than at present.

This was the last paper read at the meeting, which concluded with the usual votes of thanks.

THEORIES OF THE ORIGIN OF MOUNTAIN RANGES.

In his presidential address, delivered before the American Association for the Advancement of Science this year, Prof. Le Conte dealt with theories of mountain genesis—a subject which lies at the very foundation of theoretical geology. Want of space forbids us printing the address in full, but the most salient points are contained in the extracts from it that are here given.

Prof. Le Conte began by stating those fundamental features of the structure of mountain ranges on which every true theory of their origin must be founded. These features are: (1) Thickness of mountain sediments; (2) coarseness of mountain sediments; (3) folded structure of mountains; (4) cleavage structure; (5) granite or metamorphic axis; (6) asymmetric form. Another type of mountain, the main characteristics of which are not included under the above heads, are those only found in the Basin and Plateau regions, and therefore termed the Basin region type. In fact, "mountains may be divided into two types, viz. mountains formed by folding of strata, and mountains formed by tilting of crust-blocks. The structure of the one is anticlinal or *di*clinal, of the other, *mono*clinal. The Sierra probably belongs to both types. It was formed at the end of the Jurassic as a mountain of the first type, but the whole Sierra block was tilted up on its eastern side without folding at the end of the Tertiary, and it then became also a mountain of the second type. A complete theory must explain this type also; but since from the exceptional character it must be regarded as of subordinate importance, we shall be compelled to confine our discussion to mountains of the usual type."

Before going any further, however, Prof. Le Conte made a digression in order to clearly lay down what he meant by theory. After facts have been collected they must be explained, and the explanation, which merely gives the laws of the immediate phenomena in hand, is called the *Formal Theory*. The next step towards the perfection of knowledge consists in explaining the cause of these laws, and is termed the *Casual* or *Physical Theory*. The following is an illustration of this distinction:—

"All the phenomena of the drift are well explained by the former existence of an ice-sheet moving southward by laws of glacial motion, scoring, polishing, and depositing in its course. This is the formal theory. But still the question remains, What was the cause of the ice-sheet? Was it due to northern elevation, or to Aphelian winter concurring with great eccentricity of the earth's orbit? And if due to northern elevation, what was the cause of that elevation? A perfect theory must answer all these questions."

". . . . I wish to keep clear in the mind these two stages of theorising in the case of mountain origin. The formal theory is already well advanced toward a satisfactory condition; the physical theory is still in a very chaotic state. But these two kinds of theories have been often confounded with one another in the popular and even in the scientific mind, and the chaotic state of the latter has been carried over and credited to the former also; so that many seem to think that the whole subject of mountain origin is yet wholly in the air, and without any solid foundation."

Bearing in mind that "a true formal theory, keeping close to the immediate facts in hand, must pass gradually from necessary inferences from smaller groups to a wider theory which shall explain them all," Prof. Le Conte showed the inferences that could be made from the characteristic features of mountain structure, and he then grouped those inferences, and summed up his views as to the mode of mountain formation as follows:—

Summary Statement of the Formal Theory.

(1) "Mountain ranges, while in preparation for future birth, were marginal sea-bottoms receiving abundant sediment from an adjacent land-mass and slowly subsiding under the increasing weight. (2) They were at first formed and continued for a time to grow, by lateral pressure crushing and folding the strata together horizontally and swelling them up vertically along a certain line of easiest yielding. (3) That this line of easiest yielding is determined by the hydrothermal softening of the earth's crust along the line of thickest sedimentation. (4) That this line by softening becomes also the line of greatest metamorphism, and by yielding the line of greatest folding and greatest elevation. But (5) when the softening is very great, sometimes the harder lateral strata are jammed in under the crest, giving rise to fan-structure, in which case the most complex foldings may be near but not at the crest. Finally (6) the mountains thus formed will be asymmetric because the sedimentary cylinder-lenses from which they originated were asymmetric."

Several American examples illustrating these views were then given, and it was shown that eruptive phenomena, faults, mineral veins, earthquakes, and other minor phenomena associated with mountains are well explained by them. To quote Prof. Le Conte: "Leaving out the monoclinal type, which seems to belong to a different category, all the phenomena, major and minor, of structure and of occurrences, connected with mountains, are well explained by the theory of *lateral pressure* acting on lines of thick sediments accumulated on marginal sea-bottoms, and softened by invasion of interior heat. This view is therefore satisfactory as far as it goes, and brings order out of the chaos of mountain phenomena. It has successfully directed geological investigation in the past, and will continue to do so in the future.

"But there still remains the question, 'What is the cause of the lateral pressure?' The answer to this question constitutes the *physical theory*.

"Thus far I suppose there is little difference of opinion. I have only tried to put in clear condensed form what most geologists hold. But henceforward there are the most widely diverse views, and even the wildest speculations. But let us not imagine, on that account, that we have made no progress in the science of mountain origin. The formal theory already given is really for the geologist by far the most important part of the theory of mountain origin. For I insist that for the geologist, *formal* theories are usually more important than *physical* theories of geological phenomena. That slaty cleavage is the result of a mashing of strata by a force at right angles to the cleavage-planes, is of capital importance to the geologist, for it is a guide to all his investigations. To what property of matter this structure is due, is of less importance to him, though of prime importance to the physicist. That the phenomena of the drift is due to the former existence of a moving ice-sheet is the one thing most important to the geologist, guiding all his investigations. Whether this ice-sheet was caused by geographical or astronomical changes, is a question of wider but of less direct interest to him. So in the case of mountain ranges, the most important part of the theory is their origin by *lateral pressure* under the conditions given above. The *cause* of lateral pressure, though still of extreme interest, is certainly of less immediate importance in guiding investigations."

The Contraction Theory.

"The most obvious view of the cause of lateral pressure refers it to the *interior contraction of the earth.* This theory is so well known that I will give it only in very brief outline. It assumes that the earth was once an incandescent liquid, and has cooled and solidified to its present condition. At first it cooled most rapidly at the surface, and must have fissured by tension. But there would inevitably come a time when the surface, being substantially cool, and, moreover, receiving heat also from the sun, its temperature would be fixed, or nearly so, while the incandescent interior would be still cooling and contracting. Such has probably been the case ever since the commencement of the *recorded* history of the earth. The hot interior now cooling and contracting more rapidly than the cool crust, the latter, following down the ever-shrinking nucleus, would be thrust upon itself by lateral pressure with a force which is simply irresistible. If the crust were ten times, yea, one hundred times more rigid than it is, it must yield. It does yield along the lines of greatest weakness, *i.e.* along marginal sea-bottoms, as already explained. As a first attempt at a physical theory, it seems reasonable, and therefore until recently has been generally accepted."

Objections to the Contraction Theory.

"It is well known that American geologists have taken a very prominent part in the study of mountain structure and mountain origin; so much so, indeed, that the lateral pressure theory in the form given above and interior contraction as its cause, have sometimes been called the 'American theory.' It is also well known that my name, among others—especially Dana's—has been associated with this view. All I claim is to have put the whole subject, especially the formal theory, in a clearer light and more consistent form.[1] The formal theory I regard as a permanent acquisition. The contraction theory may not be so. It is natural, from my long association with it, that I should be reluctant to give it up. But I am sure that I am willing to do so if a better can be offered. We all dearly love our own intellectual children, especially if born of much labour and thought; but I am sure that I am willing, like Jephtha of old, to sacrifice, if need be, this my fairest daughter on the sacred altar of Truth. Objections have recently come thick and fast from many directions. Some of these I believe can be removed, but others perhaps cannot in the present condition of science, and may indeed eventually prove fatal. Time alone can show. I state briefly some of these objections."

(1) "Mathematical physicists assure us that on any reasonable premises of initial temperature and rate of cooling of the earth, the amount of lateral thrust produced by interior contraction would be wholly insufficient to account for the enormous foldings (*Cam. Phil. Trans.* vol. xii. Part 2, December, 1873). Let us admit—surely a large admission—that this is so. But this conclusion rests on the supposition that the whole cause of interior contraction is *cooling*. There may be other causes of contraction. If cooling be insufficient, our first duty is to look for other causes. Osmund Fisher has thrown out the suggestion (a suggestion, by the way, highly commended by Herschel) that the enormous quantity of water vapour ejected by volcanoes, and the probable cause of eruptions is; not meteoric in origin as generally supposed, but is original and constituent water occluded in the interior Magma. (*Cam. Phil Trans.* vol. xii. Part 2, February, 1875. "Physics of the Earth's Crust," p. 87.) Tschermak has connected this escape of constituent water from the earth with the gaseous explosions of the sun (*Geol. Mag.* vol. iv. p. 569, 1877). Is it not barely possible that we have in this an additional cause of contraction, more powerfully operative in early times, but still continuing? See the large quantity of water occluded in fused lavas to be 'spit out' in an act of solidification! But much still remains in volcanic glass which by refusion intumesces into lightest froth. Here, then, is a second probable cause of contraction. If these two be still insufficient, we must look for still other causes before rejecting the theory.

(2) "Again, Dutton (*Am. Jour.* vol. viii. p. 13, 1874; *Penn. Monthly*, May 1876) has shown that in a rigid earth it is impossible that the effects of interior contraction should be concentrated along certain lines so as to form mountain ranges, because this would require a shearing of the crust on the interior. The yielding would be evenly distributed everywhere, and therefore imperceptible anywhere. This is probably true, and therefore a valid objection in the case of an earth equally rigid in every part. But if there be a subcrust layer of liquid or semiliquid or viscous, or even more movable or more unstable matter, either universal or over large areas, as there are many reasons to think, then the objection falls to the ground. For in that case there would be no reason why the effects of general contraction should not be concentrated on weakest lines, as we have supposed.

(3) "But again, it has been objected that the lines of yielding to interior contraction ought not to run in definite directions for long distances, but irregularly in all directions. I believe we may find the answer to this objection in the principle of flow of solids under very slow heavy pressure. The flow of the solid earth, under pressure in many directions, might well be conceived as being deflected to the direction of least resistance, *i.e.* of easiest yielding.

(4) "But again, it will be objected that the amount of circumferential shortening necessary to produce the foldings of some mountains is simply incredible, for it would disarrange the stability of the rotation of the earth itself. According to Claypole, in the formation of the Appalachian range the circumference of the earth was shortened 88 miles, and in the formation of the Alps 72 miles. Now this would make a decrease of diameter of the earth of 28 miles in the one case, and 23 in the other. This would undoubtedly seriously quicken the rotation and shorten the day. This seems indeed startling at first. But when we remember that the tidal drag is all the time retarding the rotation and lengthening the day, and much more at one time than now, we should not shrink from acceptance of a counteracting cause hastening the rotation and shortening the day, and thus giving stability instead of destroying it. We must not imagine that there would be anything catastrophic in this readjustment of rotation. Mountains are not formed in a day, nor in a thousand years. It requires hundreds of thousands, or even millions of years—if physicists allow us so much.

"The objections thus far brought forward, though serious, are by no means unanswerable. But there is one brought forward very recently which we are not yet fully prepared to answer, and may possibly prove fatal. I refer of course to the level of no strain."

Level of No Strain.

"Until recently the interior contraction of the earth was considered only roughly and without analysis. It was seen that the

[1] "Theory of the Formation of the Great Features of the Earth's Surface," *Am. Journal*, vol. iv. p. 345 and 460, 1872; and also "Structure and Origin of Mountains," vol. xvi. p. 95, 1878.

surface was already cool, and its temperature fixed while the interior was still hot and cooling; and, therefore, that the exterior must be thrust upon itself and be crushed. But the phenomena are really far more complex than at first appears. It is necessary to distinguish between two kinds of contraction to which the interior layers are subjected, viz. radial and circumferential. If there were radial contraction only, then undoubtedly every concentric shell as it descended into smaller space would be crushed together laterally. But there is for all layers, except the surface, also a circumferential contraction, and this would have just the opposite effect, *i.e.* would tend to stretch instead of crush. Therefore, wherever the decrease of space by descent is greater than the circumferential contraction, there will be crush; and where the circumferential contraction is greater than the decrease of space by descent, there will be tension and tendency to crack. There would be no *real* cracking, only because incipient cracks would be mashed out, or rather prevented by superincumbent pressure. Where these two are equal to one another, there will be no strain of any kind. There is a certain depth at which this is the case; it is called the 'level of no strain.' To Mellard Reade is due the credit of first calling attention to this important principle."

After a diagrammatic representation of this principle, the president continued as follows:—

"Now laborious calculations have been made by Davison, Darwin, and Fisher to determine the depth of this level of no strain. All make it very superficial. Davison, taking an initial temperature of 7000° F. makes it five miles below the surface. Fisher, on the same data, only two miles, and with an initial temperature of 4000 only 0·7 of a mile. It is easy to see that if this be true the amount of lateral thrust must be small indeed.

"Now undoubtedly there is a true principle here which must not hereafter be neglected, but it is almost needless to say that these quantitative results are in the last degree uncertain. The calculations are of course based on certain premises. These are a uniform initial temperature of, say, 7000° F., a time of cooling, say, 100 or 200 millions of years, and a certain rate of cooling under assumed conditions. The depth of the level of no strain increases with the time, and is still going downward. In a word, in a question so complex, both mathematically and physically, and in which the data are so very uncertain, every cautious geologist, while freely admitting the soundness of the principle, will withhold assent to the conclusions. Huxley has reminded us that the mathematical mill, though a very good mill, cannot make wholesome flour without good wheat. It grinds indifferently whatever is fed to it. It has been known to grind peas ete now. It may be doing so again in this case. Let us wait.

"But besides withholding assent, and waiting for more light, I may add that these calculations, of course, go on the supposition that the whole contraction of the earth is due to loss of heat; but, as we have already said, it may be due also to loss of constituent water. This would put an entirely different aspect on the subject."

Alternative Physical Theories.

"I have given the objections to the contraction theory frankly and, I think, fairly. They are undoubtedly serious. Let us see what has been offered in its place."

I. Reade's Expansion Theories.

This, the most prominent among alternative theories, was first brought forward in Mr. Reade's book on "Origin of Mountain Ranges." Although I have carefully read all that Mr. Reade has written on this subject, I find it difficult to get a clear idea of his views. But as I understand it, it is in outline as follows: (1) Accumulation of sediments off shore, and isostatic subsidence of the same. (2) Rise of isogeotherms and heating of the whole mass of sediments and of the underlying crust in proportion to the thickness of the sediments. (3) Expansion of the whole mass in proportion to the rise of temperature. If there were no resistance this expansion would be in all directions (cubic expansion). (4) But since the containing earth will not yield to expansion laterally, this lateral expansion is satisfied by folding, and this in turn produces vertical upswelling. Thus the whole cubic expansion is converted into vertical expansion, which is therefore three times as great as the linear expansion in any one direction. (5) Elevation would of course anyhow be greatest along the line of thickest sediment; but this by itself would not be sufficient to produce a mountain. (6) But farther—and here the theory is more obscure—there is a concentration of the effects of expansion, along a comparatively narrow line of thickest sediments, by a flow of the hydrothermally plastic or even liquid mass beneath, toward this central line, and then upward through the parted starta, folding these back on either side, and appearing at the crest as the granitic or metamorphic axis. (7) In his latest utterances he seems to adopt the view of Reyer, viz. that the uplifted strata slide back down the slope, producing the enormous crumpling so often found, and exposing a wider area of granite axis. (8) From the same liquid mass which lifts the mountain come also the great fissure-eruptions and the volcanoes.

"Mr. Reade makes many experiments to determine the linear expansion of rocks, and he thinks that these experiments show that when cubic expansion is converted into vertical expansion, and this again concentrated along a line of one-fourth to one-fifth the whole breadth of the expanding mass, it would explain the elevation of the highest mountains. But still he seems uncertain if it be enough. In fact, he declares that if it were not for another factor yet unmentioned, he probably would never have brought forward the theory at all.

(9) "This factor is recurrency of the cause and accumulation of the effects. And here the previous obscurity becomes intensified. I have read and re-read this part without being able wholly to understand him. He seems to think that when expansion had produced elevation, the mountain thus formed would not come down again by cooling and contraction; but, on the contrary, would wedge up by normal faulting, and set in its elevated position. Afterward, by new accumulation of heat, another elevation and setting would take place, and the mountain grow higher, and so on indefinitely or until the store of heat is exhausted. Therefore, he characterises his theory as that of 'alternate expansion and contraction,' or, again, as that of 'cumulative recurrent expansion.' Such is a very brief, perhaps imperfect, but I hope fair outline of Reade's theory. It seems to me that there are fatal objections to it. These I now state."

Objections to the Theory.

(1) "The first objection is inadequacy to account for the enormous foldings of mountains, especially when there is no granite axis to fold back the strata. It is true that Mr. Reade makes comparison between his own and the contraction theory in this regard, and seems to show the much greater effectiveness of his own. This may be true if we accept his premises, and compare equal areas in the two cases. But the contraction theory draws from the whole circumference of the earth, and accumulates the effects on one line, while in Reade's theory the expansion is of course very local.

(2) "But the fatal objection is that brought forward by Davison. It is this: sedimentation cannot, of course, increase the sum of heat in the earth. Therefore the increased heat of the sediments by rise of isogeotherms must be taken from somewhere else. Is it taken from below? Then the radius below must contract as much as the sediments expand, and therefore there will be no elevation. Is it taken from the containing sides? Then the sides must lose as much as the sediments gain, and therefore must contract and make room for the lateral expansion, and therefore there would be no folding and no elevation. I do not see any escape from this objection.

"Thus it seems that Reade's theory cannot be accepted as a substitute. Is there any other?"

II. Dutton's Isostatic Theory.[1]

"Dutton's discussion of isostasy is admirable, but his application of it to the origin of mountains is weak. The outline is as follows:—

"Suppose a bold coast line, powerful erosion and abundant sedimentation. The coast rises by unloading, and the marginal sea-bottom sinks by loading. Now, if isostasy is perfect, there will be no tendency to mountain formation. But suppose a piling up of sediments—but on account of earth rigidity—without immediate compensatory sinking, and a cutting down of coast land without compensatory rising. Then there would be an isostatic slope towards the land. And the accumulated and softened sediments would slide landward, crumpling the strata and swelling them up into a mountain range.

"The fatal objection to this view is that complete isostasy is necessary to renew the conditions of continued sedimentation,

[1] Phil. Soc. of Washington, Bull. Vol. xi. pp. 51-64, 1889.

and therefore to make thick sediments, otherwise the sediments quickly rise to sea-level, and stop the process of sedimentation at that place. But it is precisely a want of complete isostasy which is necessary to make an isostatic slope landward. Dutton refers to Herschel as having suggested a similar cause of strata crumpling and slaty cleavage (*Phil. Mag.* vol. xii. p. 197, 1856); but the principles involved in the two cases are almost exactly opposite. Herschel supposes sediments to slide down steep natural slopes of sea-bottoms, and therefore sea-ward. Dutton supposed sediments to slide up natural, though down isostatic slopes, landward. Herschel's is a theory of strata-crumpling and slaty cleavage, Dutton's a theory of mountain formation.

"There has been no attempt to carry this idea of Dutton's to quantitative detail. It was probably thrown out as a suggestion in mere despair of any other explanation, for he had already repudiated the contractional theory. But the least reflection is sufficient to convince that such slight want of complete isostatic equilibrium as may sometimes occur, would be utterly inadequate to produce such effects."

III. Reyer's Gliding Theory.[1]

"Prof. Reyer has recently put forward certain views fortified by abundant experiments on plastic materials. His idea in brief seems to be this: strata are lifted and finally broken through by uprising fused or semi-fused matters, and these appear above as the granitic axis. As the axis rises, the strata are carried upward on its shoulders, until when the slope is sufficiently steep the strata slide downward, crumpling themselves into complex folds and exposing the granitic axis in width proportioned to the amount of sliding.

"No doubt there is much value in these experiments of Reyer, and possibly such gliding does indeed sometimes take place in mountain strata, and some foldings may be thus accounted for. But the great objections to this view are: (1) that there is no adequate cause given for the granitic uplift, and (2) that it utterly fails to account for the complex foldings of such mountains as the Appalachian and Coast Range, where there is no granite axis at all. Reade, indeed, holds that the Piedmont region is the granite axis of the Appalachian, and that the original strata of the eastern slope are now buried beneath the sea. But American geologists are unanimous in the belief that the shore line of the great interior Palæozoic Sea was but a little east of the Appalachian crest and the sea washed against land of Archæan rocks extending eastward from that line."

Conclusion.

"After this rapid discussion of alternative theories, in which we have found them all untenable, we return again to the contraction theory, not indeed with our old confidence, but with the conviction that it is even yet the best working hypothesis we have."

GEOGRAPHY AT THE BRITISH ASSOCIATION.

As in other sections, an absence of sensational papers, and an unusual abundance of good solid work, the outcome of study and research, were the characteristic features in Section E. The president's address was well adapted to his audience; the simplicity of its language, and the vivid descriptions of scenes in the Arctic Basin, with which it abounded, sustained the attention of every listener, and went over the head of none. Perhaps it was better calculated for the extension than the advancement of geographical science, but in many ways advance in geography depends on conditions different from those which determine advance in other sciences. Mr Seebohm rightly felt that to enforce principles familiar to professed geographers by a picturesque concrete example which no one could misunderstand was better than to record advances in specialised research, which could only appeal to the few geographers whose grasp of the subject equalled his own.

The section met on four days, and, including the presidential address, twenty-seven papers were read; a large number of members, in addition, took part in various discussions. A feature of the papers was the small number of mere records of travel, and the general striving after some kind of scientific elaboration of the data described. This was in some cases imperfectly done, but the imperfection was a consequence of the neglect of higher geographical education in this country, and the necessary beating out of new paths by independent workers, who, seeing the need for scientific treatment, are not always sure of the right methods to employ.

An inter-sectional discussion with Section C, on the limits between physical geography and geology, had been looked forward to with much interest, but proved somewhat disappointing. Few of the speakers addressed themselves to the subject announced, and in the extempore speeches it was evident that after a faint attempt to come to the point, there was a tendency to fall off on some familiar tack, and repeat irrelevant phrases often said before. In fact, there was no true discussion, as there was no distinct issue put forward.

Mr. Clements R. Markham, F.R.S., president of the Royal Geographical Society, commenced the proceedings by reading a paper, put together with consummate skill, in which he argued for the limit of human testimony as the line of demarcation between the domains of physical geography and geology. Thus he established a purely chronological division between phenomena of the same kind, which would fall to the province of one science or the other, according to the date of their manifestation. He concludes—

"Meanwhile, and until better instructed, I should define geology as the study of the condition of the earth and of the changes on its surface during the cycles of ages before the dawn of history; and I should define physical geography as a knowledge of the earth as it is, and of the changes which have taken place on its surface during historical times. These changes, derived from human testimony, explain to us the laws according to which similar changes are now taking place around us.

"The two sciences depend upon each other, and are very closely allied. The geologist finds the same phenomena in the rock formations of the past as the physical geographer discovers on the surface of the earth of the present. Both, for example, have the duty laid upon them of seeking out the agencies which rule in the processes of upheaval and depression. The fold, with its crest and trough, is common to both sciences; and geographers have rejoiced at the announcement of 'a wedding-ring of geology and geography uniting them at once and for ever in indissoluble union.'"

Mr. W. Topley, F.R.S., who followed, admitted the very close relations of geology and physical geography, but he devoted his attention to establishing the closeness of this relation by bringing forward numerous instances of the dependence of geographical features on geological structure, rather than to defining the limits of the two departments. His contention was that they merged the one into the other, and were not merely contiguous subjects separated by a discoverable line. Mr. E. G. Ravenstein supported Mr. Markham's chronological boundary, and summed up the conclusions of a racy speech in the statement that geology stands to physical geography in precisely the same relationship as history does to political geography. Prof. C. Lapworth, F.R.S., acknowledged the great difficulty of finding any satisfactory dividing line, contending that the geologist is in many ways absolutely dependent on the physical geographer, and the physical geographer in his turn absolutely dependent on the geologist, the physical geography of the present being indissolubly bound up with the physical geology of the past. Prof. Valentine Ball contended that the relation between geology and geography was similar to that between anatomy and art. Dr. R. D. Roberts, viewing geology as the history of the earth, argued that physical geography was merely the last chapter of that history. Dr. H. R. Mill suggested that a definition between the two departments of knowledge might be found rather in the aspect in which the phenomena of the earth were viewed than in the subject-matter or in chronological order. Physical geography being concerned with the present forms of the earth's surface borrowed from geology an explanation of the observed facts, taking results but not copying methods. Mr. H. Yule Oldham spoke of the unity of geography and of the importance of studying old travels in order to keep a record of recent physical changes. Prof. Bonney, F.R.S., characterised the discussion as waste of time and a search after the unattainable, for the words geography and geology contained in themselves all the definition that was required or could be found. Colonel Godwin-Austen and Mr. J. Y. Buchanan, F.R.S., made a few remarks; and Sir Archibald Geikie, who, by the consent of the presidents of Sections C and E, occupied the chair, summed up in a judicial manner. He

[1] Nature, vol. xlvi. p. 224, 1892, and vol. xlvii. p. 81, 1892.

sympathised with the desire to determine the best line of cleavage between the two contiguous portions of science, but had to acknowledge that any line which might be definitely formulated would, to a large extent, be artificial and arbitrary.

Several papers on physical geography were read to the Section, but they did not approach the geological border. Mr. J. Y. Buchanan communicated the preliminary results of some new experiments he has been conducting on the effect of land, water and ice on the temperature of the air, which promise, when completed, to extend our knowledge of climatology. Dr. H. R. Mill summarised the effect of different degrees of isolation from oceanic influences on the seasonal changes of temperature in the water and air of the Clyde Sea area, and Mr. H. N. Dickson communicated a brief preliminary note on the results of his recent trip in H.M.S. *Jackal* for the Fishery Board for Scotland, in the course of which he had examined the temperature and salinity of the water between the north of Scotland and the Färoe Islands. Dr. Schlichter submitted a piece of solid work in pure physical geography in the form of a series of ten vertical sections drawn across northern and central Africa from west to east. These sections exhibit graphically the relative heights of the continent as far as they have been ascertained, and by the blanks which occur where fixed points are wanting, they bring into sharp prominence the regions which are still practically unexplored.

Papers on the latest explorations were read by Mr. E. G. Ravenstein, who traced the opening up of Msiri's country by the Katanga Company's expeditions, and by Mr. E. Delmar Morgan, who communicated an admirable summary of recent exploration in Tibet. Mr. W. M. Conway described his work in the Karakoram mountains. Dr. H. R. Mill referred to the work which he and Mr. Heawood had carried out this year in the "unexplored England" of the lake-beds.

Most interesting amongst the explorational papers were the brief accounts, given by Mr. W. S. Bruce and Dr. C. M. Donald, of the cruise of the Dundee whalers *Balæna* and *Active* toward the Antarctic regions.

Mr. Bruce's communication may be summarised as follows:—

"After a boisterous passage of over a hundred days on the steam whaler *Balæna*, from Dundee, we met the first iceberg on December 16, 1892, in 59° 40′ S. 51° 17′ W. We continued on a more or less southerly course, passing to the east of Clarence Island. Danger Islets were sighted and passed on December 23, and on Christmas Eve we were in the position Ross occupied on New Year's Day, 1843. Until the middle of February we remained roughly between 62° S. and 64° 40′ S. and 52° and 57° W., the western limit being Terre Louis Philippe and Joinville's Land.

"All the land seen was entirely snowclad except on the steepest slopes, which were of black, apparently igneous, rocks. The few specimens of rocks obtained from the ice and from the stomachs of penguins bear this out; Prof. James Geikie finding olivine, basalt, basalt lava, and possibly gabbro among them. Rock fragments and earthy matter were seen on some of the bergs and ice. On January 12 we saw what *appeared to be* high mountainous land and glaciers stretching from about 54° 25′ S. 59° 10′ W. to about 65° 30′ S. 58° 00′ W. I believe this may have been the eastern coast of Graham's Land, which has not been seen before.

"The whole of this district south of 60° S. is strewn with bergs, and south of 62° S. they become very numerous. No entire day was recorded when bergs were not seen; as many as 65, all of great size, to say nothing of smaller ones, were counted on one day. The longest we met was about 30 miles long, one was about 10 miles long, and several from 1 to 4 miles in length. The highest the *Balæna* sighted could not have been over 250 feet high, and many were not over 70 to 80 feet high. All the bergs were tabular, or weather-worn varieties of that form. The base of the bergs is coloured brown by marine organisms.

"The pack ice is said not to be heavier than that of the north, and is similar in nature. It is frequently coloured brown by *Corythrum criophyllum*, a very abundant diatom. We first met pack ice on December 14, in 62° 20′ S. 52° 20′ W.; it was dense, and ran east and west. In January we met the pack edge running east and west in 64° 37′ S. from about 54° to 56° W.

"A few observations for the freezing and melting-point of ice were made, and some sea temperatures recorded. The lead was cast in the vicinity of Danger Islets, and some bottom samples obtained, the depth varying from 70 to over 300 fathoms.

"Periods of fine calm weather alternated with very severe gales, usually accompanied by fog and snow. The lowest air temperature recorded was 20·8° F. on February 17, and the highest 37·60° F. on January 15. December showed an average of 31·14° F., January 31·10° F., and February 29·65° F. The barometer never rose above 29·804 inches.

"No whale resembling *Balæna mysticetus*, *i.e.* the Bowhead or Greenland black whale, was seen; but many finbacks, some hunchbacks, bottlenoses, grampuses, and several kinds of seals, the hunting of which in default of whales was the object of the voyage."

Messrs. Bruce and Donald showed a very creditable collection of observations, but the main outcome of their papers was a demonstration of the immense value of the results which would accrue from a purely scientific expedition to Antarctic waters. Mr. Bruce announced that he was prepared to spend a year, with an assistant who had volunteered to accompany him, on South Georgia or on Grahamsland, if he could be landed there, and to undertake systematic scientific work during that time, if his passage-money and maintenance were paid for. Mr. J. S. Keltie, Mr. H. O. Forbes, Mr. Coles, Dr. H. R. Mill, Mr. Ravenstein, Sir George Bowen, Mr. G. J. Symons, F.R.S., Colonel Fred. Bailey, and others, pointed out the immense importance of Antarctic exploration to geography, geology, meteorology, and other sciences, and warmly commended Mr. Bruce's resolution to conduct a series of preliminary observations. The audience, which included Dr. Burdon Sanderson, the president of the Association, received the papers and discussion with enthusiasm, and a subscription list was started in order to supplement any grants which might be obtained from learned societies to provide a scientific outfit for Mr. Bruce and his assistant. A committee of Section E was charged with the necessary arrangements, with Mr. Clements R. Markham as chairman, and Dr. H. R. Mill as secretary. The Committee of Recommendations voted a grant of £50 for the purposes of this committee. The question of Antarctic exploration was supported by a letter from Sir Erasmus Ommaney, enclosing an appeal from the Australian Antarctic Explorations Committee, suggesting that the British Association should take steps to induce the Australian Government to subsidise southern sealing voyages. A collection of water-colour sketches, by Mr. W. G. Burn-Murdoch, of Edinburgh, who was a passenger on the *Balæna*, illustrating the scenery and incidents of the voyage, was arranged round the meeting room, and attracted a great deal of attention. The collection has already been shown in Dundee, and arrangements have been made for exhibiting it in London in the map room of the Royal Geographical Society. Unfortunately, there were no press representatives in the meeting-room during the greater part of the Antarctic discussion, and it has consequently almost entirely escaped attention in the daily papers.

Papers on special parts of the world, summarising results of travellers and geographers, were read by Mrs. Lilly Grove, on the Chiloe Islands; by Mr. Howard Reid, on the relation of Lake Tanganyika to the Congo; and by Mr. Cop Whitehouse, on the Lower Nile Valley, with reference to the various delineations of it in Ptolemaic and later maps. Mr. E. Heawood read a paper recounting his experiences in the Bengal Duars, with special reference to the settlement of Santal colonists in that region. Mr. Heawood said:—

"The term 'Duars' is applied to a tract of country lying along the foot of the Himalayas of Bhután, and including the 'doors' or passes into that country. The first ranges here rise like a wall, wooded to their summits, from an undulating plain of slight elevation, which embraces a strip of forest-clad 'Terai' and a more open country further south. Over a great part savannahs of gigantic grass alternate with patches of forest, sál on the higher and lighter soils, and mixed forest fringing the streams. The grass is burnt down annually, and the trees with which it is dotted are usually quick growing and shed their leaves annually, and are thus less affected by the burnings. The tiger, leopard, bear, elephant, rhinoceros, buffalo, bison (so-called), pig, and several kinds of deer inhabit the jungles. The peacock, jungle-fowl, florikan, parrots, and a handsome pigeon are the most prominent birds. The rainfall is very great, and the climate unhealthy, though this improves with clearing. The tract is sparsely inhabited, except in the southern and newly-settled parts, by Mechs, a tribe of Mongolian affinities who can thrive in spite of the malaria. They are of wandering habits, cultivating by burning patches of jungle, and moving on to new spots after a few years. Much of the land is very fertile, and well suited for both early and late rice crops. Channels, often of great length, are dug by the Mechs from the numerous streams for the irrigation of the late rice crops, though the tendency of the rivers to deepen their beds in the friable soil is a difficulty to more permanent settlers. The climate and the exposure to raids from Bhután have keep the country in a backward state. It became British territory as a result of the war of 1864. Much land has since then been settled and tea-gardens opened, especially in the western part; while within the last three years a large tract of jungle has been provisionally set apart by Government—at the instance of the Rev. A. J. Shields, C.M.S. missionary to the Santals, warmly supported by Mr. D. Sunder, settlement officer at Jalpiguri—for settlement by Santals, who in their hill country south of the Ganges are often unable to obtain sufficient land for cultivation. Forty families were taken up in 1891, the author assisting in their settlement, and still larger numbers have followed since. Although the partial failure of the rains in the first season caused unforeseen difficulties at first, these, it is hoped, are now in a fair way to be overcome. It should be mentioned that a similar experiment has been tried with success in Assam by a Norwegian mission."

Captain Williams, R.A., gave a popular address on the people of Uganda; Mr. Herbert Ward sent a short paper on the people of the Congo Basin; and Dr. R. W. Felkin submitted a new scheme for a map of the distribution of diseases in Africa. The Rev. C. H. Robinson gave an interesting account of the adventures of a Hausa pilgrim who passed through Khartum on the way to Mecca immediately after the capture of the town by the Mahdi, and gave a new version of the story of General Gordon's death. Mr. E. G. Ravenstein read a brief report of the Committee on African Climatology, which is engaged in accumulating meteorological data from the tropical parts of the colony.

Many of the communications were illustrated by the lantern, and the last paper read was on a system of geographical teaching in which the lantern is adapted for general use in schools, by Mr. B. Bentham Dickenson, of Rugby. A small association has been formed in order to promote this object.

The meetings of the Section were never attended by a larger average number than this year, and on the whole the scientific value of the papers has seldom been greater.

MECHANICS AT THE BRITISH ASSOCIATION.

IN Section G, that devoted to mechanical science, at the recent Nottingham British Association meeting, there were fewer papers read than usual. This, however, was a distinct advantage, for this section has generally suffered from an overabundance of matter. It is far more satisfactory to have a few good papers well discussed than a multitude of mediocre or inferior contributions, which only weary the audience, and lead to no good result. The section held its meetings in the Engineering Lecture Theatre, at University College, and the first sitting took place on Thursday, September 14, according to precedent. The president this year was Mr. Jeremiah Head, whose address we reprinted on September 21. The first paper taken was a contribution by Mr. Beaumont, entitled the "Automatic Balance of Reciprocating Mechanism," and referred to a method of utilising the vibration caused by a revolving weight for working sieves. In the discussion which followed, the opinion was expressed that the device might find a useful place in other applications than that for which it was originally intended. The rest of Monday's sitting was taken up by a description of lace machinery and hosiery machinery. Although the subject is one of considerable interest, it would be impossible to give any adequate idea of the proceedings without the numerous diagrams and lantern slides which were used by the author of the paper. Several of the most interesting machines described were shown at work in an adjoining room, and their action was explained by Mr. W. Robinson, the Professor of Engineering at University College, Nottingham.

On Friday, the 15th inst., two reports were down for reading; the first that of the committee on the dryness of steam in boiler trials, in regard to which Prof. Unwin stated that practically nothing had been done during the past year, and therefore there was no report to present. It was hoped, however, that by following certain lines of investigation which had been suggested by some American experimentalists, that good results might be arrived at, and it was hoped that a satisfactory report would be prepared for the next meeting. The report of the committee on Graphic Methods was a contrast to Prof. Unwin's statement; it being of an exceedingly voluminous character. This is the second long report that has been presented by the committee. It would be quite impossible to deal with the subject in an account of the proceedings such as we are able to give, which must necessarily be brief, and as the report will be printed in full, in common with all reports of committees, in the Proceedings, we will refer our readers to the volume when it is issued, for information on this really important subject. It is fair, however, to notice the immense amount of good and sound work that Prof. H. S. Hele Shaw has done, as secretary, in preparing the reports of this committee.

Two papers on the disposal of refuse followed; one by Mr. C. C. Keep, and the second by Mr. William Warner. In these various descriptions of destructors which had been placed upon the engineering market were described. Both authors are, we believe, members of firms which manufacture and sell apparatus of this description, and trade interests were not altogether lost to sight. The subject of refuse destruction is one of great importance, but it requires, in the interests of sanitary science, to be handled in a somewhat different manner to that pursued by the section in the reading and discussion of the papers. Mr. Frank Ashwell next read a paper on "Warming and Ventilating," in the course of which he discussed the merits of the plenum system, as against the method of ventilation by partial vacuum. He had not much difficulty in establishing the claims of the former; the chief advantage, of course, being that with a plenum inside the building any leakage there may be at doors, windows, &c. does not admit draught; the air for ventilation always coming in through the proper entrance, where it may be warmed, filtered, and, if necessary, moistened. Watchmaking by machinery next occupied the attention of the section, Mr. T. P. Hewitt, of Prescot, reading an interesting paper on the subject. As was stated by a speaker during the discussion which followed, watchmaking in England has been lately at a very low ebb. For many years it has had to meet the competition of cheap labour in Switzerland, but the most fatal blow to the system was struck by the introduction of the factory system for the manufacture of watches in America. By the use of machine tools and labour-saving appliances the Americans have been able to produce excellent timekeeping watches at a very moderate cost; for the industry is one specially suited to the genius of the American mechanic, whose inventive faculties are proverbial. So serious a blow has thus been inflicted on the English watchmaking industry that its operatives were brought to the greatest distress. Prescot, in Lancashire, is a very ancient centre of watchmaking, that is, so far as the movement of the watch is concerned, and many of the best English watches have Prescot works. It is in this town that an endeavour is being made to revive the English watchmaking industry, but on entirely new lines. A large factory has been built, and the most improved appliances introduced. These, of course, are largely American in origin, but it is satisfactory to know that the beautiful machine tools, such as used by the Waltham and Elgin Watch Companies, can now be made in England, and are equal to the productions of the United States. Several examples of these machines were exhibited during the reading of the paper.

Mr. Ross, of Glasgow, next described a pneumatic caulking and chipping tool. This is a hand-tool, working, as its name would imply, by compressed air, or steam may be used. It will make over 10,000 strokes per minute, and consists essentially of a small cylinder and loose piston, which works on to the caulking or chipping chisel. The only thing the operator has to do, therefore, is to guide the tool, and the enormous rapidity of the strokes enables the finest work to be done, either in caulking a metal seam or in chipping down a metallic surface. Some very beautiful specimens of work were shown at the meeting, and the instrument itself was exhibited.

It is the custom of Section G to devote Monday of the Association meeting to electrical science, and the first paper taken on the 16th was a contribution by Mr. Gisbert Kapp, entitled "Relative Cost of Conductors with Different Systems of Electrical Power Transmission." This was a most useful paper, and a good example of the form contributions on electrical subjects should take in Section G, where, it must be remembered electrical engineering, and not physics, should be treated upon. The author said that until recently, electrical machines for the transmission of power were of the continuous current type, but lately alternate current apparatus had come into use, chiefly because the power could be carried to greater distances with a moderate cost of conductors. The reason for this was that with continuous current plant the voltage is limited by the difficulty of insulating the generating machinery. With alternate current there is no necessity of high insulation of generator or motor, but only of the transformers, which can be easily insulated by the use of oil or other means. The author dealt with five systems of transmission.

(1) Single phase alternating current transmission by two wires.
(2) Double " " " " " four "
(3) " " " " " " three "
(4) Three " " " " " three "
(5) Continuous current with transmission by two wires.

We have not space to follow Mr. Kapp's ingenious reasoning, but will briefly give his conclusions. If all systems were put on the same footing as regards efficiency and safety of insulation, the following results would be obtained. If, for the transmission of a certain power over a given distance by continuous current, 100 tons of copper were required for the line, then the single phase alternating and the two phase four wire system would require 200 tons. The two phase three wire system would require 290 tons, and the three phase three wire system only 150 tons; therefore, so far as the line might be concerned, there would be a distinct advantage in the employment of the three phase system.

A paper by Mr. A. B. Snell, "On Water Power as a Source of Electricity," was next read. The subject is not one of such great practical importance in England as in more mountainous countries. Our rivers are small, and in comparatively few cases is there sufficient head to make the utilisation of them profitable with such a form of water motors as have yet been introduced. Mr. Beaumont described a variable power gear for electrical locomotives which he had devised. The object of the gear is to give increased power for the motor when starting the train. By its use the designer hoped that electric motors might be made of very much smaller size. A point of interest raised during the discussion was the advisability of using epicycloidal gear, it being the opinion of Prof. Hele Shaw and others who had worked with this gear that it was not suitable for heavy loads. Mr. W. B. Sayers read an interesting and valuable paper, in which he described a form of self-exciting armature and compensator for loss of pressure, which he had devised. The invention is one of considerable importance, the object being to obtain sparkless commutation. The device, however, is not quite new, it having been previously described, and doubtless is known to the majority of our electrical readers. Monday's proceedings closed with a paper by Mr. E. Payne, on "Electrical Conductors."

Tuesday, September 19, was the last day on which Section G met, and the proceedings opened with a paper by Mr. O. T. Olson, on "Flashing Lights for Marine Purposes." The author proposed that each important navigational light in the world should have a distinctive number which it should continuously flash at night, so that there might be no danger of any particular light being mistaken by the mariner for another. During fog the signals were to be conveyed by gun-cotton explosion. Probably Mr. Olson's suggested signals are somewhat too complicated, although possibly as simple as could be practically arranged were every light given a separate number. Nevertheless, something might be done towards systematising the signals given by various lights in certain geographical sections.

Mr. William S. Lockhart gave an interesting description of an automatic gem separator which he had devised. The apparatus acts by means of the difference in specific gravity between the gems and the gravel, quartz, &c., in which they are found. A stream of water flowing at a uniform velocity is directed upwards through an annular chamber. The material to be separated is fed in through a hopper at the top of the apparatus, and falls into the annular chamber. The velocity of the stream is so regulated that the lighter and more worthless substances are carried with it, whilst the heavier gems descend into a receptacle at the bottom of the machine. One of the separators was shown at work in the Section, water being laid on for the purpose, and some diamonds were actually separated from the pebble and quartz with which they were mixed. There are, it is hardly necessary to say, many points in detail which require careful consideration in working out before such a machine as this is brought to the perfection of practical working. Mr. Lockhart appears to have been very successful in overcoming the difficulties of the problem he had to solve in designing the machine.

A paper by Mr. Walker, "On Ventilating Fans," was read, and the proceedings in this Section closed by Prof. Robinson describing the Wicksteed testing machine, which had been erected in the engineering laboratory of the college. The members of the Section were able to see this machine in action during the afternoon. In most respects it does not differ from the ordinary type of Wicksteed testing machine, but there is a clever gear for shifting the poise. This was operated by hydraulic power by means of wire rope. The device is undoubtedly an improvement on the old gear, both in rapidity of action and absence of noise. There is a neat parallel adjustment for preventing the pulley of the rope influencing the result of the test.

The proceedings in Section G were brought to a conclusion by the usual vote of thanks to the sectional president, Mr. Jeremiah Head.

ANTHROPOLOGY AT THE BRITISH ASSOCIATION.

AFTER the President's address on Thursday, Mrs. Lilly Grove read a paper on the ethnographic aspect of dancing. Dancing corresponds to a universal primitive instinct in man. At all periods there were three kinds of dances: (1) the imaginative or poetic; (2) the descriptive; (3) the religious. This last is most important, and may be called the fountain of the other kinds. Religious dances can be divided into two classes: (*a*) dances directly in honour of the deity; (*b*) dances intended to propitiate the deity. A strange feature is the fact that so many dances are performed in a circle. War-dances are of two orders, either as a preparation for war, or as a rejoicing after triumph. The Corroboree illustrates the former aspect. Excellence in dancing among savages is obtained by very simple means: anyone who makes a mistake is killed.

Prof. Windle read a paper on anthropometric work in schools. It appears from answers to a circular sent to the head-masters of one hundred of the largest schools in the United Kingdom, that some form of measurement is or has been carried on in twenty-five schools, but that the methods adopted differ considerably. The author suggested that an endeavour should be made to encourage and systematise such work.

Dr. W. Wilberforce Smith read a paper on anthropometric weighing; and the following reports were also presented to the section: Report of the Anthropometric Laboratory Committee, and Report of the Physical Deviations Committee.

On Friday, the committee appointed to make an ethnographical survey of the United Kingdom presented their first report. Prof. Hans Hildebrand then read an important paper on Anglo-Saxon remains and coeval relics from Scandinavia. The question proposed was to determine the relations which existed between the civilisation of Scandinavia and that of England during the period between the arrival of the Angles and the Saxons on the English coast, and the time of their conversion to Christianity; roughly, that was from the middle of the fifth to the middle of the seventh century of our era. These limits were not exactly determinable, because both the Anglo-Saxon immigration and the spread of Christianity among the newcomers were not the work of a few years only, and progressed with very different rapidity in different parts of the country. During this period Sweden had no chronological record, and Christianity had no hold on that country until the eleventh century. The criterions of date, therefore, on the Scandinavian side were of purely archæological character. There were a few instances of Roman and Byzantine coins found associated with Scandinavian antiquities, and as these could hardly have found their way northward before the downfall of the Hunic Empire in Central Europe, they gave some indication of the date of the objects with which they were lost or interred. In England similar date evidence occurred, but was vitiated by the fact that the coins had often been long in circulation before they were buried. The practice of burial also, while it entirely superseded cremation when Christianity became predominant, appeared to have coexisted with the older method during the later Pagan period, and could not be taken as affording an accurate criterion of age.

And there was the further difficulty in comparing English and

Scandinavian objects, that in England the Teutonic peoples found the British and Romano-British culture already existing on their arrival, while there was no parallel influence to modify the style of Scandinavian art. The author discussed the Scandinavian types of sword and spear, which presented both remarkable likenesses and differences when compared with those which gave their name to the Saxons (sword-men) and the Angles (spear-men). The boar-crest on the helmet also appeared to be a point of similarity. Numerous examples were adduced to show how designs borrowed from existing art were modified to suit Teutonic taste in the English series, which herein came nearer to the French and Belgian than to the Scandinavian. As illustrations of the development of style, the ornamental fibulæ or brooches were of especial importance, and a number of types were instanced which showed the fundamental likeness of Teutonic taste on both sides of the North Sea, combined with differences in detail. Summing up his results, Prof. Hildebrand concluded that a common Teutonic taste was the source of the art styles both of Scandinavia and of Saxon England; that the Scandinavian and Anglo-Saxon races were of closely allied Teutonic descent, but that in the incessant movements characteristic of that stock, the two branches were separated from one another and developed independently; that the Kentish Jutes and the Saxons of England came not from Scandinavia, but from Germany; but that the case was not clear with regard to the Angles, who might possibly not be of German origin, but may have been settled at one time in the south-west corner of Scandinavia.

In a paper on the "Origin and Development of Early Christian Art," Mr. J. Romilly Allen traced the various decorative elements found in early Christian art in Grea Britain to their source, and showed in what way the native styles of art existing in this country at the time of the introduction of Christianity (*circa* A.D. 450) were influenced, first by the Italo-Byzantine art, which came in with the importation of the illuminated manuscripts used in the services of the church, and subsequently by the coming in contact of the Anglo-Saxon and Scandinavian conquering races with the Celtic and other populations already inhabiting the British Isles.

The following papers were also read:—Note on an implement of hafted bone, with tooth of hippopotamus inserted, from Calf Hole, near Grassington, by the Rev. E. Jones; the prehistoric evolution of theories of punishment, revenge, and atonement, by G. Hartwell Jones; four as a sacred number, by Miss A. W. Buckland.

On Saturday the following papers were read:—On ancient metal implements from Egypt and Lachish, by Dr. J. H. Gladstone, F.R.S.; notes on flint saws and sickles, by Dr. R. Munro; prehistoric remains in Crete, by J. L. Myres; funeral rites and ceremonies among the Tshinyaï or Tshinyangwe, by Lionel Decle; the Arungo and Marombo ceremonies among the Tshinyangwe, by Lionel Decle; the Ma-Goa, by Lionel Decle.

On Monday, a paper by Mr. Herbert Ward was read, entitled "Ethnographical Notes on the Congo Tribes." In it the author gave a sketch of all the salient features of native life in the Congo region, the subjects treated at greatest length being those relating to superstition and general customs. In the description of the "N'Kimba" ceremony of the Lower Congo natives, the motive for this remarkable "secret society" was, for the first time, explained.

Dr. Crochley Clapham read a paper on "The Mad Head," in which he said that the older phrenology of Gall had been superseded by Ferrier's cerebral localisation. He then gave some results of his examination of nearly 4000 insane heads drawn from eight asylums in the north of England and the south of Scotland, and compared with a number of sane heads. Insane heads he found to show a larger average size than sane ones, though insane brains were smaller. His standard of comparison was by a cranial index which he obtains by adding together the measurements of the whole circumference and the antero-posterior and transverse arches of the head. Of these measurements that of the transverse arch was the only one smaller in the insane, and was, in fact, their weak point. The cranial index he found further useful as, when expressed in inches, it showed about the weight of the normal contained brain in ounces. The frontal segment of the head circumference bore a larger proportion to the whole circumference in the insane than in the sane, and this, taken with the fact that the frontal lobes in idiots and imbeciles weigh more in proportion to the whole encephalon than in the total insane class, and the fact that the typical insane head was cuneiform with the greatest transverse diameter anterior to the central point of the head, seemed to discredit the "noble forehead," and to point out the occipital lobes as the seat of intelligence. This view was supported by facts of brain development and comparative cerebral anatomy, as well as by the flat occiput of idiots and the cerebellum of the bushman projecting beyond the occipital lobes.

In a paper on pin-wells and rag-bushes, Mr. E. Sidney Hartland suggested that the object of the usages was union with the divinity, to be achieved by the perpetual contact with the god of some article identified with the worshipper.

The following communications were also received:—Report of the Abyssinian Committee. On the external characters of the Abyssinians examined by Mr. Bent, by Dr. J. G. Garson; on the Dards and Siah-Posh Kafirs, by Dr. J. Beddoe and Dr. Leitner; the Primitive Americans, by Miss J. M. Welch; the Indians of the Mackenzie and Yukon Rivers, Canada, by the Rt. Rev. Dr. Bompas, Bishop of Selkirk; the Australian natives, by Miss J. A. Fowler; on a modification of the Australian aboriginal weapon termed the Leonile, Langeel, Bendi, or Buccan, by R. Etheridge, jun.; on an unusual form of rush-basket from the northern territory of South Australia, by R. Etheridge, jun.

On Tuesday, Mr. Francis Galton read some official letters just received by him from Surgeon Lieut.-Colonel Hendley, of Jeypore, who had memorialised the authorities in India in favour of affixing to the nominal roll of recruits an impression in ink of the fore, middle, and ring fingers of each recruit. In reply, the Commander-in-Chief "approved of the proposal to employ prints of finger-tips as marks for identification, as they are so extremely easy to make, and so useful in guarding against personation." Surgeon Lieut.-Colonel Hendley has had considerable experience in taking such imprints, having already sent to Mr. Galton those of the digits of nearly 1000 persons, most of whom were prisoners in the gaol of Jeypore.

Dr. Munro read a paper on the structure of lake-dwellings, in which he described the various methods adopted by the lake-dwellers in the construction of the understructures and platforms on which their huts had been placed. In conclusion, Dr. Munro gave a description of an important discovery recently made in Argyllshire. This was a crannog showing foundations of a circular house thirty-two feet in diameter, and divided into two compartments, one of which contained a hearth and the remains of a doorway.

Mr. Arthur Bulleid then read a paper on a British village of marsh dwellings. This village, discovered by the author in March, 1892, is situated a little more than a mile north of the town of Glastonbury, in the upper part of one of the moorland levels of central Somerset, found to the south of the Mendip Hills. There is little on the surface to indicate the site of a village, but on careful inspection between sixty and seventy low circular mounds may be seen, varying from 15 to 35 feet in diameter, and from 6 in. to 2 ft. 6 in. high at the centre. These form the foundations or floors of separate dwellings, which are constructed in the following way:—On the surface of the peat is a layer or platform of timber and brushwood, kept in place by numerous small piles at the margin. On this a layer of clay is placed, slightly raised at the centre, where the remains of a hearth are generally found. The dwelling itself was composed of timber filled in with wattle and daub. Not only have the wall-posts been found *in situ*, but also the entrance threshold and doorstep. Among other things that have been discovered is a boat 17 ft. long, quantities of wheel and hand-made pottery, sling stones, and bones of animals, and a great number of objects of bronze and iron, horn, bone, and stone, such as fibulæ and rings, knives, saws, and weapons, combs, needles, pottery stamps, and querns.

In a paper on the place of the lake dwellings at Glastonbury in British Archæology, Prof. Boyd Dawkins referred to the existence of crucibles to show that smelting had been carried on, and reasoned that the time of the occupation of the place was pre-Roman.

The following communications were also received:—On the excavation of the stone circle of "Lag ny Boiragh," on the Meayll Hill, Isle of Man, by Prof. W. A. Herdman, F.R.S., and P. M. C. Kermode; early uses of flint in polishing, by H. Stopes; palæolithic anchors, anvils, hammers, &c., by H. Stopes; Report of the Uniformity in Spelling Committee; Report of the North-Western Tribes of Canada Committee.

THE EVOLUTION OF COLOUR IN THE GENUS MEGASCOPS.

THE *American Naturalist* of June and July contains an article by Mr. E. M. Hasbrouck on "Evolution and Dichromatism in the Genus Megascops," in which he deals with the distribution of the genus in North America in relation to the colour of its plumage. The discussion leads to the following conclusions:—

"The red phase is confined mainly to *Megascops asio* (speaking of it as a whole), which, on its northern border, merges into the grey phase; the southern grey belt incompasses *floridanus*, while in eastern Texas the few red specimens of *mecallii* that are known have been taken from the extreme north-eastern portion of its range, which is influenced both by humidity and temperature. Again this distribution of colour corresponds very closely to the life areas—the grey phase of the Florida form in the south occupying a major portion of the Austroriparian; the red phase of *asio* proper conforming very closely to even the outlines of the Carolinian, while the grey phase is equally identical with the Alleghanian.

"It is worthy of note that the grey phase of *Megascops asio* is boreal in its affinities, and that where a grey phase of *asio* is found that is not boreal, it is recognised as a sub-species.

"Now if *floridanus* (grey) is separable from *asio* just north of it (red), it seems highly probable that *asio* (red) will some day be separated from the grey phase on the north. It has been shown that as regards the two phases of *asio*, certain areas are inhabited exclusively by reds, certain ones exclusively by greys, while still others are inhabited by a mixture of the two, and that three forms (*floridanus* and two colour phases of *asio* proper) inhabit, as a whole, entirely distinct areas. No one will deny that all of the forms of *Megascops* are descended from a common ancestor, and if through climatic or environmental conditions they have become sub-specifically differentiated in various localities, I see no reason to doubt that in like manner, under the influence of humidity, temperature, acquired character, and forest area, which will be felt for countless generations to come, that the species now known as *Megascops asio* will one day be separated into species and sub-species—the former represented by the original grey, and the latter by the more modern red."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Medical Session began on Monday in the schools attached to the London and provincial hospitals. Dr. W. Pasteur delivered the introductory address at Middlesex Hospital, and Mr. Thomas Holmes at St. George's Hospital. The subject of Mr. Holmes's discourse was the life and works of John Hunter, being the centenary celebration of Hunter's death within the walls of the hospital. The address at St. Mary's Hospital was delivered by Mr. J. Ernest Lane, and at the London School of Medicine for Women by Miss Helen Webb. Biology and ethics formed the subject of the opening address delivered by Sir James Crichton Browne at the Sheffield School of Medicine.

MR. WALTER GARSTANG, of the Plymouth Marine Biological Laboratory, has been elected to a Research Fellowship by Lincoln College, Oxford.

THE first entrance scholarship to St. Thomas's Hospital Medical School, of the value of £150, has been awarded to Mr. Robert Wynn Charles Pierce, and the second, of the value of £60, to Mr. Harry Edward Hewitt.

THE Entrance Scholarship, of the value of 120 guineas, to Charing Cross Hospital Medical School has been awarded to Mr. Harold A. T. Fairbank, and that of the value of 60 guineas to Mr. Stanley W. R. Colyer.

THE following entrance scholarships to Guy's Hospital have been awarded in science. First, of the value of £150, to Philip Turner, University College, London; second, value £60, to George Ernest Richmond, Owens College.

THE Balfour Studentship, of the nett annual value of £200, will be vacant on October 18. From the regulations sanctioned by the Senate of the University of Cambridge, it appears that the studentship is not awarded upon the result of a competitive examination, and the student need not be a member of the University. The holder of the studentship must devote himself, however, to original biological inquiry, and must not follow any business or profession, or engage in any educational or other work, which, in the opinion of those charged with the administration of the Balfour Memorial Fund, would interfere with his original inquiries.

MR. W. TOWNSEND PORTER has investigated the relation between physical development and success in school life, his data for discussion being obtained from 33,500 boys and girls in the public schools of St. Louis (Transactions of the Academy of Science of St. Louis, vol. vi. No. 7). The weight of a child can usually be taken as a trustworthy index of physical development, and, comparing it with standards of intelligence, it appears that precocious children are heavier, and dull children lighter than the average child of the same age. Not only is this the case, but precocious children are taller, have larger chests, and wider heads than dull children. An examination has also been made of the relationship between precocity and rate of growth, or yearly increase in size, and the results indicate that the difference in weight between dull and precocious boys increases as they grow older. The conclusions arrived at are based upon means and averages, and may not be applicable to individuals. However, one deduction of considerable importance is made. It is that no child whose weight is below the average of its age should be permitted to enter a school standard beyond the average of its age, except after such a physical examination as shall make it probable that the child's strength shall be equal to the strain.

SCIENTIFIC SERIALS.

THE *Meteorologische Zeitschrift* for July contains an account of observations taken at the Hawaiian Islands, communicated by Dr. Marcuse, of the Berlin Observatory, who for some time visited Honolulu for astronomical investigations. The position of those islands, near the northern limit of the tropical zone, is very important from a meteorological point of view, and the Hawaiian Government have for some years past established a regular service under Mr. C. J. Lyons, who publishes a monthly meteorological summary. The principal station is at Punahou (Oahu), a little to the north-east of Honolulu, on which island there are also sixteen other stations, also twenty-three stations on the island Hawaii, and fourteen on the other islands, making altogether a total of fifty-four, two of which are 4100 feet above sea-level. The oldest temperature observations date from the time of the first American mission in 1821, and with some interruptions have been continued to the present time. From the more recent observations the mean annual temperature is 74°·1. During the last ten years the lowest temperature was 54°·0, and the highest 89°·1; the greatest daily variation being 23°. The warmest month is August, mean temperature 78°·1, and the coldest, January, mean 69°·8. Barometric pressure is very regular, the yearly period amounting to about ·07 inch, and the daily period to ·06 inch. The larger oscillations occur only when the almost regular northerly trade winds, which blow on an average for 258 days in the year, are replaced by southerly winds. The rainfall differs considerably in different parts of the islands; at Honolulu the mean of thirteen years' observations is 30·6 inches. The largest amount falls between November and February; the dryest month is June, with about one inch.

August.—"Die neue Anemometer-und Temperatur-Station auf dem Obir-Gipfel," by J. Hann.—On the dynamics of the atmosphere, by M. Möller. This is a continuation of a series of valuable papers on the physics of the atmosphere. The present article deals chiefly with the behaviour of cyclones and anticyclones, and with the vertical distribution of temperature and aqueous vapour.

THE *Botanical Gazette* for August has an article on cell-union in herbaceous grafting, by Mr. John S. Wright, in which the remarkable assertion is made that not only a geranium, but also *Tradescautia zebrina* has been successfully grafted on the tomato, that is, a monocotyledonous on a dicotyledonous plant. Mr. L. N. Johnson describes the mode of formation and escape of the little-known zoospores of *Draparualdia plumosa*.

THE numbers of the *Journal of Botany* for August and September are chiefly occupied by papers on descriptive botany. Mr. H. T. Soppill gives an account of the life-history of *Æcidium leucospermum*, parasitic on *Anemone nemorosa*.

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, September 25.—M. de Lacaze-Duthiers in the chair.—M. Faye, in presenting the *Connaissance des Temps* for 1896, being volume ccxviii., pointed out some improvements newly introduced. The tables of the fundamental stars contain their magnitudes, their mean coordinates at the commencement of the tropical year, their variation and proper motion, and the dates at which the hour stars pass the meridian at noon and midnight.—The geographical coordinates of Tananarivo and the observatory of Ambohidempona (founded at Madagascar by the Rev. Father Colin), by M. Alfred Grandidier.—On the spectroscopic observations made at the Mount Blanc Observatory on September 14 and 15, 1893, by M. J. Janssen (see p. 549).—Action of the electric arc upon the diamond, amorphous boron, and crystallised silicium, by M. Henri Moissan.—Preparation and properties of crystallised carbon silicide, by M. Henri Moissan.—On the reproduction of oysters in the Roscoff aquarium, by M. de Lacaze-Duthiers. The ostreicultural work at the Roscoff laboratory was undertaken in order to demonstrate the feasibility of the revival of the oyster fisheries on the French coasts on a scientific basis. During the last two years it has been proved that seed oysters could be brought to a high state of development and commercial value in artificial surroundings. It has also been proved that oysters are capable of reproduction in the aquarium. The culture of oysters is at present divided into two main branches, that of producing seed oysters and that of developing the latter into the article of consumption. The Roscoff laboratory is now able to perform both functions. The oysters now completing their fourth year of age and their third of culture in the tank, have produced this year about 5000 young oysters, which will be used as seed oysters for future experiments.—M. Bouquet de la Grye, in connection with a recent work by M. Hatt on the harmonic analysis of tidal observations, announced that the Hydrographic Service of the Marine Department intended to adopt the method expounded, viz. that originated by Lord Kelvin, to the calculation of the *Annuaire des Marées*, and that several maregraphical stations are about to be erected in Indo-China, where the tidal phenomena are very singular.—Circles or spheres derived from any envelope, by M. Paul Serret.—On the glucoside of the Iris, by MM. F. Tiemann and G. De Laire. Iris roots contain a glucoside, iridine, which shows some remarkable properties. Alcoholic extract of iris treated with a mixture of acetone and chloroform of density 0·95, gives *iridine*. It crystallises in small white needles, fusing at 208°, and corresponding to the empirical formula $C_{24}H_{26}O_{13}$. Iridine, heated under pressure with sulphuric acid diluted with weak alcohol, decomposes into glucose and a crystalline body now termed *irigenine*. This forms alcoholic ethers, and also gives rise to two series of acid ethers. Under the action of alkaline hydrates, it absorbs three molecules of water, and then splits into three bodies—viz. formic acid, an acid phenol termed *iridic acid*, $C_{10}H_{12}O_5$, and a phenol termed *iretol*, $C_7H_8O_4$. The latter body is rapidly decomposed by the oxygen of the air when in an alkaline solution. When iridic acid is heated above its point of fusion, it splits into 1 molecule of carbonic acid and a colourless oil distilling at 239° by cooling. It solidifies in large crystals fusing at 57°, constituting a well-defined new phenol now termed *iridol*.—Anatomical researches on the grand sympathetic nervous system of the sturgeon, by M. René Chevrel.—Contribution to the histology of the spongidæ, by M. Émile Topsent.—On two new types of the *choniostomatidæ* of the coasts of France, *sphæronella microcephala* and *salenskia tuberosa*, G. and B., by MM. A. Giard and J. Bonnier.

DIARY OF SOCIETIES.

London.

TUESDAY, October 10.

Photographic Society, at 8 (at the Gallery, 5a, Pall Mall, East.)

WEDNESDAY, October 11.

Photographic Society at 3 and 8 (at the Theatre, Society of Arts, John Street, Adelphi).

THURSDAY, October 12.

Photographic Society, at 3 (at the Theatre, Society of Arts, John Street, Adelphi).——At 8 (at the Gallery, 5a, Pall Mall, East).—Special Lantern Night.

FRIDAY, October 13.

Amateur Scientific Society, at 7.—*Conversazione* and Exhibition.——At 8.—Parasitism, Commensalism, &c.: Mr. Pace.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—Inorganic Chemistry for Beginners: Sir H. E. Roscoe and J. Lunt (Macmillan).—Meteorological Observations made at the Adelaide Observatory, &c., during 1884–5 (Adelaide).—Catalogue of the Lepidopterous Super-family Noctuidæ found in Boreal America: Dr. J. B. Smith (Washington).—Method and Results: T. H. Huxley. (Macmillan)—Practical Work in Heat: W. G. Woolcombe (Oxford, Clarendon Press).—The Process of Argument: A. Sidgwick (Black).—A Dictionary of Birds: A. Newton, &c.; Part 2 (Black)—The Discovery of Australia: A. F. Calvert (Philip)—Personal Recollections of Werner von Siemens: translated by W. C. Coupland (Asher).—In Amazon Land: M. F. Sesselberg (Putnam).—Curiosa Mathematica, Part 2. Pillow Problems: C. L. Dodgson, 2nd edition (Macmillan)—Décoration Céramique au feu de Moufle: M. E. Guenez (Paris, Gauthier-Villars).—Les Moteurs à Gaz et à Pétrole: P. Vermand (Paris, Gauthier-Villars).—Biskra and the Oases and Desert of the Zibans: A. E. Pease (Stanford).—An Essay on Newton's "Principia": W. W. R. Ball (Macmillan).—Catalogue of Section one of the Museum of the Geological Survey of Canada: G. C. Hoffmann (Ottawa).—An Introduction to Human Physiology: Dr. A. D. Waller, 2nd edition (Longmans).—Anatomy, Descriptive and Surgical: H. Gray, edited by T. P. Pick, 13th edition (Longmans).—Analysis of Milk and Milk Products: Dr. H. Leffmann and Dr. W. Beam (Philadelphia, Blakiston).—Eleventh Annual Report of the Fishery Board for Scotland. Part 3: Scientific Investigations (Edinburgh, Neill).—On Hail: Hon. Rollo Russell (Stanford).

Pamphlets.—The State of Amazon, Brazil: L. B. Bitancourt.—Fauna and Flora of Norfolk, Part xii. Coleoptera: J. Edwards.—Zur Kenntniss der Postembryonalen Schädelmetamorphosen bei Wiederkauern: H. G. Stehlin (Basel, Schwabe).—Latitudine di Torino determinata coi Metodi di Guglielmo Struve: F. Porro (Torino, Clausen).—Effemeridi del Sole e Della Luna, &c.: A. Manaira (Torino, Clausen).—Osservazioni Meteorologiche fatte nell'anno 1892, All Osservatorio della R. Universita di Torino: Dr. G. B. Rizzo (Torino, Clausen).—Catalogue of Woods Exhibited by the State of Amazon, Brazil, at the World's Columbian Exposition, Chicago (Chicago).—The City of Manáos and the Country of Rubber Tree (Chicago).

Serials.—Zeitschrift für Wissenschaftliche Zoologie, lvi. Band, 3 Heft (Williams and Norgate).—Bulletin de l'Académie des Sciences de Belgique, No. 8, Tome 26 (Bruxelles).—The Free Review, October (Sonnenschein).—Michigan Agricultural Experiment Station Bulletins, 96 to 99 (Michigan).—Zeitschrift für Physikalische Chemie, xii. Band, 3 Heft (Leipzig, Engelmann).—Journal de Physique, September (Paris).—Natural Science, October (Macmillan).—Journal of the Institute of Jamaica, August (Kingston, Jamaica)—Botanical Gazette, September (Bloomington, Ind.).—Medical Magazine, October (Southwood)—Agricultural Gazette of N.S.W., July (Sydney).—Journal of the Royal Agricultural Society of England, third series, vol. 4, Part 3, No. 15 (Murray).—India Weather Review, Annual Summary, 1892: J. Eliot (Calcutta).—Geological Magazine, October (K. Paul)—Geographical Journal, October (Stanford).

CONTENTS.

THURSDAY, OCTOBER 12, 1893.

THE CORRESPONDENCE OF BERZELIUS AND LIEBIG.

Berzelius und Liebig. Ihre Briefe von 1831–1845. Mit erläuternden Einschaltungen aus gleichzeitigen Briefen von Liebig und Wöhler. Herausgegeben mit Unterstützung der kgl. bayer. Akademie der Wissenschaften von Justus Carrière. (München und Leipzig: J. F. Lehmann, 1893.)

THIS most interesting, and, for the historian of chemistry, most valuable little book owes its origin to a sentiment akin to that which prompted the publication of the no less interesting and valuable collection of the letters of Liebig and Wöhler. How important the correspondence of Berzelius and Liebig is to him who essays to write the history of the chemistry of the nineteenth century will be obvious from the fact that this exchange of letters occurred during one of the most eventful decades of the century. It began at the period of the epoch-making work of Liebig and Wöhler on the radicle of benzoic acid, and extended over the time when Liebig was devoting himself, with characteristic ardour and enthusiasm, to the study of animal chemistry and to the applications of chemistry to agriculture. Frequent reference, as might have been expected, is made to these and the many other matters which during that time engaged the energies and occupied the thoughts of Liebig at what was the most active and the most fruitful period of his career. Nor was Berzelius less communicative concerning his own work. Nothing, however, is more characteristic of the difference in temperament of the two men than the manner in which each speaks of what he has done, is doing, or means to do. With Berzelius it is nearly always concerning what he has accomplished, seldom of what he is doing, and still more rarely of what he is going to do. The sanguine, ardent character of Liebig is reflected in almost every letter. He is terribly in earnest on the matters of the moment, and full of enthusiasm and confidence concerning the plans of the future. The philosophic calm which pervades every letter of the great Swedish chemist is a source of wonder and envy to his correspondent.

"I envy you," writes Liebig, "the priceless tranquillity of mind with which you do your work. Pray tell me is it always so with you. Has not the keen desire for discovery not even once made your heart beat quicker? With you there is an ever present intellectual calm."

Liebig wrote as he thought and spoke. "I cannot, like others of cooler blood," he wrote to Wöhler, "keep myself apart from and unidentified with my work: what I do I do with all my faults and shortcomings, but also with all the energy that actuates me."

The letters, therefore, are valuable not only as side-lights on matters which are now regarded as classical in the history of chemistry, but also as evidence of the character and temperament of the two men; and from this point alone they will have a special interest for the historian of science.

The correspondence begins with a new year's letter from Liebig in the January of 1831. The two chemists had made one another's personal acquaintance at Hamburg during the summer of the preceding year, and Berzelius had already expressed to his friend and former pupil Wöhler, the pleasure it had afforded him to meet Liebig. Liebig had perfected his method of organic analysis, and the Giessen laboratory was busily engaged in determining the elementary composition of whole series of organic substances, and he gives in his first letter a brief account of the main results to which he and his pupils had arrived. Berzelius in his acknowledgment congratulates him on his work:—

"It is quite incomprehensible to me how you can have accomplished so much in so short a time."

He tells Liebig of the discovery of a new metal by Sefström, which the discoverer had named Vanadium:

"It is an interesting thing. It will take its place between chromium and molybdenum. Wöhler had well-nigh lighted upon this body. He undertook to analyse lead chromate from Zimapan. He discovered that the substance hitherto regarded as chromic acid was not so in reality, but gave himself no further trouble to determine what it actually was."

Wöhler has himself told us the story, and let the world see the characteristically humorous letter in which Berzelius "chaffed" him for being too lazy to open the door when the goddess knocked.

There is the customary Teutonic contempt for most things Gallic:

"It gives me a real pleasure to read your writings by reason of the love for truth which pervades them—in striking contrast with Dumas, who seems to do everything for show."

In the second letter Berzelius writes:—"Die Unzuverlässigkeit der französischen Analysen. . . . ist eine verdammt curiose Sache," and again Dumas and his pupils are somewhat severely handled. Berzelius is "so satt" with Vanadium that he is constrained to tell Liebig all he knows about this "sehr interessanter Körper." He has just finished his memoir for Poggendorff "in welcher die viele Salzbeschreibungen gewiss manchen Leser einschlafen machen werden." The letter was written with the so-called "vanadium ink," made by adding extract of gall-nuts to a solution of ammonium vanadate. "It flows," says Berzelius, "so extraordinarily well that it is preferable to all iron inks, and fades less easily." Unfortunately Berzelius's expectations respecting the new ink have not been fulfilled: the writing of this particular letter, the editor points out, has become quite yellow, and is difficult to decipher. Liebig does not altogether share Berzelius's opinion respecting Dumas:

"Small as is the confidence I have in Dumas' work, the calculations of this rope-dancer seldom fail in their object: I have assured myself by a direct determination of the vapour density of the non-inflammable gas [phosphuretted hydrogen] that he is right. I am continually annoyed that the fellow, in spite of his wretched and slovenly style of work, should shake masterpieces, so to say, out of his sleeve."

In 1831 Liebig's position at Giessen, in spite of his growing fame, was pecuniarily very poor. He writes to Berzelius:—

"I have latterly taken upon my back a big burden in yoking myself with Geiger as co-editor of his magazine, and all for the sake of filthy lucre. At the small university where I am, where the dullest pedantry sits enthroned, and where natural science is learnt from the Greek authors or from Wilbrand's writings, I should otherwise die of hunger."

However much Liebig may share Berzelius's opinion of French chemical work in general during the thirties, he will hear of no word of disparagement of his old master Gay Lussac, for whom he had the most genuine respect and esteem. A captious remark by Berzelius respecting Gay Lussac at once rouses Liebig, and his impetuous pen dashes off a panegyric which is almost eloquent in the warmth and intensity of its feeling. The only thing to his discredit that Liebig will allow is that, in common with his countrymen, Gay Lussac is not sufficiently attentive to what is done outside France:

"A certain mental indolence prevents the French, to their shame be it said, from making themselves acquainted with foreign work. Gay Lussac shares this failing, and feels that it will gradually effect the ruin and extinction of all scientific growth in France: all his letters to me are filled with complaints on this score, and principally as regards himself. However that is no fault in his character, and can well be forgiven him when one takes his other good qualities into account."

A letter from Liebig, dated December 28, 1831, announces the discovery, and describes the properties of chloral, a "Substanz welche ich, da ich keinen besseren Namen weiss, Chloralkohol nennen will." Berzelius, in his reply, gives an account of his work on tellurium. In May, 1832, Liebig writes that he has begun to work on amygdalin.

"I am on the point of becoming Wöhler's enemy: I see that Fate will not allow either of us to do anything that the other has not already done or is on the point of doing: all originality goes to the devil. He suggests that we should do a joint investigation on bitter almond oil—and just before I got his letter I had written to all the apothecaries I knew of to procure me bitter almond oil, because I too had the matter in view."

What came out of that memorable investigation on oil of bitter almonds no chemist needs to be reminded of. On July 2, Liebig writes that he has been engaged in determining the composition of an "ether-like substance," sent to him by Döbereiner, who had named it "Sauerstoffether."

"Oxygen-ether is no name for this substance. I am, however, very stupid at naming things. What think you of acetal (acetum and alcohol)?"

In more than one of his letters Liebig held out the hope to himself that he might be enabled to visit Berzelius in Stockholm, and do some research in common with him, and he sends to Wöhler for a Swedish grammar. The terrible pressure of his work at Giessen at this time is beginning to tell upon him. He writes to Berzelius:

"I am always ill, and fear my life's thread will not spin out much longer. Each work I undertake makes me worse, and the slightest effort excites me as if I were in a fever. Wöhler and my family tell me daily what a fool I am; however, we shall see. If the journey to Stockholm does not mend me, then I shall never be cured."

Berzelius answers:—

"The pleasure which your news of matters scientific gave me, great though it was, is as nothing compared with that of your promise to spend some months with me and to do a piece of work with me. I have seldom had such a pleasant surprise, but now comes the question: When is this good fortune to befall me? You do not need to speak a word of Swedish to come here. If you wish to learn it, may it be my privilege to be your teacher. Come soon and spend the winter months with me. A Swedish winter is healthier than a German one. Your depressed nervous system will right itself here. We will work, joke, and skate, and not over-fatigue ourselves, and yet labour to good purpose. You will find my laboratory far below your expectation. It is small and badly furnished. But it is just in such a place that one learns to do with little."

The visit, unfortunately, was never made. Wöhler lost his wife in the summer of that year, and in his dejection sought the society of his friend at Giessen. Moreover, the outbreak of cholera at various ports in North Germany made travelling irksome and dangerous. As it was, the two never met again. The correspondence was maintained, with intermissions, down to 1845—that is, until about three years before the death of Berzelius. Little by little misunderstandings arose which eventually ended in coolness, despite the most persistent efforts by Wöhler to preserve friendly relations. The conservatism of Berzelius, who clung, with the obstinacy of age, to views which the rest of the world regarded as obsolete, reacted painfully on the strong-willed, impulsive nature of Liebig, who could as little brook contradiction. There was more than one sharp passage of arms, and at length open rupture. Berzelius made his *Jahresbericht* the vehicle of many bitter attacks on the work of the Giessen school, to which Liebig, restrained by Wöhler, and to some extent swayed by mixed feelings of reverence and pity, seldom replied.

His sentiments towards the great master will be evident from the following excerpt from a letter to Wöhler, with which this most interesting volume closes:

"The opinions and theories of Berzelius were a clear and formal expression of the ideas of his time, and therefore of great value; but they went no further. I will not say that this was a fault, but it would have been a virtue had he possessed a larger measure of that creative thought which I may term the poetry of natural philosophy."

T. E. T.

BACTERIOLOGY FOR THE STUDENT.

Manual of Bacteriology for Practitioners and Students with especial reference to Practical Methods. By Dr. S. L. Schenk, Professor Extraordinary in the University of Vienna; translated from the German, with an Appendix by W. R. Dawson, B.A., M.D. (Univ. Dublin). 8vo. 310 pp. (London: Longmans, Green and Co., 1893.)

THE bacteriological library has recently been enriched by yet another text-book which, although only published in German a few months ago, has already appeared in an English translation. In this work we have the responsibility divided between the author and translator, for the latter has not merely acted as interpreter, but has added numerous foot-notes, besides an appendix intended to bring the book as far as possible up to date, all of which additions are signed by the translator. It does no appear to us that there is much advantage in thus dividing the responsibility in a small text-book which does not contain any original or speculative matter of importance; and in our opinion the reader would have gained had the German original been freely edited by the translator, who should have borne the entire responsibility for the English edition.

The arrangement of the material is much the same as in most previous works on this subject, but the description of a larger number of micro-organisms, considering the size of the book, is attempted. In this matter the time has now come for a new departure, for with the continual additions to the number of known bacterial forms, it is both impossible and undesirable that the descriptions of all of them should find place in the body of a text-book. For the purpose of illustrating the principles of bacteriology, comparatively few forms need be described in detail, whilst for an account of those forms which are of secondary importance, special works should be consulted. A work of this kind, which endeavours to describe in the tabular form, every micro-organism hitherto discovered, fortunately already exists in the shape of Eisenberg's "Bakteriologische Diagnostik" (Hamburg and Leipzig, 1891), so that the necessarily brief and imperfect descriptions of bacteria which are to be found in small text-books, like the one under review, become worse than valueless, inasmuch as they take up space which should be devoted to the discussion of general principles. Now, in this latter particular the work before us is specially weak; not only is the preliminary chapter on the "general morphology and biology of micro-organisms" very scanty, but the introductory matter at the commencement of the several chapters is generally also quite inadequate. Thus, for instance, in the chapter on the micro-organisms of soil we find no less than two pages devoted to the description of such obscure and unimportant forms as *bacterium mycoides roseum*, *b. radiatus*, *spinosus*, *liquefaciens magnus*, *scissus*, and *clostridium fœtidum*, whilst there is absolutely no mention of the bacteria producing nitrification, nor of the organisms occasioning the tubercles in leguminous plants, which are of such enormous importance, both from a practical and theoretical point of view.

In that portion of the book devoted to the practical methods, we find very ample descriptions of the mechanical details for staining bacteria, but the account given of the principles upon which these methods rest is very meagre, and often betrays much ignorance of chemical principles in general. Thus, what are we to think of the statement that "*aniline oil* and *phenol* are the mordants (*sic*) most used in bacteriological research"? Surely a few words from a competent chemist would be calculated to put some order and arrangement into the wilderness of empirical staining recipes with which the student is confronted, and would prevent such inaccuracy in the use of old-established technical terms. A mistake of more practical importance, which a little chemical knowledge again would have rendered impossible, is the statement on page 20, that plates intended for culture may be sterilised "after being cleansed with alcohol and corrosive sublimate"; in this case, however, we are inclined to believe that the "alcohol" being placed *before* instead of *after* the "corrosive" sublimate must be a *lapsus plumæ* which has failed to receive correction in the proof.

Of the same order, again, is the statement that some bacteria "cause a splitting-up of urea into ammonium carbonate"; surely if the reaction in question, and which consists in the adding on of two molecules of water,

$$\underset{\text{Urea}}{CN_2H_4O} + \underset{\text{Water}}{2H_2O} = \underset{\text{Ammonium Carbonate,}}{CN_2H_8O_3}$$

can be described as "a splitting up," the addition of two chimneys to a house might as logically be called a disruption of the building!

The author in his preface states that "conformably to the scope of a hand-book like the present, all references to the literature have been omitted," but the names of investigators have been freely introduced in the text, and in some cases they have been selected apparently without a due knowledge of the literature. Thus, from the text (p. 124 and p. 156) it would appear that it is to Rubner and Kirchner that we are indebted for the discovery of the great bacteriological efficiency of the soil as a natural filtering medium, whilst we were certainly under the impression that Pasteur, not to mention others, showed the bacteriological purity of spring and deep well waters before the names of the above gentlemen were known to the scientific world. In the same way the discovery of the increase in the efficacy of chemical disinfectants by moderately raising the temperature is ascribed to Heider, whilst it was really first made by Dr. Wynter Blyth, some eight years ago, but his paper, which was published in the Proceedings of the Royal Society, was doubtless unknown to both Heider and the author of this book; but the translator might, in the interests of British science, have seen that the papers in that and other English media of publication had received their due. In the chapter on Morphology we find no mention of the researches of Ray Lankester and others on the polymorphism of beggiatoa, which are of such interest in connection with those phenomena of variation in both the form and function of bacteria which are now beginning to receive the serious attention of investigators; nor is there, indeed, any special reference to this subject of variation, which at the present time is certainly one of the most important in the whole domain of bacteriology.

A considerable part of the translator's appendix is devoted to the bactericidal action of light; here again we think that the work of the original discoverers, Downes and Blunt, has been inadequately appreciated, for these investigators practically explored the whole subject in outline, and the more recent researches have principally consisted in a confirmation of their results, and in filling in details; thus they showed that the bactericidal action of sunlight is independent of rise in temperature, that the most refrangible rays of the spectrum are the most active, that their effect, moreover, is highly favoured if not entirely dependent on the simultaneous presence of oxygen, and, further, that the bacteria may be destroyed by light in the absence of any culture-medium, but that they are more resistant to light when immersed in water or very dilute culture material. Again, we find no reference to one of the most interesting recent additions to our knowledge of this subject, viz. the discovery by Laurent that exposure to sunlight causes some chromogenic bacteria to lose their power of producing pigment, either temporarily, as in the case of the *bacillus prodigiosus*, or even permanently, in the case of the *bacillus ruber* of Kiel. We are, therefore, surprised at being categorically informed, both in the introduction and in the appendix of this work, that pigment is formed especially under the influence of light, a statement which is entirely out of harmony with the observations of Laurent, and for which the experimental foundation should have been carefully set forth.

These and other points of a similar character will doubtless be rectified by the translator in preparing a second edition, which it would be well to amplify with references to literature, with which even an elementary student in a new science must at once be made familiar. The illustrations are in the majority of cases very good, and contrast most favourably with those we have seen in some recent works of the kind in which photographic representations have been attempted. The coloured prints of cholera and typhoid bacilli are especially excellent.

OUR BOOK SHELF.

Exploration of Mount Kina Balu, North Borneo. By John Whitehead. (London: Gurney and Jackson, 1893.)

MR. JOHN WHITEHEAD belongs to the much-maligned class of field-naturalists. For the purpose of obtaining a knowledge of the ornithology of Mount Kina Balu, he spent nearly four years collecting in the region, and accumulated a large number of new species. In addition to visiting North Borneo, he stayed some time at Java and Palawan, and made an expedition into the State of Malacca. The rather cumbersome volume before us recounts the story of these explorations. It consists of 192 pages of general description and 115 pages of matter reprinted from the proceedings of various Societies. Thirty-two excellent plates illustrate specimens from the extensive zoological collections made by Mr. Whitehead, and the places and peoples seen by him. It need hardly be said that these add considerably to the value of the book. Several woodcuts are also included. It would be ungracious to find fault with Mr. Whitehead for looseness of expression, since he craves indulgence for his "literary shortcomings." He found it far easier to explore an unknown tract of country than to write an account of his travels. Like some other travellers who have given to the world accounts of their wanderings, Mr. Whitehead dwells too much on trivialities. But for all that, there is much that is new and interesting in the book, and one cannot but admire the indomitable spirit which carried the author through numerous difficulties, and enabled him at last to reach an altitude of 13,525 feet on the mountain of Kina Balu.

Pillow Problems. Curiosa Mathematica, Part II. By Charles L. Dodgson, M.A. (London: Macmillan and Co., 1893.)

IN these pages we have a series of problems worked out, or, as the author says, "nearly all thought out during sleepless nights." In the preface he informs us the exact method of procedure, and the way in which he obtained his results. The problems are about seventy in number, and deal with many branches of mathematics, but chiefly with algebra, plane geometry, and trigonometry. The order of the three and only chapters is as follows: questions, answers, and solutions; and he explains the reason for this peculiarity in the preface. Considering the problems themselves, one is apt to think that some of them at least are not so very hard, but the publication of them will be found very interesting and perhaps useful to those of ordinary mathematical powers, who may like to follow the same routine way of thinking as that adopted by the author.

The A B C Five-Figure Logarithms. By C. J. Woodward, B.Sc. (London: E. and F. N. Spon, 1893.)

THIS small book of logarithms may be said to be a second edition of the tables previously published by the author. In addition to the tables of mantissæ of numbers, the same A B C system has been applied to logarithms of arc functions, with only a slight difference in the method. Besides these the square roots of numbers (from 1 to 100) to three places of decimals are given, and a table of "numbers often wanted," and of the densities of gases, weights and measures, &c. To facilitate the finding of the logarithms, &c., a lateral index is adopted. Besides being a compact and convenient set of tables, the worker will find them easy to use, and accurate enough for such calculations as are generally met with in the physical laboratory, the class-room, &c.

Enunciations in Arithmetic, Algebra, Euclid and Trigonometry. By P. A. Thomas, B.A. (London: Macmillan and Co., 1893.)

IN these pages one is treated to a selection of some of the chief questions that relate to Arithmetic, Algebra, Euclid, and Trigonometry. Stress is laid on the more elementary parts of each subject, and several typical problems are inserted. The latter relate chiefly to the arithmetical and algebraical sections, while the Euclid section is accompanied by important riders. The book should prove acceptable to those revising these subjects, whether for examination or not, and will be, both for teachers and taught, a useful companion to the text-books in use.

LETTERS TO THE EDITOR.

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

Thoughts on the Bifurcation of the Sciences suggested by the Nottingham Meeting of the British Association.

THE opening paragraph of the President's address contains this sentence: "We have come to learn what progress has been made in departments of knowledge which lie outside of our own special scientific interests and occupations, to widen our views, and to correct whatever misconceptions may have arisen from the necessity which limits each of us to his own field of study."

A most worthy and attractive ideal. Something of this kind of intersectional information does go on at these meetings; but to how small an extent! It may be said, indeed, that except for the presidential address and the two evening lectures, everyone sticks to his own section, and discusses matters lying in his own groove.

This state of things is perhaps inevitable, but it is none the less to be regretted. It is extremely difficult for anyone actively engaged in the work of any one section to attempt to attend any other. I myself used to make the attempt, but concluded that the results were too precarious and uncertain to be worth the dissipation of energy involved, and have now abandoned it. Yet there can be little doubt that if the state of things postulated by the President were feasible in practice it would be a distinct gain.

But it would seem as if the modern tendency were all in the other direction. Papers in the two great scientific departments are read as far as possible on different days at the Royal Society, and are published in separate volumes. Such an arrangement is decidedly convenient: I am not repining at it. The

Royal Society type of paper is almost necessarily unintelligible to any but specialists, perhaps sometimes even to them.

But the arrangement should not be regarded as anything but a lamentable necessity. If a more conjoint character could by any device be given to the meetings of the B.A. it would be an excellent thing: so it seems to me.

Whether the British Association can or cannot act as a connecting link between the sciences, there is no doubt but that the pages of NATURE do so act; and long may it be before NATURE (I mean the publication) finds herself also bifurcated or otherwise subdivided, and we on either side cease to hear even an echo of what the other side is talking about.

Perhaps few are able to say that they read NATURE all through as Mr. Darwin did, but we all have the chance of doing so; and I hope it is the practice of the biological side to communicate to its pages at least an epitome or a popular account of all the researches which have a wide embracing interest.

Much that the chemist does—still more that the biologist does—we of the physical camp do not care to hear; partly because we might not understand it, chiefly because the research lies so far from the field we are at present occupied in cultivating, that we can perceive none of the connecting links.

But some of the problems on which the biologist—especially perhaps the physiologist—is engaged are, or might easily become, of supreme interest to physicists; notably everything connected with sense organs and the "mechanism" of sensation.

The fear is lest we drift apart so far that we cease to understand each other's language.

The current language of physics consists mainly of adaptations of simple English phrases. It is full of common words, redefined and made definite in connotation. We do indeed use the word "coefficient" occasionally, but we are getting ashamed of its length and high-falutin' character. We got it from the Mathematicians. We have also a few other long words, as Electricity and its derivatives, which we sometimes try to abbreviate without much success. We got them in the Middle Ages. But the words we coin now are as nearly monosyllabic as possible, and as near akin to the ordinary usage of language as may be.

The current language of biology is quite different. Its sentences, as exemplified in parts of the presidential address, are highly dignified and elaborate structures, not wholly different from a once more prevalent German model. Its words, especially its new words, are hendecasyllabic or, at any rate, polysyllabic. They are extremely classical, and as unlike the language of daily life as can be contrived. This is done of good set purpose, viz. to keep free from the misunderstandings arising out of the attempt to give to popular words a scientific, *i.e.* an accurate, meaning.

I suppose it is inevitable, and no doubt biologists know what is best for their own science; I only lament it because it seems likely to retard that free intercommunication between the sciences which many of us would like to see made more possible than at present it is. I shall have the President with me here; but may I put a question to him without profanity? May I ask him if he can imagine a biologist asking about a process, "What is the go of it?" I conjecture, but perhaps I am wrong, that if a young biologist wanted to know more about a most important and interesting process occurring in the blood, he would ask, "What mechanism do you consider it was which supplied the chemiotactic stimulus impelling these leucocytes towards the morbific microbes which they are devitalising?"

I do not complain of this language—very likely it is well suited for home consumption—but it does seem to render intercommunion difficult.

Now, for instance, I am anxious to learn the most recent view of biologists on the subject of life, or vitality, or vitalism, or whatever word conveys the hypothesis that the life of an organism is something different from the chemical and mechanical activities of its tissues. I see that the President touches on this very subject, but somehow I cannot seize concerning it any distinct idea, though I rejoice to see his warning against the misuse of the terms "mechanism" and "mechanical." The term "mechanical" is regarded by physicists as the *ne plus ultra* of explanation, and it is unlikely that any explanation of physiological processes will skip the intervening chemical and physical stages, and land itself straight in simple mechanics.

But I wonder if I am right in supposing that the definition of life, given apparently by Treviranus, satisfies the modern biologist, viz. (I put it only in paraphrase, for more exact wording see NATURE, September 14, p. 464), "that property of an organism which enables it to respond similarly to a variety of different stimuli"; because a steam engine or any other prime mover can do as much as that. It matters nothing by what means the throttle valve is opened, whether by the proper driver, or by a larky boy, or by a piece of string, or a falling weight, or an electric current; the result is the same—wheels go round.

This property of responding to stimuli, and responding always in the same way if at all, may be characteristic of a clock-work mouse, but surely it is not a special peculiarity of *life*. If a muscle can only twitch, then, however you tickle it, it must either twitch or do nothing.

But life surely is something other than a power of response to a stimulus; it is more like a something which directs the stimulus, more like the driver who decides whether the throttle valve shall be opened or not. But it is absurd for me to attempt to answer such questions. I only want to ask them: all I clearly perceive from the physical standpoint is that live creatures have the power of directing energy into otherwise unoccupied channels, and that life in itself, whatever it is, is *not* a form of energy.

But this leads me to a subject which though apparently trivial may, if not attended to, have serious or at any rate inconvenient consequences, I mean the occasional misuse by one science of the language of another science.

The term "energy" is a physical one given us by Thos. Young, and it has been fought for by us through a great part of this century. It will be wanted seriously by Physiologists before long, in its proper sense, and it will be a thousand pities if they misuse it.

If it be urged, "but Helmholtz used the term *specific energies*," I reply yes, a long time ago, and so also he used the phrase, *Erhaltung der Kraft*. But precision in the use of the term energy is of comparatively modern growth, and every one now translates *Erhaltung der Kraft* as "conservation of energy." So, also, I venture to think, they should usually translate the phrase "specific energy" by the words *normal activity* or *normal reaction*. Of course if normal activity of an organ or tissue does not represent the thing meant, that is another matter—so far as I can judge, it usually does; but whether it does or not, I am clear that specific energy is usually wrong. There is one definite theory or hypothesis, to express which the words energy in some form would be correct—viz. when it is meant to assert that, for instance when light falls upon the retina, all it does is to pull a trigger, and the explosion or nerve stimulus which results is due to energy in or near the nerve ending itself. If that is a true statement of the case, and there must be a great deal to be said for such a view, the latent energy of the organ can no doubt be measured. But inasmuch as energy is all one thing in many forms, the adjective *specific* is better omitted; moreover the phrase is not usually limited to this particular hypothesis; and by "the specific energy of an organ," is usually meant, not anything quantitative, but simply the mode in which it normally reacts.

Another case of terminology occurs to me. For specification of small lengths microscopists have introduced the term *micron* for a thousandth of a millimetre, or a millionth of a metre; and very handy is both the magnitude and the name, and I hope physicists will adopt it. But everyone should consent to use it in the same sense. There was a discussion about it in the pages of NATURE a few years ago, but I am not sure that the usage even now is quite distinct. Many biologists call it a micro-millimetre, which it is not; and though they may mean the same thing, it can only be by an erroneous, because unconventional, use of the prefix micro. All these things are conventions, and once made the convention should be rigorously adhered to. Sometimes the word is written *micro* instead of micron; a very small divergence, but better avoided. Either term will do perfectly well, but not both.

May we understand then that a micron is a micro-metre, or a milli-milli-metre, or 10^{-4} centimetre; and that a millimicron is a micro-millimetre, or 10^{-7} centim.?

And may I incidentally protest against too much public use of the meaningless and wasteful symbols μ and $\mu\mu$ for these two lengths. If these symbols are found too handy in technical microscopy to be abandoned, they must be used there; but they should never be allowed to obtrude into anything intended for the general reader, nor for workers in other departments of science.

I trust that physicists will agree with me in this. I know that some Electricians try to sin in a similar way, by writing 6ω when they mean 6 ohms. But with all deference to any individuals who may have allowed themselves carelessly to drift into this practice, it is a thoroughly bad precedent. We shall soon be having 12*a* and 5*v* and ·3*h* for current and voltage and inductance respectively; a simple specification will look like algebra, and algebra will look like gibberish.

Similarly the custom of writing M for a millionth of an atmosphere, or 1 barad, is a worrying custom. Let us always have names for units with which we have much to do, but never single letters. Single letters have to serve a far more important purpose, that of denoting the quantities themselves—the whole of a quantity, numerical part, unit, and all.

This last is an old hobby of mine. Ever since my brother showed me the advantage of consciously interpreting algebraical symbols as standing for concrete quantities, and not merely for abstract numbers, the advantage of doing so has presented itself to me with cumulative force. Most physicists are, I think, now of a similar opinion, if they have thought at all about the matter, and Prof. Greenhill is being left almost alone in his state of grievous error; I would say heresy, but that I fear he has some of the pure mathematicians with him for company.

I have dragged Prof. Greenhill in because I want to deny the extraordinary assertion which he makes in an article on page 457 of your issue for September 14, viz. that I would like to "banish the word *hundredweight* from our language." On the contrary, for the specification of loads I have always found it a very convenient word; and if architects use it thus, for pressure on foundations, so much the better. I know what he is referring to—a part of my book on mechanics where I am instructing youth in the meaning of the term *mass*, and the difference between mass and weight. Till they are clear on this point I say that "hundredweight" is a term better avoided for the present. I should, for instance, recommend its avoidance for the present by Prof. Greenhill.

But to return to Dr. Burdon Sanderson's address, which it is perhaps evident from a former part of this article that I have been trying to read, there are two small points on which I would ask a question. First, with regard to totally colour-blind vision. If a person sees all the world in shades of gray he may properly be called colour-blind, in one, and that the most important, sense; but it does not seem to me to follow that he necessarily appreciates white, still less that he proves a specific white sense in normal eyes. On the orthodox theory, as held by physicists, such an eye would strictly be called monochromatic; one only of the three colours would be seen, and which it was would matter nothing to the seer, though it might be ascertained by studying his spectrum vision which the one colour was in any given case. I believe that Abney and Festing found it usually blue. But as regards the psychological impression produced by mono-chromatic vision on the seer, its indiscriminating monotony would obviously result in total absence of colour perception. One colour sensation is psychologically the same as none.

The other question is whether it is useful to distinguish between "physical light" and "physiological or subjective light." The term *light* applies to the stimulus as far as the retina, but after that is it not better called either *sight* or some other and more impressive-looking word, beginning with *photo* or *neuro* and perhaps ending with *taxis*, signifying the specific disturbance of the optic nerve and brain centres. These terms light, heat, sound, &c., have always been ambiguous; but, if needful to discriminate, they had better perhaps now be handed over entirely to physics, to signify monosyllabically the external physical stimulus; while fresh words are coined for the physiological, and again, where not already existing, for the psychological, result.

I trust that this letter has not the appearance of undue presumption; the whole of it is written in the key of interrogation.

OLIVER J. LODGE.

British Association: Sectional Procedure.

MEMBERS of the British Association often entertain schemes for the improvement of sectional procedure, which rarely, so far as I have seen, commend themselves to the good opinion of the organising committees. I beg leave to produce one scheme more. Whether the remedy is practicable or not, I am quite sure that the grievance I have to point out is a real one.

Every member of the Association has suffered from the great uncertainty as to the hour at which a particular paper will come on. At the recent Nottingham meeting I was unlucky enough to spend one morning to no purpose. I had a direct interest in two communications; one was not reached that day, the other was taken as read. There is no care taken to prevent such accidents, and yet it would have been easy to provide against the second one at least by marking the communication as "Title only." The other case is of greater, but not, I think, of insuperable difficulty. The remedy which occurs to me is this: a fixed time should be assigned to communications which in the opinion of the Sectional Committee are of special interest and importance. There might be at least two absolute fixtures in each day's proceedings, when members would know that nothing would be allowed to interfere with the punctual production of certain papers or addresses. I should be inclined to mark these by some distinctive title, such as "Address by request of the Section." It seems to me very desirable to send out special invitations before the meeting to persons who could communicate interesting results; and I have little doubt that a fixed time would often lead to acceptance by persons whom the Sections would be glad to hear, but who rarely or never appear in the programme under the existing system. What is bad for the audience is bad for authors too, and after an author finds that his communication is addressed only to people who come to hear something else, and to people who in their despair are working through the entire list, he ceases to offer himself.

If the facilities granted to pre-arranged addresses should lead to a stricter treatment of trivial papers and business matter of no direct scientific interest, the Sections would not suffer.

L. C. M.

Orientation of Temples by the Pleiades.

EIGHTEEN months ago, while at the Mena House, Cairo, I came across a back number of NATURE, which contained an article on "The Origin of the Year," in which reference is made to the orientation of some Egyptian temples, and I suggested that inquiries should be made as to whether they were not in some cases oriented by the Pleiades. I had not then seen the numbers that referred to stellar orientation.

A pamphlet of 105 pp. was privately printed by myself *thirty years ago* (!) for my own use in the prosecution of "A Comparison of the Calendars and Festivals of Nations," with special reference to the Pleiades.

Since that pamphlet, and a second, of about 20 pp. on cycles regulated by the Pleiades, were printed, I have collected a great deal of further data confirming the conclusions arrived at in 1863. Müller says, in his Religion, &c., of the Dorians, I. 337, that the famous eighth-year cycle, which was in general use in Greece, was luni-sidereal, and regulated by the Pleiades, and that the great feasts of Apollo at Delphi, Crete, and Thebes, were arranged by it. He also states (p. 338) that there are vestiges of a sacred calendar in general use in Greece in early ages based on this cycle, but that it fell into disuse, and, in consequence, the Attic festivals and months were thrown into confusion. He had previously stated that the Olympiads were based on the eight-year cycle. Apollo, generally assumed to have been essentially a solar deity, though he evidently was originally a type of Karlikeya, was a god of the Pleiades, and hence the seventh day was sacred to him at Athens. As those stars were the daughters of Atlas, the forty days during which they deserted the nightly sky were spent by Apollo in dancing and singing among the Hyperboreans of Marlas. When the rising of the Pleiades at early morning took place, he returned. In 1882, at the American Association, I showed that he is still remembered south of the Atlas as "Apōlo, a good god, who comes and plays upon the harp." But in the lapse of centuries the Pleiades seemed to go astray, and were forgotten, and, strange to say, Athenæus was forced to treat the history of the Pleiades as a bit of obsolete folk-lore. In discussing the subject of the two groups of *Peleiades* on the handles of the divining cup of Nestor, he says that it is a mistake to suppose that Homer by *Peleiades* meant "doves" (a mistake which Mr. Gladstone has also made in his Homeric Studies), and he explains that the cup had two clusters of seven stars represented on it. Many persons, he says, are puzzled at the prominence thus given to those stars, but in early times they were regarded as very important, and left their impress on early mythology, and he also shows that they once regulated the time of sowing, and the season for navigation. He goes at great length into the question in his *Deipnosophists;* and I invite the attention of those who wish to know something as to the early history and influence of the Pleiades to the work in question.

As Plutarch says that the great feast of Isis was always held at the time "when the Pleiades are most conspicuous," and I found that the month of Athyr, in which it was held, was described as "the shining season of the Pleiades," I sent, in 1865, a copy of my pamphlet to Prof. C. P. Smyth, before he went to Egypt, and invited his attention to the probability that those stars were in some way indicated by the Great Pyramid.

The recent discovery by Mr. Penrose that the Hecatompedon site of the Parthenon, and other archaic Greek temples were oriented by the Pleiades, lends a new interest to this subject.

This diversity of orientation has had a far wider range than has been supposed, for nearly forty years ago it was noticed in the Mississippi mounds by Squier and Davis; and was long ago detected in several early churches of the south of England, a very remarkable fact, which I think was referred to at the Anthropological Institute. As it greatly surprised and interested me, I made a careful note of it when it was published, which I regret that I cannot now hunt up, as I am preparing to leave England for the winter; but as the point cannot have escaped the attention of others, some one among your readers will perhaps be able to give you further information as to it.

NATURE of August 31 contains an interesting letter on the importance of the study of the date of the birth of Rama by competent astronomers. For several years I have been trying to find out what was the precise time of the year when Kartikeya was born—"*The Birth of the War God*" does not refer to it. There is a most interesting subject which is new to science, the connection of the Pleiades with the nativity of divine heroes. I think I can at last supply a clue to the *Star of Bethlehem* (which Kepler imagined to have been a conjunction of planets!) in "*the Christmas Stars*," of the negroes, and other African races.

September 7. R. G. HALIBURTON.

Early Chinese Observations on Colour Adaptations.

IT seems of interest to record that the Chinese, neglectful of the sciences as they are nowadays, nevertheless suggested the Darwinian interpretation of animal colours as early as the ninth century A.D.

Twang Ching-Shih, in his Yú-yáng-tsáh-tsú (Maútsin's edition, book xvii. p. 7 Kyōto, 1697), describes a trap-door spider as follows:—"Whenever rain has fallen, the ground facing my book-room has plenty of the 'tien-táng' (that is, the 'tumbling-defender'). Its nest, commonly so-called, is as deep as an earthworm's hole, and the network is finished in it. The earthy lid of the nest is quite even with the ground, and of the size of elm-samara. The animal turning upside down, guards the lid, and thus watching for the appearance of flies and caterpillars, it readily turns up the lid and catches them. As soon as it retreats the lid is closed again. The lid is coloured like the ground."

Apparently from this and other facts the observer has attained a revelation of the truth, which he expresses thus:—"In general, birds and mammals necessarily conceal forms and shadows by their assimilation with various objects. Consequently, a snake's colour is similar to that of the ground; the hare in the Imperata-grass is unavoidably overlooked, and the hawk's hue agrees with that of the trees."

Twang Ching-Shih was a man of great erudition, and versed in poetry; he died in the period of Hwi-Cháng (841–846 A.D.), leaving us the work cited above, consisting of thirty books. It is highly commended by Sie Tsái-Kang, a distinguished encyclopædist of the seventeenth century A.D., as one of the two "Crowns of all Miscellanies."

KUMAGUSU MINAKATA.

15, Blithfield-street, Kensington, September 26.

A Remarkable Meteor.

A METEOR of surpassing brilliancy and great size was seen here on the 1st inst., just before 10 p.m. The course seemed to be from westwards towards the north-east. The meteor was of a vivid blue colour, and it lighted with its splendour the whole visible horizon. In a clear blue sky the harvest moon, on the wane, was at the time shining brightly.

On disappearance the blue fiery ball left behind it for some seconds a long luminous trail, like that which follows the flight of a rocket. Travelling apparently at a considerable height, the ball was observed at much about the same time at Llanefydd, amongst the hills in North Wales. A correspondent writes thence: "Last night (the 1st inst.) I witnessed a remarkable meteor. I always, these moonlight nights, go up the Freith just before 10 p.m. I went up last night; it was just like day (the effect of the moon shining in the clear air of the hills). Just when I was on the top, turning to come down, and looking up the valley, the place suddenly became lit up with a blaze of intense blue light. I thought it was a tremendous lightning flash; but as it lasted too long for that, I looked, and then saw what it was. There was a meteor falling just behind Tan-y-Gurt Mountain, as bright apparently as the sun. It was a globe of flame as large as an ordinary football, and of a light blue colour. I saw the ball for about as long as a rocket takes when falling. The ball was very much like an enormous rocket, and afterwards there was an appearance just like a stick falling from the flame. The meteor came from the west, travelled towards the north-east, and fell perpendicularly." My correspondent adds: "The meteor did not shoot from any radiant known to me."

Worcester, October 4. J. LLOYD BOZWARD.

THIS meteor was distinctly seen at Driffield, East Yorkshire. It proceeded from a point about 45° altitude in the west, and passed towards south-south-west at an angle of about 40°, disappearing at an altitude of about 20° in the south-west. Duration two seconds; slow motion. A trail of yellowish-red sparks appeared on both sides (top and bottom) as it travelled forward. Several letters appear in the *Yorkshire Post* of the 5th inst. from persons who saw it in Yorkshire.

J. LOVEL.

TERTIARY AND TRIASSIC GASTROPODA OF THE TYROL.[1]

THOUGH much has already been done for continental palæontology, a great deal still remains to be accomplished. The earlier workers in the field laboured under the disadvantage of having to deal with comparatively scanty material, mostly scattered in private collections over large areas at a time when intercommunication was far from easy. Nowadays these old collections with their type-specimens have for the most part found their way into the museums of the principal cities. Moreover, not only may they freely be examined on the spot, but sometimes, we are glad to know, are allowed, under proper precautions, to be removed for the purpose of comparison with types preserved elsewhere. These altered circumstances and the acquisition of new specimens have not merely aided, but even provoked the revision, rectification, and completion of the labours of bygone times.

The two articles before us are examples—the one of supplementary, the other of both supplementary and revisionary work.

To take them in their order:—

Dr. Dreger's paper is the first of a projected series in which it is intended to treat of the fauna of the tertiary beds at Häring in so far only as it has not already been dealt with. Any conclusions Dr. Dreger may have come to concerning the exact age of these deposits, which Gümbel considered to be the equivalents of our Bembridge and Headon beds, are reserved till the whole of the material has been disposed of.

The fossils are in a very bad state of preservation, being much crushed, distorted, and broken: the more

[1] "Die Gastropoden von Häring bei Kirchbichl in Tirol." Von Dr. Julius Dreger. (*Annalen des K.K. Naturhistorischen Hofmuseums*, Bd. vii. 1892, pp. 11–34; Pls. i.–iv.). "Die Gastropoden der Schichten von St. Cassian der südalpinen Trias." Von E. Kittl. II. Theil. (*Ibid.* pp. 35–97. Pls. 5. (Wien: A. Hölder.)

delicate parts, such as the outer lips, long anterior canals, where such existed, and any spiny projections, are usually missing. With such unsatisfactory material to work upon it is little wonder the author has in many cases been unable to come to any definite determination as to the species; indeed in several instances, most wisely, no specific identification is attempted.

The list given at the end shows 114 forms, including 15 which are described as new; but of these some had better have been left unnamed till more perfect examples were forthcoming, whilst in certain instances, such as *Voluta stromboides*, one feels sceptical, if any reliance may be placed on the figure, as to the very determination of the genus. Nor is the description of these new species always adequate: that of *Trochus demersus* being especially insufficient. One of the figures is that of an interesting example of *Xenophora*, considered by Dr. Dreger to be very near to, if not identical with, *X. subextensa*, d'Orb. This individual must have possessed a somewhat fastidious taste, for in lieu of the ordinary fragments of shell and other oddments that its kindred usually love to attach to their tenements, it selected for the decoration of its house the fusiform shells of *Cerithium* and *Pleurotoma*, which it disposed radially, attaching them by their apices. This unwonted arrangement is paralleled in a recent example of *X. pallidula*, Reeve, dredged off the Philippines during the *Challenger* expedition, the decorative shells being those of *Terebra* and *Pleurotoma*.

The nomenclature employed by Dr. Dreger is not in all instances up to that standard of exactitude which the present-day devotees of the law of priority demand, and undoubtedly will bear revision, and so, too, we regret to see will his synonymy. Dr. Dreger's principle of giving in synonymic references the name of the authority cited for the species by the author who is quoted is decidedly the fairest and best system and one which for our part we would gladly see universally adopted. By way of instance a portion of the synonymy of *Cassidaria ambigua*, Brander is here given, omitting however for sake of brevity the references to the several papers:—.

1776. *Buccinum ambiguum*, Brander, &c.
1812. *Cassis striata*, Sow., &c.
1843. *Cassidaria ambigua*, Brander, Nyst, &c.
1851. *Cassis affinis*, Philippi, &c.
1854. ,, ,, ,, E. Beyrich, &c.
1861. ,, ,, Beyr., Gümbel, &c.
1864. ,, ,, Phil., Giebel, &c.
1865. ,, *ambigua*, Sol., v. Koenen, &c.

Unfortunately our author has not been as careful in following out his own system as he should. Moreover the reference to the first description of a species is frequently omitted altogether; the descriptions from Brander's "Fossilia Hantoniensia" are sometimes attributed, and correctly, to Solander, and sometimes, as in the example quoted, to Brander: the synonymy is frequently unduly swollen by references to mere lists such as that in Gümbel's "Geognostische Beschreibung."

The paper concludes with a table showing the distribution of the 19 species which are also known to occur in other localities. This is supplementary to the similar table given by Gümbel (*op. cit.* Abth. i. pp. 608–9).

Turning to the second article, it is needless to remark that the St. Cassian beds must ever remain a source of interest to the geologist, not only on account of the remarkable mixture they offer of palæozoic with mesozoic forms of life, as evinced by the occurrence of *Orthoceras* on the one hand and *Ammonites* on the other, but also from the fact that so large a number of fossil species are peculiar to them.

The St. Cassian fauna has been treated monographically by Münster in his "Beiträge zur Petrefacten-Kunde" (Hft. iv., 1841), by Klipstein in his "Beiträge zur Geologischen Kenntniss der östlichen Alpen" (1843), and by Laube in a series of papers published in the "Denkschriften der k. k. Akademie der Wissenschaften, Wien," between 1865 and 1870. Although the last-named palæontologist added very largely to the number of species known, the subject was far from being exhausted, and the accumulation of fresh material has enabled Dr. E. Kittl to still further augment the list of Gastropoda by the addition of many new forms, mostly of small size and many of very great beauty.

The first part of this paper, published last year in the preceding volume of the same serial, contained descriptions of all the species of Scaphopoda and of Gastropoda Prosobranchiata from *Patella* to *Clanculus*; the second portion now before us embraces the families represented in these beds between and including the Neritidæ and the Littorinidæ, and introduces two new genera—*Palæonarica*, in Neritidæ, and *Pseudoscalites* in Trichotropidæ.

The classification and nomenclature followed, it should be stated, is that adopted by Zittel in his well-known "Handbuch der Palæontologie," and of course shares the merits and demerits of that system. Only in two instances does our author depart from his model. The genus *Chilocyclus*, Bronn, is restored on the ground that it is distinct from the *Cochlearia*, Braun, to which Münster had referred the St. Cassian species. In the same way *Delphinulopsis*, Laube, which has been set aside as embracing forms referable to two genera—*Neritopsis* and *Fossariopsis*—is re-established by Kittl for reasons which are too technical to be dwelt on here, but which we confess do not seem entirely satisfactory.

To criticise so elaborate and careful a work as this in detail is, indeed, not possible without seeing the actual specimens, however good the figures and lucid the descriptions may be, and we fear it would sound ungracious when so much is vouchsafed us to wish that some of the new types had been less fragmentary, or to express an opinion, however guardedly, that some of the specimens figured, besides that so acknowledged, convey the impression of being immature and possibly the fry of other species.

The difficulties that have to be contended with in the production of a work of this sort are far from small, and the conscientious palæontologist must frequently be at his wits' ends to decide whether he shall refer a given example, especially if imperfectly preserved, to a known genus from the typical forms of which it differs considerably, or shall incur the odium of adding another name to an already overburdened nomenclature.

Take such an instance as that here afforded by the genus *Scalaria* (or should we write *Scala?*). Amongst the species are forms which the synonymy shows were referred by so able a palæontologist as Laube to the very distinct genera *Turbo*, *Trochus*, and *Turritella*. A glance at the figures shows how far these forms depart from those we have been accustomed to associate with the old familiar Wentle-traps, and it is little wonder that Dr. Kittl suggests the desirability of establishing a new subgeneric name for some of the St. Cassian species: we think he would be justified in even founding a new genus to receive them.

The plates that accompany this paper are admirable bits of drawing, but the figures would in most instances have been more satisfactory for working purposes had more of them been enlarged, and those that are enlarged yet further magnified. The double numeration of these plates is, moreover, both clumsy and unnecessary.

It is very interesting to observe in how many of the species of *Naticopsis* the colour markings seem to have been preserved, nor is this the less remarkable because instances of a similar description from yet older formations are on record.

(BV)[2].

NOTES.

SIR HENRY GILBERT sailed for America at the end of last week, to deliver the biennial Rothamsted Agricultural Lectures. There is an appropriateness in Sir Henry being the lecturer for 1893, the jubilee year of the Rothamsted wheat experiments. He is, of course, bound in the first place for Chicago, where Sir John Lawes and himself have a considerable exhibit.

WE are glad to learn that the fund which is being raised to pay the expenses incurred by Dr. Budge, of the British Museum, in the action recently decided against him, now amounts to about £900, so that there is every prospect of the whole amount being shortly obtained.

LORD KELVIN will open the new science buildings erected at the Leys School, Cambridge, on Saturday, October 28. The buildings include an extensive museum, three lecture theatres, and laboratories for elementary and advanced chemistry, biology, and physics.

THE Paris correspondent of the *Times* says that a collection of Egyptian papyri, recently purchased by subscription for the Geneva Public Library, is being examined by M. Jules Nicole. Among the discoveries already made are included a didactic elegy on the stars, and several scientific compositions.

THE Adelaide meeting of the Australasian Association for the Advancement of Science commenced on September 25, when Dr. Stirling, C.M.G., F.R.S., delivered a lecture on "Prehistoric Man." Prof. Ralph Tate, the president-elect, delivered the presidential address on the following day. The following are the sections and the names of their presidents:—Astronomy, mathematics, and physics, Mr. H. C. Russell, C.M.G., F.R.S.; chemistry, Mr. C. N. Blake; geology and mineralogy, Sir James Hector, K.C.M.G., F.R.S.; biology, Mr. C. W. de Vis; geography, Mr. A. C. Macdonald; anthropology, Rev. S. Ella; economic science and agriculture, Mr. H. C. L. Anderson; engineering and architecture, Mr. J. R. Scott; hygienic and sanitary science, Mr. A. Mault; mental science and education, Prof. Henry Larvire.

AN International Exposition will be inaugurated in San Francisco on January 1, and will remain open until June 3, 1894.

THERE is to be a "castle in the air" at the International Exhibition to be held at Antwerp next year. An immense balloon, built in six separate parts, on the principle of the water-tight compartments in steamers, will be held captive by means of ropes, and from it a castle-shaped structure, 33 yards long by 8 yards wide, will be suspended instead of a car. Entrance to the castle will be obtained by means of two lifts, and the supply of gas will be kept up by connecting a generator on the ground with the balloon by means of a silk tube.

THE Congress of the Photographic Society of Great Britain and Affiliated Societies was opened on Tuesday. In his presidential address, Captain Abney reviewed the advances recently made in photography, dwelling particularly upon the Lippmann processes for obtaining photographs in natural colours. A special lantern display will be held this evening at the Gallery of the Society in Pall Mall.

A TERRIBLE storm passed over the Gulf of Mexico on Monday, October 2, and, in conjunction with a tidal wave, did serious damage. Immense destruction was caused to the plantations, crops, and villages near the shore, and a report from New Orleans states that 1200 lives were lost in the portion of Louisiana visited by the cyclone. Hundreds of small vessels along the Gulf Coast were wrecked, and at Chandileur Island the wind is reported to have had a velocity of 100 miles an hour. All the buildings on the island, including the lighthouse, were destroyed, several miles of the island being completely washed away. As the railway and telegraph service in the region visited by the storm have been destroyed, details of the path traversed and the damage done have not yet been obtained.

THE *Société d'Encouragement pour l'Industrie Nationale* has made the following awards. The grand medal for agriculture to Prof. E. Lecouteux; the prize of 3000 francs for perfecting the ventilation of mines, to M. Murgues; the prize of 2000 francs for a study of the coefficients required in a calculation of the mechanical possibilities of an aerial machine has not been awarded, but a sum of 500 francs has been assigned to Prof. Le Dantee. The prize of 2000 francs for the inventor of new methods of utilising petroleum, advantageously and without danger, for industrial and domestic purposes, has also not been awarded, but an encouragement in the shape of 1000 francs has been given to Dr. Paquelin. M. Kayser has obtained the prize (3000 francs) for a study of alcoholic ferments, and M. Girard that of 2000 francs for the best experiments on cattle feeding. M. Decaux has received the prize of 1000 francs for a new photographic shutter. Gold medals have been awarded to MM. L. Figuier, J. Fournier, M. Mustel, E. Petrousson, and G. Tissandier (the Editor of *La Nature*).

THE Patent Laws of this country make no provision for an official search as regards the novelty of inventions, hence the necessity for a perfect system of indexing of specifications of patents can readily be understood. In order to facilitate reference and enable intending patentees to satisfy themselves whether their brain-creations are really novel or not, a new series of illustrated Abridgment Classes is being published at the Patent Office. These abridgments have been classified according to subject, and they refer to all the specifications of patents applied for in the period 1877–83. Everything depends, of course, upon the manner in which a classification of this character is made, and we are glad to be able to say that the Comptroller-General has grouped the specifications in an excellent manner. He certainly deserves the thanks of men of science for arranging philosophical instruments in a class by themselves. The volume devoted to this class includes over five hundred short illustrated descriptions of inventions relating to optical, nautical, surveying, mathematical, and meteorological instruments. It is interesting reading, and should be useful to devisers of apparatus for any branch of science. During the period covered by the summary, inventors appear to have directed their attention principally to perfecting and devising new forms of those instruments which were already in existence. At any rate, very few new discoveries are indicated by the inventions set forth, which may perhaps be taken as evidence that the fundamental laws of nature have now been fairly well recognised. Among the most ingenious apparatus we may note the telemeters, or range-finders, by means of which the distances of objects can be ascertained directly from a single station, the importance of which from a military or naval stand-point cannot be over-estimated. Other surveying instruments, such as theodolites, levels, telescopes, &c., are fully represented, as also are magnetic compasses, ships' logs and sounding apparatus, sextants, and other nautical instruments. In the field of meteorology we find barometers, thermometers, hygrometers, anemometers, wind vanes, sunshine recorders, &c., while among optical instruments occur improvements in telescopes and microscopes, stereoscopes, magic-lanterns, and spectacles, reading-glasses, lenses, and reflectors. The volume also comprises mathematical drawing instruments and tripod stands for various kinds of apparatus.

A large number of papers on various branches of anthropology were discussed at the International Congress of Anthropology, which met at Chicago from August 28 to September 2. Dr. D. G. Brinton opened the session with an address on "The Nation as an Element in Anthropology." The second day's meeting was devoted to Archæology, principally American. On the third day, devoted to Ethnology, Dr. Brinton read a paper "On the Alleged Evidences of Ancient Contact between America and other Continents," in which he categorically denied that "any language, art, religion, myth, institution, symbol, or physical peculiarity of the American aborigines could be traced to a foreign source." Folk-lore was the subject assigned to the fourth day's proceedings, Religions to the fifth, and Linguistics to the sixth. The meetings were well attended, and the presence of foreign delegates showed that the Congress was truly an international one.

At the Meteorological Congress held at Chicago in August last, as many as 130 papers were read "outlining the progress and summarising the present state of our knowledge of the subjects treated." In Section A, presided over by Prof. C. A. Scholt and Mr. H. H. Clayton, the papers were devoted to instruments and methods of observation, especially methods of observing in the upper air. Prof. Cleveland Abbe was chairman of Section B, which mostly dealt with questions of meteorological dynamics, much attention being also given to the study of thunderstorm phenomena in various countries. Section C, of which Prof. F. E. Nipher was chairman, comprised a series of sketches of the climate of different portions of the globe. Section D, in charge of Major H. H. C. Dunwoody, was devoted to the discussion of the relation of the various climatic elements to plant and animal life. Section E, under Lieut. W. H. Beehler, dealt with questions relating to marine meteorology, particularly to ocean storms and their prediction, methods of observation at sea, and international co-operation. Prof. Charles Carpmael and Mr. A. Lawrence Rotch presided over Section F, which comprised papers relating to the improvement of weather services, and especially to the progress of weather forecasting. Prof. F. H. Bigelow guided Section G, which dealt with problems of atmospheric electricity and terrestrial magnetism and their cosmical relations. Section H (Prof. Thomas Russell) had to do with rivers and the prediction of floods. Section I, under Oliver L. Fassig, was devoted to historical papers and to bibliography, with special reference to the history of meteorology in the United States. Preparations have been made for printing all the papers, and it is hoped that the work will be completed at an early date.

The weather over our islands has recently been much disturbed by the passage of atmospheric depressions across the country; rainfall has been general in all parts, while thunder and lightning have frequently occurred, especially over the western and southern parts of the kingdom. On Sunday, the 8th inst., three-quarters of an inch of rain fell in the north of Scotland, and on the following day a depression in the south caused a heavy downpour in that part of the country; the fall measured in the neighbourhood of London on Tuesday morning amounted to an inch and a quarter. The excess above the average in all the western and southern parts of England during the week ended the 7th inst. was very large, amounting to an inch in the south-western district. The greatest deficiency in the aggregate amount since the beginning of the year was then 8·7 inches in the west of Scotland, while in the south of Ireland, and the midland counties of England, the deficiency exceeded 6 inches.

We have received a copy of the *Osservazioni meteorologiche* made in the year 1892 at the Turin Observatory, containing observations taken three times daily, with daily and monthly means, and the differences from the normal values, calculated by Dr. G. B. Rizzo, assistant at the Observatory. We are indebted to the Italians for some of the earliest and best series of observations; those for Bologna began as early as 1723, and M. Toaldo, the first director of the Padua Observatory, early established a system of more than sixty stations, the results of which were published by M. Schouw, in Copenhagen, in 1839. At the Turin Observatory observations were begun in 1753 (see Nature, June 1, 1893, p. 108), and for many years past the results have been regularly published each year. The cost of the establishment is now borne partly by the University, and partly by the town of Turin.

Forest-Inspector R. Schütte reprints, from the *Agricultural Journal* for West Prussia, an elaborate account of the district known as the Tucheler Haide, the largest continuous forest district of Western Prussia, extending over an area of thirty-five square miles. It is characterised by great and sudden changes of temperature. The winter minimum generally falls below −20° R. Snow has fallen on May 19, followed by a temperature of 21° R. on the 26th, and this again by night frosts on the first and third of June. Prehistoric remains are found belonging to the later stone and to the bronze ages. The inhabitants are occupied almost entirely with forestry and agriculture. Polish is still the prevalent language, though German is now generally understood.

Although one of the most recent organisations of its kind, the Geological Survey of Russia has already taken high rank amongst the surveys of Europe; the director is A. Karpinsky. The survey was commenced in 1882, and has published thirteen 4to volumes of Memoirs and eleven 8vo volumes of Bulletins. The maps, on the scale of 1 : 420,000, are issued with the Memoirs. An additional annual publication is the Bibliography of Russian Geology from 1885 onwards, which is edited by S. Nikitin. This gives abstracts in Russian and French of all publications relating to the geology of Russia. Although the detailed survey of this vast country is not yet sufficiently advanced for the publication of all the large scale maps, the surveyors have now accumulated enough material to warrant the issue of a general map on the scale of 1 : 2,520,000. This has recently appeared in six sheets, with brief explanatory text in two editions—Russian and French. (On the title-page of the French edition the scale of the map is erroneously given as 1 : 520,000.) Fuller explanations of various districts and formations will be issued subsequently. Some of the information here published was supplied by S. Nikitin for the geological map of Europe issued by Prof. Prestwich in vol. ii. of his "Geology." The map now issued is a beautiful example of cartography; it is not overloaded with detail, but the streams, railways, and main roads are clearly indicated. The names of places, rivers, &c., are printed in Russian, but to the descriptions of geological formations in the index a translation in French is added. The following statement of subdivisions indicated on the map will give some idea of the amount of geological information supplied:—5 Quaternary, 5 Tertiary, 2 Cretaceous, 1 Volgian, 3 Jurassic, 4 Triassic, 1 Permian, 1 Permo-Carboniferous, 2 Carboniferous, 5 Devonian, 2 Silurian, 1 Cambrian, 1 Crystalline Schists, 1 Gneiss, Granite, &c., 5 Volcanic Rocks, Tuffs and Serpentine. In addition to these well-recognised rock-groups extra tablets and colours are given for beds between the Permian and Trias occurring in some districts and not yet understood; the Devonian and Carboniferous, not separated, of the Transcaucasus; the Palæozoic rock, of the Caucasus; and for the ancient sandstones, &c., of Volhynie. The interesting group of Volgian beds, linking together the Cretaceous and Jurassic, are developed around Moscow, in Simbirsk and Kalouga; they have recently been discovered in

Poland. The system of colouring adopted is, as far as possible, that of the International Geological Map of Europe. The quaternary deposits are omitted where they would much obscure the solid geology, but elsewhere they are shown. In some parts, especially in Northern Russia, these superficial deposits are thick and widely spread, so that the solid geology is not known; here it was necessary to show only these deposits. The southern limit of erratic blocks is shown by a strong red line.

Messrs. Fletcher, Russell, and Co., the well-known makers of gas appliances, have just introduced a new process to supersede the use of Berlin black and black-lead for protecting the cast-iron portions of their manufacture. The casting is coated with a film of enamel, which is so thin that even the finest details on the metal are preserved. This enamel is said to be absolutely proof against rust, and preserves its qualities at any temperature up to a bright red heat. All colours are obtainable, including gold and silver, bright or dull, and as many as are wished can be produced on one casting. The process therefore offers great facilities for decorative work of all kinds, and its protective qualities should ensure it a wide field of usefulness.

In a previous number of Nature (No. 1247) we published the opening address by Mr. Jeremiah Head, President of Section G, Mechanical Science. In this, among many of the mechanical forces used by man, he referred at some length to the prospect of man ever being capable of flying. Some very interesting experiments, to which no allusion was made, although not bearing directly on actual flight, may yet be found of sufficient importance to be here related. For a very detailed account the reader may be referred to No. 205 of the weekly journal, *Prometheus*. The experimenter in question is Herr Otto Lilienthal, and his success in his so-called "flight" is the result of much thought and considerable practice. The apparatus may be described as a pair of large wings, similar in principle and construction to those of a bird, with two tails at the back, one placed vertically, and the other horizontally. The wings are rigid and fixed, and no motive power at all is used; the whole apparatus weighs twenty kilograms. At the place where the experiments have been carried on, a long sloping hill has been used, with a platform raised about ten metres above the general surface at the top, for the starting point. From this platform the experimenter grips the apparatus between the wings or sails with his hands, and springs off the edge. In the flight he descends at an angle of about 10° to 15°, and the distance covered is sometimes very considerable. In the experiments carried on between Rathenow and Neustadt he covered 80 metres, while from another point he made a flight of 250 metres. The wind of course plays an important part in these flights, but Herr Lilienthal says that with practice one can steer the apparatus well. With the wind blowing stronger on one wing than on the other the equilibrium of the apparatus was found to be greatly disturbed, but this was checked by the movement of the legs, which changed the position of the centre of gravity. In these experiments there is a great opportunity for gaining experience in steering, and it seems very likely that we may learn much thereby.

The assumption, current some years ago, that the properties of liquids change in proportion to the amount of matter held in solution, has already been invalidated for the case of electrolytic conductivity. Messrs. F. Kohlrausch and W. Hallwachs, in *Wiedemann's Annalen*, publish some results showing that the assumption is also erroneous in the case of density of dilute aqueous solutions. The method adopted was the Archimedian one of immersing a solid in the solution and noting its decrease in weight. Errors due to capillarity were eliminated by attaching the solid, a glass ball, to the suspending wire by means of a clean cocoon fibre. During mixing and stirring, the glass was held in position by glass rings. The stirrer was one of mica or platinum. Densities were observed up to 1·03, and the weighings were reliable to within 0·2 mgr. provided that no dust or fibres were attached to the cocoon thread. This gave a limit of error equal to 1 in 10,000. Large variations of temperature were corrected by a flame or ice, smaller ones by calculation according to known formulæ. All the bodies investigated show a decrease of the ratio of condensation to concentration between 0·005 and 0·5 gramme-equivalents per litre. This decrease amounts to 1 per cent. for sugar, 2 for hydrochloric acid, 2·5 for common salt, 13 for phosphoric acid, and 20 or sulphuric acid. The correspondence between this change of density and the change of electrolytic conductivity is very apparent. Sugar, a non-electrolyte, shows the greatest constancy of molecular density in solution. The authors intend shortly to publish analogous results obtained in their investigation of optical refraction.

M. Van Aubel has continued his experiments on the resistance of bismuth, and gives an account of the results he has obtained in the *Journal de Physique* for September. The results obtained are of special interest, as the use of spirals of bismuth seems to be the most convenient way of measuring powerful magnetic fields, at any rate with a sufficient degree of accuracy for most industrial purposes. According to Righi, the electrical resistance of commercial bismuth at 0° varies considerably, and bismuth which has been compressed has its resistance less affected by magnetism than that which has been melted. The author in his experiments has made use of pure bismuth, prepared by electrolysis according to the method he gave in his former paper in the *Annales de Chimie et de Physique*, and his observations show that neither sudden cooling nor compression has much effect on the electrical properties of pure bismuth. The resistance at 0° C. and the rate of change of the resistance with temperature, and the strength of the magnetic field in which it is placed, are almost the same, for rods that have been annealed quickly cooled, or compressed. The resistance always increases with rise of temperature, and between 0° and 100° the change is very nearly regular. A mere trace of impurity, however, completely changes the properties of the metal. The action of a magnetic field being the same, whatever the mode of preparation of the bismuth, it is better to use the spirals of compressed bismuth rather than the more difficultly obtained films of electrolytically deposited metal used by M. Leduc.

In the current number of the *Philosophical Magazine*, Mr. John Trowbridge has a paper on the oscillations of lightning discharges and of the aurora borealis. By means of a rotating mirror the author has photographed the oscillating spark passing between two knobs, using both great electromotive force and great quantity of electricity. He finds that the subsequent sparks, at any rate for three hundred-thousandths of a second, exactly follow every sinuosity in the path taken by the pilot spark. Thus the comparatively small resistance to the passage of a second spark in air is probably due to this permanence of path.

The University Correspondence College Press has issued the London University Guide for the year 1893–94.

Bulletins 96–99 have been received from the Michigan Agricultural Experiment Station.

Mr. G. Gammie has prepared a report on his botanical tour made on the Sikkim-Tibet frontier during 1892. The report is issued by the Superintendent of the Royal Botanical Gardens, Calcutta.

We have received the second part of "A Dictionary of Birds," by Prof. A. Newton and Dr. Gadow, extending from "Ga" to "Moa." Messrs. A. and C. Black are the publishers.

MR. W. F. PETTERD has issued, through Mr. Wm. Grahame, Jun., Hobart, a catalogue of the minerals known to occur in Tasmania, with notes on their distribution.

WE have received reports containing the results of physical and meteorological observations made on the coast of Germany during the first half of 1892. The reports are published by Herr Paul Parey, Berlin.

THE last ordinary meeting of the session of the North of England Institute of Technical Brewing will take place in Manchester on October 20, when Prof. Percy Frankland, F.R.S., will read a paper on "The Polariscope in relation to Chemical Constitution."

THE Upper Norwood Literary and Scientific Society has prepared a varied programme of lectures for the coming session, in which science and literature are given equal prominence, and are treated by well-known lecturers.

A MEMOIR, by Dr. Carlos Berg, the Director of the National Museum at Buenos Ayres, on *Geotria macrostoma* (Burm.), Berg, and *Thalassophyrne Montevidensis*, Berg, has been reprinted from the *Anales del Museo de la Plata*.

THE second part of "Dissections Illustrated," by Mr. C. Gordon Brodie, has been published by Messrs. Whittaker and Co. It refers to the lower limb, and includes twenty finely-drawn coloured plates and six diagrams, by Mr. Percy Highley.

MESSRS. O. NEWMANN AND CO. are publishing a series of 120 new wall diagrams for instruction in botany and zoology in schools and colleges. The diagrams are well printed in colours on a black ground, and are highly commended by German educationalists.

THE thirteenth edition of Gray's "Anatomy, Descriptive and Surgical," edited by Mr. T. Pickering Pick, has been published by Messrs. Longmans, Green and Co. The work has been thoroughly revised, and in some parts rearranged, and much new matter referring to surgical anatomy has been added.

THE first number of a bright little quarterly magazine, *The Nature Lover*, edited by Mr. H. Durrant, has just been published by Mr. Elliot Stock. In style it is like the Selborne Society's magazine, *Nature Notes*, though in rather lighter vein. We trust that the lovers of nature are numerous enough to make the venture a success.

DR. V. STERKI has made an exhaustive study of those minute and interesting molluscs which are generally regarded as constituting the genus *Vallonia*. His paper appears in the Proceedings of the Academy of National Sciences of Philadelphia, 1893 (pp. 234–279), and though not a monograph of the genus, it will serve as a useful guide to further investigations.

THE Proceedings of the Liverpool Geological Society (part 1, vol. vii.) contains several interesting papers communicated during the thirty-fourth session (1892–93). Among these may be mentioned the address of the president, Mr. W. Hewitt, on "The Physical Conditions of the Aralo-Caspian Region, as bearing on the conditions under which the Triassic rocks were formed," and a paper on "The Formation of Clay," by P. Holland and G. Dickson.

A LECTURE on "Bulbous Irises," delivered before the Royal Horticultural Society in May, 1892, by Prof. Michael Foster, has been expanded, and is now published separately at the society's offices. A detailed description of the various species mentioned in the lectures has also been added. Growers of irises will find the book of great use to them, it being intended more for the gardener than the botanist.

A MONOGRAPH of the "Coraciidæ, or Family of the Rollers," by Mr. Henry E. Dresser, will shortly be published by subscription. This work will contain illustrations, accompanied by letter-press, giving as complete an account as possible of all the known species of these richly-coloured birds. All the species have been drawn, life-size, on stone, by Mr. J. G. Keulemans.

THE Rev. W. Colenso, F.R.S., read several interesting botanical papers before the Hawke's Bay Philosophical Institute during 1892, and they are published in the Transactions of the New Zealand Institute, vol. xxv. A paper of much interest, entitled "Bush Jottings," is a brightly-written account of many botanical sights to be seen in the high inland wooded district known as "the bush." More technical in their character are the descriptions of a few newly-discovered rare indigenous ferns, some phanerogamic plants, and a list of fungi. All these contributions help to make known the botany of New Zealand.

WE have received from Mr. Stanford an "Illustrated Official Handbook of the Cape and South Africa," which reflects the greatest credit upon all who have had anything to do with its production. The volume is edited by John Noble, who evidently recognises the importance of science, for we find chapters devoted to the following subjects:—"Geology, Fossils and Minerals of South Africa," "Vertebrate Fauna of South Africa," "Flora of South Africa," "Woods and Forests," and "Viticulture," all of which are contributed by specialists, who, as far as we can see, have performed their several tasks with great care. The work is enriched with a map and over a hundred "process" illustrations.

SILICIDE of carbon, CSi, has been obtained by M. Moissan in beautiful large crystals very similar in appearance to sapphires and considerably harder than rubies, by four different processes involving the use of his recently described electric furnace. The existence of this curious compound of two closely allied elements was first pointed out by M. Colson, who obtained it in the amorphous form by heating crystals of silicon in a current of hydrogen charged with vapour of benzene. Some years ago M. Moissan obtained it, in the condition of crystals several millimetres in length, by dissolving carbon in silicon, the latter being maintained in a state of fusion by means of a small but powerful blast furnace. The crystals were isolated from the excess of silicon by treating the product with a boiling mixture of nitric and hydrofluoric acid. M. Moissan now shows, however, that crystallised silicide of carbon may be much more readily prepared by heating a mixture of carbon and silicon, in the proportions of their atomic weights, in the electric furnace. The mass of crystals produced during the passage of the current may be purified by boiling first in the acid mixture above mentioned, and subsequently in an oxidising mixture of nitric acid and potassium chlorate. The crystals produced by this simple method are most frequently yellow, but are quite transparent if the operation is performed rapidly in a closed crucible of carbon, and provided the silicon employed is free from iron. Sometimes, however, the crystals are coloured blue, and closely resemble sapphires. The second process for the preparation of the compound consists in heating in the electric furnace a mixture of iron silicon and carbon, or more simply of iron silica and carbon; a regulus of metallic iron containing large crystals of silicide of carbon is produced. The third process consists in reducing silica by means of carbon in the crucible of the electric furnace, and this mode of preparation possesses the advantage of furnishing crystals which are more nearly colourless than those produced by the first two methods, inasmuch as the silica and carbon can be employed in a fairly pure state. Perhaps the most interesting of all the methods of preparation is the fourth, in which the compound is formed by direct synthesis by the union of vapour of carbon with vapour of silicon. For, as has been previously described in these columns, M. Moissan is able to actually distil carbon at the high temperature of the arc which he is able to produce in his furnace. The experiment is conducted in a small crucible of pure carbon of elongated form, and enclosing a little block of silicon. The base of the crucible is arranged so as to occupy the position where the highest temperature of the arc is attained, and after the conclusion of the experiment the interior of the crucible is found to be covered with almost colourless prismatic needles of carbon silicide.

CRYSTALLISED carbon silicide is an extremely stable substance which resists the action of the most energetic reagents, even those which are capable of readily attacking its elementary constituents. The pure crystals are colourless and perfectly transparent, and present the appearance of regular hexagons. Their density is 3·12, and they are so hard that the ruby is readily scratched, and may be ground by means of the powdered compound. They are unalterable in air or sulphur vapour at 1000°. Chlorine attacks them very slowly at 600°, but more rapidly at 1200°. Fused nitre and potassium chlorate are entirely without action upon them, as are likewise boiling sulphuric, hydrochloric, and nitric acids, and even aqua regia and the silicon-dissolving mixture of nitric and hydrofluoric acids are incapable of attacking them. Fused caustic potash, however, after heating to redness for an hour in contact with them, reacts with formation of carbonate and silicate of potassium, and thus affords a means of estimating the content of silicon. The carbon may also be estimated by repeated combustion with chromate of lead, which gradually effects oxidation of the carbon. The analyses thus carried out agree in all cases with the simple formula CSi.

NOTES from the Marine Biological Station, Plymouth.—Last week's captures include various types of *Foraminifera*, colonies of the Hydroid *Coryne pusilla* (without gonophores), a colony of the *Scyphistoma* stage of *Aurelia*, and the Nudibranchs *Platydoris planata*, *Candiella plebeia* and *Polycera quadrilineata*. In the floating fauna the Hydroid medusæ *Cytæandra areolata* and *Eutima insignis* have been observed in addition to the forms mentioned last week.

THE additions to the Zoological Society's Gardens during the past week include a Sooty Mangabey (*Cercocebus fuliginosus*) from West Africa, presented by Mr. Swaniston Cyril Hopkins; a Serval (*Felis serval*), a Nilotic Crocodile (*Crocodilus vulgaris*) from Africa, presented by Mr. T. E. C. Remington; a Lesser White-nosed Monkey (*Cercopithecus petaurista*) from West Africa, presented by Mrs. Noakes; a Yellow-collared Parrakeet (*Platycercus semitorquatus*) from Australia, presented by Miss A. Fenwick; a Common Sheldrake (*Tadorna vulpanser*) European, presented by the Rev. H. G. Morse; an Oyster-catcher (*Hæmatopus ostralegus*) European, presented by Mr. Edmund Elliot; a Goliath Beetle, from West Africa, presented by Mr. F. W. Marshall; two Great Eagle Owls (*Bubo maximus*) European, deposited; a Flocky Lemur (*Avahis laniger*) from Madagascar, a Raccoon-like Dog (*Canis procynides*) from North-east Asia, a Sanderling (*Calidris arenaria*), a Puffin (*Fratercula arctica*) European, purchased.

OUR ASTRONOMICAL COLUMN.

ASTRONOMY AT THE WORLD'S FAIR.—The astronomical exhibits at Chicago seem to be fairly representative of the state of astronomical science at the present day, but they are too much scattered about in the different buildings for a proper study of them to be made. Among many of the more interesting exhibits we may mention the following: Fine collection of astronomical photographs, made by the Harvard College Observatory, which included those of stellar spectra nebulæ and clusters, and of a portion of the lunar surface enlarged over one thousand diameters. Dr. Chandler's four-inch almacantar, the collections of Draper and Langley, and the diffraction gratings and photographs of spectra by Prof. Rowland, the last of which formed the Johns Hopkins University exhibit. Specimens of the famous Jena optical glass, Kirchhoff's original spectroscope, Brill's mathematical models, and the magnetic apparatus of Gauss and Weber form part of the German Educational exhibit. In the English exhibit are found many astronomical photographs by Roberts, Gill, and others; others from the Royal Observatory, Greenwich, Boeddicker's Milky Way drawings, and the fine five-foot glass speculum by Dr. Common. Among some of the exhibits of the American astronomical instrument makers, we are glad to note the mounting of the great forty-inch Yerkes telescope by Warner and Swasey, who exhibit also some minor instruments. J. A. Brashear exhibits the stellar spectroscope for the Yerkes telescope, eighteen-inch and fifteen-inch objectives, gratings, &c. Among G. N. Saegmuller's (of Washington) exhibits is a four-inch steel meridian circle. Two twenty-three-inch discs of the celebrated Jena glass are shown by Schott and Genossen, of Jena, in addition to other specimens of optical glass. In the Cape Colony exhibit Dr. Gill's interesting stellar photographs are prominent, while the Lick Observatory display is housed in the educational department of the California State building, and, as *Science* says, is "strangely enough mixed up with the Kindergarten exhibit there." The U.S. Government building contains interesting apparatus as used in the Coast Survey, while the Naval Observatory shows a small observatory with several instruments.

THE AURORA OF JULY 15, 1893.—The system of observation of the aurora as lately instituted, seems to be already at work, and the observations of the aurora of July 15, most of which have been made on this system, show that the results are of the highest interest. A brief account of this aurora, by M. A. Veeder, will be found in the *Bulletin of the New England Weather Service* for the month of August (No. 18), from which we gather the following few notes:—With regard to the places of visibility and invisibility, it may be mentioned that its absence was verified up to midnight in Nova Scotia. In New England it was observed at a few stations, of short duration, and not at all conspicuous. Towards New York it was a fine display, and lasted all night, and was seen as far south as Washington at this longitude, while it was defined as a fine red aurora at Salt Lake city, and was seen as far south as the Lick Observatory, at both of which places this phenomenon is very rare. A special feature of this aurora was the "formation of a narrow band having an east and west direction, and passing just south of the zenith." This was seen in New England, the neighbourhood of Lake Ontario, and occasionally in Michigan, Wisconsin, and Iowa. An unusual formation recorded was that of an auroral curtain with a clearly defined lower margin. The twenty-seventh day interval coinciding thus with a synodic revolution of the sun, shows, as M. Veeder says, that whatever it is in the sun that originates an aurora can have this effect only when it has reached a certain position relative to the earth, and, further, that "the effect must proceed from the eastern limb." That in certain cases of large sunspots auroral effects might proceed from the central meridian of the sun as seen from the earth, M. Veeder freely admits; but he adds that, until further study has been made, this question cannot as yet be said to be satisfactorily answered.

NEW VARIABLE STARS IN CYGNUS.—A communication to the *Astronomischen Nachrichten*, No. 3191, by Herr Fr. Deichmüller, informs us of two new variable stars in the constellation of Cygnus. Their positions are respectively

$$\left.\begin{array}{rrrl} \text{h.} & \text{m.} & \text{s.} & \quad\;\; ^\circ \quad\; ' \\ 19 & 8 & 27 & +\ 49\ 24{\cdot}2 \\ 20 & 6 & 24 & +\ 47\ 23{\cdot}0 \end{array}\right\} 1855$$

The first of these stars has a range of one and a half magnitudes, while the second varies from $7\frac{1}{2}$ to the ninth magnitude.

ASTRONOMICAL WORKS (ANTIQ.).—We have received the catalogue of Herr Oswald Weigel's Antiquarium in Leipsig, which is devoted simply to works on astronomy (astronomical geography and geodecy). Included also is the library of Prof. C. Fearnley, of Christiania; so that our readers may be sure that there are now some important works for sale.

GEOGRAPHICAL NOTES.

NORWEGIAN enterprise has led to the fitting-out of a steamer, renamed the *Antarctic*, for a whaling voyage to the Antarctic Sea south of New Zealand, where Ross attained his highest south latitude in 1842. The *Antarctic* has already sailed, but will touch at an Australian port to complete preparations. It is understood that those on board will endeavour to make as complete meteorological observations as possible throughout the voyage.

A TELEGRAM from San Francisco, dated October 3, states that the American steam-whaler *Newport*, one of the fleet working north of the Arctic coast of America, which passed last winter at Herschell Island (long. 139° W. near the mouth of the Mackenzie), succeeded this summer in steaming through an almost open sea to 84° N. No details are given, and until the observations for latitude have been critically examined it is necessary to reserve an opinion as to the latitude really attained. The farthest north points, reached through Smith Sound, are 83° 20′ by Markham, and 83° 24′ by Lockwood. If the report is correct, the *Newport* got nearly fifty miles farther north than any previous expedition.

MR. F. G. JACKSON, who is travelling in the Yalmal peninsula, reports that Dr. Nansen did not finally leave Yugor Strait until August 20, the ice in the Kara Sea turning out to be much worse than was expected. The conditions must have improved shortly afterwards, however, as a telegram from St. Petersburg announces the safe arrival in the Yenesei of the Russian vessels which left Dumbarton with railway material on July 29. The date of arrival is not mentioned, but the fact proves that the *Fram* would have no difficulty in getting east as far as the Yenesei, at any rate, and as she is not reported by the Russian vessels, she was probably far beyond that river before they arrived.

PROF. KOTO publishes in the *Journal of the College of Science*, Imperial University, Japan, a detailed description of the surface changes accompanying the great earthquake of 1891, illustrated by sketch maps and photographic views of the great fault, forty miles long, which was formed in the valley of Neo. On one side of this fault the ground has subsided in places for nearly twenty feet, and has also been displaced horizontally. The result, apart from the destruction of towns and buildings, has been to considerably modify the physical geography of an extensive area, changing the course of streams and their rate of flow, forming swamps, and in many ways accelerating the gentler processes of surface change by erosion.

MR. CLEMENTS R. MARKHAM, President of the Royal Geographical Society, has this year been invited to deliver the opening lecture at the three provincial Geographical Societies. He opened the session of the Tyneside Geographical Society at Newcastle, by a lecture on Peru, on the 6th; that of the Liverpool Geographical Society, by an address on the Polar Regions, on the 10th; and that of the Manchester Geographical Society on the 11th, when his subject was Central Asia with special reference to trade routes. The interest taken in the younger societies by the Royal Geographical Society is sure to increase their popularity and usefulness in their own localties.

BIOLOGY AT THE BRITISH ASSOCIATION.

ON Thursday the address of the President was for several reasons postponed till 12.30, and the work of the section was opened by the Chairman (Sir William Flower) with a sympathetic reference to the recent sudden death of Mr. George Brook, who was to have been one of the secretaries at this meeting. A paper was then read by Dr. David Sharp, on the zoology of the Sandwich Islands. This was followed by the report of Prof. Newton's committee on the present state of our knowledge of the zoology of the Sandwich Islands. The committee have obtained valuable results in several departments of zoology, and more especially in entomology. The consignments received during the year from their collector may be roughly estimated at nearly 150 birds'-skins, 3000 insects, 1000 shells, a collection of spiders in spirit, together with some crustaceans, worms and myriapods. The importance and urgency of the work carried on was testified to by Sir William Flower, Prof. Newton, Dr. Hickson, and others. The report of the committee dealing with observations on the migrations of birds at lighthouses was then read by Prof. Newton. This committee have made progress with the systematic tabulation of their statistics, and are now commencing to fill up the schedules for their final report. The sixth report of the committee investigating the zoology and botany of the West India Islands shows that the Committee have been chiefly engaged during the past year in working out the great series of specimens secured from the West Indian region by means of the collectors. Papers on the birds, on the myriapods, scorpions, pedipalpi, peripatus, and the parasitic hymenoptera, have been published, and investigations on other groups of insects are now proceeding. Collections of various groups of cryptogams have also been made, are now being worked out, and are proving to comprise many new species. The committee propose to examine next the island of Margarita, the natural history of which is wholly unexplored. An important note on the discovery of *Diprotodon* remains in Australia, by Prof. Stirling, was read by Prof. Newton. The new material now found has added to our knowledge of the structure of this remarkable gigantic marsupial, especially in regard to its limbs and feet.

The presidential address (*see* NATURE, p. 490), in the absence of Canon Tristram from illness, was read in the afternoon by Sir William Flower; and the vote of thanks was proposed by Prof. Newton and Prof. Burdon Sanderson.

The section opened on Friday with a physiological discussion on the physico-chemical and vitalistic theories of life. The discussion was opened by Dr. J. S. Haldane, of Oxford, who, starting from the fact that about the middle of the century physical and chemical theories to explain the peculiar properties of living organisms were completely substituted for the traditional vitalistic theories, proceeded to inquire how far this substitution has been justified by the results of subsequent investigation. He argued that as evidence has accumulated the failure has become more and more manifest of the attempts to specify physical and chemical factors from which vital properties may be deduced. This argument he based on the facts relating to cell-formation, nutrition, heat-production, the secretion and absorption of solids, liquids, and gases, and to other physiological processes. He then endeavoured to show that the old vitalistic theories were not mere expressions of the negative fact that physiologists are face to face with a large residuum of unexplained facts, but constituted real working hypotheses, which summarised the peculiarities of living organisms, and indicated fruitful lines of inquiry. In conclusion he maintained that the former crude beliefs as to the existence of a material or immaterial "vital principle," formed no essential part of a vitalistic theory of life.

The Chairman (Mr. Langley), in inviting discussion, said that the problems of life had been thought to be physical and chemical questions, and the mistake had been that they had been thought to be easy questions. Possibly the fact was that the unexplained residue appertained to more complex chemistry and physics than we know at present.

Prof. Cleland said that the old vitalism was dead, but that there was a new vitalism which must be supported. To him there appeared to be something in life in addition to the mere laws of dead matter.

Prof. Burdon Sanderson said that the real change that took place about 1840 was not a change of doctrine but a change of method. It was then seen that the only way to investigate the phenomena of life was by processes which they understood, such as those of chemistry and physics. A great number of easy questions had since been settled, and the difficult ones appeared now all the greater because we had come nearer to them. Profs. Schäfer, Allen, Heger, Hartog, Bohr, and Dr. Waller also took part in the discussion. In his reply Dr. Haldane maintained that physiologists had always employed methods of observation based on physics and chemistry. The change at the middle of the century seemed to him to be a change in working hypotheses rather than in methods.

The Chairman, in closing the discussion, said that during the first half of the century there had been a lamentable absence of results, mainly owing to the fact that the whole process of research was governed by the vitalistic theory.

A paper by Dr. A. R. Wallace, on malformation from prenata influence on the mother, was illustrated by photographs of a remarkable case of a child born with an imperfect arm some months after the mother had been engaged in dressing the wound of a gamekeeper who had had his arm amputated.

In the afternoon the section divided into the two departments of Physiology and Zoology. In the former, the following papers were read:—(1) On the digestive ferments of a large Protozoon, by Prof. Marcus Hartog and Augustus E. Dixon. The authors experimented with about 2000 large individuals of *Pelomyxa palustris*, and found that the watery extract hydrolyses starch paste in a neutral solution, and converts the starch rapidly into erythro-dextrin, has no action on thymolised milk in two days, liquefies fibrin rapidly in presence of dilute acids, only attacks fibrin very slowly and partially in neutral solution, and indol and skatol are not formed. (2) On the effect of the stimulation of the vagus on disengagement of gases in the swim-bladder of fishes, by Dr. Christian Bohr (Copenhagen). This showed that the air secreted in the bladder is largely composed of oxygen. The paper was illustrated by tables showing the increase in the proportion of oxygen at stated times during the refilling of the bladder after puncture. (3) On a method of recording the heart sounds, by Prof. W. Einthoven. (4) On nerve stimulation, by Prof. F. Gotch. The author finds that with the induction current he obtained excitation of the nerve of a frog at a low temperature which disappeared at a higher temperature, while with the discharge of a condenser the result was the reverse of that. He also found a similar difference in action in regard to the passage of the impulse down the nerve in the two cases. Therefore he comes to the conclusion that the impulse started in the nerve is somewhat different in the two cases. (5) On fatigue of nerves, by Prof. Schäfer. (6) On Calorimetry, by Dr. A. Waller. This applied more particularly to the temperature difference of the body under varying conditions of the surrounding medium. (7) The report of the committee on the physiological action of the inhalation of oxygen in asphyxia. The results are as follows:—(1) In the case of asphyxiated rabbits, oxygen is of no greater service than air; (2) pure oxygen when inhaled by a healthy man for five minutes produces no effect on the respiration or pulse; (3) oxygen produces no effect upon a patient suffering from cardiac dyspnœa, either on respiration or on pulse; (4) an animal can be kept for a long time in a chamber containing 50 per cent. of carbonic acid without muscular collapse, provided a gentle strea n of air or oxygen be allowed to play upon the nostrils.

In the Zoological Department the following papers were read:—(1) Report of the committee appointed to explore the region of the Irish Sea lying around the Isle of Man. The committee have conducted eight dredging expeditions, most of them lasting for several days; about 1,000 species of marine animals have been collected and identified, of these thirty-eight are new records to the British fauna, 224 are new to the district, and seventeen are new to science. Prof. Herdman gave a general account of the expeditions and the results attained, while Mr. A. O. Walker, Mr. I. C. Thompson, Mr. Stebbing, and Prof. Brady gave more detailed accounts of special groups of Crustacea. (2) Report of the committee on a deep-sea townet. (3) On luminous organs in Cephalopoda, by W. E. Hoyle. These minute light-producing organs are scattered over the general integument in certain species. (4) On the origin of organic colour, by F. T. Mott. This was to show that the colours in going from stem to blossom indicate a decrease in the amount of light absorbed, and the author contends that the amount of reflected light increases as the plant attains maturity. (5) On the roots of *Lemna*, and the reversing of the fronds in *Lemna minor*, by Miss Nina F. Layard, who showed that in dry seasons, when the fronds dried up, the root-cap would act as a protector for the tender cells of the root. Miss Layard accounted for the observed reversal of the fronds as cases where a growth had covered the upper surface, and the fronds had revolved in order to expose a better surface to the air.

The section met on Saturday forenoon, when the following papers, chiefly botanical, were taken:—(1) Report of the committee on the legislative protection of wild birds' eggs. This was read by Dr. Vachell, and supported by Prof. Newton, who urged the necessity of making known to the schoolboy which birds' eggs ought to be protected. (2) On the ætiology and life-history of some vegetal galls and their inhabitants, by C. B. Rothera. The author traced out the life-history of certain typical galls, those of *Cynips kollari*, *Teras terminalis*, and *Biorhiza aptera* being specially dealt with. He gave a series of facts positive and negative, which point to the action of the embryo, and not to the deposit of a special virus by the parent *Cynips*, as the direct and necessary agent in the production of the gall. He therefore discards the hypothesis of a specific virus deposited by the parent, and attributes the genesis and metamorphoses of the gall to the activities of the living embryos combined with the normal forces of the plant. (3) Report of the Committee on the Botanical Laboratory at Peradeniya, Ceylon, where a good deal of the apparatus requires to be renewed. (4) On some new features of nuclear division, by Prof. J. B. Farmer. This paper, illustrated by microphotographs, included some new results of researches on the centrogomes and the behaviour of the achromatic spindle. (5) Variations of fecundity in *Trifolium pratense* and its varieties, and *Trifolium medium*, by W. Wilson. This paper detailed some observations made as to varieties of clover, contrasting them with hybrids as regards fertility. (6) Lime salts in relation to some physiological processes in the plant, by Dr. J. Clark. The action of lime salts may modify the effect of low temperatures in seed germination. The author had succeeded in finding a *Bacillus* which is capable of breaking up the calcium oxalate, which is at one time precipitated in the plant. (7) On the cortex of *Tmesipteris tannensis*, by R. J. Harvey Gibson. This gives an account of the histology of the cortex of the stem, with special reference to the origin and nature of the "brown deposit" seen in the cells.

On Monday a joint meeting with Section C was arranged, when a discussion on "Coral Reefs" was opened by Prof. W. J. Sollas, F.R.S.

Prof. Sollas said that the problem before the Sections was to explain the presence of large groups of atolls in the deep ocean, every atoll in some of the groups, save for the land piled up by the breakers, rising just up to the level of the sea. The two fundamental difficulties which had to be met were the existence of a submarine bank and the presence of a lagoon, which sometimes attained a depth of 60 fathoms or more. Volcanoes had once been supposed to furnish by their cones the bank, and by their craters the lagoons. Possibly some individual atolls might be explained in this way, but not whole groups. Chamisso, postulating a submarine bank, accounted for the lagoon by the fact that corals grow fastest in the wash of the surf. In this way a lagoon 9 or 10 fathoms in depth might be formed, and some of the Florida reefs might be so explained. Dr. Murray accounted for submarine banks by the precipitation of organic sediment on volcanic cones, and for the lagoon by an explanation similar to Chamisso's, which he supplemented by supposing that the central part of the shoal was removed by solution. There was, however, no evidence that lagoons were deepened by solution, and much opposed to it. Deposition, and not solution, occurred in the lagoon, and so long as an atoll remained stationary the lagoon tended to become filled up.

Darwin, instead of meeting each difficulty by a separate assumption, proposed a theory which, by a single assumption, in itself very probable, accounted for all the facts. One of the gravest objections to Darwin's view had been the apparent absence of coral reefs resembling atolls in ancient systems of rocks. That had been removed by the labours of geologists, who were able to point to atoll-like limestones, from 400 to 800 fathoms in thickness, in the Tyrol, the Eastern Alps, and elsewhere. Elevation had recently affected some existing atolls, as might naturally be expected in an unstable area. That fringing reefs, barrier reefs, and atolls should occur together in a single area proved, when the facts were examined in detail, to furnish a striking confirmation of the theory, since these different kinds of reefs were not confusedly intermingled, but arranged along lines which showed a progressive change from elevation at one end to subsidence at the other. The arrangement of atolls in linear series, curving in the Pacific, and straight in the Indian Ocean, was in accordance with the outlines of the surrounding continents, and pointed to deep-seated structure in the earth's crust. Most remarkable in connection with this was the fact that individual atolls were elongated in the same direction as the group of which they formed a part. This was readily explicable on Darwin's theory, but not by the supposition that the elongation was determined by oceanic currents, since these cut the atolls in various directions, not correlated with that of their longest diameter. Further, the areas in which subsidence had occurred were in many cases just those where geologists had reason for supposing that land had existed in secondary times. Particularly was this true of the Indian Ocean, across which, as Neumayer had shown, a great tract of land had probably extended in the Jurassic period.

Dr. Hickson (Section D) said that he agreed with Prof. Sollas in thinking that the Darwinian hypothesis was both clear and beautiful, but that that was about the only point in which he found himself in agreement with the opener of the debate. In his opinion it seemed to be quite possible that some barrier reefs and atolls had been formed during subsidence of the land but in the majority of cases there was very good evidence of recent elevation, and the Darwinian hypothesis would not hold good. Contrary to the statements that are usually made, the outer edge of the reef is seldom, if ever, precipitous, and the evidence tends to show that in most cases the reefs are growing seawards on the talus of their own *débris*. There is a great difference of opinion amongst geologists as to the origin of the Dolomites, and there is no evidence of any fossil coral reef more than a few hundred feet in thickness. In conclusion Dr. Hickson urged upon the combined Sections the importance of initiating some investigations upon the causes regulating the growth and destruction of living coral reefs.

Dr. Rothpletz (Munich) criticised the diagrams and explanation given by Prof. Sollas of the supposed coral reefs of the Dolomites. He did not consider them to be coral reefs.

Mr. Gilbert Bourne confined himself to a few criticisms of Prof. Sollas. It had been stated that reef-building corals flourished best where the breakers are heaviest on the edge of the reef. His own experience was that at these points only a few true corals grow, and that the gardens of coral described by Prof. Sollas were only to be found in quieter spots where the corals were sheltered from the force of the breakers, but bathed by a gentle and uniform current. Photographs of luxuriant coral-beds bore out this assertion. Nor did he agree with the statement that the rocks of which atolls were composed was formed by masses of coral flung over the edge of the reef by the waves. Dr. Guppy had shown that the large masses torn off at the edge of the reef tended rather to roll down the seaward face of the reef, and to form a talus slope. It had been said that soundings of lagoons invariably showed a filling-up and shallowing of the lagoon. On what evidence did this assertion rest? Probably no atoll had been so thoroughly surveyed as the one with which the speaker was personally acquainted, Diego Garcia. He had very carefully compared the soundings made by Captain Moresby in 1837 with those made by H.M.S. *Rambler* in 1885, and found that in every case the soundings were nearly identical, with the exception of a few channels in which, on the whole, the *Rambler* soundings showed greater depths. After referring to Semper's discovery, in the Pelew Islands, of atolls, barrier reefs, fringing reefs, and recent elevated reefs, all found in the same area, the speaker showed that the information just given by Prof. Rothpletz fully corroborated the assertions made over and over again by Murray and Agassiz, that the upward growth of submarine banks was largely due, not to coral growth, but to the accumulation of the calcareous skeletons of mollusca and echinoderms on those banks. Finally, he pointed out that while Prof. Sollas had revived the old theories of a Lemuria and an Atlantis, and had used the existence of the coral islands of the Indian Ocean as evidence of a previously existing continent, he had given no explanation of the fact that the tropical regions of the Atlantic Ocean, across which the old Atlantis was supposed to have stretched, are almost entirely destitute of coral formations.

Prof. Bonney replied to some of Dr. Hickson's criticisms. He cited Masamarhu as a case of a steep slope. He thought judgment on the Dolomites must be reserved. He asked, Was a growing reef ever found deeper than twenty-five fathoms? for that was a point of primary importance.

Sir H. Howorth confined himself to whether coral reefs are now in regions of upheaval or of subsidence. The Pacific islands consist of two regions, the Sandwich Islands, which are an old land surface, and the rest, which have very recently risen from the sea, and so are in an area of elevation, although atolls. This is fatal to Darwin's theory, which depends upon the correlation of reef-building and subsidence.

Mr. Stebbing pointed out that as the young coral animals might settle down on rising or sinking areas indifferently, so reefs might be begun on either, but that only those on an area of subsidence would be under favourable conditions for growth. He also stated that it could not be said that all naturalists who had recently lived on coral reefs were agreed, as Mr. Saville Kent endorsed Darwin's view.

Mr. H. O. Forbes stated that in the Keeling Islands in the Indian Ocean he had found undoubted evidence of elevation, both between two of the islets, and also in the constitution of Horsburgh Island, the largest of the group.

Prof. Sollas briefly replied, and adhered to his original contention.

Section D then took the following, chiefly zoological, papers:—(1) Report on work carried on at the Zoological Station, Naples, viz.—On the action of coloured light on assimilation, by C. C. Duncan, and on the function and correlation of the pallial organs of Opisthobranchiata, by J. D. F. Gilchrist. (2) Report on work carried on at the Biological Station, Plymouth, viz., on Turbellaria, by F. W. Gamble; on decapod larvæ, by E. J. Allen; and how fishes find food, by Gregg Wilson. (3) Report on the production of an index generum et specierum animalium. (4) On seals and whales seen during a voyage to the Antarctic, by W. S. Bruce. (5) On the penguins of the Antarctic, by C. Donald. (6) On the development of the molar teeth of the elephant, with remarks on dental series, by Prof. Cleland, who exhibited a specimen showing the sacular condition.

On Tuesday the remaining papers were taken, viz.:—(1) On cytological differences in homologous organs, by Prof. G. Gilson, dealt chiefly with differences in nephridia. (2) The lateral canal system of fishes, by W. E. Collinge, showing the modification effected by this system in the cranial elements and nervous system, and the evidence the sensory organs afford of the development of the higher sense organs. (3) On the ovipositor of the cockroach, by Prof. Denny. This shows that the ovipositor represents the eighth and ninth sterna, while the two pairs of gonapophyses are developed in connection with these sterna. (4) On a new butterfly, by Mrs. White. (5) On certain gregarinidæ, and the possible connection of allied forms with tissue changes in man, by Dr. C. H. Cattle and Dr. J. Millar. In this important paper the authors described the changes caused in the rabbit's liver by *Coccidium oviforme*, and compared them with the changes produced in glandular organs by cancer. The authors gave reasons for believing the bodies found in cancer to be parasites allied to *Coccidium*. (6) The wings of *Archæopteryx* and of other birds, by Dr. C. H. Hurst. The author regards the two large digits of a bird's wing as IV. and V. (7) The starch of the chlorophyll granule, and the chemical processes involved in its dissolution and translocation, by Horace T. Brown, F.R.S. The author gave an account of the work done by himself and Dr. Morris on the formation of starch and its dissipation. He showed that cane sugar was the first carbohydrate recognisable in the leaf, and that the starch, both in green and colourless parts of the plant, is formed from pre-existing carbohydrates. (8) On nuclear structures in the hymenomycetes, by H. Wazer. The author finds, in contradiction to Rozen's results, that during karyokinesis in hymenomycetes an achromatic spindle exists, and the process is nearly similar to what obtains in higher plants.

CONFERENCE OF DELEGATES OF CORRESPONDING SOCIETIES.

First Conference, September 14.

The Corresponding Societies' Committee was represented by Dr. Garson (in the chair), Mr. Topley, Mr. Symons, and Mr. T. V. Holmes (secretary).

Dr. Garson, the chairman, gave a hearty welcome to the delegates present. These conferences were begun at Aberdeen, in 1885. At that time only twenty-four delegates were appointed, while last year there were forty-two. The number of Corresponding Societies had also increased. This was evidence that the attempt to bring to a focus, as it were, the efforts of the various Corresponding Societies had met with considerable success. But there was also evidence that the societies did not always sufficiently value their privileges. When circulars were sent from the office of the British Association, the majority of the secretaries of the Corresponding Societies did not fill up and return them until they were written to a second time. Again, out of more than sixty societies, only forty-two thought it worth while to send delegates, though it could hardly be a difficult matter to find members able and willing to serve. It was a very great advantage to the workers in the various local societies to have the titles of their papers printed and published in the Annual Reports of the British Association. Then, the Transactions of the various Corresponding Societies were bound and kept for reference in the library of the British Association at Burlington House, while papers read before other local societies were likely to remain unknown or unconsulted. It was most desirable that the British Association should be brought into closer communication with the societies. It had been usual hitherto for representatives from the different Sections to attend the conferences and to mention anything that had been done, such as the appointment of a committee for some special purpose, in which the co-operation of the Corresponding Societies would be advantageous. It would be a good thing that there should be better means of communication between the Corresponding Societies and the secretaries of the various committees appointed by the British Association. A good example of a committee especially needing the assistance of the Corresponding Societies was that appointed by Section H to make an ethnographical survey of the United Kingdom. The first report of this committee had just been presented to the delegates, and Mr. Brabrook, the secretary, would shortly call their attention to it. At their last meeting at Edinburgh some delegates had asked whether the council of the Association might not be able to obtain greater facilities from the railway companies for members travelling to and from these meetings. The council, consequently, appointed a committee, of which Sir Frederick Bramwell was an active member, to see what could be done. The result, however, could not be deemed satisfactory.

The Chairman proposed to take the report, which had been circulated, as read, and would be glad to hear any remarks from delegates regarding the work done during the past year.

Meteorological Photography.—Mr. Symons (Section A) was much indebted to the delegates for the number of photographs of clouds sent in to him up to the present time. He did not press for more, as the committee appointed by the British Association for the Elucidation of Meteorological Phenomena by the application of photography had the very considerable collection of 1467 to deal with. They proposed to select the typical ones, reduce them to a uniform scale, and print perhaps 100 copies of them. They were hoping to publish the atlas during the year, and would then be glad if the meteorologists would take copies. They would be pleased to have additional photographs of lightning.

Mr. A. S. Reid said that the Geological Photograph Committee of the British Association were publishing their fourth report that year. During the year they had received more than 40 new photographs, making the total collection 846. They were all British. Their appeal to the Corresponding Societies had been more successful than in any previous year, but there was still much to be done, and he hoped the delegates would stir up their societies on this point. As to the best camera, the smallest was to be preferred. He had also to report that many prints had been sent in without the names of the societies sending them, that of the photographer, or that of the place photographed. They had decided not to lend any more photographs to the societies, and they would recommend the societies to send duplicate copies. Mr. Jeffs, the secretary of the Geological Photographs Committee, had unfortunately been ill during nearly the whole of the year, and this had seriously hampered their work.

Mr. P. F. Kendall remarked that not one of the Corresponding Societies had given any information to the British Association Committee appointed to record the character and position of Erratic Blocks, though appeals for help had been made. There were whole counties strewn with blocks of which not a single report had been sent.

Mr. Topley inquired whether any society had made researches like those brought before the Conference last year by Mr. Watts in the neighbourhood of Rochdale, as to the quantity of material brought down streams in flood.

Mr. Watts' work had been confined to the Rochdale district, and it was desirable that the results in other districts should be noted. Any local society wishing to do similar work should consult Mr. Watts.

Mr. Slater (Section D) said that it was an interesting fact that a member of the Yorkshire Naturalists' Union recently found the wild maidenhair fern on the northern portion of Morecambe Bay. It would not be desirable that the exact spot should be given. He would also remark that it was better to obtain seeds from these rare plants than to take the plant itself.

In Section E, Mr. M. H. Mills said that a paper on the subject of ordnance maps had been read before the Federated Institute of Mining Engineers by Sir Archibald Geikie, whose chief conclusion seemed to be that nothing could be done without increased funds.

Mr. Eli Sowerbutts said that their member, Mr. Cooke, went before the Departmental Committee, appointed to consider the state of the Ordnance Survey, in order to give evidence. He had suggested to Mr. Cooke that he should write a report on what had been done by the Departmental Committee, which might be presented at the next year's meeting of delegates. The examination on geography mentioned in the report of the Conference of Delegates at Edinburgh did not take place. They would, however, conduct some examinations next year, and he would be glad if the delegates would make their intentions widely known. It was a curious fact that there was no cheap book in existence giving a fairly good account of Yorkshire. The examinations were open to all public and private schools. There would be one on Canada for secondary schools. The latter had been found to know nothing about geography last year, and he looked for some improvement next time.

Mr. Hembry said that he had learned that in a certain county children attending schools were not taught geography in any way. He would like to know if this was the case anywhere else.

Mr. Andrews replied that geography was not a class subject, and was not compulsory. As regards the ordnance maps, the archæologists of Warwickshire, acting on the advice of Mr. Whitaker, forwarded a list of thirteen ancient works to the Ordnance Survey Office, Southampton, ten of which had since been inserted in the map.

Mr. Hembry thought that geography should certainly be a class subject. In secondary schools they absolutely ignored it; but he had been astonished to find that an immense advance had been made in the teaching of geography in primary schools. In many of the latter, museums of commercial products were now being formed.

In Section G, Prof. Merivale had nothing to report about flameless explosives.

Mr. Brabrook (Section H) made some remarks on the progress made by the committee appointed to make an ethnological survey of the United Kingdom, whose first report was in the hands of the delegates. The committee had, he said, obtained, by communication with the Corresponding Societies, a list of nearly 300 villages, with some account of their leading features and peculiarities, all of which were worthy of special examination by the committee. For this result, which was much beyond their anticipations, the Ethnographical Committee gave its most hearty thanks to the members of the corresponding societies who had helped them so efficiently. The next step taken by the committee had been to draw up a brief code of directions for the guidance of those who had been kind enough to offer assistance. This code would be found at the end of the report.

Second Conference, September 19.

The Corresponding Societies' Committee was represented by Dr. Garson (in the chair), Mr. Galton, Mr. Symons, and Mr. T. V. Holmes (secretary).

The Chairman announced that he had received a letter from the President of the Cardiff Natural History Society, stating that Dr. Vachell was unable to attend as a delegate, and that Prof. Viriamu Jones, Principal of University College, Cardiff, had been appointed in his place. He thought it would be best to take first any discussions upon the committees appointed in the various sections.

Mr. Symons (Section A) said that the work of the Earth Tremors Committee was going on under the care of Mr. Davidson, and he did not think that there were other committees connected with Section A that bore upon the work of the delegates. With regard to the report of the Earth-Tremors Committee, he should like to hold it in suspense for a while, in the hope of co-operation with some of the corresponding societies.

In Section C, Mr. A. S. Reid said he had been asked by the Committee to make some remarks. The Underground Waters Committee would present its final report next year, and would be glad to receive further information up to the date of publication. The Geological Photographs Committee thought that the size of photographs should be left to the donors. As to the best camera, further comments from practical photographers were invited; also remarks as to the best methods of printing. With regard to publication, negotiations respecting the proposed album of representative photographs were then in progress. The Erratic Blocks Committee had presented a report, and they were going to publish as much as they could as soon as possible. The Coast Erosion Committee had not sent in a report, though they had plenty of material in hand. The Committee on Type Specimens in Museums was making arrangements for the registration of those specimens, and information was required as to where those specimens were housed.

In Section D, Mr. T.V. Holmes (secretary) read a letter from Dr. Vachell stating that he had come to Nottingham in order to present the Report of the Birds' Eggs Protection Committee that morning, September 16, and regretted he should be unable to stay till the conference on the 19th.

Mr. Slater thought it was high time something was done to protect the eggs of wild birds. Influence might be brought to bear upon boys. He also deprecated the wanton shooting of gulls.

The Chairman stated that the committee had been re-appointed, and that the delegates would in due time receive a final communication on the question.

Mr. Holmes then read a letter from Mr. W. Cole, hon. sec. Essex Field Club, on the maintenance of local museums. Mr. Cole thought that if an annual sum for the maintenance of local museums could be obtained from the Technical Education grants in each county, there would be no great difficulty in obtaining substantial sums towards buildings and fittings. The fear that a museum might not be permanent often kept back subscriptions. Donations, both of money and of specimens, would rapidly come in when once the public felt that the museum would be permanent. And in no way could a portion of the Technical Education grant be better expended than in placing on a satisfactory footing the local museum of the county.

The Chairman hoped that members of the Corresponding Societies would occasionally read papers on the specimens in their local museums, each writer keeping to a certain department. These papers would be catalogued in the societies' list, and brought before the notice of many workers in the same subject elsewhere. They would also be available for reference at headquarters in London.

In Section H, the Chairman commended the Ethnographical Survey (the first report of which had been placed in their hands at the previous meeting) to the attention of the delegates and the societies they represented, and explained in what ways they could assist the committee. Local physical, intellectual and moral characteristics, folk-lore, manners, customs, dialect, and ancient monuments might all be noted by various observers, and the results sent to the Ethnographical Committee. Ancient human remains should be carefully preserved, together with any pottery and implements found with them. If any difficulty occurred with regard to the best mode of making any exploration, information might always be obtained at the Anthropological Institute, 3, Hanover Square, London. In some cases he had known pottery and implements had been carefully preserved, and bones thrown away or buried; in others skulls had been kept by the explorer, and the large bones thrown away. The Anthropological Institute was always ready to advise or to send some one down to examine the remains found. It was better to leave barrows, &c., as they were, unless people were prepared to examine them thoroughly and systematically.

After some remarks on a proposed excursion of the delegates, a vote of thanks to the chairman closed the proceedings.

THE GEOLOGICAL SOCIETY OF AMERICA.

THE fifth summer meeting of the Geological Society of America was held at Madison, Wisconsin, on August 15 and 16; vice-presidents J. C. Chamberlain and John J. Stevenson presiding, in the absence of the president, Sir J. W. Dawson.

The popular feature of the meeting was an illustrated lecture in the Assembly Chamber of the Capitol, by Prof. H. F. Reid, on "The Gravels of Glacier Bay, Alaska." The stereopticon views gave quite the best exhibit of this interesting glacial region that has yet been presented.

The papers presented included a description of a new species of *Dinichthys*, a new *Cladodus* from the Cleveland shale, and a remarkable fossil jaw from the Cleveland shale, by Prof. E. W. Claypole, who is carrying on the work begun by the late Prof. J. S. Newberry on Devonian fossil fishes. The remains described are those of new and remarkable species, one of them showing a degree of specialisation quite surprising for that low horizon. The author even surmised that some of the remains may be amphibian.

Prof. J. J. Stevenson, in his paper on the origin of the Pennsylvania anthracite, seemed to have actually subverted the accepted dogma, that the metamorphosis into anthracite was caused by disturbances of the strata. He showed that the difference between anthracite and bituminous beds is due to circumstances connected with deposition; the former having been laid down rapidly and in thick beds, and having been long under water; they are also earlier than the bituminous beds.

G. Frederick Wright and A. Frederick Wright, in their respective papers on extra-morainic drift in New Jersey, and on the limits of the glaciated area of New Jersey, admitted the correctness of Prof. Salisbury's first announcement that these were genuine glacial deposits, though occurring beyond the limits of the glaciated area.

Edward H. Williams, Jun., in a paper on South Mountain glaciation, described a similar formation in Pennsylvania, where he found transported Medina sandstone and glacial striation.

The programme also included papers on the study of fossil plants, by J. W. Dawson; the Manganese series of the North-Western States, by C. W. Hall and F. W. Lardeson; on the succession in the Marquette Iron district of Michigan, by C. R. Van Hise; terrestrial subsidence south-east of the American Continent, by J. W. Spencer; evidences of the derivation of the kames, eskers, and moraines of the North American ice-sheet, chiefly from its englacial drift, and the succession of pleistocene formations in the Mississippi and Nielson River basins, by Warren Upham; the cenozoic history of Eastern Virginia and Maryland, by N. H. Darton; the Arkansas coal measures in their relation to the Pacific carboniferous province, by James P. Smith; glaciation of the White Mountains, N. H., by C. H. Hitchcock; dislocation in the strata of the lead and zinc region of Wisconsin, and their relation to the mineral deposits, with some observations upon the origin of the ores, by W. P. Blake; geology of the sand hill region in the Carolinas, by J. H. Holmes; notes of geological exhibits at the World's Fair, by G. N. Williams.

BLEEDING BREAD.

THE phenomenon known in Germany as "Blut im Brode," and to us as bleeding bread, has appeared in this country, to no little dismay of the peaceful inhabitants. The subjects of this visitation are not only bread and biscuit, but also boiled potatoes, rice, and other farinaceous substances, on which red stains appear, which resemble blotches of blood. In former times, before their nature was known, these blood stains created much consternation amongst the superstitious as portents of calamity. The first modern naturalist who described it in scientific terms was Dr. Sette, of Venice, who recorded its appearance in Padua, in 1819, and gave it the name of *Zoögalactina imetropha*. In this instance it is stated that "a peasant of Liguara, near Padua, was terrified by the sight of blood stains scattered over some polenta, which had been made and shut up in a cupboard on the previous evening. Next day similar patches appeared on the bread, meat, and other articles of food in the same cupboard. It was naturally regarded as a miracle and warning from heaven, until the case had been submitted to a Paduan naturalist, who easily recognised the presence of a microscopic plant."[1] Subsequently Ehrenberg saw the same production near Berlin, in 1848, and, as usual with him under like circumstances, referred it to the animal kingdom, under the name of *Monas prodigiosa*; but during the same year it occurred in the experience of Dr. Camille Montagne, who saw it on cooked fowls and cauliflower, at Rouen, and it was regarded as an Algoid, under the name of *Palmella prodigiosa*. The first definite record of its occurrence in Britain appears to have been in 1853, when H. O. Stephens communicated an account of it to the Bristol Microscopical Society, and submitted specimens to the late Rev. M. J. Berkeley, who declared it to be identical with the organisms described by Ehrenberg and Montagne, but which he regarded as a fungus.

The record of its appearance at Bristol is to the following

[1] Trouessart, "Microbes, &c." London, 1889, p. 126.

effect[1]:—"I observed at table the under surface of a half round of boiled salt beef, cooked the day before, to be specked with several bright carmine-coloured spots, as if the dish in which the meat was placed had contained minute portions of red currant jelly. Suspecting what these might turn out to be, I directed the beef to be placed aside. On examination the next day the spots had spread into patches of a vivid carmine-red stratum of two or more inches in length. With a simple lens the plant appears to consist of a gelatinous substratum of a paler red, bearing an upper layer of a vivid red hue, having an uneven or papillated surface. The microscope shows this stratum to consist of generally globose cells, immersed in, or connected by, mucilaginous or gelatinous matter. The cells vary in size, and contain red endochrome; they seem to consist of a single cell-membrane, and contain a nucleus. Treated with sulpho-iodine they become blue."

As to its place in the organic kingdom, Mr. Stephens was of opinion that it was a *Palmella* closely allied to *Palmella cruenta*, but distinct, the cells or granules of the latter differing from it, not only in their colour but size, being very much smaller than those of *P. prodigiosa*. As to its propagation, he further remarks that it seems to extend itself by elastically spurting a sort of jet or column of red particles, which Berkeley compared to a jet of blood from an artery, and by this method it was suggested that the extraordinary rapidity with which a large surface becomes covered can be explained. The vitality of the cells is not impaired (within a certain time) by desiccation, even at a high temperature, and when dry they retain their germinating powers for a considerable period.

The spherical cells are filled with a reddish oil, which gives to them a peach-blossom tint, and when transferred to raw meat they assume a splendid fuchsia-colour, resembling spots of blood. The plant is only developed in the dark, and the nitrogen necessary for its nutriment must be derived from the air, especially when developed upon bread. About 1886 an epidemic appearance on the Continent was attributed to this source. Pieces of cooked meat presented a singular carmine-red colouration, and stained vividly the fingers or linen with which they came in contact. These phenomena prevailed regularly for a period of three months. Food cooked over-night was found the next morning covered with red patches, and it then underwent rapid alteration. Coincident with a sudden and considerable fall in the temperature the epidemic ceased, and did not reappear.[2]

Fresenius records the result of his examination of this organism, in his "Beitrage," to the effect that "he took four boiled potatoes, and placed them in a drawer, having previously rubbed two of them slightly here and there with the red substance. After about twenty-four hours, the two potatoes which had not been rubbed, and which had not been in immediate contact with the other two, were affected with fresh spots of the red substance, whilst the spots upon the two which had been rubbed had increased in extent. The spots showed themselves in the form of irregular groups of blood-red drops of different size, which in some places were distinct, and in others had run into one another. The individual bodies of which the spots consist are mere molecules, their diameter varying from one two-thousandth to one four-thousandth of a line. They are mostly round, occasionally oval, and sometimes slightly constructed in the middle, by way of preparation for increase by division into two small round cells. By far the greater number of them, when brought under the microscope in a drop of water, remain at rest—they lie close together in large numbers; when they are more dispersed in the fluid they have a motion which is not distinguishable from ordinary molecular motion. When the drop of water moves they are carried mechanically over the stage like other molecules, and when this motion ceases they remain at one spot in a sort of quivering state until a fresh current carries them in another direction. If the eye be kept carefully upon a part of the stage where the small bodies are thinly dispersed, it will be observed that they passively follow the current of the water, nor, when the current has become sluggish, or has even altogether ceased, are individual bodies ever seen to detach themselves from the group, and take a contrary direction, which real monads would do with great activity."

The present determination of this organism, according to some, is *Micrococcus prodigiosus*, but according to others it is *Bacillus prodigiosus*, and consequently one of the *Schizomycetes*. It has been pointed out that as the temperature rises this *Bacillus* loses its power of forming a pigment, and if it is grown on potato or bread-paste, in an incubator at blood heat, instead of at the temperature of the room, the colour is gradually lost, and the culture no longer smells of herring brine, but the power of forming lactic acid from milk-sugar, with the accompanying precipitation of the casein, is frequently considerably increased; so that it would appear that the energy required for the building-up of the pigment substance was, in this case, diverted into another channel, and lactic acid, and perhaps other substances, are produced in place of the usual pigment.[1]

The reappearance of this organism in this country, during the late hot weather, and especially on cooked potatoes, gives interest to its history, and is sufficient apology for these observations.

M. C. COOKE.

[1] H. O. Stephens, on *Palmella prodigiosa* in *Annals of Nat. Hist.* vol. xii. December, 1853.

[2] *Pharmaceutical Journal*, January 29, 1887, p. 610.

[1] Dr. G. S. Woodhead, "Bacteria and their Products" (1891), p. 9.

FORTHCOMING SCIENTIFIC BOOKS.

THE autumn publishing season has opened with announcements of forthcoming books to suit all requirements. From this year's list we see that many works of high scientific importance are in the press, but the chief feature is the large number of text-books announced. The work of the Technical Instruction Committees of our County Councils has naturally resulted in the preparation of books on various arts and handicrafts, and since the authors of these books are usually well versed in the technicalities of their subjects, it may be presumed that the 'prentice hand will derive benefit from their literary efforts.

The following books are announced by Messrs. MACMILLAN AND CO:—The Collected Works of Thomas Henry Huxley, F.R.S., in monthly volumes, from October 1. Vol. i. "Methods and Results" (just published); vol. ii. "Darwiniana"; Vol. iii. "Science and Education"; vol. iv. "Science and Hebrew Tradition"; vol. v. "Science and Christian Tradition"; Vol. vi. "Hume." "Systematic Survey of the Organic Matters," by Drs. G. Schultz and P. Julius, translated and edited, with extensive additions, by Arthur G. Green, Examiner in Coal Tar Products to the City and Guilds of London Institute. "Text-Book of the Diseases of Trees," by Prof. R. Hartig, translated by Dr. R. Somerville, Lecturer on Agriculture at Durham College of Science, with a preface by Prof. H. Marshall Ward, F.R.S., with numerous illustrations. "Methods of Histological Research," for the use of students and physicians, by Dr. C. V. Kahlden, Lecturer in the University of Freiburg, translated by H. Morley Fletcher. "Materials for the Study of Variation in Animals." Part i. "Discontinuous Variation," by William Bateson, Balfour Student and Fellow of St. John's College, Cambridge, illustrated. "Handbook of British Marine Fauna," vol. i. Tunicata, Polyzoa, and Echinodermata, by Prof. W. A. Herdman, F.R.S., with numerous illustrations. "The Romance of the Insect World," by Miss L. N. Badenoch, with illustrations. "A Text-Book of Pathology," systematic and practical, by Prof. D. J. Hamilton, vol. ii. "Handbook of Public Health and Demography," by Edward F. Willoughby, Diploma in State Medicine of the London University, and in Public Health of Cambridge University. "The Practitioner," an index to vols. 1–50 of the *Practitioner*, a journal of therapeutics and public health. The three following volumes have been designed to suit the requirements of the examinations of the Department of Science and Art:—"Organic Chemistry for Beginners," by Dr. G. S. Turpin; "Physiography for Beginners," by J. E. Marr, F.R.S., and Alfred Harker, M.A.; "Physiology for Beginners," by Prof. Michael Foster, F.R.S., and Dr. L. E. Shore. "Geometrical Conic Sections," by Charles Smith. "Geometrical Conic Sections," by Asutosh Mukhopadhyay, Fellow of the University of Calcutta. "Geometrical Conics," Part ii., the Central Conic, by John J. Milne and R. F. Davies. "Elementary Trigonometry," by H. S. Hall, Master of the Army Class, Clifton College, and S. R. Knight. "Sketches in Sport and Natural History," by the late Dr. George Kingsley; "The Beauties of Nature," by the Right Hon. Sir John Lubbock, Bart., F.R.S., new edition without illustrations; "The Theory of Heat," by Thomas Preston, with illustrations; "Researches on the Propagation of Electrical Force," by Prof. Heinrich Hertz, of Bonn, authorised translation by Prof. D. E. Jones, with preface by Lord Kelvin, P.R.S., illustrated; "A Text-book on Electro-Magnetism and the Construction of Dynamos," by Dugald C. Jackson, Professor of Electrical Engineering, University of Wisconsin; "The Mechanics of Hoisting Machinery, including Accumulators, Excavators, and Pile Drivers," by Dr. Julius Weisbach and Prof. Gustav Hermann, with 177 illustrations, authorised translation from the second German edition, by Karl P. Dahlstrom, Instructor in Mechanical Engineering at the Lehigh University; "Hydrostatics," by A. G. Greenhill, F.R.S., Professor of Mathematics to the Senior Class of Artillery Officers, Woolwich; "Essays in Historical Chemistry," by Prof. T. E. Thorpe, F.R.S.; "The Rise and Development of Organic Chemistry," by the late C. Schorlemmer, F.R.S., translated and edited by Prof. Smithells, Yorkshire College, Leeds; "Popular Lectures and Addresses," Vol. ii., contributions to Geology, by Lord Kelvin, P.R.S.; "The Life of Sir A. C. Ramsay," by Sir Archibald Geikie, F.R.S.; "A Text-book of the Physiological Chemistry of the Animal Body, including an Account of the Chemical Changes occurring in Disease," by Dr. Arthur Gamgee, F.R.S., Brackenbury Professor of Physiology in the Owens College, with illustrations, Vol. ii.; "Boot and Shoe Manufacture," by C. W. B. Burdett, Head Master City and Guilds of London Leather Trade Schools, with numerous illustrations; "Lead Work," by W. R. Lethaby, with illustrations; "Gold-Milling," with illustrations, by H. Louis; "Elementary Course of Practical Science," by Hugh Gordon.

The CAMBRIDGE UNIVERSITY PRESS announce:—"The Scientific Papers of John Couch Adams," Vol. i., edited by Dr. William Grylls Adams, F.R.S., &c., Professor of Natural Philosophy in King's College, London, late Fellow of St. John's College, Cambridge, with a memoir by Dr. J. W. L. Glaisher, F.R.S., &c., Fellow of Trinity College, Cambridge; "A Treatise on Spherical Astronomy," by Sir Robert S. Ball, F.R.S., Lowndean Professor of Astronomy and Geometry; "A Treatise on the Theory of Functions of a Complex Variable," by Dr. A. R. Forsyth, F.R.S., Fellow of Trinity College, Cambridge; "Plane Trigonometry," by S. L. Loney, Part i., up to and including the Solution of Triangles, is published separately; "Solutions of the Examples in a Treatise on the Elements of Statics and Dynamics," by S. L. Loney, late Fellow of Sidney Sussex College, Cambridge: "Elementary Hydrostatics," by John Greaves, Fellow and Lecturer of Christ's College; "The Steam Engine and other Heat Engines," by J. A. Ewing, F.R.S., Professor of Mechanism and Applied Mechanics in the University of Cambridge; "Elementary Palæontology for Geological Students," by Henry Woods; "Practical Physiology of Plants," by F. Darwin and E. H. Acton. Pitt Press Mathematical Series:—"Euclid's Elements of Geometry," Books v. and vi., by H. M. Taylor, Fellow and formerly Tutor of Trinity College, Cambridge; "Solutions to the Exercises in Euclid," Books i.-iv. (Pitt Press Mathematical Series, by H. M. Taylor), by W. W. Taylor. The Cambridge University Press are also about to publish a series of Natural Science Manuals, which will cover a wide field, some of the books being adapted for beginners, whilst others will deal with special topics, and will be useful only to more advanced students. The series will be divided into two sections, a Biological and a Physical. The former will be published under the general editorship of Mr. Arthur E. Shipley, Fellow and Tutor of Christ's College, Cambridge; it will include "A Manual of Invertebrate Palæontology," by Mr. H. Woods, Demonstrator of Palæobotany at Cambridge, which is now ready; "A Text-book on the Practical Physiology of Plants," by Mr. Francis Darwin, of Christ's College, and Mr. E. Hamilton Acton, of St. John's College, which is in the press; "Works on Physical Anthropology," by Prof. Alexander Macalister; "On the Vertebrate Skeleton," by Mr. S. H. Reynolds, of Trinity College; "On Fossil Plants," by Mr. A. C. Seward, Lecturer in Botany in the University, and "An Introduction to the Study of Botany," by Mr. Francis Darwin, which are in preparation. Other volumes will shortly be announced. The volumes of the Physical Series already arranged for include three by Mr. R. T. Glazebrook, F.R.S., Assistant-Director of the Cavendish Laboratory, on "Light and Heat," "Electricity and Magnetism," and "Mechanics and Hydrostatics"; these will be elementary text-books, based on the Practical Courses of Physics for Medical Students at the Cavendish Laboratory. The volume on "Light and Heat" is in the press, and the other volumes are in preparation.

Messrs. CHARLES GRIFFIN AND CO.'s announcements include:—"A Text-book of Ore and Stone Mining for the Use of Mine-owners, Mine-managers, Prospectors, and all interested in Ore and Stone Mining," by Dr. Clement Le Neve Foster, F.R.S., Professor of Mining, Royal College of Science, H.M. Inspector of Mines; a new Metallurgical series, edited by W. C. Roberts-Austen, C.B., F.R.S., Chemist and Assayer of the Royal Mint, Professor of Metallurgy in the Royal College of Science. (1) "Introduction to the Study of Metallurgy," by the Editor; third edition. (2) "Gold (The Metallurgy of)," by Thos. Kirke Rose; (3) "Copper (The Metallurgy of)," by Thos. Gibb; (4) "Iron and Steel (The Metallurgy of)," by Thos. Turner; (5) "Metallurgical Machinery: the Application of Engineering to Metallurgical Problems," by Henry Charles Jenkins; (6) "Alloys," by the Editor. Technological Manuals: "Oils, Fats, Waxes, and Allied Materials, and the Manufacture therefrom of Candles, Soaps, and other Products," by Dr. C. R. Alder Wright, F.R.S.; "Agricultural Chemistry and Analysis: A Practical Handbook for the Use of Agricultural Students," by Dr. J. M. H. Munro, Professor of Chemistry, Downton College of Agriculture; "Dairy Chemistry: A Practical Handbook for Dairy Managers," by H. Droop Richmond; "Cements: A Practical Handbook on their Manufacture, Properties, Testing," &c., by Gilbert R. Redgrave; "Petroleum: A Treatise on the Geographical Distribution, Geological Occurrence, Chemistry, Production, and Refining of Petroleum; its Testing, Transport, and Storage; and the Legislative Enactments relating thereto; together with a Description of the Shale Oil Industry," by Boverton Redwood, assisted by Geo. T. Holloway. With maps and illustrations. The special features of Mr. Redwood's work will be (1) the hitherto unpublished descriptions of undeveloped sources of petroleum in various parts of the world; and (2) that the testing, transport, and storage from the point of view of legislation, and the precautions which experience in this and other countries has shown to be necessary in the interests of public safety. "A Text-book of Physics: including Properties of Matter, Heat, Sound and Light, Magnetism and Electricity," by Dr. J. H. Poynting, F.R.S., late Fell. of Trinity Coll., Cambridge; Prof. of Physics in the Mason Coll., Birmingham, and J. J. Thomson, F.R.S., Fell. of Trinity Coll., Cambridge; Prof. of Exper. Physics in the Univer. of Camb.; "The Mean Density of the Earth: An Essay to which the Adams Prize was adjudged in 1893 in the University of Cambridge," by Dr. J. H. Poynting, F.R.S., in large 8vo, with bibliography, illustrations in the text, and lithographed plates; "Marine Engineering Rules and Tables (A Pocket-book of): for the use of Marine Engineers, Naval Architects, Designers, Draughtsmen, Superintendents, and all engaged in the design and construction of Marine Machinery, Naval and Mercantile," by A. E. Seaton and H. M. Rounthwaite, with illustrations; "Gas, Oil, and Air Engines: A Practical Text-book on Internal Combustion Motors without Boiler," by Bryan Donkin, with illustrations; "Sewage Disposal Works," by W. Santo Crimp. Second edition, with additional plates; "Engineering Drawing and Design: A Practical Manual for Engineering Students," by Sidney H. Wells, Principal, Battersea Polytechnic Institute, late of Dulwich College. Part I.—Geometry: Practical, Plane, and Solid. Part II.—Machine and Engine Drawing and Design. Complete in one vol., with numerous illustrations and folding-plate; "Applied Mechanics (An Advanced Text-book of)," by Prof. Jamieson, Glasgow and West of Scotland Technical College, with very numerous illustrations.

Messrs. SWAN, SONNENSCHEIN AND CO.'s forthcoming works are chiefly text-books. We note:—"A Student's Text-book on Botany," by Dr. Sidney H. Vines, Professor of Botany in the University of Oxford, editor of "Prantl's Botany," copiously illustrated; "Text-book of Embryology, Invertebrates," by Drs. Korschelt and Heider, of the University of Berlin, translated and edited by Dr. E. L. Mark, Professor of Anatomy in Harvard University, and Dr. W. M. Woodworth, Instructor in Microscopical Anatomy in Harvard University, Part I., illustrated; "The Cell, its Anatomy and Physiology," by Dr. Oscar Hertwig, of the University of Berlin, translated and edited by Dr. H. J. Campbell, illustrated; "Text-book of Palæontology for Zoological Students," by Theodore T. Groom, illustrated; "Lectures on Human and Animal Psychology," by Wilhelm Wundt, Professor of Philosophy in the University of Leipzig, translated and edited by James Edward Creighton, Instructor in Philosophy to the Cornell University, Ithaca, New York, and Edward Bradford Titchener, of the Cornell University; "Handbook of Systematic Botany," by Dr. E. Warming, Professor of Botany in the University of Stockholm, translated and edited by M. C. Potter, M.A., Lecturer on Biology and Botany in the Durham College of Science, illustrated; "Town Flowers," by J. W. N., with a preface by Canon Benham and Prebendary Webb-Peploe; "Zoology," by B. Lindsay, illustrated; "Fishes," by the Rev. H. A. Macpherson; "Flowering Plants," by James Britten, editor of the *Journal of Botany*; "Grasses," by W. Hutchinson; "Mammalia," by the Rev. H. A. Macpherson; "The Natural History and Antiquities of Selborne," by Gilbert White, Bennett's edition, with notes by J. E. Harting, illustrations by Bewick, Harvey, &c., new edition.

Messrs. CROSBY LOCKWOOD AND SONS have in preparation and in the press.—"Machinery for Metalliferous Mines: a Practical Treatise for Mining Engineers, Metallurgists, and Managers of Mines," by E. Henry Davies (illustrated); "The Practical Engineer's Year-book for 1894, comprising Modern Engineering Formulæ, Rules, Tables, and Memoranda, in Civil, Mechanical, Electrical, Marine, and Mine Engineering," by H. R. Kempe; "Practical Building Construction: a Handbook for Students Preparing for the Examinations of the Science and Art Department, the Royal Institute of British Architects, the Surveyors' Institution, &c., designed also as a Book of Reference for Persons engaged in Building" (1000 illustrations), by John Parnell Allen; "Concrete: Its Nature and Uses: a Book for Architects, Builders, and Clerks of Works" (with numerous illustrations), by George L. Sutcliffe; "Tramways: Their Construction and Working, embracing a Comprehensive History of the System; with an exhaustive Analysis of the various Modes of Traction, a description of Rolling Stock, and details of Cost and Working Expenses" (with plates and other illustrations), by D. K. Clark. new edition, in one volume, rewritten and revised; New Volumes of Hasluck's Series of "Handybooks for Handicrafts," viz.: "The Woodworker's Handybook: a Practical Manual on the Tools, Materials, Appliances and Processes employed in Woodworking" (with 100 illustrations); "The Metalworker's Handybook: a Practical Manual for use in Technical Classes and Workshops" (with 100 illustrations); "Wall Paper Decoration" (with numerous illustrations), by A. S. Jennings; "An Astronomical Glossary; or Dictionary of Terms used in Astronomy, with Tables of Data and Lists of Remarkable and Interesting Celestial Objects," by J. Ellard Gore.

Messrs. CASSELL AND CO. promise the following books:—"The Story of the Sun," by Sir Robert S. Ball, F.R.S., Lowndean Professor of Astronomy in the University of Cambridge, about 380 pages, with 8 coloured plates and other illustrations; "The Story of our Planet," by T. G. Bonney, F.R.S., Professor of Geology in University College, London, Fellow of St. John's College, Cambridge, with 6 coloured plates and maps and about 100 illustrations; "The Dawn of Astronomy, a Study of the Astronomy and Temple Worship of the Ancient Egyptians," by J. Norman Lockyer, F.R.S.; "Our Railways, their Development, Enterprise, Incident, and Romance," by John Pendleton, illustrated; "Electricity in the Service of Man, a Popular and Practical Treatise on the Applications of Electricity in Modern Life," with nearly 850 illustrations, new edition, revised by Dr. R. Mullineux Walmsley; "Cassell's New Technical Educator," an entirely new Cyclopædia of Technical Education," with coloured plates and engravings, Vol. ii.; "The Book of the Horse," by S. Sidney, thoroughly revised and brought up to date by James Sinclair and W. C. A. Blew, with 17 full-page collotype plates of celebrated horses of the day, specially produced for this edition, and numerous other illustrations.

The following are included in Messrs. GEORGE PHILIP AND SON's list of forthcoming publications:—"The Mineral Resources of Western Australia, with full descriptions of the Goldfields," by Alfred F. Calvert; "Philips' Anatomical Model," a Pictorial Representation of the Human Frame and its Organs by means of superimposed Plates printed in colours, with descriptive text by Dr. Schmidt, English edition by William S. Furneaux; "Philips' Geological Map of the Environs of London, extending about twenty miles round Charing Cross, showing the Nature of the Soil and the Elevation of the Land," by George Philip (scale, one inch to a mile); "Lessons on Woodwork for Evening Classes, comprising Exercises in the Principles of Joinery, and Studies and Designs for Wood-Carving," with numerous illustrations and explanatory letter-press; published under the direction of the Technical Education of the Hants County Council.

In addition to a number of books of travel, Messrs. SAMPSON LOW, MARSTON AND CO.'s publications will be:—"A History of Scandinavian Fishes," described by B. Fries, C. Y. Ekström, and C. Sundevall, with coloured plates painted from living specimens, and engraved on stone by Wilhelm von Wright, besides numerous text illustrations, second edition, thoroughly revised and completed by Prof. F. A. Smitt; "A School Course in Heat," revised and enlarged, by W. Larden, Assistant Master in the R.N.E. College, Devonport, late Science Scholar, Merton College, Oxford, numerous illustrations, fifth edition; "Chemistry for Beginners," adapted for Elementary Stage of the Science and Art Department's Examinations in Organic Chemistry, by R. L. Taylor, fifth edition, thoroughly revised and partly rewritten.

Messrs. CHAPMAN AND HALL have in hand:—"About Orchids: a Chat," by Frederick Boyle, with numerous illustrations; a book by Mr. Charles Dixon, entitled "Jottings about Birds"; "Woodworking Positions," by W. Nelson, with twelve illustrations by Herbert Cole; "A Text-book of Mechanical Engineering," by Wilfrid J. Lineham, Head of the Engineering Department at the Goldsmiths' Company's Institute, New Cross, late Professor of Engineering at the School of Science and Art and Technical College, Newcastle-on-Tyne; "Illustrations of the Principal Natural Orders of the Vegetable Kingdom," prepared for the Science and Art Department, by Dr. D. Oliver, F.R.S., with 109 plates by W. H. Fitch; "Food, some Account of its Sources, Constituents, and Uses," by A. H. Church, F.R.S., Professor of Chemistry in the Royal Academy of Arts in London, new edition, revised.

The following works will be published by Mr. YOUNG J. PENTLAND:—"Atlas of Diseases of the Skin, in a Series of Coloured Illustrations from Original Drawings, with Descriptive Letterpress," by Dr. H. Radcliffe Crocker; "Manual of Practical Anatomy," by Dr. D. J. Cunningham, Professor of Anatomy and Surgery, Trinity College, Dublin; "Hygiene and Diseases of Warm Climates, in a Series of Articles by Eminent Authorities," edited by Dr. Andrew Davidson, author of "Geographical Pathology," illustrated; "Beri-Beri, Researches concerning its Nature and Cause, and the Means of its Arrest," by C. A. Pekelharing, Professor in the Faculty of Medicine, University of Utrecht, and C. Winkler, Lecturer in the University of Utrecht, translated by James Cantlie; "Atlas of Ophthalmoscopy, a Series of Coloured Plates from Original Drawings, with Text," by W. Adams Frost.

Mr. W. B. CLIVE (University Correspondence Press) will publish:—"Elementary Qualitative Analysis," by William Briggs and Dr. R. W. Stewart; "An Elementary Text-book of Geometrical Conics," by G. H. Bryan; "Geometrical Deductions," by T. W. Edmondson; "Geometry of the Simpler Figures and the Plane, Euclid VI. and XI.," by C. W. C. Barlow; "An Elementary Text-book of Hydrostatics," by William Briggs and G. H. Bryan; "Examples in Magnetism and Electricity," by C. H. Dibb; "An Elementary Text-book of Mechanics," by William Briggs and G. H. Bryan; "The Elements of Trigonometry," by William Briggs and G. H. Bryan; "Co-ordinate Geometry, Part II.," by G. H. Bryan.

In Mr. MURRAY'S list of forthcoming books we find:—"The Life of Prof. Owen, based on his Correspondence, his Diaries, and those of his Wife," by his grandson, the Rev. Richard Owen, with portraits and illustrations. 2 vols. "A Manual of Naval Architecture, for the Use of Officers of the Navy and Mercantile Marine, Ship-owners, Ship-builders, and Yachtsmen," by W. H. White, C.B., F.R.S., Assistant-Controller and Director of Naval Construction, Royal Navy. Third edition thoroughly revised and in great part rewritten, with 150 illustrations.

The announcements of the CLARENDON PRESS include "Mathematical Papers of the late Henry F. S. Smith," Savilian Professor of Geometry in the University of Oxford, with portrait and memoir, 2 vols.; "A Manual of Crystallography," by M. H. N. Story-Maskelyne, F.R.S.; "Observations on some Points connected with Hospital Construction," by Sir Douglas Galton, K.C.B. F.R.S.; "A Monograph on the Oligochæta," by Frank E. Beddard, F.R.S.; "Adler's Alternating Generations, a Biological Study of Oakgalls and Gallflies," authorised translation, by C. R. Straton.

Messrs. Longmans, Green and Co. have in preparation:—"Agricultural Analysis, a Manual of Quantitative Analysis for Students of Agriculture," by Frank T. Addyman; "The Outdoor World, or the Young Collector's Handbook," by W. Furneaux, with 546 illustrations, including 16 coloured plates; "Eskimo Life," by Fridtjof Nansen, author of "The First Crossing of Greenland," translated by William Archer, with illustrations.

Camille Flammarion's "Popular Astronomy" is being translated by Mr. J. Ellard Gore, and will be published by Messrs. Chatto and Windus. This firm will also publish "The Sagacity and Morality of Plants: a Sketch of the Life and Conduct of the Vegetable Kingdom," with coloured frontispiece and 100 illustrations; "Our Common British Fossils, and Where to Find Them, a Handbook for Students," with 331 illustrations; "The Playtime Naturalist," with 366 illustrations.

The volumes on scientific subjects announced by Messrs. Rivington, Percival and Co. are:—"The School Euclid," by Mr. Daniel Brent; "The Beginner's Text-Books of Science": "Chemistry," and "Heat," by Mr. G. Stallard; "Geology" and "Physical Geography," by Mr. C. L. Barnes; "Electricity and Magnetism" and "Mechanics (Treated Experimentally)," by Mr. L. Cumming; "Light," by Mr. H. P. Highton; "Practical Physics," in three parts, by Prof. W. F. Barrett; "Practical Lessons and Exercises in Heat," by Mr. A. D. Hall.

In the list of books about to be published by Messrs. W. H. Allen and Co. we find:—"The Naturalist's Library," each section rewritten by well-known naturalists, edited by Dr. R. Bowdler Sharpe, in 20 vols.; "Handbook of British Hepaticæ, containing Descriptions and Figures of the Indigenous Species of Marchantia, Jungermannia, Riccia, and Anthoceros," by Dr. M. C. Cooke, author of "A Manual of Structural Botany," &c.; "The Flowering Plants of Western India," by the Rev. Alexander Kyd Nairne.

Messrs. Kegan Paul and Co. announce a new volume of "Modern Science Series": "The Fauna of the Deep Sea," by Sydney J. Hickson, Downing College, Cambridge (with illustrations); also a new volume of the "International Scientific Series: "The Dispersal of Shells: an Inquiry into the Means of Dispersal possessed by Fresh-water and Land Mollusca," by H. Wallis Kew, with a Preface by Dr. Alfred Russel Wallace, F.R.S., &c. (with illustrations).

Messrs. George Bell and Sons propose to issue Vol. iii. of the "British Fungus-Flora, a Classified Text-book of Mycology," by George Massee, author of "The Plant World," with numerous illustrations; "The Elements of Applied Mathematics, including Kinetics, Statics, and Hydrostatics," by C. M. Jessop: "Elementary Analytical Geometry," by the Rev. T. G. Vyvyan.

Messrs. Frederick Warne and Co. announce:—"The Royal Natural History," edited by Richard Lydekker, with preface by P. L. Sclater, illustrated with seventy-two coloured plates, and upwards of sixteen hundred wood engravings, by W. Kuhnert, J. Wolf, T. Specht, Gambier Bolton, P. J. Smit, &c., to be issued in monthly parts, beginning this month.

Messrs. Methuen and Co. will add to their University Extension Series a popular introduction to modern physical astronomy, entitled "The Vault of Heaven," by R. A. Gregory; and "Meteorology; the Elements of Weather and Climate," by Mr. H. N. Dickson.

From Messrs. A. and C. Black will come "Investigations in Microscopic Foams and on Protoplasm," by Prof. O. Bütschli, translated from the German by E. A. Minchin, illustrated; and the remaining two parts of Prof. Newton's "Dictionary of Birds."

The following are among the educational announcements of Messrs. Blackie and Son:—"Text-book of Heat," by Dr. C. H. Draper; "Students' Introductory Handbook of Systematic Botany," by J. W. Oliver; "Elementary Hydrostatics and Pneumatics," by R. Pinkerton.

Messrs. W. and R. Chambers will add to their list:—"Electricity and Magnetism," by Prof. Cargill G. Knott; "Organic Chemistry," by Prof. Perkin; "Elementary Science," by S. R. Todd; "Navigation," by J. Don.

Among Messrs. Williams and Norgate's forthcoming books is "A Pocket Flora of the Edinburgh District," by C. O. Sonntag, of the Edinburgh High School, with an Analytical Key to Orders and Genera.

Messrs. J. Hughes and Co. announce "Honours Physiography," by R. A. Gregory and H. G. Wells, and a second edition of Prof. Walker Overend's "Elements of Physiology."

The Religious Tract Society announce "The Romance of Electricity," by John Munro, with illustrations.

TRILOBITES WITH ANTENNÆ AT LAST!

Mr. W. D. Matthew[1] is to be warmly congratulated on being the first to describe Trilobites with visible antennæ. His detailed and illustrated description of a rich find (some sixty specimens) of *Triarthrus Beckii* with antennæ, made by Mr. Valiant in the Hudson River shales near Rome, N.Y., must naturally cause excitement among biologists all over the world.

The complete absence of all traces of visible antennæ, and, further, the failure of Walcott, after the most patient research by means of sections, to discover any antennal system at all, have resulted in the Trilobites remaining without abiding home in the zoological system. They have been Isopods, Phyllopods, and even Arachnida. And now, at last, Trilobites have been found with very pronounced antennæ! The first question we naturally ask is, what light do these antennæ throw upon the affinities of this mysterious group?

According to the description, these organs are long, many-jointed, typical crustacean antennæ. "They come out close together from just under the centre of the anterior border of the head shield." . . . . "Their point of origin seems to be under the front part of the glabella, as they can be traced a little way under the head shield, where they almost coalesce, then turn upwards and outwards and disappear." . . . . "Just over the spot where they come out, the anterior margin of the head shield is arched slightly upwards, seemingly to give room for them to play to and fro."

From these details we deduce the following:—

(1) All Trilobites had antennæ, which except, as far as we know, in the case of *Triarthrus Beckii* alone remained shut in under the head shield.

(2) These ventrally placed antennæ were inserted, approximately, one on each side of the labrum.

It seems to me that these natural conclusions from the facts go far to establish the relationship between the Trilobites and the Apodidæ originally maintained by Burmeister, and recently elaborated by the present writer ("The Apodidæ," "Nature Series," 1892). But however weighty the arguments (amounting, it seemed to me, to a proof) in favour of this relationship, the inability actually to demonstrate the existence of the antennæ was a felt weakness. That weakness has now been finally removed, and my arguments have been fully confirmed, by the finding that the Trilobites had antennæ in practically the same position as the anterior pair in the Apodidæ.

The Trilobites may therefore take a firm place at the root of the Crustacean system, with the existing Apus as their nearest ally.

The modern Crustacea, with their two pairs of antennæ arranged in a group with the eyes at the most anterior end of the body, have then to be deduced from primitive forms in which the antennæ were placed ventrally at the sides of the labrum, and were shut in under a large head shield. *Triarthrus Beckii* shows us one attempt to bring the antennæ forward. A pair of antennæ (presumably the anterior pair) lengthened considerably, and, without apparently changing their places of insertion, projected from under the head shield through a median groove. In spite of this actual discovery, I still think that the method of attaining the same end proposed by me (*loc. cit.*) was the method finally adopted. I suggested two grooves, one on each side of the median line, along which the antennæ moved bodily to the front. This would allow both pairs to act as anterior feelers, whereas the method adopted by Triarthrus would apparently only allow one pair to do so. Further, the piece between the grooves would account for the rostrum, which we know was very early developed. The antennæ in the early Phyllopod *Ceratiocaris papilio* were not long and filiform as in the Trilobite Triarthrus, but look exactly like a pair of Apus antennæ moved bodily to the front.

Whether the remarkable resemblance of the Isopods to the

[1] "On the Antennæ and other Appendages of *Triarthrus Beckii*." (*American Journal of Science*, August, 1893.)

Trilobites is due to direct descent, or is a case of convergence, cannot here be discussed.

We shall wait with impatience for further details of these important discoveries, inasmuch as there seems great promise that the soft black shale to which we owe the fine preservation of the antennæ has also preserved for us further details of the organisation of these interesting fossils. The fragments of limbs shown in the drawings make us eager for more.

H. M. Bernard.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

An influential and well-attended Conference on Secondary Education was opened on Tuesday in the Examination Schools, Oxford. The subjects considered were the need of various types of secondary education in England, with special reference to (1) the curricula and gradation of first grade schools (classical and modern), second grade schools, and higher grade board schools respectively; (2) the provision of preparatory schools for the upper grade of secondary schools; and (3) the relation between secondary schools and the Universities.

Mr. A. Austen Leigh, Provost of King's College, Cambridge, was admitted Vice-Chancellor on September 30. Dr. Peile, in resigning office, commented on the events of the University year. He called special attention to the straitened finances of the scientific departments, and trusted that help might be obtained from external sources. The departments of Engineering, Geology, Astromony, and Pathology appear to be those most urgently in need of additional resources. The Senate would be asked to appoint a syndicate for conducting Examinations in Agricultural Science, being strongly moved thereto by the County Councils and the Royal Agricultural Society. The Galileo Tercentenary at Padua, the Harvey Centenary in Cambridge, and the appointment of Mr. H. Y. Oldham as University Lecturer in Geography, in the room of Mr. Buchanan, were sympathetically referred to.

Mr. R. A. Sampson, Fellow of St. John's College, and Isaac Newton Student in Astronomy, Cambridge, has been appointed Professor of Mathematics in the Durham College of Science, Newcastle.

A new course of lectures on "The Physiology of the Special Senses, chiefly the phenomena of Vision," will be given this term by Dr. W. H. R. Rivers, of St. John's College, Cambridge, beginning on Monday, October 16. The lectures will be accompanied by practical work in the Psychophysical Laboratory.

The Technical Instruction Committee of the Bolton County Council has issued a syllabus of day and evening classes for the session 1893–4. The youth of Bolton can obtain instruction in many of the arts and most of the sciences at their Technical School, and judging from the well-equipped workshops illustrated in the syllabus, excellent courses of manual training are given.

The Entrance Scholarships in Science at St. Bartholomew's Hospital have recently been awarded. The scholarship of £75 in biology and physiology has been given to E. C. Morland, of Owens College, Manchester; the scholarship of £75 in chemistry and physics has been gained by R. H. Bremridge; the junior open scholarship of £150 in biology, chemistry, and physics has been gained by H. A. Colwell; and the preliminary scientific exhibition has been awarded to J. E. Robinson. The Jeaffreson exhibition in classics and mathematics has been gained by G. V. Bull.

A digest of the University Extension Science Lectures, to be delivered this autumn, shows that the movement is doing good work in many parts of the country. In connection with the Cambridge University Extension Syndicate, nine courses will be delivered on Botanical subjects, seven on Natural History, seven on Hygiene and kindred matters, six on Chemistry, and two on the History of Science, while single courses have been arranged in Agriculture, Electricity, and Geology. The programme of the London Society for the Extension of University Teaching shows six courses on Chemistry, four on Astronomy, three on Geology, and the same number on Hygiene. The Oxford University Extension Delegacy have made arrangements for the delivery of sixteen courses on Chemistry, twelve on Hygiene, nine on Agriculture, four on Astronomy, three on Geography, three on Geology, two on Electricity, two on Physiography, one on Light, and one on the Forces of Nature.

SCIENTIFIC SERIALS.

The *American Meteorological Journal* for August contains an important investigation on the movements of the air at all heights in cyclones and anticyclones, as shown by cloud observations made at Blue Hill Observatory. A record was made of the kind of each cloud visible, its direction of motion and relative velocity, and the observations, classified into five levels, were plotted by means of arrows on maps prepared for the purpose. The increased velocity of the wind near the centre of the cyclone and the decreased velocity near the centre of the anticyclone are distinctly shown. The arrows also show that the inclination of the wind to the centres of the two is not the same on all sides. In the cyclone the winds blow most nearly tangential south-east of the centre, and most nearly inward north or north-east of the centre; while in the anticyclone the winds are most tangential north-west of the centre; and most nearly outward south or south-east of the centre. In the cumulus region the cyclonic and anticyclonic circulation are still visible, but the general westward drift has become much stronger, while above that region that circulation is entirely masked by the drift. The diagrams also show that the currents do not all turn to the right as one ascends into the atmosphere, as is usually stated; when the winds have a northerly component, they show that the currents turn to the left as one ascends. The tables show that the circulation of the air is much more rapid in the higher regions than near the earth's surface, both in cyclones and anticyclones.

Bulletin de l'Académie Royale de Belgique, No. 8.—Determination of the constant of aberration, of the parallax of Polaris, of the velocity of the solar system, and of the constants of diurnal nutation, by means of the latitude observations of Gyldén and Peters at Pulkowa, by F. Folie. A further discussion of the evidence for diurnal nutation claimed as discovered by the author, and other deductions from the Pulkowa latitude observations. Among the latter is the R.A. of the apex of the sun's way, 277°, the positive parallax of 0″·05 for Polaris, and the negative correction for the constant of aberration, 0″·037, which harmonises the velocity of light and the parallax of the sun.—Correct determination of the constant of aberration by observations in the prime vertical, by the same author. This shows that the accepted formula for the reduction of prime vertical observations is faulty, and substitutes a corrected one.—Researches on the mono-carbon derivatives, by Louis Henry. This portion of the researches contains a preliminary account of the ammoniacal derivatives of methyl aldehyde.—On a simple method of measuring retardation in minerals cut in thin plates, by G. Cesaro. A compensating quartz prism is placed between the microscope and the mineral, and moved across the field by means of a screw permitting a displacement of 0·05 mm. The tints utilised for the determination of the amount of retardation experienced by the extraordinary ray are those known as sensitive tints, which easily change from a bluish to a reddish violet.—On the nutrition of the echinoderms, by Marcelin Chapeaux. The author maintains that the amibocytes of the cœlomic cavity of starfishes play an important part in the continuation of the process of digestion originated by the radial glands. Small drops of the oils emulsified by the radial glands traverse the epithelium and enter the body cavity. They are then absorbed by the amibocytes, and their duplication is carried out in the interior of these phagocytes, under the influence of an acid ferment.

Bulletin de la Société des Naturalistes de Moscou, 1892, No. 4.—Contributions to the fauna of the Aral Steppes, by A. Nikolsky. List of mammals and birds collected or noticed in the Steppes, with very short remarks.—*Astragalus Uralensis*, a new species, by D. Litwinow.—On the cold of January, 1893, note by B. Sresnewskij.—To the memory of N. I. Koksharoff and A. W. Gadolin, by W. Vernadsky. An excellent summary of Gadolin's work.

1893, No. 1.—On some ecto- and ento-parasites of the Cyclopides, by Dr. W. Schewiakoff (with a plate). A new species, *Trichophrya cordiformis*, is described, also the ento-parasitic slimes of the cyclopides.—On the anatomy of *Siredon pisciformis*, by W. Zykoff (with a plate).—Notes on a new skull of *Amynodon*, by Marie Pavloff (with a plate). The skull has been received from America, and was found in the miocene of the Black Hills, South Dacota.—Catalogue of Lepidoptera of the Government of Kazan (third paper), by L. Krulikovski, containing the Noctuæ.—On the molecular forces in the chemically simple bodies, on the basis of thermodynamics, being the third part of a remarkable memoir by J. Weinberg.—On the development of the ocean, by Prof. H. Trautschold. An attempt to prove that the ocean, at its first appearance, must have been very poor in chlorides as well as in carbonates and other salts.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 2.—M. Lœwy in the chair.—On the Serpent d'eau of the Rhône at Geneva, by M. H. Faye. This paper contains a description of a peculiar phenomenon seen at a weir near Geneva. It is a species of whirl in a vertical plane produced by a recoil of the water from the top of the barrier to a distance of 1·5 m. The axis of the whirl is horizontal, and parallel to the barrier. A delicate experiment performed by the late M. Colladon proved that this "serpent" exercises in its interior a considerable aspiration or suction. The phenomenon is complicated by the superposition of another whirl round a vertical axis in the neighbourhood of places where the barrier is interrupted, and the water is allowed a free fall. In these places conical tubes are formed whose apices descend to the bottom of the river, and into which air is noisily precipitated. Light objects—wood, paper—thrown into the whirlpool, descend, turning upon themselves with extraordinary speed. The whole phenomenon is very transitory and unstable. M. Faye does not share M. Colladon's view that the phenomenon is analogous to an ascending tornado. It has no analogy to a tornado, although it essentially requires a descending whirl for its production.—Observations of the comet Rordame-Quénisset, made with the great equatorial of the Bordeaux Observatory, by MM. G. Rayet, L. Picart, and F. Courty.—Values of the magnetic elements determined by the polar expedition of the Imperial Russian Geographical Society to the mouth of the Lena, by M. le Général A. de Tillo. The values for the magnetic elements at Sagastyr, as found by Captain Jurgens, are the following:—

Declination	4·7° E.
Dip	83·2°
Horizontal intensity	0·072°

G. Neumayer's map shows the greatest error in the declination, which it gives at 11·0° E.—Influence of the state of the surface of a platinum electrode upon its initial capacity of polarisation, by M. J. Colin. The results of M. Colin's experiments are in agreement with M. Blondlot's proposition that gases, and hydrogen in particular, are the cause of changes in the capacity of a platinum-water surface. If, in conformity with this hypothesis, the presence of hydrogen diminishes the capacity, the capacity of an electrode having served as kathode in the decomposition of water is very small; conversely, that of an electrode which has served as an anode, must be very great, since the oxygen set free must have eliminated the hydrogen with which the platinum might have been charged. Chromic acid, being a powerful oxidiser, must act in the same sense.—The fixation of iodine by starch, by M. G. Rouvier. The weights of starch remaining the same, as well as the other circumstances of the experiment, if the quantity of iodine added is increased, the quantity fixed rises at first. If the iodine is employed in sufficient quantity a compound is obtained whose percentage of iodine is always near 19·6, corresponding to the formula $(C_6H_{10}O_5)_{16}I_5$. A higher percentage was never obtained. If the weights of iodine and starch remain the same, as well as the other circumstances of the experiment, and the volume of the mixture increases, the quantity of iodine fixed diminishes, on condition that no more iodine is employed than is necessary to obtain the percentage 19·6. Otherwise, the volume may increase, and yet this percentage may be obtained.

SYDNEY.

Royal Society of New South Wales, August 2.—Prof. T. P. Anderson Stuart, President, in the chair.—The following papers were read:—Notes on the Bingera diamond field, by Rev. J. Milne Curran.—On the occurrence of a chromite-bearing rock from the Pennant Hills Quarry, near Paramatta, by W. F. Smeeth, J. A. Watt, and Prof. T. W. E. David.—Note on the occurrence of barytes at the Five Dock Sandstone Quarry; and note on the occurrence of calcareous sandstone allied to Fontainebleau sandstone from Rock Lily, near Pittwater, by Prof. T. W. E. David.

Linnean Society of New South Wales, August 30.—Prof. Haswell, Vice-President, in the chair.—The following papers were read:—Notes on Australian Coleoptera, with descriptions of new species, part xiv., by Rev. T. Blackburn.—Note on *Colina Brazieri*, Tryon, by Prof. Ralph Tate.—Descriptions of some new species of *Araneidæ* from New South Wales, No. iii. by W. J. Rainbow.—Notes on aboriginal stone weapons and implements, No. xviii.-xx. by R. Etheridge, Junr.—Three additional types of womerah, or throwing-stick, by R. Etheridge, Jun.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—A Manual of Telephony: W. H. Preece and A. J. Stubbs (Whittaker).—The Principles of Fitting: A Foreman Pattern Maker (Whittaker).—Dissections Illustrated: Part 2, C. G. Brodie, (Whittaker).—An Elementary Text-book of Coal Mining: R. Peel (Blackie).—Biologia Centrali-Americana, Part 3, Text and Plates, Archæology; Part 4, Plates, Archæology: A. P. Maudslay (Porter).—Selections from the Philosophical and Poetical Works of Constance C. W. Naden: compiled by E. and E. Hughes (Bickers).—Our Reptiles and Batrachians, new edition: Dr. M. C. Cooke (W. H. Allen).—The Zambesi Basin and Nyassaland: D. J. Rankin (Blackwood).—Some Salient Points in the Science of the Earth: Sir J. W. Dawson (Hodder and Stoughton).—A Text-book of Physiology, 6th edition, Part 1: Dr. M. Foster (Macmillan).—The "Thumb" Prayer-book (Frowde).—Marine Boiler Management and Construction: C. E. Stromeyer (Longmans).—An Elementary Text-book of Agricultural Botany: M. C. Potter (Methuen).—Pêches et Chasses Zoologiques: Marquis de Folin (Paris, Baillière).—Lectures on the Comparative Pathology of Inflammation: E. Metchnikoff, translated by F. A. Starling and Dr. E. H. Starling (K. Paul).—Machine Drawing: T. Jones and T. G. Jones (J. Heywood).

PAMPHLETS.—The Upper Hamilton and Portage Stages of Central and Eastern New York: C. L. Prosser.—The Climate of Chicago: H. A. Hazen (Washington).—Mikroskopische Vivisektion: Dr. A. Gruber (Freiburg).—Restoration of Coryphodons: O. C. Marsh.—Massachusetts Institute of Technology, a Register of Publications of the Institute, &c. 1862–93, 3rd edition (Boston).

SERIALS.—Gazzetta Chimica Italiana, Anno xxiii. 1893, Vol. 2, fasc. 9 (Palermo).—Engineering Magazine, October (New York).—Observatory, October (Taylor and Francis).—Popular Astronomy, September (Wesley).—Himmel und Erde, October (Berlin).—L'Astronomie, October (Paris).—Journal of the Chemical Society, October (Gurney and Jackson).—Journal of the Statistical Society, September (Stanford).

CONTENTS.

THURSDAY, OCTOBER 19, 1893.

BRITISH BUTTERFLIES.

The Lepidoptera of the British Islands; a Descriptive Account of the Families, Genera, and Species Indigenous to Great Britain and Ireland, their Preparatory States, Habits, and Localities. Vol. I. *Rhopalocera.* By Charles G. Barrett, one of the Editors of the *Entomologist's Monthly Magazine.* (London: L. Reeve and Co., 1893.)

NOTWITHSTANDING the number of popular books on British insects which are constantly issuing from the press, it is only occasionally that we have to notice the appearance of a work of higher pretensions than this, even as regards our British butterflies. And yet it is of great importance that we should place on record a full and complete account of our native insects as speedily as possible. Much information that might still have been preserved fifty years ago is now irrecoverably lost, for the drainage of the fens has robbed us of many of the British insects which were absolutely peculiar to our country. But some still remain; and notwithstanding the comparative poverty of the British insect-fauna as compared with that of the Continent, the British Islands possess a much larger number of peculiar forms than is generally imagined, and the French entomologists actually call Britain "le pays des variétés."

The volume before us is the commencement of a comprehensive work on the whole of the British Lepidoptera (about 2000 species in round numbers) and is edited by Mr. C. G. Barrett, who is well known to entomologists as one of our best practical workers. He has had unusual facilities for personal observation in many parts of the country, and has devoted much attention to our native Lepidoptera, and more especially to some of the more difficult groups of the smaller moths; but he has hitherto only contributed to periodical literature.

The work appears in monthly parts, with plain or coloured illustrations. It commenced last year, and the first volume, including the butterflies, and illustrated with forty plates representing all the species regarded as undoubtedly British, in addition to numerous figures of larvæ and varieties, is now complete in ten parts, and has been reprinted on smaller paper, and without plates. It appears to us to be a grave oversight that there is no reference to this in the smaller edition, except in the advertisements at the end of the volume. Prominent attention should certainly have been called to the larger edition, even at the risk of injuring the sale of the smaller one, either in the preface or by a conspicuous advertisement.

In his introduction Mr. Barrett gives a concise account of the general structure and metamorphoses of Lepidoptera, and remarks on classification and synonymy. With respect to classification, everyone will agree with him in the following observations:—

"Classification is, however, largely a matter of opinion. The absolute necessity—in books, lists, and collections—for a linear arrangement precludes the possibility of one which is really natural, since, although the relation of groups to each other is often evident, they ramify, extend, intersect and interlace to such a degree that it is only possible to take group after group in as natural a succession as seems to commend itself to the individual writer, with the knowledge on his part that the arrangement is partly the outcome of his own particular views, and that in all probability those of other authors are equally substantial."

But when he adds, "That which has hitherto been followed for our native species does not appear to be disturbed to a very large extent by an examination of the species found in other parts of the world," it is only so far true on account of the vast bulk of the Order having hitherto prevented any rearrangement of the families (the butterflies excepted) in a sufficiently natural series to be regarded in any other light than as tentative.

Mr. Barrett cuts the Gordian knot of synonymy, as is best in a work of limited scope, by quoting every name under which any species is widely known. No other course was open to him, unless he had worked out the synonymy of every species for himself, a work of great labour, difficulty, and at times uncertainty, or unless he had decided to follow some previous author throughout.

Dealing with British Lepidoptera only, Mr. Barrett appears to have almost confined himself to the use of English authors, from the time of Haworth, including an examination of the principal periodicals. A great deal of hitherto unpublished information is also included in the work, from the observations of the author and his correspondents. But little use appears to have been made of continental authors, except as regards the larvæ of some of the species described.

Turning to the body of the work, we find that under each species the dimensions, essential characters, variation, larvæ, pupæ, habits, &c., are discussed in sufficient detail for most practical purposes. A useful feature of the book is the addition of many of the species which have been reputed, on fairly good authority, to have been taken in Britain, but which are still regarded either as accidental immigrants, or as doubtfully British. Of course these notices are much briefer than those of the well-established British species, about which there is no question. But we do not see what has guided the author in his selection of reputed British species; he has included such an insect as *Thais rumina*, a conspicuous South European butterfly, once found flying in Brighton Market, but which could hardly by any possibility be indigenous in Britain, while he makes no mention of many species recorded by the old authors as having been at least casually taken in England. As he has included such species as *Thais rumina* and *Parnassius Delius*, we think he should have given at least a passing notice of every butterfly recorded as having been taken in Britain (except, perhaps, in cases where there was reason to believe that there had been an actual error of identification, or when a careless and ill-informed author like Turton has marked species as British at random); or else have omitted all the reputed British species, except those which there was some ground for believing might ultimately prove to be indigenous. Among the latter were many moths which were really omitted from, instead of inserted in, the British list "without authority," by the late Henry Doubleday, and which have since been proved to be indigenous, and reinstated. But we are glad to find that Mr. Barrett admits *Lycæna argiades* and *Danais Archippus* among our native butterflies. The latter, though an importation from America, has been so frequently taken in England of late years, that it is hoped it may become permanently naturalised. On the other hand, there are several apparently extinct species, formerly common in England, such as *Chrysophanus dispar*, last taken in 1865, as well as others which appear to be now on the verge of extinction as British species, without any obvious reason, such as *Aperia cratægi* and *Polyommatus acis.* In a few years we fear that entomologists may have seriously to consider the desirability of finally erasing several of our British butterflies from our list as absolutely and undoubtedly extinct. *Per contra*, we may look for occasional additions (though very rarely among the butterflies) among species which are possibly overlooked or confounded with others, like *Lycæna argiades* and *Hesperia lineola*, the two latest novelties. In the case of *Lycæna bætica*, first taken in England in 1859, there is good reason to believe that the species is naturally extending its range in North-Western Europe. Possibly this may also be the case with the moth, *Syntomis phegea*, which is said to have been taken once or twice in England of recent years, and which, though gregarious and generally abundant wherever it is found, is excessively local north of the Alps, though there are several isolated colonies in Germany and the Netherlands.

We could have wished that Mr. Barrett had paid more attention both to the foreign literature relating to British butterflies, and to the older English literature before Haworth; but no man can accomplish everything, and within the limits to which he has confined himself his work must be regarded as by far the best and most complete which has yet appeared. W. F. Kirby.

COOKE ON LOCOMOTIVES.

British Locomotives. By C. J. Bowen Cooke. (London and New York: Whittaker and Co., 1893.)

Locomotive engineers, like their brethren in the medical profession, very often differ widely in their practice; again, they often follow the practice of some older locomotive engineer dead and gone, may be. Who can say that the late Mr. William Stroudley has not left his mark on the locomotive design in this country, and that many British railways do not bear his handiwork in the design of their locomotive stock? To the layman the question why certain railways have engines with domes, and other railways have engines without domes, will always remain unanswered. The same may be said of bogies, injectors, pumps, &c.

In the large locomotive works, where engines are built by contract, these divergencies of practice are brought prominently forward, and one is in danger of coming to the conclusion that anything will do in the way of locomotive design. Nor is it only in the design that there is so much variation, for one finds quite as much in the systems of doing work often rigidly specified to be followed.

Another point also deserves attention. Since the use of steel has come into use as a material for the construction of boiler shells, it is amusing to observe the different ways this material is handled, or rather specified to be handled. Some engineers allow the plates to be sheared to size, and the rivet holes punched full size without hesitation; others again partly follow this practice, but require the sheared edges of plates to be planed to a depth of a quarter of an inch, and punched holes to be machined to a depth of an eighth of an inch on the diameter. Another school declines to have punched rivet holes at any price. The same variation in practice holds good with the question of annealing the plates, and particularly the flanged plates which go to form the boiler.

It is possible to take the principal parts of a locomotive and to demonstrate that what is considered good practice by one locomotive engineer is considered by some other to be decidedly wrong, and for this reason no good can be attained by following this view of the question further. Any book, therefore, treating on locomotive engineering will naturally tend to follow the practice of some particular locomotive engineer as regards design, and particularly the details, the principles of course being the same in all cases.

The volume before us "does not profess to be a scientific work; its purpose being more to give the reader, who may not feel disposed to dive into figures and calculations, some information about locomotives in a condensed and intelligible form." This is to be regretted, because there is no modern work on locomotive design available for reference. But on the other hand, the author has written a most readable book, useful alike to the apprentice and lay reader.

The author, being on the locomotive staff of the London and North-Western Railway, naturally follows the practice in vogue on that line, and a better example of good all-round locomotive engineering will be difficult to find.

The volume may be roughly divided into three parts; viz. the early history of the locomotive, details of construction of recent engines, and descriptions of modern locomotives in use on the principal railways in this country. In all three divisions the author has done ample justice to the subject; although, as we have before pointed out, the book would have been of far more value to an engineer had the author gone deeper into the question of design, and particularly the strengths of parts.

Chapter v. deals with the boiler, the most important and delicate part of a locomotive engine; for given a well-made boiler of ample capacity, then the engine will have every chance of being a success. The author on page 91 mentions Bessemer steel as a material for boiler shells n such a way as to give an impression that it is the common practice to use that material for this purpose, whereas Siemens-Martin open hearth steel is generally used, and Bessemer steel is the exception. Further on, the tensile strength of various materials used for making boiler shells is given. Surely the author should also specify an extension or contraction of area as well?

We read that "rivet holes may be drilled, but in general practice with locomotive boilers they are punched when the plates are cold." Has the author ever seen rivet holes punched in a hot plate? It certainly is the practice to punch the rivet holes at Crewe, but no large contractor dreams of punching at all, nor would most engineers allow it to be done; and as regards cost, it is certainly no more expensive to drill.

Fig. 55 represents the arrangement for staying the crown of the fire-box by direct stays to the casing plate. This is said to be "a good arrangement." There are, however, several objections to it, the more important being that no provision is made for the expansion of copper tube plate on raising steam, the first two rows of stays being usually carried by a sling attached to the boiler shell. The old-fashioned roof-bar is again coming into vogue, owing probably to the fact that the fire-box is not held so rigidly, and therefore the plates are not so liable to crack with the constant expansion and contraction.

The chapter on boiler fittings is good, but the asbestos packed fittings made by Messrs. Dewrance and Co. might have been included with advantage. On the subject of cylinders we find much useful information, the latest types being clearly illustrated. Under the heading of general details, the radial axle-box, Adams' bogie and blast-pipe are described, but the bissel truck is not included. This is to be regretted, because it is very commonly in use abroad, and is more efficient than the radial axle-box. The all-important question of brakes is discussed in Chapter xiii. Everybody will agree with the author that it is a pity there should be two brakes in the field, because where vehicles have to run over lines using different brakes, both systems of brake gear are usually fitted: and so thoroughly has this to be done, that in the case of fish trucks used with passenger trains the cost of the brake gear comes to more than half the total cost of the vehicle.

The many improvements recently made in the design of the fittings and gear of the automatic vacuum brake have rendered it most efficient and easily maintained; a sectional drawing of the combination ejector, as made by Messrs. Gresham and Craven, would have been welcome in this chapter. The Westinghouse brake is well described, and is illustrated with the familiar sectional drawings of that company.

Chapter xiv. is on modern locomotives, and is capitally illustrated. The locomotive types on the L. and N.W.R. are described, and a table is given, being a complete list of the different standard classes with the number of engines of each class. Another table gives the numbers and names of all the passenger engines; following this chapter we find the standard types of other companies' locomotives treated in much the same manner. On p. 252 there is evidently an error. The author mentions "Mr. Stirling's 4 ft. coupled inside cylinder engines with 5 ft. 6 in. driving wheels." What does this mean? Page 266 gives the information that the Chatham and Dover Railway has the automatic vacuum as their standard brake. Surely this line is claimed by the Westinghouse Company. Scotch locomotive practice is well represented by Messrs. Holmes and Drummond's fine engines running on the North British and Caledonian railways respectively. Page 286 contains an error in the statement that Mr. Drummond's engines of a particular type are fitted with the Bryce Douglas valve gear. One engine certainly was so fitted, but after a series of breakdowns the gear was done away with, and the ordinary link motion was adopted.

The compound locomotive is treated in Chapter xvi. Both the Webb and Worsdell types are copiously illustrated and described, but there is nothing absolutely new to be learned from a careful perusal of this chapter. No drawing is given of the Worsdell intercepting valve; but this is a mistake which can be rectified in a future edition.

The volume concludes with chapters on lubrication and packing, combustion and consumption of fuel, engine-drivers and their duties, &c. The question of metallic gland packing is just mentioned, and that is all. There are hundreds of engines now running fitted with the Jerome metallic packing, or that of the United States Company, and descriptions of these would not be out of place in this work.

Taken as a whole, this volume contains much readable and useful matter. The author has certainly succeeded in writing a most interesting book, which is sure to leave many clear notions, on the minds of its readers, concerning the practical side of a subject of vast importance. Most of the illustrations are very clear. The printing is good, and the volume is strongly bound.

N. J. LOCKYER.

WEATHER PROPHESYING.

Sécheresse 1893, *ses Causes*. Par l'Abbé A. Fortin, Curé de Châlette. (Paris: Vic et Amat, 1893.)

WHATEVER effect such a period of drought as that through which some parts of England and the Continent have recently past may have had on the harvest, it is pretty certain to be followed with a heavy crop of literature. Some writers content themselves with a simple record of facts, and a comparison with similar experiences in the past; some try to explain the causes, and others have remedies to suggest which may diminish the ill effects of similar periods in the future.

The work quoted above belongs rather to the two last categories, but unfortunately we cannot congratulate the author on his contribution to either the scientific or the economical side of the question. His explanation of the cause of the drought is easily expressed, though we cannot hope that the suggestions put forward will carry conviction to the readers of this journal. In the opinion of the author, the drought is due to three contributory causes. (1) To the sun-spots, which for the three months in question exhibited themselves, it is stated, on the southern side of the sun. (2) To the fact that during the three months, March, April, and May, "Vénus s'est trouvée en opposition constante et prolongée." (3) The third cause is due to the fact that from the beginning of the year the lunar apogee has coincided with the new moon, and the perigee with the full moon.

M. l'Abbé Fortin has apparently many readers and admirers. If we have understood the text correctly, he publishes an almanack in which the weather predictions are given a year in advance, and to judge from the advertisement, these predictions have met with a ready circulation. Further than this, it is mentioned with pardonable pride, that when the gifted author was in need of a micrometer for the prosecution of his studies of these sun-spots, a generous and a sympathising public subscribed 700 francs with a readiness and devotion that should attest the usefulness of his labours and his popularity. With these advantages on his side we feel the responsibility of venturing to disagree with him, or of questioning his figures and his results. Nor is any hope entertained of convincing him of the inadequacy of his arguments, and some apology is perhaps due for pointing out one or two facts which, if they do not convict the reverend Abbé of misrepresentation, exhibit at least a want of candour, which we should not have expected to meet in one of his sacred calling. We may pass over his first argument resting on sun-spots, because it is not impossible but that these do exercise an influence on our atmosphere not yet explained, though we are certain that the warmest adherent of such a theory will find little additional support from the arguments stated by the Abbé. It may not be possible to do justice by a translation to the words "opposition constante et prolongée," as applied to Venus. By "opposition" is evidently meant superior conjunction, but why constant and prolonged? The superior conjunction of Venus did not take place till the beginning of May, and we regret to say that the words "coincident cette année 1893 avec les mois de Mars et Avril" (p. 46) are unwarranted and misleading. The same remark applies to the words (p. 90), "Vénus ne se rapprochait de sa conjonction qu' en Juillet," and it may further be remarked that since Venus was approximately at the same distance from the earth in the beginning of July as at the beginning of March, June ought to have been included in this "constant and prolonged opposition." Again, with regard to the moon's apse, it is declared (p. 90), "il arrivait encore que l'apogée se faisait juste en pleine lune, et le perigée à la nouvelle lune." A comparison of the dates of new and full moon with those of perigee and apogee shows that the Abbé is not more accurate here than in his remarks on Venus. The average deviation for the three months under notice is two and a half days, and in one case the time of full moon was March 31, 19h, while the apogee did not occur till April 5, 7h., or a difference of time of four and a half days. But the curious and to some extent the most interesting feature of the whole is, that the admirers of the Curé will still continue to regard him as an authority, and, what is more to the purpose, eagerly purchase his almanacks, and would continue to do so even if his errors were more palpable—more numerous they could scarcely be.

The remedy which the gifted author would apply to prevent a recurrence of the ill effects which have made themselves felt this year consists in an extensive system of irrigation. Doubtless financial considerations would enter in a perplexing manner into such a scheme, and prevent it becoming a part of practical agriculture. But the knowledge of local circumstances which the Abbé probably possesses, and certainly we do not, permits him to speak with an authority we do not like to question.

W. E. P.

OUR BOOK SHELF.

Geological and Solar Climates: their Causes and Variations. A Thesis. By Marsden Manson. (London: Dulau and Co., 1893.)

Several thinkers have from time to time set to work to enlighten their fellow-creatures on the subject of the cause of the Ice age, a period when ice covered quite generally both the temperate and the tropical areas. Each one has in his own way added something towards the solution of this problem, whether that something was large or small, but the theory that will produce conviction in all minds, or rather in the majority of minds, has yet to come. The causes which have been suggested are many and varied. Some say the age was due to a decrease in the original heating of the globe; changes in the elevation of the land, and therefore varied land and water distributions; changes in the position of the axis of the earth; while others account for the phenomenon by suggesting a period of greater moisture in the atmosphere; variations in the amount of heat radiated by our sun; variations in the absorbing power of the sun's atmosphere; variations in the temperature of space; coincidence of an Aphelion winter with a period of maximum eccentricity of the earth's orbit; a combination of the last mentioned with that of changes in the elevation of the land; and lastly, the explanation recently put forward by Sir Robert Ball.

In the present thesis the author, after reviewing briefly the suggested explanations, goes back to the idea of the decrease in the original heating of the globe, and on that builds up a very plausible theory. To state briefly this theory, one must mention that two sources of heat were at work—first that of the resident or internal heat of the earth, and second that of the sun. As the earth passed from the era in which its climates had been controlled by internal heat to one in which solar heat predominated, uniform climates "must have been passed through during which isotherms were independent of latitude." Before the era was reached at which the sun had complete control over the climates, the author says the continental areas must have been glaciated, independent also of latitude.

To state in so many words the direct *cause* of the Ice age, he says that it is due to the remarkable properties of various forms of water in relation to heat and cold. As vapour it played an enormous part in the loss and receipt of heat by radiation, as water it was the last to retain "the effective remnant of earth heat, on account of its high specific heat, and as ice it was able to store a great amount of cold."

The author then deals in detail with the way these three forms of water played their part in this stupendous phenomenon.

The end of the Ice age was brought about so soon as the solar heat could find its way to the earth's surface; the air being cleared of obscuring clouds and fogs by the chilling of the oceans and the glaciation of continental areas.

The first zone over which the solar energy would first establish its power would be the torrid zone; travelling polewards the glacial conditions would gradually be removed upon lines parallel with the present isotherms.

More on the subject need not be said here, but we would recommend any one who takes an interest in this problem to give this book a perusal, for although there may be many who would not agree with the writer in all points, yet he has made an honest and plausible attempt at suggesting a cause of one of the most difficult and yet most fascinating problems with which we have to deal.

A Manual of Electrical Science. By George J. Burch. (London: Methuen and Co., 1893.)

Of the many useful volumes in the University Extension Series published by Messrs. Methuen, this is one of the best. "I have written," says the author, "not for wealthy amateurs, nor for people who do not care to think, but for men and women who have to give up something else to spend a sovereign on their own education. Nearly all the apparatus described in this book can be made by anyone with a few tools and a little finger-skill." In conformity with this laudable desire, technical terms are rarely introduced without being explained, and by simple words and apt illustration the way to electrical knowledge is made as easy and pleasant as it possibly could be. Indeed, popularity of style appears to be the book's sole *raison d'être*, for, with one or two exceptions, the facts described are to be found in a number of elementary text-books. However, it can be said that there are very few, if any, books of the modest dimensions of the one before us in which so much information is imparted in a more popular manner. The descriptions of experiments and principles are easy reading without being diffuse; the hydrostatic and other analogues are numerous, yet they are never used where likely to lead to a misconception. The illustrations, however, are not worthy of the text. They should have been far more numerous and less sketchy in order to appeal to the public for whom the book has been specially designed.

LETTERS TO THE EDITOR.

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

The Supposed Glaciation of Brazil.

IN the second volume of NATURE, p. 510, I reviewed the late Prof. Hartt's "Geology and Physical Geography of Brazil," and called attention to the author's views, as well as those of the late Prof. Agassiz, relating to the supposed glaciation of that country. From their very positive statements I concluded that the evidence as described by them did actually exist, and that until it was disproved it should not be ignored. In my "Darwinism," p. 370, I stated, on the authority of my friend, Mr. J. C. Branner, now Professor of Geology in the Stanford University, California, who succeeded Prof. Hartt in Brazil, and had a much more extensive knowledge of the country, that the supposed glacial drift and erratic blocks were all results of subaërial denudation. Recently, however, Sir Henry Howorth has quoted some passages from my review in illustration of the wild and incredible theories of some geologists, as samples, in fact, of the "Glacial Nightmare"; and, as no authoritative disproof has yet been given of the exceedingly strong and positive statements of Agassiz and Hartt, I beg leave to lay before the readers of NATURE some extracts from a paper on "The Supposed Glaciation of Brazil," by Prof. Branner, which will shortly be published, and of which he has kindly sent me a type-written copy in advance. As a partial justification of what has now proved my too hasty acceptance of the statements of these gentlemen, I will give one passage in which Prof. Agassiz refers to the supposed glacial phenomena near Ceara:—"I may say that in the whole valley of Hasli there are no accumulations of morainic materials more characteristic than those I have found here, not even about the Kirchel; neither are there any remains of the kind more striking about the valleys of Mount Desert in Maine, where the glacial phenomena are so remarkable; nor in the valleys of Loch Fine, Loch Awe, and Loch Long, in Scotland, where the traces of ancient glaciers are so distinct." Both Agassiz and Hartt were equally strong as to similar phenomena near Rio.

It is to be first noted that Hartt had only spent eighteen months in Brazil when he wrote his book, and his views on the glacial phenomena were thus based on a very hasty survey of that enormous territory. Prof. Branner went with him when he again visited Brazil in 1874, helped him in his geological work till his death in 1877, and himself remained five years longer making a geological survey of the country; and he states that, before his death, Hartt's views underwent a radical change. Prof. Branner says:—

"Under his direction I did more or less work in the mountains about Rio de Janeiro for the purpose of sifting the evidence of glaciation in that region, and I am glad to say, in justice to the memory and scientific spirit of my former chief and friend, that long before his death he had entirely abandoned the theory of the glaciation of Brazil, and that the subject had ceased to receive further attention, even as a working hypothesis."

A few extracts must now be given showing to what causes the phenomena which deceived these observers are really due. And first as to what were supposed to be erratic boulders often embedded in boulder clay.

"The boulders believed to be erratics are not erratics in the sense implied, though they are not always in place. The first and most common are boulders of decomposition, either rounded or subangular, left by the decay of granite or gneiss. Sometimes they are embedded in residuary, and therefore unstratified, clays, formed by the decomposition in place of the surrounding rock. And everyone has heard of the great depth to which rocks are decomposed in Brazil. The true origin of these boulders and their accompanying clays is often obscured by the 'creep' of the materials, or in hilly districts by land slides, great or small, that throw the whole mass into a confusion closely resembling that so common in the true glacier boulder clays. In this connection too much stress cannot be placed upon the matter of land slides; they are very common in the hilly portions of Brazil, and aside from profound striations and faceting produce phenomena that, on a small scale, resemble glacial till in a very striking degree." . . . .

"The second method by which these boulders have been formed is quite similar to the first, but instead of being cores of granite or gneiss, they have been derived by the same process of exfoliation and decomposition from the angular blocks into which the dikes of diorite, diabase, or other dark-coloured rocks break up. Their colour marks them as quite different from the surrounding granites, and the dikes themselves are almost invariably concealed. The residuary clays derived from the decomposition of these dikes are somewhat different in colour from those yielded by the granites, so that when 'creep' or land-slides add their confusion to the original relations of the rocks the resemblance to true glacial boulder clays is pretty strong. The chance of discovering the source of such boulders is further decreased by the depth to which the mass of the rock has decayed, and by the inpenetrable jungles that cover the whole country, and so effectually limit the range of one's observations. Dikes, such as these last mentioned, are not uncommon in the mountains about Rio de Janeiro. Indeed, what have generally been regarded as the very best evidences of Brazilian glaciation, some of the boulders near the English hotel at Tijca, fall under this head, though some are of gneiss. The fact is that the great mountain masses about Rio are of granite or gneiss, while some of the boulders come from the dikes of diabase or other dark-coloured rock high on their sides—dikes which were not visited by Agassiz or Hartt."

Prof. Branner then describes a third class of supposed erratic, derived from certain sandstone beds of the tertiary deposits, which, by exposure, change to the hardest kind of quartzite, and when the surrounding strata are removed by denudation, and a few blocks of this quartzite are left, they are so unlike the rocks by which they are surrounded that unless the observer has given a special study to the tertiary sediments, he is liable to be misled by them.

The wide-spread coating of drift-like materials tha covers considerable areas of the country, consisting of boulders, cobbles, and gravels, sometimes assorted and sometimes having clay and sand mixed with them, are then described, and are shown to be due to the denudation of the tertiary beds during the last emergence of the land, aided by subsequent subaërial denudation and surface wash. Prof. Branner thus concludes:—

"I may sum up my own views with the statement that I did not see, during eight years of travel and geological observations that extended from the Amazon valley and the coast through the highlands of Brazil and to the head waters of the Paraguay and the Tapagos, a single phenomenon in the way of boulders, gravels, clays, soils, surfaces, or topography, that required to be referred to glaciation."

The very clear statement above given of the real nature of the phenomena which deceived Prof. Agassiz and Mr. Hartt, is very instructive, and it shows us that a superficial resemblance to drift, boulder-clay, and erratic blocks, in a comparatively unknown country, must not be held to be proofs of glaciation.

We require either striated rock surfaces or boulders, or undoubted *roches moutonnées*, or erratics, which can be proved not to exist sufficiently near to have been brought by "creep" or land-slides. In view of these liabilities to error, we may be almost sure that the supposed evidences of glaciation described by the late Mr. Belt in his "Naturalist in Nicaragua" (p. 260), are explicable in the same manner as the Brazilian evidences, since he nowhere found glacial striæ or any boulders that could be proved to be true erratics; and this is the more certain because he himself states (p. 265), "I have myself seen, near Pernambuco, and in the province of Maranham, in Brazil, a great drift deposit that I believe to be of glacial origin."

All students of the past and present history of the earth are indebted to Prof. Branner for having relieved them of a great difficulty—a true glacial nightmare—that of having to explain the recent occurrence of glaciation on a large scale far within the tropics and on surfaces not much elevated above the sea-level. ALFRED R. WALLACE.

Telegony.

DR. ROMANES' letter inviting a discussion concerning the remarkable phenomenon of telegony will be welcomed by many who have felt that too little notice has been paid by men of science up till now to one of the most obscure problems of heredity. At the conclusion of his remarks, Dr. Romanes rejects Prof. Weismann's hypothesis that sperm elements are capable of penetrating into the ovary, and fertilising immature ova *in situ*, on the ground of their obvious incapability of doing so. It seems, however, possible to doubt whether the spermatozoa are so incapable of penetrating such tissues as the stroma surrounding an ovarian follicle. Although, as far as I am aware, the actual penetrating of spermatozoa through ovarian tissues has in no case ever been shown to take place, yet we are bound to take it for granted that in some cases this actually occurs, from facts observed in many Invertebrata.

Prof. Whitman, in an exhaustive paper published in the *Journal of Morphology*, January 1891, has collected a considerable mass of evidence to show that in many widely-differing animal groups the spermatozoa make their way through the external body wall at many different points, usually a large number being bound together to form spermatophores. Perhaps the best examples of animals where this occurs are found among the Turbellarians and Leeches. In these forms the spermatozoa pass directly through the epidermis, basal membrane, and the layers of muscular and connective tissue till they reach the body cavity. Here the spermatophores break up, and in some instances the individual spermatozoa undoubtedly must penetrate the wall of the ovary in order to fertilise the ova *in situ*.

As in many mammals, the immature ova lie very near the surface of the ovary, it does not seem to be beyond possibility that even in the higher vertebrates some similar process may occur.

On the other hand, as Prof. Weismann points out, if such be the case we should expect to find animals pregnant several times in succession after once being crossed, of which no instance has ever been recorded.

Dr. Romanes' suggestion that the followers of Weismann may explain the facts of telegony by supposing the spermatozoa to disintegrate and that their "ids" and "determinants" somehow enter the unripe ova, must for the same reason be dismissed as impracticable, unless it be assumed that enough "ids" never reach one egg to supply the place of those "ids" which have been got rid of by the reducing division of the egg nucleus, and would be replaced in the ordinary course of things by the spermatozoon. Such an assumption would be obviously unscientific and unwarrantable.

It seems, therefore, unsafe, until more definite experimental work has been done with regard to this obscure and interesting problem, to attempt to give any very definite explanation of the facts as they now stand, if we adopt Prof. Weismann's, views as to the continuity of the germ plasm. The facts, as Dr. Romanes very rightly insists upon, show that telegony is on the whole, of very rare occurrence, and on this account it is premature to go so far with Mr. Spencer as to maintain that the few isolated instances of telegony are sufficient to knock down at a blow the far-reaching theories of heredity which Prof. Weismann has put forth. M. D. H.

September 29.

The Use of Scientific Terms.

PROF. LODGE has made a valuable statement regarding scientific terms in last week's NATURE as follows:—"The words used in the current language of biology are extremely classical and as unlike the language of daily life as can be contrived. This is done to keep free from the misunderstandings arising out of the attempt to give to popular words a scientific, *i.e.* an accurate meaning." Botanists have not always been as careful as Prof. Lodge would have us believe, and as an instance to the contrary I would cite the following: I was recently lecturing on forest utilisation, and used the word bark in its ordinary meaning of the outer envelope of a tree. One of the students in the class interrupted me to point out that I was speaking loosely, as *bark* is now a scientific term, meaning the transformed outer envelope of a plant, the German *Borke*, after the growth in it of corky or stony tissues.

I appealed to the sense of the class as to whether botanists have any right to adopt a common English word for something beyond its ordinary meaning, and the class took my view of the subject unanimously, carrying eventually even the objector with them.

The substance now scientifically termed *bark* might be styled *rhytidome*, as is done in France (*vide* "Flore Forestière," by A. Mathieu, edition 1887, p. 595); or can any reader of NATURE propose a better term? W. R. FISHER.

Coopers Hill, October 16.

Rustless Steel.

SOME months ago I noticed, in *The Field*, the statement that steel containing twenty per cent. of nickel was free from rust and, on that account, very suitable for the manufacture of small arms of high quality. From its use in the manufacture of ordnance and armour-plate I presume, moreover, that the nickel alloy does not compare unfavourably with ordinary steel in point of tenacity and hardness.

If this proves to be the case—and it is the object of this letter to elicit the information from some of the numerous readers of NATURE—nickel-steel would form an invaluable material for the construction of certain parts of astronomical and geodetic instruments, notably the pivots and axes, which, as made at present, slowly deteriorate from rust when of steel, or from wear when of bronze. With geodetic instruments, continually set up as they are in exposed situations, sometimes near the sea, it is seldom there is not, after a few years' use, evidence of rust enough on the pivots to have destroyed much of the extreme perfection of figure attained by makers like Repsold or Ertel. The wear of bronze pivots is even worse. I am informed that the earlier meridian observations at a leading observatory are not comparable in accuracy with those taken after the original bronze pivots had been replaced by steel ones.

Cape Town, September 27. H. G. FOURCADE.

RESEARCH LABORATORIES FOR WOMEN.[1]

THE session which we inaugurate to-day will in the future be regarded as of prime importance in the history both of Bedford College and of the higher education of London at large.

It will be remembered in the history of London, for in the course of it the Gresham Commissioners will issue their long-expected report. Whatever the nature of that report may be it will be important; most important if the Commissioners succeed in solving the difficult problem which has been proposed to them, and enlist in favour of their recommendations so strong a sentiment of public approval that a teaching university is at length established on the lines which they lay down. Important, though no doubt less important, if they add to the long list of failures to find the true solution, and thus only prove that another route to the desired end is barred.

As regards Bedford College itself, we meet this session under the shadow of a loss. Miss Martin, for many years the Lady Resident, who has done so much in helping to

[1] Inaugural address delivered at the Bedford College for Wome , by Prof. A. W. Rücker, F.R.S.]

guide our institution amid the difficulties which have surrounded it, has retired from her post. Many here have already had opportunities of expressing their regrets to her in person, but I feel sure that none interested in Bedford College would wish the first meeting of this session to pass without our conveying to Miss Martin the assurance of the affection with which she has inspired many generations of Bedford College students, or without our telling her once more of our hopes that she may enjoy for many years the rest she has so well earned.

In an inaugural address, however, it is natural to look rather to the future than to the past.

It has been thought well that the organisation of the College should be brought into closer approximation to that which obtains in most similar institutions, whether intended for the education of men or of women. We have now a Lady Principal. It would be impossible in the presence of Miss Penrose to express fully how much we hope from her in the future; it may be sufficient to say that we welcome her as the daughter of a distinguished scholar, and as one who has shown herself capable of climbing the very highest rounds of the ladder of learning. Miss Penrose was selected as Principal by the Council from among a group of candidates, of whom several would have adorned the post, and we believe that the large share in determining the future of Bedford College, which she must now take, has been placed in safe hands.

On the occasion of this new departure it may be well to consider how widely the position of those who are now engaged in working for Bedford College differs from that of its founders.

When the College was first instituted the very principle which it was intended to embody was disputed on all hands. It was denied that the doors of the Temple of Learning should be thrown open to women equally with men; that there is no crypt, however dark, no chapel, however sacred, which may not be entered by both alike.

That principle has now been vindicated. Women are working side by side with men in the same universities, competing with them in the same examinations, and proving by their successes that they can bear a worthy part in the intellectual strife of the schools.

But if in this respect the Council have not to face the prejudices which their predecessors overcame, they have to encounter new difficulties caused in part by the very success of the principle for which their predecessors contended.

Bedford College was the first institution designed for the introduction of women to the higher learning, but unfortunately, or, as the cause is greater than the College, I should perhaps say fortunately, it had no patent rights in the theory which it first illustrated. Rivals, friendly rivals, have sprung up, and in some respects they possess advantages we cannot claim.

Some share the charm of the surroundings and the prestige of the names of the older universities. Another, near London, has wealth to which we have not yet attained. As women's colleges have become more numerous, the beauty of their buildings has increased, the standard of their equipment has improved. To beauty of outward adornment we cannot in York Place pretend, but I would not have dwelt on this point to discourage you. Our laboratories, though small, are well fitted; the art studio, the class and lecture rooms are sufficient for all the claims that are at present made upon them, and we may truly assert that Bedford College, though without the advertisement of external decoration, is adequately equipped for its great task.

Another change which has taken place since Bedford College was founded is in the ideals of those who are engaged in promoting the higher education.

When the College was first inaugurated the great examination craze was at, or was approaching, its height. Since then we have learnt that that method of testing ability is not all-sufficient, and signs are not wanting of a growing disbelief in its efficacy, especially when applied to very advanced students.

The Education Department is laying greater stress on inspection and less on examination. In the University of London the note-books of the work done by scientific students in the laboratory are submitted to the examiners, thus recognising work done outside the examination room.

At Cambridge the Smith's prizes are given for successful theses instead of after an examination test.

To have completed an original research now carries a man further towards his fellowship than all the triumphs of the Schools.

In the University of London the degree of Doctor of Science is given without further examination, if the candidate can prove that he has added to knowledge on the subject he professes.

I am told that there is at present a movement on foot at Oxford for giving to those who have carried out a successful research, what is still to some Englishmen almost inconceivable, an examinationless degree.

It is perhaps chiefly in the mathematical and physical sciences that this movement is most noticeable, and it is largely based upon the growing conviction of both teachers and students, that it is, if not useless, at all events unsatisfactory to master all the intricacies of a mathematical or experimental machinery for investigating nature, if the knowledge gained with much pain and labour is not turned to account.

Every man who has solved a mathematical problem has done work which is, as far as he is concerned, original, and it is absurd to train men so as to endow them with a special facility for such work, and yet to do nothing to show them in what direction their exceptional attainments may be of real service.

A student who has mastered a science but complains that he can add nothing to knowledge, is like an athlete who has learned to run well on a cinder track, but fails on the high road.

More and more stress, then, is now being laid on the power both of teacher and students to use their knowledge. It is no exaggeration to say that original papers are produced in the principal London colleges by the score. If we turn to the provinces we find that the Commissioners of the 1851 Exhibition give scholarships to those among the provincial students whom their colleges recommend as capable of undertaking advanced scientific work. And here it may be noticed that examination has again been dispensed with. In the old days the candidates would have been selected after a centralised examination held in London, whereas now the Commissioners are content—and, in my opinion, very properly content—with the recommendation of responsible authorities.

In view then of this great change in the aims and objects of the higher education, I want to impress upon you that fact that if Bedford College, if women's colleges in general are to hold the high position which the success of their students in the examination room has won for them, they must become places, not merely for acquiring knowledge, but for adding to it. I do not think that it can be honestly said that up to the present time the success of women as investigators has, in spite of some notable exceptions, been as great as their rapid and extraordinary achievements as students would have led us to expect. Nevertheless, if the fundamental idea of our founders is to govern us in the future as it has guided us in the past, the students of Bedford College must distinguish themselves in the research laboratory as they have often distinguished themselves in the struggle for a degree. In undertaking this task, many of them possess one qualification for success which most men lack: they have, at all events, time at their disposal.

Do not let me be misunderstood. I am far from desiring that the students of Bedford College should leave its walls impressed only with the importance of adding to knowledge, and inclined to neglect other and, at least as urgent duties. In my opinion, no man or woman can afford to cultivate any one part of their nature to the exclusion of the others. Sad stories have sometimes been told of homes in which work has been done which will never be forgotten, but done at the cost of all the brightness and happiness which are usually associated with the name of home. This want of the sense of proportion, of the relative importance of different claims, casts a shadow on the brightest intellectual fame. I am not asking for such sacrifices. I believe that in general they are absolutely unnecessary. But where the over-mastering curiosity of the born investigator exists, it will find a career, which may indeed involve self-sacrifice, but which need make no harsh demand on others.

There are, to my knowledge, at the present moment a large class of men who are living more hardly than they otherwise might live, who are cheerfully surrendering days which might be given to pleasure or to money-making, and are spending laborious nights, simply because they are impelled by the desire to add something to the pile of knowledge which our race is through the centuries accumulating. It cannot but be that if the same spirit animated the women and girls of this generation, many would be found among them who, without neglecting any duty, would work with the same energy for the same object.

It is possible that some of my hearers may accuse me of holding up an impossible ideal. My answer is that the founders of Bedford College held up to their generation an ideal which was then regarded as impossible but which has nevertheless been realised. Women, if they please, can now be educated to the same high level as men. I in turn venture to hold up to you an ideal at which Bedford College should aim in the future. It is that it should be known as a place of learning as well as a place of education, as a place where not only is the number of those who know added to, but where knowledge itself is increased.

THE INNER STRUCTURE OF SNOW CRYSTALS.

THE ice and snow crystals photographed and described by me[1] may be referred to the following types.

I. Crystals developed in the direction of the vertical axis. (*a*) Hexagonal prisms. (*b*) Bottle-shaped prisms. (*c*) Needles.

II. Tabular crystals. (*a*) Hexagonal tables. (*b*) Stellated tables. (*c*) Dendritic tables.

III. Crystals equally developed along the vertical and lateral axes.

Among these groups, types I. (*c*) and III. are in no way different from the ordinary hexagonal crystals, and accordingly of less general interest. The former, I. (*c*), is common in drifting snow; to the latter belong the sharp edged hexagonal prisms *without cavities*, which compose the under layers of the snow covering. They are never found among the snowflakes, and are accordingly originated by a molecular change in the snow covering. Type II. (*c*) comprises the relatively large dendritic crystals with complicated ramifications which are visible even to the naked eye as handsome regular stars. They have been figured and described by several observers, from Claus Magnus and Keppler to Scoresby and Glaisher, and I shall therefore not dwell upon them in the present paper. Of the remaining extremely interesting types (I. *a*, *b*; II. *a*, *b*), which, owing to their microscopic dimensions, have hitherto received no attention from men of science, I give a brief description.

I. (*a*) *Hexagonal Prisms.*

Fig. 1 shows the commonest type. It is bounded by the basal planes and the hexagonal prism, and of interest on account of the *hour-glass shaped cavities* invariably present within the crystal. These are, as shown by the figure, widest near the two basal planes, where they are bounded by a negative hexagonal prism; nearer the centre they contract again to expand in the form of two bulbs, elongated to points and confluent. The shape of the cavities is almost always the same. Crystals of this type are very small (about 0·5 mm. long), and the inner structure only distinguishable under the microscope. They are common in drifting snow.

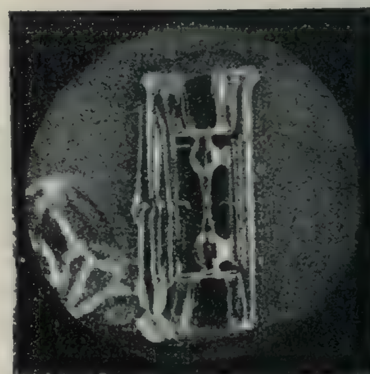


Fig. 1.

I. (*b*) *Bottle-shaped Prisms.*

The bottle-shaped crystals of elongated, prismatic form have the appearance shown in Fig. 2. Like the crystals of the preceding type, they are bounded by an hexagonal prism and the basal plane; but one end is pointed, and the crystals accordingly hemimorphic. The bottle-shaped crystals also contain cavities, less regular, however, than those in the crystals of the preceding type. The following circumstance attaches a special interest to these crystals. On February 8 there was a rather sparse fall of agglomerations of bottle-shaped crystals such as are shown in Fig. 2. *The cavities in these crystals proved under the microscope to*

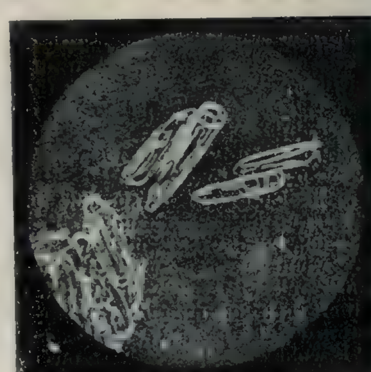


Fig 2.

[1] "Geol. Foren. i Stockh." Forh. Bd. 15, p. 146.

contain water in which one could sometimes (as in Fig. 2) *discern a small air-bubble*. On the day when this snowfall occurred the temperature was −8° C. Still there was a continual dripping of water from the house roofs, in spite of the fact that the sky was overcast, and the sun thus could not contribute to melt the snow. The dripping continued even at midnight in a temperature of −12° C. Shortly after the fall of snow a transformation could be observed in the crystals; on the surface of the snow they had passed from prismatic bottles to hexagonal tables *without any cavities*. The above described fall of small ice-bottles containing water, a phenomenon, as far as I know, new to meteorologists, combined with the transformation of the crystals after their descent, affords a simple explanation of the fact that, in spite of the severe cold, the new-fallen snow was so saturated with water as to cause an incessant dripping from the roof.

II. (*a*) *Hexagonal Tables*.

To the naked eye these crystals look like small, lustrous scales. Their dimensions vary between 0·8 and 1·4 mm. Under the microscope they prove to contain regular cavities, remarkable as being bounded not by planes, but, contrary to the accepted principles of crystallography, by *regularly distributed curved surfaces*. The limits of these cavities are shown under the microscope as fine black markings, to which, on account of their resemblance to forms within the organic world, I have applied the name of *organoid* lines, cavities, and formations. The following

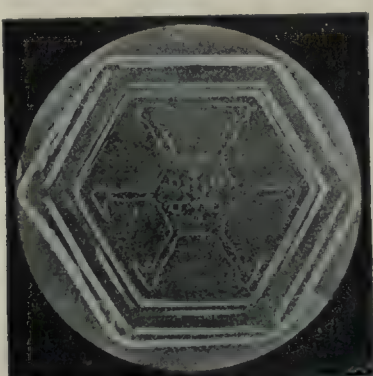


FIG. 3.

example will illustrate the structure of such crystals, including such organoid cavities. The snow-crystal (Fig. 3) shows in the centre a handsome star. The crystal is composed of two (or more?) superimposed tables, with the same orientation. The different hexagons indicate the outer limits of these tables. Two tables are united by a stratum, which has the outlines shown by the stellate figure. Within this figure the crystal is therefore homogeneous; without the same, its two different layers are separated by a flattened cavity, bounded by sinuate surfaces, and probably containing air. The same star includes some extremely regular cavities of smaller size. On this table we can observe a hemihedral development, the six triangular fields into which the hexagon is divided by lines drawn between the centre, and the angles being only alternately equal to each other. Such a hemihedry is the rule in this type. It is most developed in some almost triangular tables that occur among the equilateral hexagons. The above described structure, two tables united by a stellate layer of ice, is the general rule in the tabular ice crystals.

The organoid figures show a great multiplicity of forms, but the fundamental type is the same in all of them. It is evident that their outlines are fixed by certain crystallographic laws yet unknown to us. We might possibly find in these organoid formations, which so strongly remind us of shapes in the world of life, a clue to the mathematical laws of the structural outlines of organisms. Or perhaps these remarkable organoid figures are caused by microscopical aërozoic organisms, around which the crystals have developed. I hope next winter to be able to collect observations for the answering of this question

II. (*b*) *Stellate Tables*.

Figs. 4–6 show some of the countless modifications exhibited by crystals of this type. The central table often shows beautiful organoid figures sometimes hemihedrally developed and regularly orientated cavities. Similar

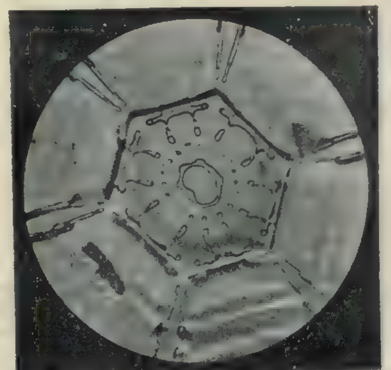


FIG. 4.

cavities, usually of very minute size, are with great regularity distributed in the arms of the star.

The ramification of the plates has some connection or other with the orientated cavities. Through each arm of the six-sided star runs what may be called the *main nerve*, which originates either in the central plate or just outside it. This nerve is present in all the tables and dendritic stars with elongated arms. The main nerve is bounded by two fine, parallel *gas canals*.

The first beginning of these canals consists of two or

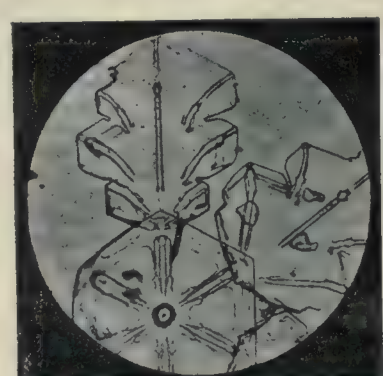


FIG. 5.

four small cavities with parallel orientation. In the continuation of these small cavities lie larger ones, often prolongated to extended canals (see Fig. 4). Owing to evaporation on the surface of the crystal, these canals gradually become open, first at one end, and then along a part or the whole of their extent, only the ridge that divides them remaining as a *nerve* (Fig. 5). That these canals are really cavities in the ice I have ascertained by observing and photographing snow crystals in a coloured liquid.

I found that the liquid gradually penetrated into and filled the canals which were open. Fig. 4 shows the central parts of crystals with canals partly filled with the coloured liquid. Near the centre small air-bubbles are still visible. Fig. 6 is the central part of a star powerfully magnified. The interesting structure may be judged by the photograph.

Phenomena attending the Compression of Snow Crystals.—A stellate plate was slowly compressed by screwing down the objective upon the cover-glass. After this pressure it was still entire. In the interior of the crystal *new curvilinear figures or pressure lines had appeared*, following a regular course analogous to that of the organoid figures. This analogy suggests that the latter may possibly be explained as tensional phenomena.

Exceptional Symmetrical Conditions.—The fine cavities in the centre of the stars are sometimes regularly ar-

FIG. 6.

ranged after only *two* symmetrical planes at right angles to each other and of different value (see Fig. 4), in accordance with the symmetrical conditions that we find in crystals belonging to the orthorhombic system.

Hoar-frost.—In addition to the photographing of snow crystals, I have also examined and reproduced by photography crystals of hoar-frost deposited on window-panes. Even these crystals formed often hexagonal tables, but were entirely without the remarkable cavities observed in snowflakes.

The investigations of which I have here given a brief account show that the structure of snow crystals is very complicated, and display several peculiarities which, so far as we know at present, are unexampled in other crystals. I hope to be able to resume these investigations next winter on a more extensive scale, in order to obtain, if possible, a complete elucidation of the interesting phenomena alluded to in the present paper.

G. NORDENSKIÖLD.

BÜTSCHLI'S ARTIFICIAL AMŒBÆ.[1]

PROF. BÜTSCHLI, of Heidelberg, so well known by his valuable work on the Protozoa, and his contributions to Bronn's "Klassen und Ordnungen," has, in the monograph under review, approached a subject of deep interest and great difficulty, namely, the cause of protoplasmic movement. His researches in this direction are already known to readers of the *Quarterly Journal of Microscopical Science*, for in 1890 Prof. Lankester inserted a letter from Prof. Bütschli, in which the latter gave a short account of his experiments. In the present monograph his researches are given in a completed form and in great detail. The gist of the whole subject may be put as follows:—Prof. Bütschli makes an artificial oil and water emulsion in a way suggested by Nuincke, and finds that under certain conditions drops of this emulsion exhibit streaming movements and changes of shape: according to Prof. Bütschli, protoplasm is itself a natural emulsion, and the streaming and amœboid movements of protoplasm are, like those of the artificial emulsion, due to surface tension.

Working at emulsions, Nuincke had previously found that if substances soluble in water be finely powdered and rubbed up with oil, and the oil subsequently surrounded with water, the latter diffuses into the oil, which it converts into a foam or emulsion of little water droplets closely packed together in the oily matrix. The emulsion may obviously be compared with the sea-foam, in which we find air globules closely packed in a water matrix, the oil in the emulsion and the water in the sea-foam having an alveolar or honeycomb build or form. The Nuincke emulsion is obviously, too, the reverse of the emulsions made by Johannes Gad with weak K_2CO_3 and oil, in which the oil droplets lie closely packed in a water matrix; it is also the reverse of the numerous emulsions made every day by the druggist who uses oil in mucilage, malt-extract, &c. When Bütschli first tried the Nuincke method he used common salt, sugar, and nitre, taking these as examples of substances readily soluble in water. He succeeded, however, better by using Na_2CO_3, or K_2CO_3, and proceeded as follows. The salt, preferably K_2CO_3, was obtained pure and dry, and was finely powdered in an agate mortar. He then breathed upon it until it was slightly moist, and rubbed it up with olive oil until a thick white paste was formed. A tiny drop of the paste was then placed on the centre of a cover-glass, and inverted over a drop of water, and in order that the drop might not be pressed out of shape by the weight of the cover, the latter was supported by little pellets of wax or paraffin. The preparations so obtained were placed on one side in a damp chamber for twenty-four hours, and then washed out with water by inserting a piece of blotting-paper into the chink between the slide and cover, and supplying fresh water at the opposite side of the cover by means of a pipette. The water was then replaced by equal parts of glycerine and water, after which the drops of emulsion became clear and transparent, exhibiting changes in shape and streaming movements very much like those of an amœba. It appears that the consistency of the olive oil is a very important factor in determining the successful issue of one of these experiments. Ordinary oil is of no use, it must be kept for some time in an open vessel, though the time may be shortened by keeping it in a hot-air chamber at 50°C. and testing the oil from day to day. It must be thick and viscous, but not too much so.

When examined by the aid of a microscope the emulsion appears as a network of oil enclosing the water droplets, for the structure is, of course, seen in optical section. Curious streaming movements may be observed within the emulsion, and these may continue for hours; movements of the drop as a whole occur, and always in the direction of the stream. If the emulsion drop be carefully watched it will be seen to change its shape, and to throw out processes—which, by the way, are always club-shaped—and to withdraw others. Up the centre of these processes a streaming movement takes place, and the streams at the tops of the processes spread out and flow back in a layer next the surface. These movements are influenced by warmth and electricity, and we have, therefore, in these Bütschli's drops something which might deceive one into supposing that actual amœbæ were in the field of observation.

The movements of the oil emulsion are due, no doubt, to changes in the surface tension of the fluids in contact with each other, Bütschli's case being an illustration of

[1] "Untersuchungen über mikroskopische Schäume und das Protoplasma." Von O. Bütschli. (Leipzig: Wilhelm Engelmann, 1892.)

the effects of surface tension, effects which are more simply shown in the contracting films, and tears of wine of the laboratory and dinner-party. It is well known that surface tension is capable of producing important and curious changes in the form of fluids, and will induce well-defined movements of a streaming character; surface tension, and the movements resulting from it, are modified and influenced by heat and electricity, and many biologists have suggested that surface tension may play an important part in producing amœboid movement. Prof. Bütschli takes many steps in advance of this; for having formed his artificial emulsion, he sees in all living protoplasm nothing but a similarly constructed emulsion, and concludes that because it is so similar its movements must be of the same nature. We feel in reading his work that not only does he in his enthusiasm twist the appearances of protoplasm to suit his own especial view of what its structure must be, but he is guilty of want of logical treatment of his premises when he has got them. Frommann, Hertzmann, Klein, and, indeed, most histologists regard protoplasm as consisting of a network of less fluid material, the interstices of which network are filled with a more fluid material, and this structure has been demonstrated in almost every animal cell. This view of the nature of protoplasm is open, however, we think, to criticism, for histologists are in the habit of preserving and hardening their tissues in fluids such as alcohol, picric acid, corrosive sublimate, which act as precipitants to protoplasm, and they blindly conclude that what they see in these preparations are present in the living cells. On this account many have questioned whether these networks are ever present in the living cells, and Berthold and Bütschli view living protoplasm as an emulsion of two fluids, one forming an alveolar honeycomb, the other filling its cavities. This honeycombed structure—emulsion—Bütschli finds everywhere, from the protoplasm of the protozoa to that of the higher vertebrates; where there was once a network now there is an emulsion. The interfibular substance of muscle mistaken by a few observers for a network is, for Bütschli, a honeycomb with frequent transverse partitions, and the fibrillated axis cylinder of a nerve has cross strands indicating that this is a honeycomb too. In the apparently structureless protoplasm of the outer part of an amœboid cell, such as is figured by Schäfer in the last edition of "Quain's Anatomy," this structure is present to Bütschli, and as he cannot see it there, even with the eye of faith, it is believed to be too delicate and the meshes too finely drawn out to be seen.

As to the chemical nature of protoplasm, about which most biologists who have had anything of a chemical training feel themselves rather in the dark, Prof. Bütschli has fairly definite views, and these it must be admitted fit in admirably with the emulsion theory. The honeycomb he regards with Reinke as a nucleo-albumen, containing some molecules of a fatty acid, and not miscible with water; the more fluid portion of protoplasm, filling the interstices of the honeycomb, he regards as a watery fluid containing albumen and an alkali free or combined with it.

Holding the above views concerning the structure of protoplasm, which indeed, according to Bütschli, resembles both in minute anatomical structure and chemical and physical properties the microscopic froth which he can manufacture, he looks upon the cause of the movements of the froth as the cause of the movements of the amœba, and also in all probability of striped muscle itself. Let Prof. Bütschli speak for himself:—

"Die Bewegung einfacher Amöben, wie A. guttula, limax, A. blattæ, Pelomyxa, ist den früher beschriebenen strömenden Oelseifenschaumtropfen so ungemein ähnlich, ja in allen wichtigen Punkten, so ganz ihr Ebenbild, dass ich von der Uebereinstimmung der wirksamen Kräfte in beiden Fällen vollkommen überzeugt bin" (page 198, see also pages 200 and 208.)

Now, for some time past it has been held that surface tension plays a part both in the streaming movements of protoplasm and in the production of amœboid movement, but no one has pushed this idea to the extent that Bütschli has done. Let us see if the facts of the case justify him in so doing. It is true that the picture of the moving foam and of the moving protoplasmic mass present many points of similarity to the eye of the observer, but what of that? The waxwork figure may deceive us all into imagining that it is a man, but once we know what it is the most ignorant of us would hardly venture to argue from its mechanism to our own. So when we look at Bütschli's foam particles, and when we are told that they do not consist of protoplasm, and merely of rancid olive oil and a weak carbonate of potash, then we may exclaim at their interest and novelty, but we shall not seriously compare them with living protoplasm. Science is passing through two phases—the first spiritualistic, the second mechanical. Psychology is still very much in the first stage, and physiology in the second. There are still those among us to whom the circulation is a thing of tubes and force-pumps, and nothing more, and absorption a process that can be imitated by a parchment dialyzer. Fortunately, we are getting rapidly through these two stages, and are beginning to recognise that the force-pump and parchment paper have led us often into wrong conclusions. Studies in evolution have taught us that protoplasm, made up no doubt of elements of the inorganic world, is nevertheless a complex of these elements of unique character, and with properties distinct from everything that is not protoplasm. The oil emulsion may, to the eye of the observer, conduct itself in a way exactly similar to an amœba—which, by the way, it does not, its processes being club-shaped, and never pointed—but this does not indicate that amœboid movements are similar in their nature. With equal right would the to-day representative of Madame Tussaud urge, on the strength of their waxwork show, that human arms move by springs and clockwork. Not only do these foam particles tell us nothing about protoplasm, but for the investigation of questions of surface tension they are evidently ill fitted. They are toys for the physicist, not for the physiologist. We know that surface tension can well account both for changes in shape and flowing movements of fluids; it is only by experimenting on protoplasm itself that it will be possible to determine what part this agency plays in protoplasmic activity.

In Professor Bütschli's work the reader will find much valuable information as to the views held from time to time as to the structure of protoplasm; and the production of this monograph is a strong indication of the single-mindedness both of German scientific men and of German publishers. It is a large quarto volume of two hundred and thirty pages, well printed, and illustrated with six beautiful plates, and upon a subject which of necessity appeals to a very limited number of readers.

JOHN BERRY HAYCRAFT.

FINGER-PRINTS IN THE INDIAN ARMY.

IT may interest some of your readers to see the terms of the order by which the method of finger-prints for purposes of identification has now been introduced into the Indian Army. A copy of it, sent by Lieut.-Colonel Surgeon Hendley, of Jeypore, has just reached me.

Army Headquarters, Medical Division, Simla, August 25, 1893.

In continuation of this Office Circular, No. 5, dated January 16, 1891, it is requested that as a means of identification of recruits for the Native Army, examining medical officers will cause an impression in printer's ink of the ends of the first three fingers of the right hand of each recruit passed by them as fit for the service, to be made on the Nominal Roll opposite the name of the recruit; and in the case of the Army Hospital Corps, in the Verification Roll.

A specimen of the required impression is shown below.

By order.

(Signed) C. H. Pearson, Surgeon-Major,
Secretary to the P.M.O., H.M.'s Forces in India.

[Here follows the specimen impression.]

I trust that the medical officers who will have to take these prints, understand the importance of using so little ink that the impression shall be *clear*, though its tint may be only brown and not black; also that when comparing two prints they will use a low power lens and four pointers, two for each print. I have lately been using a watchmaker's glass of two-inch focus, secured to the end of a long and counterpoised arm, which turns, not too easily, round the screw by which it is attached to its support. The lens can be brought into focus with great ease, and it remains steady when left alone. I use at least two pointers for each print. They are T-shaped; their long arms are six or seven inches long, they are roughly made of wood as thick as the thumb, so that they are purposely not over light. Each pointer stands on three supports, viz. on the point of a bent pin, whose headless body has been thrust into the end of the long arm of the T, and on the ends of two nails, or better on staples, one of which is driven under either end of the cross-arm. It is most easy to adjust the point of the bent pin upon any desired character in the finger-print. Both hands of the observer are thus left free to manipulate other pointers, when desired. The stationary pointers are a great help in steadying the eye while pursuing a step by step comparison between two finger-prints.

Francis Galton.

NOTES.

The collected works of Jean Servais Stas, which it is proposed to publish as a mark of honour to his memory, form three quarto volumes of about 500 or 600 pages each. The first volume contains the memoirs and papers relating particularly to the determination of atomic weights; the second comprises notes, reports, and lectures; and the third, posthumous works, which especially refer to spectroscopic researches. The edition is under the direction of MM. Spring and Defaire, and it will probably be completed in about a year. The three volumes will be published simultaneously at the uniform price of thirty francs. Subscribers of twenty francs or more to the Stas memorial fund will each receive a copy of the work, and contributors of less than twenty francs may increase their contributions to that sum, and so become a recipient. The names of subscribers will be published in an appendix to the third volume. After the completion of publication, the balance of the fund will be used for the erection of a monument. Stas' scientific work is more than sufficient to perpetuate his name among men of science, and the monument which it is proposed to erect will make it "known to all people."

At the second day's meeting of the Photographic Congress, the opening of which was noted in our last issue, Mr. Andrew Pringle read a paper on "The Present Position of Micro-Photography," and W. Weissenberger contributed one on "A Process of Photo-Mechanical Printing in Natural Colours." The president, Capt. Abney, read a paper dealing with "Exposure and Chemical Action," in which he showed that the sum of excessively small exposures is not equivalent to the same exposure given at one time, and further, that very feeble intensity of light fails to produce the calculated amount of chemical action. Capt. R. H. Hills followed with a description of the instruments employed and the results obtained during the recent solar eclipse. At the final meeting of the congress, on October 12, Dr. A. Miethe read a paper on "The Practical Testing of Photographic Objectives," and Dr. P. Rudolph one on "The Measure and Numeration of the Stops of Photographic Lenses."

A statue of Duhamel-Dumonceau was unveiled at Pithiviers, on October 1. The French Minister of Agriculture, who performed the ceremony, claimed that Dumonceau was the first to institute agricultural experiments in the field.

Dr. H. Möller has been appointed Professor of Botany in the University of Greifswald.

At the meeting of the International Geodetic Association, recently held at Geneva, a Commission, composed of M. Tisserand, with Profs. Foerster and Schiaparelli, was appointed to draw up a programme of observations to be made permanently at a number of different places in order to elucidate the question of latitudinal variations. The association will hold its annual meeting in Austria next year.

The *Lancet* says that the Apothecaries' Society are about to apply to the courts for powers to sell their Botanical Gardens at Chelsea, the money value of which has been fixed at about £30,000. The removal of this historic garden would be a source of keen regret to the many who have profited by the instruction conveyed by its means.

We are informed that the fund raised for paying the costs of Dr. Wallis Budge in the recent action of Rassam *v.* Budge has been fully subscribed. The list of the contributors, which is too long to print in its entirety, includes the following names:—Miss H. M. Adair, the Duke of Argyll, K.G., K.T., Lord Armstrong, C.B., the Marquis of Bath, Walter Besant, Dr. C. Bezold, Rev. H. Blunt, E. A. Bond, C.B., the Earl Cadogan, K.G., the Earl of Carlisle, Somers Clarke, N. G. Clayton, Miss Clendinning, Alfred Cock, Messrs. Thos. Cook and Son, Sir John Evans, K.C.B., F.R.S., Sir W. H. Flower, K.C.B., F.R.S., C. Drury Fortnum, A. W. Franks, C.B., F.R.S., Right Hon. W. E. Gladstone, M.P., Rev. Canon Greenwell F.R.S., Major-General Sir F. Grenfell, G.C.M.G., K.C.B., H. Rider Haggard, Lawrence Harrison, Thomas Harrison, James Hilton, Thomas Hodgkin, Sir H. H. Howorth, K.C.I.E., M.P., F.R.S., Right Hon. Thomas Huxley, F.R.S., Sir Frederick Leighton, Bart., P.R.A., William Lethbridge, Rev. W. J. Loftie, Right Hon. Sir John Lubbock, Bart., M.P., F.R.S., Lady Meux, F. D. Mocatta, Walter Morrison, Sir Frank Mowatt, K.C.B., Sir Charles Nicholson, Bart., D.C.L., the Duke of Northumberland, K.G., F. G. Hilton Price, Hon. W. F. D. Smith, M.P., E. Maunde Thompson, C.B., Cecil Torr, Sir Reginald Welby, G.C.B., John White.

New and extensive electrical works were inaugurated at Blackpool at the end of last week. In the course of a speech made during the celebrations, Lord Kelvin expressed the opinion that municipal corporations were right to take into their hands everything calculated to further the general good of the borough. It seemed to him that the Government ought to take up the whole business of telegraphs and telephones, and it would not be an improper thing if the whole railway system of the country were placed under the same management.

An International Congress on Aerial Navigation formed one of the series of congresses which have recently been held at Chicago. The papers read on that occasion are being published in the form of a supplement to the *American Engineer*, together with other information relating to aeronautical engineering. The new publication is given a distinctive title, *Aeronautics*, but whether it will be continued after the whole of the proceedings of the aeronautical conference have been issued will depend upon the success of the enterprise.

The first International Botanical Congress ever convened on American soil was held at Madison, Wis., immediately after the adjournment of the American Association for the Advancement of Science, August 23 and 24. The foreign representation, however, was so small that the title of the meeting was changed to the "Madison Botanical Congress." The meeting was an outgrowth of that at Genoa last year. Prof. E. L. Greene, of California, was elected president. All the subjects discussed at the meeting referred to terminology, the following being the topics:—(1) Plant diseases; (2) anatomy and morphology; (3) physiology; (4) horticultural forms; (5) bibliography. It is expected that the next meeting will be held in Europe in 1894, but the precise time and place was not announced.

That Traugott Friedrich Kützing, the author of the *Phycologia generalis*, should have been still with us until within the last few weeks will probably be a surprise to many. As an author, Kützing had indeed completely disappeared from the scientific world; he had published nothing for more than twenty years, and nearly all his most important works appeared before the close of the first half of the present century. He may indeed be regarded as the founder of a scientific study of the Algæ, especially of sea-weeds. Much of his work has, of course, been superseded by more recent investigations; but his *Phycologia generalis*, published in 1843, his *Tabulæ Phycologicæ*, issued in twenty volumes from 1845 to 1870, with 2000 illustrations, and his *Species Algarum*, 1849, are still classical works, which must needs be in the hands of every student of the lower forms of vegetable life, if it is only for the excellence and life-likeness of their illustrations. In 1841 he published the *Umwandlung niedrer Algenformen in höhere*, and in 1844 the *Die kieselschaligen Bacillarien oder Diatomen*, the introduction to our knowledge of the structure of the diatom-shell, in which there is now so extensive a literature. Kützing died on September 9, at Nordhausen, in the 87th year of his age. His extensive collection of dried Algæ has long been in the possession of the University of Leyden.

Mr. G. W. Young has issued "A Key-table showing the characteristics of the principal Natural Orders of the British Flora," compiled for the use of students. A very brief synopsis is given of the leading characters of each natural order, and a familiar plant is mentioned as a "type." A few small corrections might be made in a subsequent edition. Thus, *Dielytra spectabilis* is the gardener's, not the scientific, name of the plant indicated; in the Caryophyllaceæ the "free central placentation" is by no means universal.

Few geographers of the present day enjoy so wide a reputation as Baron F. von Richthofen, Professor of Geography in Berlin University, and it is pleasant to observe the fitting way in which his former students did honour to the sixtieth anniversary of his birth on May 5, 1893. Many of them wrote papers, either on geographical or geological subjects, for special publication in the form of a handsome book, "Festschrift," bearing Baron von Richthofen's portrait as frontispiece. Among the contributors we note the names of A. Philippson, F. Frech, H. Yule Oldham, C. E. M. Rohrbach, and E. Hahn.

Dr. A. Philippson's contribution to the "Festschrift" is an interesting investigation of the "Types of Sea-coasts" (Ueber die Typen der Küstenformen). Dr. Philippson insists upon the study of the simplest types of form and the individual relationship of these types to the groups of natural agents which produce them. He shows how all sea-coasts may be reduced to two great and fundamental types. (1) Isohypsal coasts, where the existing form of the coast-line still coincides with the primary relief of the earth's surface at that part, so that we may trace its origin from tektonic, volcanic, or other earth movements. (2) Thalassogenic coasts, where the primary isohypsal condition of the coast-line has been in greater or less degree obliterated by the action of "littoral forces." Dr. Philippson gives particular prominence to the flat-beach variety of thalassogenic coasts, and describes in detail the purely potamogenic type due to the action of inflowing rivers, the purely thalassogenic type due to the action of breakers, and to the building-up and breaking-down of "strand-walls." Lastly, the mixed potamogenic and thalassogenic type combining the characteristics of both. Numerous examples are drawn from familiar European coast-lines, and several diagrams are given.

A paper on "The Mechanical Genesis of the Form of the Fowl's Egg," was read before the American Philosophical Society on April 21. In it Dr. J. A. Ryder gives evidence that the configuration of the outline of the hen's egg is determined by mechanical means while the egg membranes and shell are in the process of formation within the oviduct. "The pressure preventing the passage of the elliptical mass down through an elastic tube must be developed largely in the form of friction, and the resistance of the walls of the oviduct to dilation. To overcome this a greater pressure must be exerted on the elliptical egg-mass at a point above its minor axis than below the latter. This will tend to squeeze part of its substance, since it is at last enclosed in an elastic capsule before shell-formation takes place, into the lower or larger end of the mass. In this way the ovoidal form of the egg seems to have first arisen." It therefore appears that the development of the figure of the eggs of birds is a purely dynamical problem, or one in which energy is applied in a definite manner to the plastic surface of a mass in statical equilibrium within the oviduct. This principle has many extensive applications, and may lead to the elucidation of several obscure points connected not only with the eggs of birds, but also those of reptiles and insects.

In a letter to *Science* for September 15, Mr. O. T. Mason relates the discovery at the World's Columbian Exposition of two examples of the Mexican atlatl, or throwing-stick, lying in the Colorado Alcove. His description is as follows:—The shaft is a segment of a sapling of hard wood. At the distal end is a shallow gutter and a hook to receive the end of a spear-shaft. At the proximal end or grip in the more perfect specimen, about four inches from the extremity, is a loop on either side of the stick, one for the thumb, the other for the forefinger. The remaining three fingers would be free to manipulate the spear-shaft. These loops were made by splitting a bit of raw hide, sliding it down the proper distance on the stick, forming loops less than an inch in diameter by bringing the projecting ends of the raw hide, and seizing it fast to the shaft. Below the finger-loops or stirrups were a long chalcedony knife or arrow-blade, the tooth of a lion, and a concretion of hematite seized by a plentiful wrapping of yucca cord. Mr. Mason believes that the Bourke example from Lake Patzcuaro belongs also to the same outfit. This is the first instance, as he says, of "finding the ancient atlatl figured in the codices, and described by Mrs. Nuttall." A connection between the cliff dwellers and the Mexican peoples is thus indicated.

Dr. G. Schott contributes to a recent number of *Globus* an account of the Atlas of the Indian Ocean, published by the *Deutsche Seewarte*, with particular reference to the behaviour of the storms of the tropical part of that ocean. The article plainly shows that whereas some twenty years ago the Germans were dependent on the labours of English seamen for their sailing directions, they now rely almost entirely on their own publications, except as regards nautical charts. Dr. Schott gives an intelligible account of the older or circular theory of storms, and of the later, or spiral theory, to which attention was drawn by Dr. Meldrum, in 1860. If the former theory be correct, a ship which in a given position might safely run across the path of an advancing storm, would according to the later theory run into the most dangerous part of it. Between these theories seamen must therefore have great difficulty in shaping a correct course at the most critical time, and every careful investigation into the movements and laws of storms should be welcomed, in the interest of science, whether undertaken by this country or by foreign nations.

IN connection with the science meetings at the Chicago Exhibition, Dr. M. A. Veeder read a paper on periodic and non-periodic fluctuations in the latitude of storm tracks, in which he referred to the occasional rearrangements in the distribution of the atmosphere, consisting, in the main, in the displacement of the belts of high pressure on each side of the equator, with the consequent deflection northward or southward of the usual courses taken by storms. Notable instances of this kind have occurred at different times, such as in 1877–8 and in 1888–9, and the present year also affords another example, the winter in northern latitudes being distinguished by a severity in strong contrast to their mildness during the years above mentioned. These rearrangements of weather conditions on a large scale make it difficult, the author considers, to resist the conclusion that the atmosphere as a whole is under the control of forces which have a common origin, and depending upon some form of solar variability. Although it is not yet beyond dispute whether the sun is hottest or coldest when most free from spots, the evidence appears conclusive that the weather conditions in question bear some sort of relation to the spottedness of the sun. The author thinks that there is ground for the belief that there may be special forms of solar activity not yet fully understood, which exercise powerful terrestrial effects independently of the amount of solar heat falling upon the earth as a whole, and which may be of the nature of electro-magnetic induction, and depend upon conditions different from those which appear in the case of simple radiation from a source of combustion. If the variation in weather types follow the solar electro-magnetic record, he thinks that it would not be unwise to approach the problems from this side of the question, although it would involve a reconsideration of the facts of meteorological science from a standpoint different from that of an assumed variability of solar heat. The author considers that it may be necessary o discard provisionally the accepted theory of the origin of storms, in order to determine the part which electro-magnetic induction of solar origin plays, independently of heating effects. In any case, the study of periodic and non-periodic fluctuations in latitude of the cyclonic and anti-cyclonic belts surrounding the earth is most important in many ways.

A CONVENIENT modification of the hydrometer method of determining the densities of gases has been devised by M. Meslans, whose apparatus is described and illustrated in the *Comptes rendus*, No. 11. It consists of two hollow spheres hung to the arms of a balance. Each sphere, which is made of glass, aluminium, or gilt copper, hangs in a separate compartment, the suspending thread being introduced through a hole in the lid. The compartments are enclosed in a box and surrounded by water in order to keep them at equal temperatures. They are at first filled with air to determine the position of equilibrium. The gas whose density is to be determined is then introduced through a long tube immersed in the water, and enters one of the compartments, having previously been dried. The gas is passed through in a slow and continuous stream, and if its density differs from that of air, the equilibrium of the balance is disturbed. The weight necessary to re-establish equilibrium is noted, and the density calculated according to a simple formula. Thus the density is found by a single weighing, and by keeping the current of gas continuous any variation in its density is easily observed. A fairly high accuracy is attainable, depending upon the sensitiveness of the balance and upon the perfection of gauge of the spheres. One important application of the apparatus is that for determining the density and composition of the products of combustion in furnaces. The scale of the balance is graduated so as to show at a glance the percentage of carbonic acid, and hence the degree of efficiency of the furnace in question. This percentage, which is 21 theoretically, never exceeds 18 in practice, except in gas generators. In a great number of works it varies between 6 and 8. M. Meslans' apparatus is being applied to the study of the various methods of heating. Another application is that by which the presence and percentage of marsh-gas is indicated. With spheres of 1 litre capacity and a balance sensitive down to half a milligramme it was found possible to detect 0·1 per cent. of methane in the air of a mine.

THE *Electrical Review*, in the course of an article on "Electrical Engineering at the World's Fair," describes the curious rotary effects of a two-phase alternating-current field-magnet. A ring-armature is wound with four coils, connected in pairs across the circle; one pair is connected to one of the two-phase currents, the other pair to the second current. The ring-armature is then laid horizontally on a table, and a board placed over it. Almost any metallic article placed on the board immediately begins to run round above the ring. Copper balls, coins, &c., or any other easily movable conducting article will at once get into motion.

THE October number of *Mind* contains an article on theories of light-sensation, by Mr. C. L. Franklin.

MR. GEORGE HOGBEN has sent us two papers extracted from the Transactions of the New Zealand Institute, 1892, and referring to earthquakes experienced at the Antipodes in June, July, and December, 1891.

THE lecture on "The Interdependence of Abstract Science and Engineering," delivered by Dr. W. Anderson, F.R.S., at the Institution of Civil Engineers, in May last, has been extracted from the Proceedings of the institution, and is now published separately.

A COURSE of lectures upon Planetary Astronomy, with especial reference to "The Planet Venus" will be delivered in the theatre of Gresham College, on the evenings of October 24, 25, 26 and 27, by the Rev. E. Ledger.

A HANDY book on "The Art of Projection and Complete Magic Lantern Manual," by an expert, has been published by Mr. E. A. Beckett, Kingsland-road, N.E. Lantern operators will find in it many useful hints upon matters of manipulation.

MESSRS. WHITTAKER AND CO. have published the "Principles of Fitting," for apprentices in engineering and students in technical schools, by a Foreman Pattern Maker. The book is profusely illustrated, and should be of great assistance to the workers for whom it is intended.

STUDENTS preparing for the examination in the "Principles of Mining" held by the Department of Science and Art, or for colliery managers' examinations, are recommended to use an elementary text-book of "Coal Mining," by Mr. Robert Peel, just published by Messrs. Blackie and Son. The book is very well written and quite trustworthy.

A DAINTY brochure, by Martha F. Sesselberg, entitled "In Amazon Land," and containing adaptations from Brazilian writers, with original selections, has been published by Messrs. G. P. Putnam's Sons. The part of the book of interest to us refers to Amazonian legends, beliefs, traditions, and superstitions.

A SECOND edition of "An Introduction to Human Physiology," by Dr. A. D. Waller, F.R.S., has been published by Messrs. Longmans, Green and Co. Several alterations and transpositions of text have been made, and the results of many recent investigations have been included, thus giving additional value to an already highly appreciated work.

WE have received the Transactions of the Sanitary Institute, vol. xiii. The volume consists chiefly of reprints or abstracts of the papers read at the conferences which were organised in connection with the congress held at Portsmouth in 1892. It also includes an address to sanitary officers, delivered by Sir Douglas Galton at Worcester.

A CLASSIFIED list of plants in the Royal Botanic Gardens, Trinidad, has been issued as a *Bulletin of Miscellaneous Information*, No. 17, by Mr. J. H. Hart, the Superintendent. The list contains the names of plants under cultivation and indigenous in the Gardens, and is of scientific as well as economic interest.

DR. KICUCHI, of Tokyo, has just published, in Japanese, a text-book on Trigonometry, thus carrying on the good work he has begun in his manuals on Geometry, Logic, &c., and in his translations of "Clfford's Common-sense of the Exact Sciences," of "Russell's Technical Education," &c. The degree of Rigakuhakushi (= D.Sc.) is a degree conferred by the Minister of Education with the advice of the Council of the University.

LIEUT. J. P. FINLEY has prepared a report on "Certain Climatic Features of the Two Dakotas" for the U.S. Department of Agriculture. The report is illustrated with 163 tables, charts and diagrams, and it presents a vast amount of information concerning the meteorological phenomena which are believed to have a marked influence upon the agricultural interests of the States investigated. From the report it appears that the Dakotas should at once resort to an extensive system of irrigation in order to increase the precipitation and check the high evaporation. Forests ought also to be preserved, and extensive plantings of trees should be made. In the words of the report, "The meteorological and physical features of the Dakotas are such that, under the influence of settlement and the consequent development of agriculture, changes are effected which tend to the rapid dissipation of the moderate rainfall, through absorption and evaporation. Irrigation and reforestation are the only remedies."

THE disinfecting properties of peroxide of hydrogen have long been known, but considerable additions have been recently made to our more exact information concerning its bactericidal action. Richardson (*Chem. Soc. Journal*, Sept. 1893) has shown that the antiseptic action of sunlight on urine is due to the production of peroxide of hydrogen, for samples exposed to sunshine remained clear, and on examination were found to contain peroxide, whilst similar samples kept in the dark became turbid and contained no peroxide. Traugott, in "Einige Ergänzungen zur Praxis der Desinfection" (*Zeitschrift für Hygiene*, vol. xiv. 1893, p. 427), points out as the result of his investigations that this material may be substituted in all cases for corrosive sublimate and carbolic acid where the period of contact is not less than a quarter to half an hour; but that it is not suitable where rapid disinfection is required, as in the case of the disinfection of the hands, &c. Being innocuous and also harmless as regards clothing and the like, it is a safer disinfectant for general application than the former; its cost is, however, considerably greater. Some years ago, Heidenhain stated that he had constantly used peroxide of hydrogen as a gargle in cases of diphtheria, and Traugott mentions in his memoir that ten seconds' contact of a 2 per cent. solution of H_2O_2 with a young and vigorous growth of the diphtheria bacillus on blood serum, entirely destroyed this organism. If however two days' old cultures were similarly treated, contact for thirty minutes, even when repeated three times, was not sufficient for its annihilation. Thus the therapeutic value of this material consists in its immediate application at the very outset of the disease, whilst it may be recommended as an important prophylactic during epidemics of diphtheria.

AS regards the hygienic importance of peroxide of hydrogen, and its practical application, the experiments of Van Tromp and, later, Altehoefer on its action upon bacteria, pathogenic and otherwise, in water are of much interest. Van Tromp mentions that an addition of peroxide of hydrogen in the proportion of 1 : 10,000 parts of the water, when shaken up and allowed to stand for twenty-four hours, is usually sufficient to sterilise a water. Altehoefer, however, found that to ensure sterility it was advisable to use larger quantities, viz. 1 : 1000 parts of the water. Experiments made with waters purposely infected with cholera and typhoid bacilli, respectively, showed that in both cases these organisms were destroyed after twenty-four hours by this proportion of peroxide of hydrogen. Altehoefer, moreover, specially mentions that he found this addition in no way interfered with the dietetic value of the water, and recommends its application for household purposes as a protective measure during any epidemics of typhoid fever and cholera. Traugott also testifies to the innocuous character of this material even when swallowed in large doses, and states that 100 grm. or half a wineglassful of a 5 per cent. solution was administered by one of the doctors in a hospital in Breslau without any ill-effects whatever, whilst undoubted benefit was derived from its use. Care must, however, be taken that the particular material employed is as pure as possible, as traces of the poisonous barium chloride in larger or smaller quantities may be present; moreover, it is important that the sample should be freshly prepared, as its strength and consequently bactericidal action is reduced when it has been preserved for some time.

WE are indebted to *The Gas World* for the following particulars concerning a remarkable process, which is now being successfully worked, for very considerably increasing the illuminating power of coal gas, involving what at first sight would appear the highly dangerous operation of introducing into the gas a quantity of pure oxygen. In the year 1890 Mr. Edward Tatham, of New South Wales, made the bold proposal to add considerable quantities of pure oxygen to warm, heavy oil gas, with the object of producing a stable gas of very high illuminating power. Later in the same year Dr. L. T. Thorne communicated to the Gas Institute the results of preliminary experiments with this gas, which he had carried out on behalf of Brin's Oxygen Company. These experimental results led to the conclusion that rich oxy-oil gas *per se* was far and away more effective as an illuminant than the coal gas now employed for this purpose, but that its more immediate prospect of use lay in the direction of enhancing the lower illuminating power of ordinary coal gas. Preparations have since been made for practically testing the applicability of oxy-oil gas to the enrichment of coal gas, and the Hydro-Oxy Gas Patents Proprietary, Limited, have erected at 11, Salisbury-square, E.C., a complete experimental plant for the purpose. Moreover, the corporation of Huddersfield are erecting a plant for the purpose of enriching the coal gas supplied to the borough. The Huddersfield installation is not yet completed, but a portion of it is ready, and is now in actual operation. When complete it will consist of an oxygen plant and four bays of oil-gas retorts, capable collectively of producing 200,000 cubic feet of oxy-oil gas per day, together with the necessary condensers and holders. The oxygen plant has been already erected by Brin's Oxygen Company, and is their newest type of producer. It is built in two sections, which may be worked together or independently, and will make no less than 30,000 cubic feet of oxygen per day. This, the largest oxygen-producer ever constructed, is now in active operation. Of the oil gas plant one bay, consisting of fifteen cast iron retorts, is also working, and is capable of producing 50,000 cubic feet of oil gas per day. The lowest and hottest of the retorts are intended for "cracking" the residues from the upper retorts, but they may of course be fed with clean oil if required. The oxygen is introduced into the oil gas soon after the latter leaves the retorts and while still warm; the mixed gases then pass together through the condensers. The admission of the oxygen is automatically adjusted by means of a combination of meters, so that the proportion is constantly maintained at fifteen per cent. The oxy-oil gas is stored in special holders, and it is arranged to admit it into the coal gas just before the entry of the latter into the station meter, the quantity being regulated by a meter coupled to the station meter. The results so far attained are highly satisfactory. The admission of about six per cent. of oxy-oil gas is already found to increase the illuminating power of the corporation gas by the equivalent of five and a half candles, and this is probably much below the enrichment which will eventually be attained when the plant is complete, and when normal coal can again be employed at the cessation of the strike. The results attained by the Salisbury Square plant are considerably superior to this, and it is expected that the Huddersfield installation will eventually attain the same standard. Further, a marked increase in the stability of the gas is observed, for poor coal gas actually loses more illuminating power by storage than the same gas admixed with oxy-oil gas does. As regards cost, it is calculated from the experimental data furnished by the working portion of the Huddersfield installation, that the increased cost of production of the gas so enriched will not, at the highest estimate, exceed a third of a penny per thousand cubic feet.

Notes from the Marine Biological Station, Plymouth.—Last week, like its immediate predecessors, was characterised by stormy weather, which confined the dredging operations to inshore areas. The chief capture was a large haul of the Opisthobranch *Oscanius* (*Pleurobranchus*) *membranaceus*. The approach of winter is already indicated in the bottom fauna: colonies of the Compound Ascidian *Fragarium elegans* have been frequently taken in their state of "hibernation," and the colonies of the Polyzoan *Bugula turbinata*, which in the summer orms extensive forests on the stones in certain areas, have now almost completely died down. The Nemertine *Amphiporus dissimulans* has begun to breed, and the greater number of *Micrura fasciolata* are full-grown and sexually mature.

The additions to the Zoological Society's Gardens during the past week include two Sykes's Monkeys (*Cercopithecus lbigularis*, ♀ ♀) from West Africa, presented by Mr. W. H. Barber; a Thick-furred Capuchin (*Cebus vellerosus*) from South America, presented by Mr. R. Kettle; three Tigers (*Felis tigris*, ♂ ♀ ♀) from India, presented by H.R.H. Princess Beatrice; a Senegal Parrot (*Pœocephalus senegalus*) from West Africa, presented by Mrs. Rylands; a Ruddy-headed Goose *ernicla rubidiceps*, ♂) from the Falkland Islands, presented y Mr. Henry Phillips; a Tuatera Lizard (*Sphenodon punctus*) from New Zealand, presented by Mr. C. Stonham, F.Z.S.; a Diamond Snake (*Morelia spilotes*) from New South Wales, presented by Mr. Arthur W. Darker; a White-fronted Lemur (*Lemur albifrons*) from Madagascar, two Common Squirrels (*Sciurus vulgaris, albino*) British, deposited; two Blue-winged Teal (*Querquedula cyanoptera*) from South America, a Japanese Teal (*Querquedula formosa*) from North-east Asia, a Himalayan Monaul (*Lophophorus impeyanus*) from the Himalayas, a Turnstone (*Strepsilas interpres*), a Curlew (*Numenius arquata*) European, purchased; a Molucca Deer (*Cervus moluccensis*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

The Scintillation of Stars.—Though the question as to the cause of the scintillation of stars has not received the attention of many workers, yet it has had and still retains its adherents. In a recent number of the *Revue Scientifique*, M. Dufour gives the results of observations commenced in the year 1853. The observations were made with the naked eye, and were continued in all seasons and in all conditions of the weather, since the chief object of the investigation was to find out whether there was any relation between the scintillations of stars and the disturbances which occur in our atmosphere. The first results which were obtained led to the forming of the following laws. (1) That red stars scintillate less than white stars. (2) The intensity of the scintillation is nearly proportional to the product obtained by multiplying the astronomical refraction for the height at which the star appears, by the thickness of the stratum of air traversed by the luminous ray that one is considering, and (3) that the causes of some of the essential differences between the scintillations of different stars may perhaps be due to the stars themselves. Experiments for studying the question as to whether there was any difference between the scintillation on mountains and upon the plain, showed that on the mountains the scintillation was most feeble. An important meteorological conclusion, which, as M. Dufour says, is contrary to general opinion, and which he deduces from his numerous observations, is that a feeble scintillation generally announces the approach of bad weather. He gives many instances in support of his view, among which occur the observations at Col du Géant on July 12, 1788, when the brightest stars in Lyra, Cygnus, and the Eagle at the same altitude showed practically no signs of scintillating, while the next day there broke out over France the most violent storm that the annals of meteorology had ever registered. M. Dufour compares his work with that of M. Montigny, who commenced work after him, and who was led to the same three laws above mentioned. He suggests that as his observations were made in Switzerland, it would be interesting to find out if a feebleness of scintillation observed at sea also indicates bad weather.

A Universal Telescope Stand.—The construction of a good and simple universal mounting for small telescopes has been the aim of many instrument makers, and it is pleasing to note an advance in this direction made by the firm of K. Fritsch, formerly Prokesch, in Vienna. In their new so-called "*Universal statio*" they have overcome many of the main difficulties. The chief point about this special kind of mounting is that the observer can either use the telescope as a theodolite—that is, with circles reading altitude and azimuth—or, by a slight adjustment, he may have the equatorial mounting where the circles read right ascension and declination. This end is gained by hinging what would be the polar axis on to a pivot at the side of the stand, thus allowing the axis to be moved from the horizontal to the vertical or any intermediate position. A strong metallic arc fixed on the top of the stand supplies a means of clamping this axis, and giving it a slight adjustment. With the axis vertical, we have then practically a theodolite mounting; with the axis out of the vertical, a parallactic mounting. It is needless to say that this mounting is only for small telescopes, and indeed its application to large ones is not needed. A detailed account of the mounting, with figures, will be found in No. 208 of *Prometheus*.

Popular Astronomy.—Some time ago we inserted a note in this column to the effect that the editors of *Astronomy and Astro-Physics*, if they received sufficient support, would publish a monthly journal—*Popular Astronomy*—written especially for the rapidly increasing number of amateurs. We are glad to say that we have recently received the first (September) number, and, as far as one can judge, the journal has a successful future before it. The present number contains the first chapters of some series of articles on various subjects. To give some idea of the subject-matter and their writers, we may mention that "The Spectroscope, and some of its applications," is dealt with by Keeler; "Concerted Observation of the Aurora," by Veeder; "Shooting Stars: How to observe them, and what they teach us," by Denning; "Nebulæ and Comet-seeking," by Lewis Swift; "The Moon," by W. W. Payne, &c.; while future numbers will contain a series of articles by Barnard, on "Celestial Photography"; one by Elgar, on "The Moon"; another by Hale, on "The Sun," and many others. The treatment of the subjects is all that could be desired for those not acquainted with technicalities, and the illustrations, which include two excellent ones of the moon, are of the same style as those familiar to readers of *Astronomy and Astro-Physics.* The various tables, notes, &c., which complete this journal of forty-eight pages, form a useful and important addition.

THE AUGUST METEORS.—The prevalence of fine weather during the month of August afforded many observers excellent opportunities of observing the Perseids, and it is not surprising to hear that so many observations were made. *Astronomische Nachrichten* (No. 3192) gives some of the results, showing that at Warendorf, August 8–11, 410 paths were recorded, at Eversunital 72, Brilon 184, Arnsberg 114, Altona Hamburg more than 400, and so on. Prof. Denza, in the current number of *L'Astronomie* (No. 10, October), gives a list of some of the observations made in Italy. He refers to the shower as among "les plus éclantantes remarquées jusqu' à présent," and suggests that for the next few years it should receive special attention. The radiant point he locates as $\alpha = 44°$, $\delta = +55°$, the number of meteors attaining their maximum on the night of the 10th to 11th. Mr. Denning has also a few words to say (the *Observatory* for October) with regard to this shower, commencing first with the inaccuracy shown in observing the Lyrids of April, and pointing out "the same extraordinary differences" manifested in these Perseid observations. The accurate places, as he believes, were obtained by Mr. Booth on August 9, 43° and + 57°, and by Mr. Evershed on August 10, 44° + 57°. On August 16 he himself deduced the radiant as 52° and + 57°, a value agreeing approximately with Kleiher's theoretical position for that date, namely 54° + 59°.

ASTRONOMY OF THE FELLAHIN OF PALESTINE.—An interesting paper by Mr. P. J. Baldensperger, on the beliefs of the Fellahin of Palestine, is found in the] October report of the Palestine Exploration Fund. It appears that the Fellahin know the Pleiades by the name of Thureiyah. Besides this, many of the conspicuous stars and constellations have received names. The following are examples, though the list can be considerably extended :—

Banat Na'asch	The Great Bear.
Nijmetain el-Joz	Castor and Pollux.
Thureiyah	Pleiades.
Hareef el Thureiyah	Auriga.
Sawak el Thureiyah	Aldebaran.
Il Jiddi	Vega.
Nijmet el Danab	Denebola.
Ilsamak	Fomalhaut.
Ilmizâne	Orion's Belt.
Nashallat il mizâne	Betelgeuse and Rigel.
Sawak il mizâne	Sirius.
S'héle	Canopus.
Tareek i-tubânet	The Milky Way.

The planet Jupiter is known as Nijmet el Gharara, Venus as Morning Star, and Mars as Nijmet el Sha'ate. A number of curious stories and beliefs are connected by the Fellahin with the stars, and a few with planets.

GEOGRAPHICAL NOTES.

M. A. HAUTREUX has been engaged this summer (*Bulletin* of the Bordeaux Society of Commercial Geography, 1893, No. 14) in investigating the difficult question of the currents of the Bay of Biscay, by means of specially contrived floats consisting of two bottles attached by a cord a metre in length. The lower bottle being weighted with water keeps the upper one, containing air, from being driven by the wind, and the whole drifts along with the superficial layer of water. The results obtained seem to point to the absence of any current northward along the coast of the bay. From all points of the line at which floats were discharged west of France they showed a tendency to drift rapidly south-eastward towards the south-eastern angle of the bay. The observations will be continued, and the result will be of value in furnishing additional information to sailors of the landward drift that has so often proved fatal to vessels on the north coast of Spain.

THE Queensland Branch of the Royal Geographical Society of Australasia has adopted a resolution approving of Sir Thomas McIlwraith's proposal to adopt an hour-zone system of time reckoning for Australia and New Zealand, with the 150th meridian (ten hours from Greenwich) as a unit, and urging the other branches of the society to take the matter up. The meridian of 150° E. runs through Cape Howe in the south-east of Australia and through the south-east of New Guinea, and its time would hold for the capitals of the three eastern colonies and Tasmania. The next hour interval westward (135° E.) would include the whole of South Australia, and the third (120° E.) would hold good for Western Australia. Eastward the time of the 165th meridian would apply to the south island of New Zealand, and that of the 180th meridian (twelve hours from Greenwich) to the north island and to Fiji.

Globus announces that an exploring and surveying expedition, to which five Germans are attached, has been organised in Brazil to study the less known parts of the Amazon basin and collect information as to ethnography and natural history. The expedition was intended to leave Santos in August, and cross the plateau of Matto-Grosso towards the upper waters of the Amazon, where surveys and scientific collections will be made.

THE last number of the *Mouvement Geographique* gives a sketch-map of Lake Leopold II., which lies south of the Congo. It has been resurveyed, in April 1892, by Mr. Mohun, the United States Consul to the Congo State, who was accompanied by M. De Meuse. The lake extends from 1°5′ S. to 2°45′ S., and its outflow drains into the Congo from the southern end. The lake receives no important streams, but is fed by drainage from extensive marshes which stretch away from its north-western end. The water is shallow, but rises 1·5 metres in the rainy season, inundating a large area of country. The deeply-indented bays serve as harbours for the canoes of the warlike slave-hunting races who inhabit the surrounding country, their villages being hidden deep in the forests at some distance from the shores of the lake.

THE new session of the Royal Geographical Society will be opened by an address on "Geographical Desiderata" by the new President, Mr. Clements R. Markham, F.R.S., on November 13. At the second meeting a paper on the Antarctic regions is expected from Dr. John Murray, of the *Challenger*, which will be followed by a discussion. Other papers which are being arranged for will be announced later. Mr. Mackinder will give the second course of his educational lectures on the relations of geography to history after Christmas, and a course of educational lectures on the principles of commercial geography is now being given, under the auspices of the Society, by Dr. H. R. Mill, in the London Institution.

THE HARVEIAN ORATION.[1]

IT is now 237 years since the illustrious Fellow of this College whose name we are met to commemorate, provided, when two years before his death he conveyed his estate at Burmarsh to the College, that :—

"There shall be once every year a general feast for all the Fellows; and on the day when such feast shall be kept, some one person of the said College shall be from time to time appointed by the President and two Eldest Censors and two Eldest Elects for the time being of the said College (so that the person so to be appointed be not in that behalf appointed two years together), who shall make an Oration publicly, in the said College, wherein shall be a commemoration of all the benefactors of the said College by name, and what in particular they have done for the benefit of the said College, with an exhortation to others to imitate those benefactors, and to contribute their en-

[1] Delivered by Dr. P. H. Pye-Smith, F.R.S., at the Royal College o Physicians, on Wednesday, October 18th.

deavours for the advancement of the Society, according to the example of those benefactors; and with an exhortation to the Fellows and members of the said College to search and study out the Secrets of Nature by way of experiment; and also for the honour of the profession to continue in mutual love and affection among themselves, without which neither the dignity of the College can be preserved, nor yet particular men receive that benefit by their admission into the College which they might expect; ever remembering that '*concordia res parvæ crescunt, discordia magnæ dilabuntur.*'"

I. Concerning the originality of that immortal discovery, which places Harvey in the limited class represented by Aristotle and Archimedes, Copernicus, Newton, and Darwin, it is sufficient to bear in mind the following considerations:—

1st. If Harvey's doctrine of the circulation was not new, why was it opposed by men in the position of Riolanus and Hoffmann, and welcomed as a discovery by Bartolinus and Schlegel and Descartes? Surely his contemporaries were better judges of the novelty of his views than we are!

2nd. Admitting that Servetus and Columbus taught the doctrine of the lesser circulation, we need but a moment's thought to convince us that no complete knowledge of this part of the subject was possible until the existence of a systemic circulation was established; for the one is physically impossible without the other.

3rd. The title of Harvey's great work is not, as it is sometimes quoted, "The Circulation of the Blood," but "*De Motu Cordis et Sanguinis.*" He first showed that the flesh, or parenchyma, of the heart is true muscle, that the heart is not a passive chamber receiving the blood, but a contractile organ expelling it. Until the motive power of the heart was understood there *could* be no true theory of the circulation.

The fact is, that when we know the true solution of a problem, it is easy to see or think we see it in any discussion which preceded the discovery; for there is only a limited number of answers to most questions, and therefore true as well as false solutions are almost sure to have been proposed.

In the writings of Columbus, Servetus, and Cæsalpinus, phrases occur which sometimes seem as if the writers were going to state the truth that Harvey first asserted.

But it would be as reasonable to infer, from such passages, that the circulation of the blood was then known, as from the lines that Shakespeare puts into the mouth of Brutus:

"As dear to me as are the ruddy drops
That visit my sad heart."

As Paley well said, *he* only *discovers* who *proves.* To hit upon a true conjecture here and there amid a crowd of untrue, and leave it again without appreciation of its importance, is the sign, not of intelligence, but of frivolity. We are told that of the seven wise men of Greece, one (I believe it was Thales) taught that the sun did not go round the earth, but the earth round the sun, and hence it has been said that Thales anticipated Copernicus—a flagrant example of the fallacy in question. A crowd of idle philosophers talking all day long about all things in heaven and earth, must sometimes have hit on a true opinion, if only by accident, but Thales, or whoever broached the heliocentric dogma, had no reason for his belief, and showed himself not more but less reasonable than his companions. The crude theories and gross absurdities of phrenology are not in the least justified, or even excused, by our present knowledge of cerebral localisation; nor do the baseless speculations of Lamarck and Erasmus Darwin entitle them to be regarded as the forerunners of Erasmus Darwin's illustrious grandson. Cuvier was perfectly right in his controversy with Geoffroy St. Hilaire; the weight of evidence was undoubtedly on his side. Up to 1859 impartial and competent men were bound to disbelieve in evolution; after that date, or at least so soon as the facts and arguments of Darwin and Wallace had been published, they were equally bound to believe in it. He discovers who proves, and by this test Harvey is the sole and absolute discoverer of the movements of the heart and of the blood.

Concerning the *methods* used by Harvey they were various, and his discovery, like most great advances in knowledge, was not achieved by one of the happy accidents which figure in story books, or by the single crucial, and never-in-after-ages-except-under-license-and-special-certificate-to-be-repeated, experiment which some members of a certain Royal Commission supposed to be the only kind of experiment needed in scientific inquiries.

A perusal of Harvey's own statements makes it plain, it seems to me, that having gained his knowledge of the anatomy of the heart and of the current hypotheses of its function from his Italian masters, he reasoned thus:—First, that the cardiac valves must be intended for such physiological service as their construction would indicate. He believed that every part of this human microcosm has a meaning; that it is by no chance result of blind forces that an organ is adapted to its end. This great postulate is necessary for scientific progress. If the difficulties of physiology, whether normal or morbid, seem so intricate and insuperable that we are tempted to doubt whether the riddle after all has an answer, we must again and again fall back on the faith of Harvey and of Newton, of Boyle and of Linnæus. The great doctrine of natural selection has thrown wonderful light upon the methods by which the results that we see have been reached, but has not impaired the excellence of those results nor their evidence of beneficent design.

Belief then that the body and all its parts is a machine constructed for certain uses, that everything in Nature has a reason and an end—this was Harvey's postulate when he argued out the functions of the heart and vessels from their anatomical construction.

Harvey's second method was that of actual experiment. On this point he leaves us in no doubt. His second chapter is headed, "*Ex vivorum dissectione qualis sit cordis motus,*" and in the introductory chapter which precedes this, he says:—

"Tandem majori indies et disquisitione et diligentia usus, multa frequenter et varia animalia viva introspiciendo, multis observationibus collatis et rem attigisse et ex hoc labyrintho me extricatum evasisse, simulque motum et usum cordis et arteriarum quæ desiderabam comperta habuere me existimabam."

Many of his vivisections were not strictly speaking experiments, but observations—inspection of the living heart and arteries—others were experiments in the modern and restricted use of the word. These were Harvey's methods, as they must be the methods of all natural science. First, observation; next, reflection; then experiment. "Don't think; try," was Hunter's advice to Jenner; an advice that is often needed by an acute inquiring genius like his; still more often by sheer idleness, that will never bring its fancies to the test of fact.[1]

Experiments without hypotheses are often fruitless, but hypotheses which are never brought to the test of experiment are positively mischievous.

How far have the Fellows of this College obeyed Harvey's precept and followed his example in "searching out the secrets of nature by way of experiment." We must, I fear, confess that after the brilliant period of the seventeenth century (in some respects the greatest of our history and certainly the most fruitful in great men) experimental science made slow and uncertain progress, so that between Harvey and Newton, Hook and Grew, Mayow and Boyle on the one hand, and Cavendish, Black and Priestley, Hunter and Hewson on the other, there was a long period of stagnation or even retrogression. Hypotheses and dogmas, misapplied mathematics, imperfect chemistry, and an affected literary style (made more conventional by the practice of writing in a foreign language better fitted for rhetoric than science) contributed to make the eighteenth century comparatively barren, in so far as science generally, and physiology and medicine in particular, are concerned.

The "way of experiment," in the strict sense of the word, has been hitherto most successfully applied to normal physiology. The successors of Harvey were not Sydenham, Radcliffe, Arbuthnot, Garth, Meade, Freind and Heberden, but Lower, Mayow, Hales, Vierordt, Ludwig and Chauveau. *Pathology* as an experimental science is still in its infancy, but the infancy is that of Hercules, and bids fair to strangle such dire pests as anthrax, cholera, tetanus and hydrophobia.

Before quitting this part of my subject, I would fain correct a popular misconception that Harvey was a neglected genius—that his contemporaries, his professional brethren, and in particular this ancient College, refused to listen to his new notions, ridiculed his discoveries, and spoiled his practice. Whether as his fame grew his practice diminished, we cannot tell. If so, his patients were the losers. What Harvey and every honest man cares for, is not popular applause, but the confidence and esteem of his comrades; and this he deserved and received. It was as lecturer at this College that he propounded

[1] Ea autem vera esse vel falsa. Sensus nos facere debet certiores, non Ratio; αὐτοψια non mentis agitatio. Second Epistle to Riolanus, p. 133. (College edition).

his discoveries; it was here that he found his disciples and his friends. Here he was urged to take the presidential chair; and here his statue was erected, five years before his death, with the inscription, "*Viro monumentis suis immortali.*" It would have been a poor compliment to his elaborate demonstrations, and unworthy of a liberal profession, if so startling a revolution as Harvey proposed had been accepted without inquiry. It was considered, it was discussed, and, without haste but without timidity, it was at last accepted—the very way in which Darwin's theory was received and criticised, and finally adopted by Lyell and by Hooker. Let then no scientific impostor or medical charlatan quote Harvey to console him under merited censure.

II. Of Harvey's writings, the second, and by far the longer treatise, is that upon Generation. This formed the subject of a valuable criticism in the Harveian Lecture by the late Sir Arthur Farre. It is full of interest and contains many observations that remain true for all times, many acute criticisms, and a few broad and true generalisations, such as the famous dictum—"*Omnia animalia ex ovo progigni.*" Perhaps, however, what most strikes the reader of this treatise is the *learning* of the writer. He is familiar with his Aristotle, and quotes from Fabricius and other writers with much greater freedom than in the succinct and almost sententious treatise, "*De Motu Cordis et Sanguinis.*" Some would have us believe that here, as in other cases, erudition was a clog upon genius. This question has been often discussed, and it has even been maintained that he is most likely to search out "the secrets of Nature by way of experiment" who comes fresh to the task with his faculties unexhausted by prolonged reading, and his judgment uninfluenced by the discoveries of others. This, however, is surely a delusion. Harvey could not have discovered the circulation of the blood had he not been taught all that was previously known of anatomy. True, no progress can be made by mere assimilation of previous knowledge. There must be intelligent curiosity, an observant eye, and intellectual insight.

"Doctrina sed vim promovet insitam,"

and few things are more deplorable than to see talent and industry occupied in fruitless researches, partially rediscovering what is already fully known, or stubbornly toiling along a road which has long ago been known to lead nowhither. We must then instruct our students to the utmost of our power. Whether they will add to knowledge we cannot tell, but at least they shall not hinder its growth by their ignorance. The strong intellect will absorb and digest all that we put before it, and will be the better fitted for independent research. The less powerful will at least be kept from false discoveries, and will form (what genius itself requires) a competent and appreciative audience. Even the dullest scholars will be respectable from their learning, and if they cannot make discoveries themselves, can at least enjoy the delight of intelligently admiring the discoveries of others.

III. There is, however, a third phase of Harvey's intellectual work of which, unfortunately, the records have for the most part perished, and which has not, perhaps, been duly appreciated. What I believe Harvey contributed, or would, but for adverse fate, have contributed to medicine as distinct from physiology, was a systematic study of morbid anatomy. In the following passage he speaks of the great benefit that would ensue from the regular observation of the structural changes produced by disease:—

"Sicut enim sanorum et boni habitûs corporum dissectio plurimum ad philosophiam et rectam physiologiam facit, ita corporum morbosorum et cachecticorum inspectio potissimum ad pathologiam philosophicam."

Now this was a new notion. It was not uncommon for the body to be opened after death, especially in the case of great personages, either for the purpose of embalming or for discovering (as it was supposed) the fact of poison or other foul play; and occasionally a physician would obtain permission for a like inspection when something unusual in the symptoms had excited a laudable curiosity to ascertain their cause. But the records of such inspections in the seventeenth century by Bartolinus, or Tulpius, or Bonetus, or, in our own country, by Mayerne, or Bate, or Morton, are fragmentary, their object being limited to the individual case. There was no attempt to search out the secrets of nature in disease by a systematic observation of the state of the organs after death, nor was there for more than a century after Harvey's death. Morgagni in Italy; the French anatomists of the early part of this century, Corvisart and Laennec, Broussais and Cruveilhier; in Germany Meckel and Rokitansky, and in England Baillie, Abercrombie, Carswell and Bright—these were the founders of scientific pathology on a sure anatomical basis almost within living memory.

Not only had Harvey the prescience to recommend the study of morbid anatomy for itself, but he had himself carried it out by recording a large number of dissections, or, as we should now call them, inspections, of diseased bodies. Unfortunately most of these post-mortem reports, with his observations on the generation of insects, and other manuscripts were destroyed, or irrevocably dispersed, when his house in London was searched while he was with the King at Oxford. If the records of these inspections had been published, may we not asssume that Harvey's great authority would have set the fashion, and that the systematic study of morbid anatomy would have begun a century and a half earlier than it did? And think what this would have meant. With the exception of a few shrewd observations, a few admirable descriptions, and here and there a brilliant discovery, such as the origin and prevention of lead colic and of scurvy and the introduction of vaccination, it may be said that medicine made no important progress between the time of Harvey and that of Laennec. The very notion of diagnosis in our modern sense of the word depends upon morbid anatomy. The older physicians seldom attempted to determine the seat of an ailment. Disease was looked upon not as a condition depending upon disordered physiological functions, but as something external, attacking a previously healthy person, disturbing, and, if not expelled by art, finally destroying him; while any structural changes which were found after death were regarded rather as the effects than the causes of the symptoms during life.

Now, the ambition of every intelligent student—and in medicine we are life-long students—is to fix upon the most objective, certain, and important of the symptoms of a patient, to follow out this clue, to determine the organ affected and the nature of the affection, so that in his mind's eye the tissues become transparent and he sees the narrow orifice for the blood-stream and the labouring muscle behind it; or the constricted loop of intestine with violent peristalsis above and paralysis below, the blood-current stopped and congestion passing hour by hour into gangrene; or, the spinal cord with grey induration of a definite region, and the motors, sensory and trophic changes which physiologically ensue.

Sometimes this minute search to fix upon the locality and exact nature of a lesion has been ridiculed; and we are asked what benefit to the patient such knowledge when attained can bring. We answer, that in medicine, as in every other practical art, progress depends upon knowledge, and knowledge must be pursued for its own sake, without continually looking about for its practical application.

Harvey's great discovery (which we physicians rightly celebrate this day) was a strictly *physiological* discovery, and had little influence upon the healing art until the invention of auscultation. So also Dubois Reymond's investigation of the electrical properties of muscle and nerve was purely scientific, but we use the results thus obtained every day in the diagnosis of disease, in its successful treatment, and in the scarcely less important demonstration of the falsehoods by which the name of electricity is misused for purposes of gain.

It is true that Bernard's discoveries of the diabetic puncture and of the digestive function of the pancreas have not yet received their practical application. He was right when he said, "*Nous venons les mains vides, mais la bouche pleine d'esperances légitimes*"—but he should have spoken for himself alone.

The experiments on blood-pressure begun by Hales, and carried to a successful issue in our own time by Ludwig, have already led to knowledge which we use every day by the bedside, and which only needs the discovery of a better method of measuring blood-pressure during life, to become one of our foremost and most practical aids in treatment.

Again, we can most of us remember using very imperfect physiological knowledge to fix, more or less successfully, the locality of an organic lesion in the brain. I also remember such attempts being described as a mere scientific game, which could only be won after the player was beaten, since when the accuracy of diagnosis was established, its object was already lost; but who would say this now, when purely physiological research and purely diagnostic success have led to one of the most brilliant achievements of practical medicine, the operative treatment of organic diseases of the brain?

It has often been questioned whether the study of morbid anatomy has not withdrawn attention from morbid physiology; and, again, whether the time employed upon pathological researches would not have been better spent in directly therapeutical inquiry. To both these questions I take leave to answer, No. Anatomy must precede physiology, whether in the normal or the diseased state. The humoral physiology of the ancients did infinite mischief (mischief not yet exhausted), because it lacked the sound basis of anatomy; and experimental pathology, necessary and important as it is, and valuable as even its first endeavours have proved, was impossible without previous knowledge of the anatomy and histology of disease. As to therapeutics, I hold that for the successful cure of a patient it is far better that his physician should have a thorough and extensive knowledge of morbid anatomy, than that he should be acquainted with all the baths and waters, the hotels and lodging-houses throughout the world, or familiar with the barbarous names and pretended virtues of all the advertised nostrums that deface the fair English fields from London to Oxford. The public suppose that it is *their* business to know what is the matter, and the doctor's to find the remedy; if so, our art would be confined to learning the name of the patient's disorder by letter, post-card, or telegram, and looking up in an index of remedies the twenty or thirty drugs which are "good" for that particular complaint. *We* know that the real difficulty is to ascertain the nature and origin of our patient's disorder; when that is done, the treatment in most cases is obvious, and in many effectual; when it is not done, our treatment is vacillating, and either futile or mischievous. We have already ample means at our disposal for influencing almost every organ of the body. A new tool is occasionally offered us which deserves proving, but what we want far more is knowledge how to use the tools that we have. Treatment without diagnosis, besides its inefficiency, brings us for the time unpleasantly near to the charlatan who, whatever title he may assume, is always therapeutical and never pathological. Rational, bold, and effectual treatment, whether preventive or curative, must always depend upon accurate diagnosis and sound pathology, and the power of diagnosis depends upon that systematic inspection of the bodies of diseased persons which was recommended and practised by Harvey.

"Ad hanc inspectionem, cum Heraclito apud Aristotelem, in casam furnariam (sic dicam) introire si vultis, accedite: nam neque hic Dii desunt immortales. Maximusque omnipotens Pater in minimis et conspectior vilioribus quandoque est."

Suffer me, then, Mr. President and Fellows of this College, to obey the instructions of the founder of this lecture, by exhorting my hearers, and especially those Fellows who are junior to myself, to emulate, according to the varied talents entrusted to each, the example of Harvey in these three particulars:—

(1) In investigation by experiment, whether by pathology or physiology.

We have now difficulties unknown to Harvey in carrying out this duty, for duty it certainly is, incumbent upon all who have the opportunity and the necessary training. The countless experiments on living animals which were carried out during the 17th century in all civilised countries—in Italy, Holland, Denmark, France, Germany, and England—bore a rich fruit of physiological knowledge. If the anatomy of the human body was thoroughly ascertained by the great men of the 16th century, by Vesalius, Sylvius, and their successors, it is no less true that to the 17th century is due the discovery of the elements of physiology. The action of the heart and the circulation of the blood, the absorption of chyle by the lacteals and thoracic duct, the mechanism of respiration and some knowledge of its chemical effects, the function of secretion by glands, the minute structure of the eye and ear, and of the reproductive apparatus, and a knowledge—imperfect, but true as far as it went—of the functions of the brain and nerves, these were the achievements of the 17th century due to Harvey, Glisson, Willis, and Mayow, among our own countrymen, and to Pecquet, Malpighi, Leuwenhoeck, De Graaf, Swammerdam, Aselli, Redi, and Bartolinus. In all this brilliant advance of knowledge, experiment upon the lower animals was the method used, and the method is as indispensable now.

Anyone conversant with a single branch of natural science is aware that experiment, as well as observation, is necessary. Who would expect discoveries in physics, or in chemistry, without laboratories and experiments? Do not botanists investigate the functions of plants by dissection, by microscopic and chemical investigation, and by *experiment?* Have we not this very year celebrated the important results of fifty years' *experimental* researches into the life and growth of plants by Lawes and Gilbert? And is it not obvious that the same necessary well-tried and indispensable method of inquiry must be continued in the case of animals? Happily the same experimental science has discovered the means of abolishing the tribute of suffering which the brute creation paid in the hands of Harvey and Hales, of Haller, Magendie, and Sir Charles Bell. By means of chloroform and other anæsthetics, and by means of the antiseptic methods which we owe to Sir Joseph Lister, the subjects of experiment are spared the pain and shock of an operation, and the pain which used to follow an operation. In fact, almost the only experiments upon the lower animals which involve distress are those which are most immediately and directly useful to ourselves and to them; inoculations, namely, with a view to reproduce diseases, and the direct therapeutical testing of drugs. Cruelty is utterly repugnant to our calling; and it seems absurd that men, who will with just confidence entrust themselves and the lives of those nearest to them to our protection and care, should yet so far distrust us as to shackle attempts to improve our knowledge and our power by cumbersome and ridiculous restrictions. Let us hope that on the one hand increasing humanity and gentler manners will extend compassion for the lowest of God's creatures from the educated classes of England and America until it permeates all ranks and all nations; and that on the other full liberty will be given to the prosecution of researches, laborious and thankless in themselves, but of the utmost value for the relief and prevention of disease in man and brute alike. May I also express a hope that those who administer our laws will take heart of grace, and in this, as in other matters, try whether Englishmen do not prefer the conscientious maintenance of a statesman's own judgment before a time-serving submission to ignorant clamour.

(2) In the second place, I would exhort my brethren, and especially the members of this College, to cultivate learning. Harvey went to study in Italy, then the nursery of science as well as of art, and he was familiar with the writings of Plato and Aristotle and Virgil, as well as with those of his immediate predecessors, Fabricius and Columbus. So in that golden time which comes to most of us, between taking the academical degree and becoming immersed in the daily duties of hospital life, I strongly advise a visit to one of the German universities, or to Paris, to acquire the key to the two languages in which the best modern books are written; and to widen the mind by seeing the aspect of science and affairs from a continental standpoint. It is lamentable that there is so little professional intercourse between the students of one of our London schools and the teachers of another. The laudable energy which has made each of them complete, and well-equipped colleges has had this drawback, that at the present day the attention of a diligent student is more confined to the teaching and practice of his own school than it was sixty or seventy years ago.[1] The narrowness and prejudice bred by this isolation may be corrected by a visit to the famous sister universities of Edinburgh or Dublin; for their complete removal no prescription is so efficient as a prolonged stay in continental laboratories and hospitals. But even such a broad and liberal education, even familiarity with the daily advances of medical science recorded in periodicals and archives and year-books, or transmitted by telegraph to the wondering readers of the daily newspapers, is not all that is needful to make a learned physician. We know well the difference between reading of an experiment, or even seeing it performed, and doing it with our own hands. We know the difference between studying a pathological atlas, or even a cabinet of histological slides, and seeing and handling morbid tissues and making sections for oneself. So also is there all the difference between learning the present conclusions as they stand recorded in the

[1] Let us hope that the University of London when reconstituted by the labours of the Royal Commission, which is now preparing its report to the Crown, may provide by the regulations of its medical faculty for more community of teaching and learning among students of medicine in this city.

last edition of a text-book or compendium and tracing the steps by which our present knowledge has been reached.

With regard, for instance, to the physiology of the circulation, it is not only curious but instructive to follow its gradual growth from Galen and Vesalius, Columbus, Cæsalpinus, and Servetus, to Harvey and Lower and Malpighi, to Hales and Vierordt, to Ludwig, and Chauveau, and Gaskell, and Roy. The only true scientific method is the historical one. If we only know the results of a science without the steps by which they have been reached, we have indeed its practical use, but lose half its educational value. We are almost in the position of an engineer who knows the conclusions of trigonometry by rote, but is ignorant of the demonstration. I would therefore urge upon junior Fellows, while still enjoying the prospect rather than the fruition of professional success, to spare some of the time which is unoccupied by work in wards and laboratories for the perusal of such antiquated works as have been published as much as twenty years ago, and particularly for gaining acquaintance at first hand with classics like Virchow's "Cellular Pathology," and the lectures of Watson, Trousseau, and Stokes; or, if their time and inclination does not allow of more extended researches, at least to read such succinct masterpieces as Laennec's "Mediate Auscultation," Heberden's "Commentaries," Sydenham's "Treatise on Gout," and Harvey "On the Movement of the Heart and of the Blood."

(3) I would, moreover, exhort Fellows of the College to see that, while all the new methods of experimental pathology and pharmacology are carried out by duly trained physiologists, we do not neglect the fundamental method taught and practised by Harvey of inspecting the bodies of those who have died of disease. It was this union of morbid anatomy with clinical observation which made the discoveries of Laennec and of Bright really fruitful. Without these autopsies, clinical medicine is but an empirical art, diagnosis a sham, and treatment little better than quackery. Exclusive attention to therapeutics is apt to bring a man dangerously near to homœopathy and other pretended systems of treatment, but sound pathology, and diagnosis controlled by *post-mortem* inspection, give positive knowledge and that union of modest self-confidence and prudent enterprise which become the physician.

Lastly, I have to fulfil the duty of exhorting the Fellows of this ancient College "to continue in mutual love and affection" among ourselves; and this is the easiest task of all. For, if we must admit that experimental science in England, and particularly scientific pathology, is not surpassing our byegone achievements as it ought to surpass them, considering the increased number of competent labourers and the vastly improved methods of research; and if we admit that the crowd of modern literature, and the distractions which we fondly imagine to be peculiar to our generation, leave small opportunity for the cultivation of ancient learning; and if the prejudices of our patients, both gentle and simple, still make post-mortem inspections less common and systematic than they should be—whatever, I say, may be our shortcomings in these or in other respects—your Harveian orator may most honestly congratulate the College and the profession upon the concord and mutual esteem which has happily marked our history from the days of Linacre to those of Harvey, from the days of Arbuthnot and Garth to those of Meade and Freind, from the days of Fothergill and Heberden to those of Matthew Baillie, of Babington, and of Sir Thomas Watson. Long may this continue, for thereon depend not only the dignity and peace of our profession, but in great measure our power of doing good. However ignorantly our patients will sometimes decry what they call professional etiquette, the wiser among them know (and in the long run the wise lead the foolish) that this term really means the observance of the rules which distinguish a profession from a trade, which make our calling honourable as well as honest, which check the arts of advertisement and direct our ambition to obtaining the suffrages, not of the public which *cannot*, but of our profession which *can*, judge truly—rules of conduct which are, in fact, nothing but the carrying into daily practice of the golden rule to do to others as we would they should do to us. For maintaining and strengthening this spirit of concord and good feeling, we depend upon each one of our Fellows, but especially on the example and authority of our Head—an example and authority which, as the College well knows, are worthily maintained by the untiring devotion to its best interests of our honoured President.

THE EFFECT OF WATER VAPOUR ON ELECTRICAL DISCHARGES.

A VERY interesting paper by Prof. J. J. Thomson, on the effects of electrification and chemical action on a steam jet, and of water vapour on the discharge of electricity through gases, appears in the October number of the *Philosophical Magazine*. In it the author first considers the effect of an electrical field on the surface tension of a water drop, and he shows that if the electrical field is uniform, the diminution in the surface tension is very small and independent of the size of the drop; so that a uniform field will not be able to counterbalance the effect of surface tension, since the latter varies inversely as the radius of the drop, and therefore when the drop is excessively small must be greater than the constant effect due to the electric field. When, however, the electric field instead of being uniform is due to a number of charged atoms distributed throughout the volume occupied by the steam, the effect of the electric field in diminishing the surface tension varies inversely as the square of the radius of the drop. Thus for very small drops the electrification will overpower the cause (surface tension) which, under ordinary circumstances, puts an end to the existence of small drops. The above seems capable of explaining the effects of electrification on a steam jet first observed by Helmholtz, for the electricity which escapes into the gas is carried by charged atoms of the gas, and since in the region immediately around these atoms there will be a very intense electric field there will be a tendency for the steam to condense into drops in these regions. Helmholtz also discovered that chemical action in the neighbourhood of the jet affected it in much the same way as a discharge of electricity. If the forces which hold the atoms together in a molecule are electrical in their origin, so that in a diatomic molecule one atom has a positive and the other an equal negative charge, the above explanation will also apply to this case. For when the molecule of the gas is in the ordinary state, the equal and opposite charges of the atoms will, in the region outside the molecule, neutralise each other's effect, so that the electrical field round a molecule will be much less intense than that round a single charged atom, and thus, though the field round the latter may be sufficient to cause condensation, that round the molecule may not. When, however, the molecules which enter into chemical combination come together and form a new compound, requiring a rearrangement of the atoms, then while the chemical change is going on, there will be an interval during which the atoms are comparatively free, and there will be an electric field almost as strong as if the atom were dissociated.

The author also considers the effect of moisture in promoting chemical action, for if the forces which hold the atoms in the molecule together are electrical in their origin it is evident that these forces will be very much diminished when the molecule is near the surface of, or surrounded by, a conductor or a substance like water having a high specific inductive capacity. Thus if A and B represent two atoms in a molecule placed near a conducting sphere, then the effect of the electricity induced on the sphere by A will be represented by an opposite charge placed at the image of A in the sphere. If A is very near the sphere, this opposite charge will be very nearly equal to that at A. Thus the effect of the sphere will be to practically neutralise the electrical effects of A, and as one of these effects is to hold the atom B in combination, the affinity between the atoms A and B will be almost entirely annulled by the presence of the sphere. Molecules condensed on the surface of a drop of water or surrounded by water will thus be practically dissociated, or at any rate the forces between their component atoms will be much reduced. Since water vapour produces so great an effect on chemical combination, it is interesting to investigate whether its presence has any considerable influence on the passage of electricity through gases, since there is strong evidence that this phenomenon is closely connected with chemical changes taking place in the gas through which the discharge takes place. Observations were made on dry and damp hydrogen, and show that there is a marked difference both in the appearance of the spark and in the proportion between the potential difference necessary to produce the first spark through the gas, and that which is sufficient to cause one to follow it immediately afterwards. In the damp gas this difference was comparatively small, averaging about ten per cent. In the dry gas, however, this effect attains quite abnormal proportions, the potential difference required to produce the first spark being often more than twice that required to maintain it when once started. These experiments show that the behaviour of a gas with reference to the passage of an electric spark is analogous to that of a vapour condensing to a liquid, the freezing of a liquid, or the deposition of crystals from a saturated solution. For in the case of a gas which contains a foreign substance (water vapour) the potential difference which the gas can support without a spark passing is approximately steady, but when the gas is carefully dried it can support an abnormally large potential difference, though when once the discharge has started the potential difference at once falls to its normal value. The passage of the spark producing a supply of modified gas which persists for some time after the discharge has stopped.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Oxford.—The opening of the new department of Human Anatomy was the occasion of some ceremony on Saturday afternoon. The Vice-Chancellor presided at a large gathering of scientific and medical men, including some distinguished visitors from the leading medical schools and universities. After speeches from Sir William Turner, Mr. Arthur Thomson, Sir Henry Acland, and Prof. MacAlister, the Vice-Chancellor declared the buildings open, and the proceedings closed with a vote of thanks to the Vice-Chancellor, moved by Prof. Burdon Sanderson.

The lectures and practical courses in the Natural Science Department are as follows for the current term:—In Physics, Prof. Clifton lectures on Electricity, and gives practical instruction with the assistance of Mr. J. Walker and Mr. S. A. F. White. Mr. R. E. Baynes, lectures at Christ Church on Heat and Light, and Sir John Conroy and Mr. F. J. Smith lecture at Balliol and at Trinity College, respectively, on Elementary Physics and on Mechanics and Physics.

In Chemistry, Prof. Odling lectures on Organic Chemistry, and Mr. W. W. Fisher, on Inorganic Chemistry. Other lectures and practical instruction are given by Mr. J. Watts, Mr. V. H. Veley, Mr. J. E. Marsh, and Mr. J. A. Gardner. Mr. Vernon Harcourt and Mr. P. Elford lecture at Christ Church and St. John's respectively. Prof. A. H. Green lectures on Geology in the Museum on Mondays, Wednesdays, and Fridays.

Prof. Ray Lankester lectures three days a week on the Comparative Anatomy of the Vertebrata, and Dr. W. B. Benham and Mr. G. C. Bourne give other lectures in the Linacre Professor's Department. Mr. J. Barclay Thompson lectures on the Osteology of Fish and Amphibia; and the Hope Professor of Zoology, on Means of Defence in the Struggle for Existence.

In Physiology, lectures and practical instruction in the subjects for the Final Honour Examination are given by Prof. Burdon Sanderson, Mr. J. S. Haldane, and Mr. M. S. Pembrey.

Prof. S. H. Vines gives advanced and elementary courses on Botany at the Botanical Gardens.

In Anthropology, lectures are announced by Dr. E. B. Tylor, by Mr. H. Balfour, and by Mr. Arthur Thomson.

It is announced that the examination for a Biological Fellowship at Merton College will commence on November 14.

Examinations for Natural Science Scholarships and Exhibitions at Balliol, Christ Church, and Trinity, are announced to begin on November 21.

Cambridge.—The Vice-Chancellor gives notice that Mr. H. Yule Oldham, University Lecturer in Geography, will deliver an inaugural lecture on the progress of geographical discovery, in the large lecture theatre of the chemical laboratory, on Tuesday, October 24, at noon.

During the Michaelmas and Lent terms, Mr. Oldham will give courses of lectures on the principles of physical geography, in the same theatre, on Thursdays, at noon, beginning on October 26.

The Council of the Royal Geographical Society offer to award during the present academical year an exhibition of £100 to be spent in geographical investigation (physical or historical) of some district approved by the Council, to a member of the University of not more than eight years' standing, who shall have during his residence attended the courses of the lectures in geography. Further particulars will be announced.

The office of Director of the Fitzwilliam Museum is vacant by the resignation of Dr. Middleton. A new Director will be appointed on Friday, November 17. The stipend is £300 a year. Candidates are to send their names to the Vice-Chancellor by Friday, November 10.

The Walsingham Medal, founded by the High Steward of the University, will be offered during the present academical year for the best monograph or essay giving evidence of original research in any subject connected with biology or geology. Essays are to be sent to Prof. Newton by October 1, 1894.

There are this year 132 freshmen who have indicated their intention of studying medicine in the University.

Entrance Scholarships in Natural Science have been awarded at Christ's College to A.V. Cunnington (£60), Clifton College, and J. Hart-Smith (£30), Berkhampstead School; and at Emmanuel College to W. F. A. Ermen (£50), Clifton College, and R. G. K. Lempfert (£50), Manchester Grammar School. At Downing College an Examination for Minor Scholarships (£50) in Natural Science will be held on April 17, 1894. At St. John's the Examination for Natural Science Scholarships (£80 and under) and Exhibitions (£50 and under) will begin on December 5, 1893.

The United States Bureau of Education has published a remarkable "Circular of Information," by Dr. Arthur Macdonald, entitled "Abnormal Man." The volume includes essays on education and crime and related subjects, with digests of literature and an extensive bibliography. With regard to the effect of education on crime a statistical investigation shows that in France and Italy there has been an increase of both education and crime. Germany shows an increase of habitual criminality and a general increase of both university education and crime. As far as statistics are accessible, Austria shows an increase in education and a decrease in crime. Also, while there has been a decrease in the number of convictions for crime from 1881 to 1887 in Norway and Sweden, there has been an increase in education. But in Norway alone for the year 1888–89 there was an increase in the number of crimes. In England, Scotland, and Ireland all statistics are in accord in showing an increase in education and a decrease in crime from 1885–1890. Japan and Saxony also exhibit an increase in education and a decrease in the number of convictions. It thus appears that while some countries show an increase in both education and crime, yet not a few, and some of the most developed nations, show an increase of education and a decrease of crime. The statistics, therefore, fail to show the exact relation between education and crime.

SCIENTIFIC SERIALS.

American Journal of Mathematics, vol. xv. No. 3. (Baltimore, 1893).—On groups whose orders are products of three prime factors, by F. N. Cole and J. W. Glover (pp. 191–220). In this paper the authors fully determine the groups for three prime factors, equal or unequal. Those of order pq and p^2 are known from Netto.—The nature and effect of singularities of plane algebraic curves, by Miss Scott (pp. 221–243) is a continuation of the paper in vol. xiv. In the earlier memoir the method employed was stated to be directly applicable, in general, to the determination only of the joint components of the singularity; in this the restriction is removed, and it is shown that the process enables one, in every case, to enumerate the double lines (double tangents and inflexional tangents) involved in the singularity. —The elliptic irregularities in the lunar theory, by E. W. Brown (pp. 244–263), gives a general solution in series of the problem: a system of three bodies is in motion in one plane, the first is revolving about the second, and is disturbed from its elliptic orbit by the third. The third body is supposed to be of infinite mass, and to be moving in a circle of infinite radius with a finite angular velocity. Given the relative positions of the three bodies at any one time, to find their relative positions at any other time. The differential equations used at the outset are given in Dr. Hill's paper (vol. i.) and M. Poincaré's researches (*Acta Math.* vol. xiii.) afford considerable help in the work.—On the transformation of linear differential equations of the second order with linear coefficients, by Oskar Bolza (pp.

264–273), is a fresh treatment of the problem by methods of the theory of invariants.—On certain properties of symmetric, skew-symmetric, and orthogonal matrices, by W. H. Metzler (pp. 274–282) proves in another way properties of these matrices which have been obtained by Dr. Taber (*L. Math. S. Proc.* vol. xxii.), and Mr. Buchheim (*Messr. of Math.* vol. xiv.). The number closes with a deduction and demonstration of Taylor's formula, by W. H. Echols (pp. 283–4).

Symons's Monthly Meteorological Magazine for September contains an interesting climatological table for seventeen selected stations in the British Empire, for the year 1892. This valuable summary has now been published for several years, and corresponding monthly tables with remarks have been also regularly printed since July, 1881. The highest temperature in the shade was 110°·8 at Adelaide on January 20. This station also recorded the highest temperature in the sun, and had the lowest mean humidity. The lowest shade temperature was -44°·4 at Winnipeg, on January 18; this station had also the greatest yearly and daily range, and the lowest mean temperature. The dampest and most cloudy station was Esquimalt. The greatest rainfall was 95·1 inches at Bombay, and the least, 21·3 inches at Jamaica. Attention is again drawn to the fact that the Australian stations record higher temperatures both in shade and in sun than occur at the East Indian stations. A table is given of the absolute maximum temperature in shade and sun for each of the ten years 1883–92, at Adelaide and Calcutta, and shows an average excess at Adelaide of 5°·2 in shade, and 6°·4 in sun; but the heat is more prolonged in India, and in the hottest months the average maxima in the shade are always higher at Calcutta.

Wiedemann's Annalen der Physik und Chemie, No. 9.—Luminous phenomena in vessels filled with rarefied gas under the influence of rapidly alternating electric fields, by H. Ebert and E. Wiedemann. Gas vessels without electrodes were placed between the condenser plates of a Lecher wire combination. The luminous phenomena were investigated and discussed from the point of view of tubes of electric force undergoing displacement. It was shown that the portion of energy dissipated by radiation is perfectly commensurable with that occurring in the field generally. The glowing of a gas is therefore a sufficient cause for diminution of pressure in tubes of force, and hence for the displacement of tubes in the field, leading to a dissipation of the energy contained in them. Experiments were also made with tubes fitted with electrodes, one or both of which were attached to an end of the Lecher system. It was shown that any metal plate in contact with a rarefied gas and exposed to slightly damped electric oscillations, shows all the phenomena of a kathode. Also, that at every wall suitably crossing a gaseous space filled with electric oscillations a kathode is produced.—Vapour pressures of aqueous solutions at 0° C. by C. Dieterici.—Thermo-electric studies, by E. Englisch.—Concerning the physical interpretation of thermo-electricity, by F. Braun.—Density of dilute aqueous solutions, by F. Kohlrausch and W. Hallwachs.—Solubility of some "insoluble" bodies in water, determined by the electric conductivity of the solutions, by F. Kohlrausch and F. Rose. The determination of small quantities of "insoluble" substances in a large amount of water is subject to many experimental errors due to the necessity of evaporating large quantities of water at the boiling point, whereby the solubility of the material of the dish becomes a disturbing factor. As the laws governing the relation between concentration and electric conductivity are fairly well known, it is possible to arrive at an estimate of minute quantities of dissolved matter by a determination of the electric conductivity of the solution. This method has proved to be very simple, expeditious, and accurate.—On heat generated by dielectric polarisation, by A. Kleiner.—Experiments on the generation of electricity by small drops, by A. L. Holz. A jet of mercury was projected upon an amalgamated copper plate, whence it rebounded in small globules on to a glass plate, and thence to the electrometer. The increase of potential was found to be proportional to the sectional area of the jet, the pressure and height of fall of the mercury, and the size of the saturated glass plate.—Dielectric constants of liquid bodies as dependent upon temperature and the Mossotti-Clausius formula, by A. Franke.—Experiments on the interference of electric waves in air, by I. Klemencic and P. Czermak.—Notice on secondary heatings of galvanic cells, by H. Jahn.

SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, October 4.—Henry John Elwes, President, in the chair.—Mr. F. Merrifield exhibited specimens showing the effects of temperature in the pupal stage on several species of Lepidoptera. *Vanessa polychloros* was much darkened, especially towards the hinder margin, by a low temperature. *Vanessa c-album* showed effects on both sides, especially in the female; they were striking on the under side. Some *Vanessa io* showed the gradual disintegration, by exposure to a low temperature, of the ocellus on the fore wing, which in the extreme specimens ceased to be an ocellus, and was a remarkable confirmation of Dr. Dixey's views of the origin of that ocellus, as exemplified in the plate attached to his paper in the Entomological Society's Transactions for 1890. Mr. Goss stated that in his experience of *V. c-album* in Northamptonshire, Gloucestershire, Herefordshire, and Monmouthshire, the form with the pale under side was the first brood, occurring in June and July; and that the specimens of the second brood, occurring from the end of July to October, were invariably dark on the under side.—Mr. A. H. Jones exhibited Lepidoptera collected in Corsica in June last, including dark forms of *Polyommatus phlæas*, *Lycæna astrarche*, in which the orange marginal band is very brilliant on upper and under sides of both wings, *Lycæna argus*, the females of which are much suffused with blue, probably var. *calliopis*: a series of *Vanessa urticæ* var. *ichnusa*, bred from larvæ, *Argynnis elisa*, *Satyrus semele* var. *aristæus*, *Satyrus neomiris*, *Cœnonympha corrina*, both spring and summer brood, and many others.—Mr. G. C. Champion exhibited for Mr. G. A. J. Rothney, a number of *Methoca ichneumonoides*, Latr. (female), taken at Bexhill, Sussex, showing great variation from the usual large black and red form.—Dr. D. Sharp, F.R.S., exhibited a pupa of *Galleria melonella*, on which the eggs of a parasitic Hymenopteron had been deposited while the insect was in the cocoon. He also exhibited the hitherto unique *Asprostoma planifrons*, Westw.—Mr. J. J. Walker exhibited specimens of the following species, viz. *Halobates sericeus*, from the Pacific; *H. sobrinus*, and *H. wüllerstorffi*, from Marquesas Islands; *H. princeps*, from the China Sea; and a female of *H. wüllerstorffi*, with ova attached.—Mr. W. H. B. Fletcher showed a variable series of 75 specimens of *Cymatophora or*, bred in 1893 from larvæ from Sutherland, a series of about 40 *C. ocularis* bred-in from stock from Oundle; also a series of 33 moths, all females, supposed to be hybrids between *C. ocularis* male and *C. or* female, from the above stock in each case, bred as a second brood in August and September, 1893. He stated that he placed the reputed parents in a muslin sleeve on a branch of *Populus nigra*, and did not open the sleeve until the resulting larvæ required fresh food. The supposed hybrids resembled the female parent, except that both orbicular and reniform stigmata were very conspicuous, being pure white filled up slightly with black.—Mr. F. J. Hanbury exhibited a specimen of *Leucania vitellina*, taken at Brockenhurst on August 24, 1893, and another taken at Freshwater, Isle of Wight, on September 7; also an extraordinary *Gonepteryx rhamni*, showing red blotches at the tips of the fore wings, taken at Walthamstow, Essex.—Mr. C. G. Barrett exhibited a gynandrous *Argynnis paphia* recently taken in the New Forest by Mr. Cardew.—Mr. J. M. Adye exhibited a specimen of *Deilephila livornica* recently caught at Christchurch, Hants.—Mr. Elwes exhibited and described two species of the genus *Œneis* (*Chionobas*, Bdv.) *Œ. beani* and *Œ. alberta*, from North America, which had not been previously described, and stated that he had prepared a revision of this very difficult genus, which would be read at the November meeting.—Mr. Osbert Salvin, F.R.S., exhibited a new genus and species of Papilionidæ (*Baronia brevicornis*). He also communicated a paper entitled "Description of a new genus and species of Papilionidæ from Mexico."—Dr. Sharp read a paper entitled "On the Cost and Value of Insect Collections." Mr. W. F. H. Blandford, Mr. McLachlan, F.R.S., Mr. Jacoby, Mr. Waterhouse, and the President took part in the discussion which ensued.—Prof. Auguste Forel communicated a paper entitled "Formicides de St. Vincent, récoltées par Mons. H. H. Smith."—Mr. Blandford read a paper entitled "Description of a New Subfamily of the Scolytidæ." The President, Mr. Jacoby, and Mr. Waterhouse took part in the discussion which ensued.

PARIS.

Academy of Sciences, October 9.—M. Lœwy in the chair.—On the theory of pyro-electricity and piezo-electricity, by Lord Kelvin.—On a class of new transcendentals, by M. Emile Picard.—Theorem on triple orthogonal systems, by M. Lucien Lévy.—Circles or spheres derived from a plane or solid envelope of any class, by M. Paul Serret.—On the aperture fringes, in the experiment with parallel gratings, by M. Georges Meslin. These fringes are independent of the form, the size, and the orientation of the slit; they do not require a particular position of the screen or the slit, and the use of a lens is not indispensable. Their essential characteristic is that of exhibiting alternate colorations, which are sensibly complementary. In other respects they present the same aspect as those produced by one slit illuminating one grating. But the black fringes, which are very fine in the first case, are less sharply defined; the second phenomenon does not reproduce the delicate portions of the first, but shows only those bands which have a certain breadth. If the periods of the gratings are identical, the bands are sharply defined. If the illuminating grating has a number of slits per mm. equal to half that of the second, the colorations are the same, but less brilliant. On reversing the positions, the fringes become achromatic, owing to the superposition of the red and green bands of the two systems.—On the relation between the precipitation of chlorides by hydrochloric acid and the lowering of the boiling point, by M. R. Engel. To precipitate one molecule of a chloride from its saturated solution at 0° requires in the case of monovalent chlorides, one molecule of HCl, and in the case of divalent chlorides, two molecules. This is now proved also to hold good for temperatures other than 0°, and for double chlorides, like that of copper and ammonium, containing four atoms of chlorine and requiring four molecules of HCl. The molecular depression of the freezing point of solutions of the various chlorides was also investigated in its relation to the concentration. It was found that for the monovalent chlorides the molecular depression remains sensibly the same, varying between 35 and 40, but tends to reach twice that value for divalent, and four times that value for tetravalent chlorides. Hence at the freezing point of the saturated solution of alkaline chlorides, bromides, and iodides, there must be a relation between the atomic weights of the constituents of the molecule and the solubility.—On the variations of glycogeny in anthrax infection, by M. H. Roger. The glycogenic function remains intact during the first stages of anthrax infection. The amount of sugar contained in the blood is normal or slightly diminished. At the end of the disease, the hepatic glycogen rapidly disappears and a considerable hyperglycemia is produced.—Researches on the extension of the blastoderm and the orientation of the embryo in the ova of the Teleostea, by MM. R. Kœhler and E. Bataillon.—On the localisation of the active principle in the Cappardeæ, by M. Léon Guignard. The existence of special ferment cells is general in the Cappardeæ. By their morphological characteristics in the root and the stem they resemble those found in the corresponding organs of the Cruciferæ. In the leaf and especially the flower of the caper-tree their grouping is peculiar. All the reactions of their contents are those of myrosine. In the capers they are most numerous, and the glucoside is most abundant. The grains of all Cappardeæ, however, are relatively poor in ferment and in glucoside, and of their two constituents the embryo alone contains the ferment.—Sexual reproduction of the Ustilagineæ, by M. P. A. Dangeard.—On plane-tree honey, by M. Edm. Jandrier. During dry summers an exudation of varying consistence and aspect may be found on certain planes (*Platanus Orientalis*). It is sometimes dry and bright, sometimes pasty and yellowish, and contains, besides a small quantity of reducing sugar, probably glucose, about 80 or 90 per cent. of mannite, which may be extracted with the greatest ease by means of boiling alcohol and crystallisation.—Observation of an Aurora Borealis, by M. le duc Nicolas de Leuchtenberg. This was observed from the camp at Krasnoe Selo in the middle of July, about 10h. 30m. p.m. Its apex was situated very near the zenith, and seemed based upon a cluster of light vapours from which regular and regularly spaced bands proceeded, passing from white to a delicate pink and green, with a vibration resembling that exhibited by rarefied gases in Geissler tubes. It was seen to last about a quarter of an hour.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Solutions of the Examples in the Elements of Statics and Dynamics: S. Soney (Camb. Univ. Press).—An Elementary Treatise on Theoretical Mechanics, Part 1, Kinematics: A. Ziwet (Macmillan).—Text-book of Geology: Sir A. Geikie, 3rd edition (Macmillan).—Eskimo Life: F. Nansen, translated by W. Archer (Longmans).—Key to Carroll's Geometry (Burns and Oates).—The Shrubs of North-eastern America: C. S. Newhall (Putnam).—Handbook of Public Health and Demography: Dr. E. F. Willoughby (Macmillan).—An Elementary Treatise on the Geometry of Conics: A. Mukhopadhyay (Macmillan).—A Treatise on Hygiene and Public Health, Vol. 2, edited by Dr. T. Stevenson and S. F. Murphy (Churchill).—Vorlesungen über Maxwell's Theorie der Elektricität und des Lichtés ii. Theil: Dr. L. Boltzmann (Leipzig, Barth).—Healthy Hospitals: Sir D. Galton (Oxford, Clarendon Press).—Sporozoen als Krankheitserreger, Erstes Heft: Dr. A. Korotneff (Berlin, Friedländer).—Zoological Record 1892 (Gurney and Jackson).—Everybody's Letter Writer (Saxon).—The Out-door World: W. Furneaux (Longmans).

PAMPHLETS.—Reports of the Director of the Michigan Mining School for 1890–92 (Lansing).—Anleitung zur Krystallberechnung: Dr. B. Hecht (Leipzig, Barth).—Report on the Present State of our Knowledge respecting the General Circulation of the Atmosphere: L. T. de Bort (Stanford).—History of Slavery in Connecticut: Dr. B. C. Steiner (Baltimore).—Merchant Venturer's School, Prospectus 1893–94 (Bristol).—The Interdependence of Abstract Science and Engineering: Dr. W. Anderson (London).

SERIALS.—Mind, October (Williams and Norgate).—American Meteorological Journal, October (Ginn).—Boletin del Instituto Geografico Argentino, tomo xiv. Cuadermos 1 to 4 (Buenos Aires).—American Journal of Science, October (New Haven).—American Naturalist, September (Philadelphia).—John Hopkins University, Baltimore, Studies from the Biological Laboratory, Vol. v. No. 4 (Baltimore).—Records of the Geological Survey of India, Vol. xxvi. Part 3 (Calcutta).—Botanische Jahrbücher, Siebzehnter Band, 3 and 4 Heft (Williams and Norgate).—Kryptogamen-Flora von Schlesien, 3 Band, 2 Hälfte, 1 Lief (Williams and Norgate).—Annals of Scottish Natural History, No. 8 (Edinburgh, Douglas).—Agricultural Gazette of N.S.W., August (Sydney).—Palestine Exploration Fund. Quarterly Statement, October (Watt).—Nyt Magazin for Natur videnskaberne, 34 ke Binds, 2 det Hefte (Christiana).—Proceedings and Transactions of the Nova Scotian Institute of Science, Halifax, 2nd series, Vol. i. Part 2 (Halifax, Nova Scotia).

CONTENTS.

THURSDAY, OCTOBER 26, 1893.

ANALYTICAL MECHANICS.

A Treatise on Analytical Statics. With numerous Examples. Vol. II. By Edward John Routh, Sc.D., LL.D., M.A., F.R.S. (Cambridge: at the University Press, 1892.)

THIS volume finishes Dr. Routh's work on the subject of analytical statics, the first volume of which was reviewed in NATURE, June 16, 1892. It contains, in three long Sections or Books, the subjects of Attraction, Bending of Rods, and Astatics, left over from Vol. I.

In Attraction a start is made with the Newtonian Law, and the Gravitation Constant is introduced.

The experimental redetermination of the numerical value of the Gravitation Constant is engaging the attention of Mr. Poynting (who has just been awarded the Adams Prize for his Essay on this subject) and of Mr. C. V. Boys. But we cannot hope to obtain, with the greatest refinements, an accuracy of determination within limits of error of less than one per cent.; the Astronomical Unit of Mass, defined in § 3, would be subject to the same limits of error, which are far beyond what is permissible in careful measurements with the Balance.

The only reason for the introduction of the Astronomical Unit of Mass is to save the trouble of writing down k, the Gravitation Constant, in our equations; but we agree with Prof. Minchin, in his Analytical Statics, in thinking that it tends to clearness if we take the trouble to write k in its proper place, so as always to measure m in such well-determined units as the gramme or kilogramme.

Nowadays the theorems of Attraction receive their most appropriate interpretation, analytical and experimental, from the subject of Electrostatics; the theorems on the Potential of Laplace, Poisson, and Gauss, on Tubes of Force, Green's Theorem, Inversion, Laplace's Functions, and on the Attraction of Ellipsoids of Chasles, all present themselves as fundamental in the Electrostatical chapters of Maxwell's "Electricity and Magnetism;" insomuch that Maxwell ventured to present a demonstration of some of the most abstruse analytical results of Laplace's Functions, founded on physical principles of Electrostatics, and thereby excite the ire of certain mathematicians of the purest proclivities.

For instance, the complicated theorems on Centrobaric Bodies, discussed in §§ 111, 116, become self-evident when interpreted as the analogues of the electricity induced on an uninsulated closed surface by an electrical point in the interior. The external electrical effect being zero, the potential of the induced electricity is equal and opposite to that of the point, and therefore the surface has an electrical coating which is centrobaric, the function which represents the superficial density being *Green's Function* for the surface and the point.

If the dielectric in the interior is stratified, an electrical concentration is distributed throughout the space, and thus the analogue of the centrobaric body is obtained; but incidentally the electric analogy shows that the strata of equal density in the centrobaric body are each separately centrobaric, so that the centrobaric body is built up of centrobaric shells. The sphere is the homogeneous centrobaric body, as Newton showed in the "Principia"; and an application of Sir W. Thomson's powerful geometrical method of electrical inversion deduced the fact that a solid sphere whose density varies inversely as the fifth power of the distance from an external point O′ is centrobaric with respect to the interior inverse point O. So also for a spherical shell, either this or composed of a series of concentric strata; and this by inversion leads to the theorem that a shell bounded by two excentric spheres of which the limiting points are O and O′ is centrobaric if the density at any point P in it is

$$\mathrm{OP}^{-5}\phi(\mathrm{OP}/\mathrm{O'P}/)$$

The discovery of Green's function for a given surface, or rather the discovery of surfaces for which Green's function can be assigned, is one of the most difficult and baffling of modern analysis; and it has so far only been effected for some few simple cases.

The British Association met recently at Nottingham, the birthplace of George Green in 1793. There must be people still living there who remember him, and could supply now, before it is too late, some interesting details of the causes which led to the development of his wonderful mathematical genius, at a time too when little encouragement was vouchsafed to such abnormal proclivities. In France a statue would long ago have arisen in his honour; but at least an interesting paper on the subject of Green's life could be communicated to Section A.

The theorems of Chasles and Maclaurin on the attraction of homœoids and focaloids are fully discussed in §182; the homœoids receive ample illustration in electrical phenomena; but Maclaurin's theorem on the attraction of confocal homogeneous solid ellipsoids is rendered more convincing by supposing the smaller confocal to be scooped out of the larger so as to form a thick focaloid, the matter which is scooped out being condensed homogeneously with the rest of the substance. The effect of this operation is to leave unaltered the external potential, and the original matter may thus ultimately be condensed into a thin focaloid, in which the thickness is inversely proportional to the perpendicular on the tangent plane; and this focaloid will have the same external equipotential surfaces as the solid ellipsoid.

Part ii., on the Bending of Rods, does not assume any new experimental knowledge beyond that of the proportionality of the curvature to the bending moment, an assumption which we know from Prof. Karl Pearson's "History of Elasticity" to be only a first rough approximation to the truth.

The analytical consequences of the hypothesis are, however, very elegant and instructive, and Dr. Routh has brought together an interesting collection of illustrative examples.

He does not, however, develop the elliptic function solution of the plane Elastica or associated Lintearia, curves which can now be drawn with great accuracy and rapidity by Mr. C. V. Boys's scale. He also restricts himself to the uniform helix in the tortuous Elastica; but the student who wishes to pursue this branch of the subject to its fullest development must consult vol. ii. of Mr. Love's "Elasticity," which has recently appeared.

Kirchoff's Kinetic Analogue between this Elastica and the motion of a Top, makes the same analysis serve for both; thus, as pseudo-elliptic solutions, we may mention that tortuous Elasticas are given by:—

$$\text{(i.)}\ r^2 e^{2i(\psi+ps)} = \sqrt{\{r^2 - \tfrac{1}{4}c(1-4c)a^2\}}\sqrt{\{r^2 + \tfrac{1}{4}(1-2c)(1-4c)a^2\}} + \tfrac{1}{2}i(1-4c)a\sqrt{\{\tfrac{1}{2}c(1-2c)a^2 - r^2\}};$$

$$\text{(ii.)}\ r^3 e^{3i(\psi+ps)} = \{r^2 + (1-c)(2-3c)a^2\}\sqrt{\{r^2 - (2c-3c^2)a^2\}} + i(2-3c)\sqrt{\{-r^4 - (1-c)(1-3c)a^2r^2 + (1-c)^2(2c-3c^2)a^4\}};$$

corresponding to parameters $\omega_1 + \frac{1}{2}\omega_3$ and $\omega_1 + \frac{2}{3}\omega_3$ of the related Elliptic Integrals of the third kind.

Here a determines the scale of the figure, and c is an arbitrary parameter, upon which p depends; and it is curious that in case (ii.) the value $c = \frac{1}{3}$ makes p vanish, and then $\omega_3 = \sqrt{(-3)}\omega_1$.

Other interesting applications of the Theory of the Bending of Rods, requiring Bessel Functions, are the investigations of the greatest height consistent with stability to which a vertical wire or mast can be carried, or to which a tree can grow, without drooping over under its own weight; we can thus supply the analysis required in the old German proverb, quoted by Goethe, "Es ist dafür gesorgt, dass die Baüme nicht in den Himmel wachsen."

The third part, on Astatics, is intimately bound up with the distribution in space of Poinsot's central axis for a system of forces; or with Sir Robert Ball's investigation on Screws. A great analogy exists with the analysis required in the distribution of principal axes in space. A problem which might well find a place here is, "The moment of inertia of a body of mass M about any generating line of the hyberloloid of one sheet

$$\frac{x^2}{a^2+\mu} + \frac{y^2}{b^2+\mu} + \frac{z^2}{c^2+\mu} = 1,$$

confocal with the ellipsoid of gyration

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1$$

is constant, and equal to

$$M(a^2 + b^2 + c^2 + 2\mu)."$$

Dr. Routh has now completed his work on "Analytical Statics," and the two volumes form an indispensable addition to the library of the mathematical student.

A. G. GREENHILL.

MOLESWORTH'S POCKET-BOOK.

Pocket-Book of Useful Formulæ and Memoranda for Civil and Mechanical Engineers. By Sir Guilford L. Molesworth, K.C.I.E., M.Inst.C.E., and Robert Bridges Molesworth, M.A., Assoc.M.Inst.C.E. 23rd edition. (London: E and F. N. Spon, 1893.)

OF all the many books published for the assistance of engineers generally there is none so well known to the profession as "Molesworth." This pocket-book is to be found in the possession of every engineer, and rightly so, because it is certainly the most useful and accurate of the many to be obtained.

Any work which has reached the 23rd edition requires no praise to verify its position. This edition is said to contain new and important information on recent engineering and industrial developments, many of them entirely new, and much of the matter in previous editions has been revised. "Molesworth" treats with nearly all the various branches of engineering, and so extensively has this been carried out that it is impossible to notice but slightly its contents; besides the many purely technical formulæ there is to be found a collection of most useful tables applying generally to engineering. There are, however, a few mistakes in the mass of matter brought together in this book, and in some instances statements are made which would have been better omitted.

On page 254 we read that Vickers' straight steel axles should have an ultimate tensile strength of not more than 23 tons per square inch, and that this test can only be made by destroying the tested axle. Crank axles should also have a maximum tensile strength of 23 tons. There is either a typographical error or gross mistake in this statement. Had the maximum limit been given 33 tons it would have been nearer the mark; 23 tons is absurd. Probably the best tensile tests for steel axles would be 30 tons per square inch, 25 per cent. extension measured over a length of three inches, and 40 per cent. contraction of area at point of fracture. The author omits to state that straight axles are tested under the tup, and that it is this test which destroys them. It is usual to take the tensile sample from this axle. Again, in the tests for steel tyres given on page 255, we notice that a tensile strength of 47 tons is required, but no extension or contraction of area is specified. This is all very well, but tyres have been known to stand the tup test and give the proper tonnage in the tensile test, still the extension has only been 5 to 8 per cent. on three inches, when 16 per cent. is the lowest limit safety demands.

On p. 410, under the head of workshop recipes, there are several mixtures given for case-hardening of wrought iron. The first recipe is used by a few people, but the majority use ordinary charcoal mixed with about 2 per cent. of soda ash. This gives a very uniform and close-grained casing. The author gives no time-allowance for the articles to remain in the furnace; this is all-important, because the time governs the depth of the casing. Further on, at p. 418, we find some recipes to prevent the incrustation of boilers. One cannot help being amused to discover in "Molesworth" of 1893 that potatoes, $\frac{1}{50}$th the weight of water in the boiler, when put in prevent adherence of scale. Twelve remedies are given, but the only one a man having any regard for his boiler would use is that of frequent blowing off.

When dealing with the question of the proportions of locomotive boilers on p. 453, the statement is made that—(1) no fixed rule can be established as to the best relative proportions of grate, fire-box, and tube surfaces. (2) Length of tube does not affect economic result. (3) Diameter of tube is a matter of indifference.

These conclusions are, to say the least of it, very dogmatical. Given the class of fuel to be consumed and the work to be done, then the question of the design of boiler is not very difficult, and the general practice in this respect may be said to be uniform. This practice is certainly approaching a fixed rule. Given the conditions, the design, or we should say the proportions, becomes an easy matter to designers worthy of the name.

We leave our readers to form their own opinions upon conclusions Nos. 2 and 3. It is a pity they are to be found in "Molesworth," because they may lead students and others to form the opinion that these most important details are matters of no consequence. The compound locomotive naturally is included in the new matter added to this edition, and being of great interest to all connected with railways, we expected to find the subject thoroughly up to date. In this we are disappointed; two-thirds of a page is considered ample space to discuss this important question, the other third being taken up with a few lines on American locomotive practice! American locomotive engineers do not consider the two-cylinder arrangement for compounding "most suitable," nor does Mr. F. W. Webb, the able locomotive superintendent of the L. and N.W. Railway. Surely these two subjects are worthy of more space and better treatment.

On p. 466 we notice a formula having reference to the blast pipe of locomotive engines, applying in particular to the exhaustive power of the pipe, as the efficiency of a blast pipe seems to depend more on its vertical position in the smoke-box than on anything else. This fact might have been noted with advantage.

The rule given on p. 499 for the safe load on locomotive springs, by Mr. D. K. Clark, is found to be rather excessive; the constant 11·3 can be increased with advantage to 15, the result thus obtained being the actual load to be carried. Notwithstanding these few weaknesses, Molesworth's Pocket-Book is, without doubt, incomparably the best of its kind; and so accustomed have engineers, and particularly draughtsmen, become to the continual use of this valuable book that most of them would be now really lost without it.

This book is clearly and well printed, nicely got up, and is a credit to all concerned in its publication.

THE AMERICAN CATALOGUE OF MEDICAL LITERATURE.

Index Catalogue of the Library of the Surgeon-General's Office U.S. Army. Vol. xii. (Reger—Shuttleworth), pp. 1004, 1892, and vol. xiii. (Sialogogues—Sutugin), pp. 1005. Imp. 8vo. Washington, (Government Printing Office, 1893.)

IT is a great pleasure to all who are interested in any form of library or literature to observe how punctually, year by year, these magnificent volumes appear, and show in a very practical way how American enterprise can deal with old-world questions of gathering together and keeping up a collection of books that is superior in its own department to any other, and which has been got together in little more than thirty years. What is framed as an Index Catalogue of the Library of the Surgeon-General's Office at Washington constitutes in effect a dictionary of all medical and surgical literature, ancient and modern, with very few *lacunæ;* the entries under authors' headings have now reached 240,007, and under subject-headings 539,927; and the attempt which at first sight may well have seemed too ambitious —viz. to catalogue under subject-headings all the signed articles which touch on medicine which exist in the periodical publications of all languages, as well as to cross-catalogue all medical books and pamphlets of the world under both author and subject-headings—has turned out perfectly successful. In the first eleven volumes there were mentioned 3,929 periodical publications which were thus treated; in the two more volumes which are before us there are 341 additions, and though some of the older ones may have died out, yet the labour remaining is obviously no light one. The thirteenth volume brings us within sight of the end, and it is probable that two years more may finish the first edition of the catalogue; yet it cannot but be that some provision, by supplement or otherwise, must be made for the literature which during fifteen years has been accumulating under the headings of the earlier volumes, and some arrangement must be made for the literature of the future. From the monthly issues of the *Index Medicus,* which is a catalogue issued by Mr. Billings, on similar lines, of purely contemporary medical literature, we may estimate that the sum total of titles of additions to the world's medical literature would amount to about one such volume as the present every three years, which leaves us no doubt that the successors to Mr. Billings, the present librarian, will have occasion for all the indomitable activity and accuracy he has shown. In the twelfth volume, considerable use in various quarters has enabled us to find only one trifling misprint of a well-known physician's initials (xii. 449), but accuracy in such details is indispensable when we have to do with 136 authors of the name of Richter, 227 of the name of Smith, and 240 of the name of Schmidt. The student may be overwhelmed at first by the 39 imperial 8vo. pages that are required for a closely-printed catalogue of the titles of the literature of scarlet fever, but he will find that 46 pages are needed for rheumatism, 63 for small-pox, and 102 for surgery. Under these large headings the sub-indexing is excellent. The great importance of such a classification under subject-headings should never be lost sight of in a catalogue which deals mainly with matters of observation and natural science, for, in a large majority of cases, the importance of the record depends more on the observation than on the observer, and the student for whom all these volumes are such an invaluable help to knowledge is much more likely to be wishing to pursue an inquiry on a particular subject, regardless of those who wrote on it, than to trace out the works of a particular author regardless of what he wrote upon. However, Mr. Billings is extremely liberal to him, and gives him an excellent chance of doing both, of seeing all the vast mass of signed periodical literature as well as the books written on the particular subject, and also of seeing a list of all that each author has written with the exception of the articles in periodical literature that he has not republished, and he will find that many authors have republished in pamphlet form all that is worth reading.

The task of classification under subject-headings of all literature, both periodical and other, has been felt too enormous for any first-rate general library, and, so far as we know, has only been attempted by the Germans over comparatively small branches of knowledge, *e.g.* Carus and Engelmann's *Verzeichniss der Scriften über Zoologie welche in der periodische Werken enthalten.* The Royal Society's "Catalogue of the Scientific Papers contained in the Scientific Periodicals" (8 vols. 4to) contained only a list under authors' headings of the publications between

1800 and 1873, and did not attempt to deal with any subject-headings, or any of the past history of the subjects as Mr. Billings has done in his rich and varied Index Catalogue of very nearly all the Medical Literature printed between the fifteenth century and the present day. A. T. MYERS.

OUR BOOK SHELF.

Lehrbuch der Botanik nach dem gegenwärtigen Stand der Wissenschaft. Bearbeitet von Dr. A. B. Frank. Zweiter Band: Allgemeine und Specielle Morphologie. 8vo, 431 pp. with 417 Woodcut Figures in the text, and an Index to Volumes I. and II. (Leipzig: Wilhelm Engelmann, 1893.)

THE first volume of this work, dealing with histology, anatomy, and physiology, was noticed in NATURE, vol. xlvi. p. 610, where some facts may be found connected with its history, scope, and arrangement. The present volume is concerned with general morphology and special morphology, or classification. It is, on the whole, exceedingly well compiled, and, as was said of the first volume, it is written in the clearest and easiest style, with no superabundance of words, such as often render German text-books unnecessarily difficult to the beginner. The illustrations (upwards of 400) are for the greater part borrowed from the works of Sachs, Gœbel, Schenk, Prantl, Pringsheim, Hanstein, Schimper, Strassburger, Hofmeister, De Bary, Tulasne, Bornet, Brefeld, Woronin, and other specialists, but chiefly from the first. These are all duly acknowledged, and, as the author states in his preface to the first volume, he has made the best selection he could, and he has used these familiar figures because he could not substitute better ones. This is, of course, true; yet we put it on record to inform the student that he will find little that is original in this way. General morphology occupies fifty-four pages, under four heads, namely: discrimination of forms in the vegetable kingdom, directions of growth, general laws of the relative positions of the members of the vegetable body, and origin of the members of the vegetable body. The remainder of the volume is devoted to special morphology, or systematic botany; but the large groups are somewhat unequally treated, 179 pages being devoted to cryptogams, as against 140 to phanerogams. Indeed, too much has been attempted in the space. For instance, the very brief diagonses of the natural orders given at the end of this volume can be of little service to the beginner. Few of them exceed six lines, and many of them are even less, consequently the characters given are often insufficient to include half of the genera. Generally speaking, they are correct as far as they go, but they are often not sufficiently comprehensive. We have said that this is an excellent book, yet here and there one stumbles upon statements that cause no little surprise. Thus the pictures of Nepenthes, Sarracenia, and Cephalotus are described indiscriminately as transformed terminations of tendril-like continuations of the leaves. Then with regard to the bibliography, the selections are by no means critical, and sometimes defective, especially in foreign literature. The indexes, of which there are three, are sufficiently copious. There is an index to the woodcuts, an index to the subjects, and an index to the plant-names. When will authors learn that one general index is preferable to a number of classified references? In this work it would have been much more convenient to have had an index to each volume.

The Elements of Natural Science. Part III. Natural Philosophy. By Dr. H. Wettstein. (London: O. Newmann and Co., 1893.)

THE German edition of this book is obligatory for all the secondary schools of the canton of Zurich, which partly accounts for the fact that more than seventeen thousand copies have been sold. It is doubtful, however, whether the translation will be so widely appreciated in England. There are already many excellent introductions to science covering practically the same ground as Dr. Wettstein's work. In one feature only is the book superior to the majority of those produced in England; viz. in the abundance of illustrations. As a rule, our text-books of science are very poorly off in this matter, whereas Ganot, and Deschanel, and the book before us, are brightened considerably by the insertion of numerous illustrations.

When we say that in the 138 pages of the book the sciences of mechanics, sound, light, heat, electricity, and magnetism are treated, it will be at once understood that the descriptions are of a rather sketchy nature. In spite of this, however, the book will give its readers a good grounding in the principles of physical science. Though most of the text can be easily comprehended by the average pupil, there are portions which should hardly be inserted without explanation. Thus, on p. 44 we read: "The atmospheric pressure carries our legs and arms, for the condyle of the femur fits air-tight into the acetabulum of the pelvis, and likewise the condyle of the humerus into the articular cavity of the shoulder-blade." And it is misleading to say: "The complete spectrum of sunlight consists of three parts—*the heat spectrum, the light spectrum, and the chemical spectrum*" (p. 71). The table of spectra given in the frontispiece is poor, one of its defects being that the solar spectrum only differs from the spectrum of Sirius by the addition of the three lines A, a, and B. With this exception, however, all the illustrations are very clear and accurate.

A Short Course in the Theory of Determinants. By L. G. Weld. (London: Macmillan, 1893.)

WE have read Prof. Weld's book with much interest, for though there are few, if any, novel results brought forward, he has certainly attained the goal he set before himself, and has developed the theory in a very simple manner. Some of the methods he has employed are new to us. The greater part of the work requires little beyond an intimate acquaintance with the principles of algebra as given in the ordinary school text-books. To confine the treatment within very moderate limits, there is no application of determinants to analytical geometry, but many of the more important algebraical applications find a place. After treating with sufficient detail of the origin and notation of determinants, our author gives a general definition of them, and enumerates and proves the more useful of their properties, and then touches lightly upon their applications to elementary algebra, *i.e.* to matrices and Sylvester's and Euler's methods of elimination. In Chapter vi. he briefly discusses the multiplication of determinants and reciprocal determinants. The last three chapters give a brief account of special forms, and of linear transformation. The text is very clearly printed, and we have detected but few trivial errors. There is a good store of examples, some of which appear to us to be rather "stiff." Due acknowledgment is made in the preface to the sources from which results have been derived.

A Practical Treatise on Bridge Construction. By T. Claxton Fidler, M.I.C.E. Second Edition, enlarged and revised. (London: Charles Griffin and Co., 1893.)

THE first edition of this book was reviewed at length in NATURE, vol. xxxviii. p. 2. Since then the Forth Bridge has been completed, and great advance has been made in the manufacture of steel.

The principal criticism to be added to the former review is that the author should add some remarks on the method of erecting a bridge, large or small. As it is, the structures are described as if they dropped down ready made from the sky into their appropriate place.

Many superior designs could at this rate be made for the Forth Bridge; but then this ignores an important controlling element, that the bridge was to stand, not only when completed, but at every intermediate stage of the erection.

Even the operation of hoisting or rolling into place a forty-foot girder is not a simple matter; during the process the ordinary stresses are mostly reversed, and the structure runs the risk of "cockling."

We find no mention of the Tower Bridge, the most important experiment of a drawbridge *à bascule*. G.

The Amphioxus and its Development. By Dr. B. Hatschek. Translated and edited by J. Tuckey. (London: Swan Sonnenschein and Co., 1893)

THIS is a translation of Dr. Hatschek's well-known paper on the subject published twelve years ago. It will no doubt enable those who cannot read German to follow Dr. Hatschek's statements. But unless the rest of the translation is more accurate than that of the title, readers will be deceived and disappointed. This book is not correctly called "Amphioxus and its Development." That is a salesman's title. There is nothing in it about Amphioxus, except an account of the earlier part of the development. The important facts of the larval development discovered by Willey, as well as the adult structure, are not dealt with. The original plates have not been reproduced in this translation, but very small and often obscure reductions of them are substituted.

E. R. L.

LETTERS TO THE EDITOR.

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

The Use of Scientific Terms.

I AM glad that so distinguished a physicist as Dr. Lodge has found certain matters relating to the history of physiology, which I discussed, I fear very imperfectly, in my Nottingham address, to be of sufficient interest to induce him to read and criticise it. Fully appreciating the geniality with which his criticisms are expressed, I will ask your permission to comment on one or two points in his letter, which may not be uninteresting to the readers of NATURE.

One of the principal objects which I had in view in my address was to promote that intercommunication between the physical and physiological sciences which Dr. Lodge thinks so desirable, and I am no less sensible than he is that this solidarity is much impeded by inconsistency in the employment of words. Your correspondent avers that whereas the language of Physics consists in "simple English phrases" and "common words made definite by connotation," our biological words are "polysyllabic," and our modes of expression as unlike those of daily life as can be contrived. We say "devitalising," for instance, when we mean killing, just as the chemist says "desiccating" when he means drying.

It is difficult to express the complicated relations which exist between the phenomena of life without using terms which are themselves complicated. Thus, I venture, notwithstanding Dr. Lodge's good-natured pleasantry, to think that the word "chemiotaxis," bad as it may be, serves better to express the little that we know about the "particular go" of certain processes than any simple English phrase we could substitute for it.

Two words, "life" and "energy," are specially referred to by Dr. Lodge as examples in illustration of the inconveniences which are to apt to arise from their improper use. In Physiology the word "life" is understood to mean the chemical and physical activities of the parts of which the organism consists together with their co-ordination—not the processes only, nor their co-ordination only, but both at the same time. Dr. Lodge uses the word life without making it "definite in connotation," but from what is said about it, it is evident that the life which he has in view is not made up of processes, but merely consists in their co-ordination or adaptation for the purposes of the organism; for it is defined as the "power of *directing* (the italics are mine) energy into otherwise unoccupied channels." This being understood, all that Dr. Lodge says about life, and particularly his statement that it is *not* a form of energy, seems to me to be in accordance with the views that I endeavoured to set forth in my address. The only difference, therefore, that exists between us relates to the sense in which the word life is to be used for scientific purposes. Next follow some trenchant observations as to the misuse of the word "energy." I do not think that I am accused of such misuse. Nevertheless it may be useful to note that in referring to the sense in which J. Müller and his illustrious pupil had used the term "specific energy," it was expressly stated that their use of it was in a sense entirely different from that in which it is employed in physical science; and further, that the words quoted from the "Physiological Optics," viz. "energies of the nerves of special sense," were written in 1886, not "long ago," as Dr. Lodge suggests.

I can assure your readers that to the best of my knowledge the word "energy" is never used in the old sense by physiological writers, excepting, so to speak, between inverted commas; and with reference to the historical importance of Müller's doctrine, and still more of Helmholtz's earlier physiological writings, the words "normal activity," or others of similar import, are substituted for "specific energy," not as necessarily meaning anything quantitative, but simply the mode in which the organ normally reacts.

To the suggestion that "subjective light" should in future be designated by an impressive-looking word beginning with *photo* and ending with *taxis*, I have no objection to make, excepting that it might turn out to be rather sesquipedalian. May I add, that I hope to have the opportunity of recurring to the subject of the vision of the totally colour-blind.

J. BURDON SANDERSON.

The Thieving of Antiquities.

A RECENT case, which has occupied some space in NATURE, raises much larger issues than the character of individuals, and issues which must be faced sooner or later.

The present conditions of the laws and practice regarding antiquities is most unhappy, both in the interests of science and in the interests of museums. Two matters require much revision: (1) The modes of excavating; (2) the laws regarding excavation and exportation.

As to the mode of excavating it is still generally the custom to leave much in the hands of native overseers, and often the European in charge does not live on the work. Until it is recognised that it is unjustifiable to disturb antiquities without recording everything that can be observed, we shall remain in the state of mere plunderers, without a claim much higher than that of the treasure-hunting natives. In Egypt, hitherto, nearly all official excavations have been made by trusting entirely to uneducated and dishonest native overseers; and while the laws are strict concerning Europeans working, the natives plunder almost at their will under one pretext or another. With suitable regulation it has been proved practicable to entirely excavate a site without any loss or pilfering of the smallest objects by the natives; and such excavation, entirely under trained and educated observers, either native or foreign, should be the aim in all future work.

But in the matter of the legal position it is far more difficult to reach a satisfactory basis. Baldly stated the case stands thus. Every country in which there is anything much worth having, stringently prohibits exportation and excavation; and nearly all the growth of museums of foreign antiquities is in direct defiance of the laws. Most countries are engaged in thieving from others on a grand scale, by various underhand agencies; a form of thieving which is as much tolerated by public opinion as smuggling was in former days. According to law, no antiquities of any kind can possibly leave Turkish or Greek territory, and nothing that is of great importance can leave Italian or Egyptian territory. Yet museums grow.

The actual course of affairs is that some private agent, or museum official, hears of something important, and buys it up in order to smuggle it for the museum in which he is interested. Sometimes museum officials go on missions to collect, or to excavate in accordance with the laws, while what they obtain is smuggled out in defiance of law. This is going on yearly, and will go on till some better system is established. Meanwhile all information concerning such discoveries has to be suppressed; and the most important acquisitions of museums are a matter which cannot be published, or even talked about in detail, while official papers have to be treated as secret archives.

In England the Government is a hindrance rather than a help to a better state of things. France and Germany ask other powers in a straightforward way for presents of antiquities by diplomatic channels; and they often get what they want, as we did in the days of Lord Stratford de Redcliffe and Sir Henry Layard. But recently English diplomacy has, on the contrary, repeatedly thrown away what rights Englishmen might claim concerning antiquities, in order to gain petty advantages which diplomatists were capable of understanding.

The work which has been done in Egypt by the Exploration Fund and myself, at least shows that such an unsatisfactory state of things is not unavoidable. The Egyptian laws are administered with more sense than such laws in other lands, and with a little diplomatic protection the position would be all that could be reasonably wished. For many years large excavations have been made openly, and with complete freedom, by Englishmen; nothing has been lost, either of objects or information, owing to surreptitious methods; all that has not been most essential for the country itself has been openly brought to assist study in England, and the fullest statements can be openly and honourably made on the subject. Meanwhile objects smuggled by officials have to be kept quiet, and lose whatever scientific value their record might have possessed.

Until our Government sees its interests in backing up work for its museums by honest methods, and straightforward dealing, we shall continue to lose the greater part of the scientific value of museum acquisitions, and to have a seamy side to our administration which is more discreditable than those personal questions that have lately been raised.

W. M. FLINDERS PETRIE.

University College, London, October 10.

The Glaciation of Brazil.

DR. WALLACE'S pointed reference to myself in this week's NATURE induces me to send you these few lines.

It has been said by more than one critic of my book on the "Glacial Nightmare" that in some cases I was merely slaying the slain, and notably in regard to Agassiz's views about the glaciation of Brazil. It has been overlooked that Agassiz's experience and authority on glacial matters were unrivalled, and that he had written on this very question: "An old hunter does not take the track of a fox for that of a wolf. I am an old hunter of glacial tracks, and I know the footprint whenever I find it."

Again, Dr. Wallace, whose knowledge of the tropics is so profound, had written: "Professor Agassiz was thought to be glacier-mad, but if we separate his theories from his facts, and if we carefully consider the additional facts and arguments adduced by Prof. Hartt, we shall be bound to conclude that however startling, the theory of the glaciation of Brazil is supported by a mass of evidence which no unprejudiced man of science will ignore merely because it runs counter to all his preconceived opinions." Again he says: "It can hardly be maintained that the discoverer of glacial phenomena in our own country, and who has since lived in such a preeminently glaciated district as the Northern United States, is not a competent observer; and if the whole series of phenomena here alluded to have been produced without the aid of ice we must lose all confidence in the method of reasoning from similar effects to similar causes, which is the very foundation of modern geology."

Lastly, Mr. James Geikie, in his second and revised edition of "The Great Ice Age," quotes Agassiz's conclusions without a word of protest or warning (*op. cit.* 484–5).

With these strongly expressed views before me, it was impossible to ignore the issue, and it can hardly be said I was slaying the slain in criticising those who believed in tropical glaciation.

I did not then know that in his subsequent work on Darwinism Dr. Wallace had, with that candour which makes his works so valuable to some of us, qualified and partially withdrawn his previous conclusions on the subject, a fact which he again emphasises in his letter to you. With this letter *cadet quæstio*, I know no one now who is willing to support Agassiz's theory, and we may take it to be dead. *Requiescat in pace.*

Meanwhile, however, let us do justice to those whose observations and logic have dispelled one phase at least of the glacial nightmare. Dr. Wallace attributes this to his friend and correspondent, but the work had already been done, and amply done, by others, as I tried to show in my recent book. In it I have quoted largely from the admirable remarks of Prof. Orton, Dr. Ricketts, M. Crevaux, and last, but not least, Prof. Hartt himself, who as far back as 1871 had given up Agassiz's views in regard to the Amazonian glacier (see *American Journal of Science*, 3rd ser. vol. i. pp. 294–5).

When we have got rid, however, of Agassiz and his Amazonian glacier, we have not got rid of all our difficulties. While we cannot accept the notion of tropical ice-sheets, we have still to explain the existence of erratic phenomena in the tropics, such as those described by Schomberg in Guiana, by De la Beche in Jamaica, by Blandford in Southern Persia, by Chardin in Media, by Belt in Nicaragua, and by Hartung in the Azores. There seems some difficulty in explaining these phenomena without invoking the former existence of local glaciers in parts of the tropics where they no longer exist, and also the occurrence of large diluvial movements there. I should be greatly indebted to Dr. Wallace, and so would others, for his views on this subject. There remains another and a more critical difficulty which I must reserve for another letter. In conclusion he will permit me to thank him for his very valuable and courteous letter.

HENRY H. HOWORTH.

30 Collingham Place, Cromwell Road, S.W.

The Glaciation of Brazil.—Scintillation of Stars.

A VERY cursory examination of the gneiss rocks about Rio de Janeiro—particularly the Corcovado—will show how the rock breaks up. In some places it comes off in great flakes like the coats of an onion, and the edges of these flakes are quite friable, and can be reduced to fine grains between the fingers. In many places it is found quite crumbled up by the weather, and down the coast towards Santos fine grains of these rocks can be found in the soundings at some distance from the land.

It is somewhat singular that observation has led me to a contrary opinion to M. Dufour in the scintillations of stars (NATURE, October 19). My attention was first drawn to the phenomenon by an old and experienced sailor, a native of the Western Islands, and a most clever weather prophet. I have constantly observed at sea that steadily-burning stars indicated calm, fair weather, and the more they twinkled the worse the weather was likely to be. The forecast given by this variation in scintillating was almost invariably correct in the high latitudes, though it failed sometimes in the tropics.

DAVID WILSON BARKER.

The *Worcester*, Greenhithe.

The Summer of 1893.

IN his letter in NATURE of August 31, Mr. W. B. Crump explains how the weather of the year has influenced the times of the flowering of the Halifax flora; and it may be of some interest to offer a note on the blossoming of a few common plants, trees, and bushes around Worcester.

The cardamine blossomed on April 16, herb Robert on the 16th, the oak on May 5, the elderberry on the 10th, the purple orchis on the 13th, and bear's garlic on the 13th also.

In this part of England field blossoms form an important factor in cottage economy. The harvest of this flora begins in spring with the primrose, the violet, and the wild daffodil, the latter here called the Lent lily. This season the Lent lily blossomed in March, as did the primrose and violet. Of late years these flowers have acquired a commercial importance, and engage, especially the former, a multitude of pickers and packers, lending life and colour to lonely railway stations. During the season dealers station in suitable country habitats agents who collect the flowers gathered by the pickers, and in large hampers despatch them to destinations all over the kingdom. This year the daffodil yielded less abundantly than usual.

Next to these blossoms follows the cowslip crop. This, for the sake of the pips, which, at 1*s.* a peck, are in demand at the British wine makers, is collected largely by cotters' children.

Owing to the drought the crop, greatly to the distress of poor folk, proved an utter failure. Happily the wealth of the season's blackberry crop atoned in some measure for the cowslip failure.

The modern taste for cut flowers has given a commercial place also to the blossoms of the wood anemone, the marsh marigold, the ladies' smock, and the yellow iris.

The apple, pear, and plum crops were excellent. In some plantations the gooseberry crop, through the ravages of the scourge known as the red spider, was destroyed, and the bushes killed.

The hop crop was good and great, the bulk being of a quality rarely, if ever, surpassed. As early as July 28 two pockets reached Worcester market; a date, save one, the earliest on record. Some twenty-four years ago—I cannot put my hand on the exact date—a pocket was delivered in this market on July 26.

On August 8 this season picking began to get general. On September 8, some days earlier than picking usually commences, many planters had finished.

On September 19, in ordinary years, hops begin to reach the market. This season much before that date the public warehouses were filled with new hops. The season being in advance of the hop requirements of the brewers, merchants did not attend to buy. For all this, waggons heavily laden with towering loads of hops came pouring in, and not only were the public warehouses filled, but the floor spaces of the Shirehall, the Guildhall, and the Gymnasium were packed.

The most notable feature of the year, doubtless, is the circumstance that during the latter part of July, as well as through the month of August, and down to the present date, there was, and is, a second leafing, blooming and fruiting of fruit and forest trees, and blossoming of the spring and summer flora.

In Paris the horse-chestnut trees blossomed and leafed afresh, as happened with many horse-chestnut trees in Cambridgeshire. In Kent orchards again put forth blossoms, while the ripening fruit of the year loaded the boughs. As far north as Manchester, and likewise near Wigan, the rhododendrons blossomed again. Throughout England many fruit trees are in second bearing. In the avenue of lindens in the New Road, in this city, many of the trees are garnished with new foliage of the exquisite vivid green tincture of spring; the leaves have attained full size. Strawberries ripe and of large size (5 inches in circumference) are common over a wide area of England. At Redruth, Cornwall, primroses, gentians, and golden chain, and most of the early spring flowers are again in splendid blossom; and there also fruit trees, while in full crop, are again in rich bloom.

In the Cottenham district of Cambridgeshire a second crop of various kinds of fruit is being gathered. Green gooseberries have been secured during the last few days from one of the gardens; raspberries have in several places blossomed again, and produced finer fruit than the first crop; while apple-trees also show a rich second bloom. In North Wales dog-roses, honeysuckle, and foxgloves are again in splendid bloom. In Worcestershire the midsummer flora is again in flower. Generally the late potato crop is growing again, and great deterioration of the tubers ensues. In Tenbury, Worcestershire, many of the potato tubers are flabby, as though scalded, and when boiled turn black and become nauseous, and the growers are wondering what is the matter.

At Médoc the vintage began on August 20, a month anterior to the usual date. For generations such an early date has not been known. The Girondins say the crop is splendid; sufficient casks for the crop are not procurable.

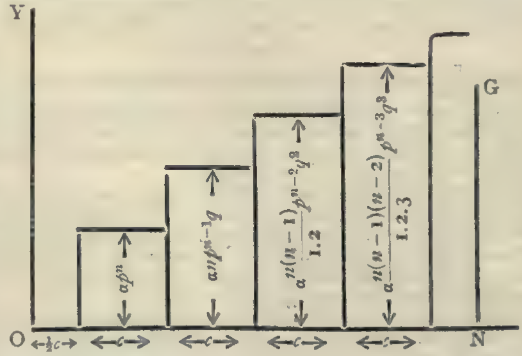
Here, in spite, or perhaps in consequence, of the drought, the familiar wayside wilding, the ladies bed straw, formed (in meadows put up for mowing) a great part of the crop, and, flinging lavish perfume around, lined every wayside hedgerow. The humming-bird moth, of which the bed straw is a food plant, was more common than ever before within my rather long experience. At the end of August, a month before the usual time, the thousand of Irish harvestmen left our shores for home.

The summer of 1818 resembled greatly that of the present remarkable year.

Worcester, September. J. LLOYD BOZWARD.

Asymmetrical Frequency Curves.

SOME six years ago (September 1, 1887) Dr. Venn wrote to you pointing out the asymmetrical character of certain frequency curves occurring in physical and biological measurements. I have recently obtained a generalised form of the probability curve which fits with a great degree of accuracy such curves, and propose to discuss it at length shortly. Meanwhile I wish to point out that an asymmetrical *point* binomial may be readily fitted to such curves, although not with the completeness of the above referred to continuous curve. Let n be the number of events in a group, p the probability for single event, and q that against it; let c be the horizontal space selected as the basis of each rectangle forming the point binomial, and let α be the total area. Then we have the following diagram given by the point system:



where the successive heights are the terms in

$$\alpha\left(p^n + np^{n-1}q + \frac{n(n-1)}{1.2}p^{n-2}q^2 + \ . \ . \ .\right).$$

Then I premise that to fit this to any real curve we *cannot* (1) use the length of base $(n+1)c$, for by trial I find this is never sufficiently accurately known; (2) use the magnitude or position of the maximum ordinate of the observation curves, for the first is not accurately known, and the second is dependent on knowing the exact end of the observation curve.

Accordingly I proceed *not* by the method suggested in Prof. Edgeworth's "Law of Error and the Elimination of Chance" (*Phil. Mag.* p. 318, April 1886), but by a method of higher moments.

Reckoned from O, the distance ON to the vertical through the centre of gravity, G, of the system of rectangles is $c(1+nq)$.

I now calculate the moments of the rectangles round the vertical, OY, and find for the rth moment

$$M_r = \alpha c^r \frac{d}{dq} q \frac{d}{dq} q \frac{d}{dq} \ . \ . \ . \text{ to } r \text{ differentiations } \{q(p+q)^n\},$$

where $p + q$ is only to be put unity after differentiation, and c is supposed small. From the first four moments about OY, I find the first four moments about NG with the following results:—

$$\mu_1 = 0,$$
$$\mu_2 = npq\alpha c^2,$$
$$\mu_3 = n/q(p-q)\alpha c^3,$$
$$\mu_4 = npq\{1 + 3(n-2)qp\}\alpha c^4.$$

Now the centre of gravity of the observation curve is found at once, also its area and its first four moments by easy calculation. Thus the position of NG, α, μ_2, μ_3, and μ_4 are given quantities. Taking the values of μ_2, μ_3, μ_4, given above, and also $p+q=1$, I have four equations to determine p, q, n, and c.

Solving them, I have the following results:

p and q are roots of the *quadratic*;

$$p^2 - p + \frac{(3\mu_2^2 - \mu_4)\mu_2 + \mu_3^2}{4(3\mu_2^2 - \mu_4)\mu_2 + 6\mu_3^2} = 0;$$

$$n = \frac{2\mu_2^3}{(3\mu_2^2 - \mu_4)\mu_2 + \mu_3^2};$$

$$c = \frac{\sqrt{2(3\mu_2^2 - \mu_4)\mu_2 + 3\mu_3^2}}{\mu_2^2}.$$

As verification note that for the normal probability curve $3\mu_2^2 = \mu_4$ and $\mu_3 = 0$.

Thus we have

$$p^2 - p + \tfrac{1}{4} = 0, \text{ i.e. } p = \tfrac{1}{2}, \text{ and } q = \tfrac{1}{2},$$
$$n = \alpha, \text{ and } c = 0,$$

as it should be.

The method enables us to fit a binomial to any asymmetrical curve, the results being based on no single ordinates, but on the moments of the whole system throughout.

The importance of this solution is that it enables us to determine p and q very approximately for any system of physical, biological, or sociological measurements; *i.e.* it tells us how much greater is the tendency for a deviation to occur on one side of the mean rather than on the other. A scientific measure of this is clearly given by

$$\frac{\mu_3}{\mu_2} = (p - q)c,$$

which measures the asymmetry of the frequency curve, and tells us at the same time the difference of p and q.

University College, October 17. KARL PEARSON.

British Association Report on Thermodynamics.

As I am now drawing up a second report for the British Association, on certain researches connected with thermodynamics, may I be permitted to invite the assistance and cooperation of all specialists in that subject?

It is proposed to deal with (1) the "Boltzmann-Maxwell" law of distribution of energy in systems of colliding and non-colliding bodies; (2) the virial equation when intermolecular force is taken into account, and its application to liquids and gases. It is desirable that the report shall be completed in time for the 1894 meeting of the Association.

The compilation of reports on different branches of science is one of the most important functions carried out by the British Association, but it is essential that every paper bearing on the subject of a report should be consulted in its preparation. The labour involved in wading through the enormous mass of existing literature on any physical subject can only be appreciated by those who have undertaken such work, and there is a constant risk of overlooking important papers, which are often buried in the Transactions of some obscure foreign society. It sometimes happens, too, that such papers cannot be procured, and hence cannot be consulted, to the great detriment of the report. May I therefore hope that the authors of any investigations bearing on the subjects of my report will kindly send me reprints? Lists of papers or suggestions will also be most acceptable.

G. H. BRYAN.

Thornlea, Trumpington Road, Cambridge, October 18.

Curious Phenomenon.

I WAS on the top of a small mountain in the Dövrefjeld, near Hjerkin, in the late afternoon of August 26, the sun being 10–15° above the horizon, when I saw a remarkable phenomenon. On the opposite side to the sun was a bright disc, perhaps 5° in diameter, shown on some drifting clouds. The shadow of my head appeared in the centre of the disc, that of my body below, while outside the disc the shadow of my legs was faintly visible. The phenomenon continued on and off—that is to say, when the clouds were favourable—for nearly a quarter of an hour. The landlord of the hotel said he had never seen anything of the sort.

WILLIAM CHURCHILL.

New University Club, St. James' Street, S.W., October 17.

HUMAN AND COMPARATIVE ANATOMY AT OXFORD.

ON October 14, a distinguished company, including the Professors of Human Anatomy in Edinburgh and Cambridge, the President of the College of Surgeons of England, and many well-known medical men and teachers, attended the opening of a new institute of Human Anatomy by the Vice-Chancellor of the University of Oxford.

The occasion is one in connection with which a few words are appropriate concerning the history of anatomical studies in Oxford and the relation between the special technical study of the anatomy of man required by medical students, and the more general study of the comparative anatomy of man and animals, or animal morphology. Historically the study of natural science has had the closest connection with the profession of medicine. In the last century, zoology and botany were not pursued in the universities of Europe as branches of science to be studied for their own intrinsic value as departments of knowledge, but primarily as giving the student acquaintance with "drugs" or "materia medica." Linnæus was the first university professor who lectured on animals from the strictly zoological point of view; until his time, animals had been studied, even in the universities, chiefly in relation to their supposed medicinal virtues. Concurrently the anatomists, who had mainly confined themselves to exploring the structure of the human body and of the animals nearest to man, extended their area of study. Through John Hunter and Georges Cuvier an immense body of knowledge as to the anatomy of all kinds of animals was accumulated and systematised, to which the name Comparative Anatomy was applied—more especially by Cuvier and his followers.

In this country, and very generally elsewhere, the study of "comparative anatomy" was carried on by men like Hunter, members of the medical profession, even practitioners. In the earlier half of the present century it was usual to find in the universities of Germany, as well as of Britain, that anatomy, including the wider comparative anatomy, as well as the topography of man required for medical purposes, together with physiology and even pathological anatomy, were all taught by one professor. Thus the great Johannes Müller discharged this multiple function until his death in Berlin in 1858.

It is not therefore surprising that when the Oxford University Commissioners of 1856 revived the ancient foundation of Linacre, they charged the new professor with the teaching of both anatomy and physiology. To this large task Rolleston, the first Linacre professor, devoted himself with characteristic energy and with a breadth of view which few nowadays could command. Rolleston taught physiology, comparative anatomy, as well as that topographical anatomy of the human body which medical training demands—a pursuit which he loved to call "anthropotomy." Anthropotomy was not neglected in Rolleston's time; those students of the University who wished to pursue human dissections in Oxford found the necessary material and assistance in his department.

The more recent Commissioners (of 1880) came to the conclusion that it was desirable that a separate chair of Physiology should be founded in the University of Oxford, and accordingly instituted such a professorship from the funds of Magdalen College, whilst they altered the title and scope of the Linacre chair to "Human and Comparative Anatomy." It was to the Linacre chair thus modified that Moseley was appointed on the death of Rolleston in 1881, whilst subsequently Burdon Sanderson was appointed to the newly-created Waynflete (Magdalen) chair of Physiology.

A further division of labour now became desirable. The teaching of anthropotomy—the medical student's necessary groundwork—could not be carried on personally by the same professor who was charged with the subject-matter of Cuvier's life-work. It was a question between either assigning to the Linacre Professor a specially qualified assistant to superintend the dissecting-room of Human Anatomy, or appointing an independent lecturer in that subject. The latter course seemed to be the better, and Mr. Arthur Thomson, the senior demonstrator in the Medical School of Edinburgh University, was appointed as Lecturer in Human Anatomy in Oxford. The expressed purpose of this appointment was to relieve the Linacre professor of that part of his duties which consisted in teaching human anatomy for the specific purposes of medical education, and it was in no way proposed to remove from the professor his functions as a teacher of the anatomy of man in its morphological aspects and his duties as guardian of the anatomical and ethnological collections of the University.

On the death of Prof. Moseley, in 1891, I was appointed his successor in the Linacre chair of Human and Comparative Anatomy. The University voted funds for the building and fitting of additional laboratories for the Linacre professor (which were completed and opened without ceremony last year) at the same time that we approved the expenditure necessary for a new laboratory for Human Anatomy. At my suggestion a statute was prepared, and has received the assent of her Majesty in Council, removing the words "human and" from the title of the Linacre professor; so that the professorship in question is now the "Linacre professorship of Comparative Anatomy," whilst the duty of teaching anthropotomy or that special study of the topography of the human body which medical training requires, is definitely assigned to the "lecturer in Human Anatomy."

The consideration of human structure in relation to that of vertebrate animals—the morphology of man as of other animals—the "comparative" anatomy of man and animals—remain as heretofore the charge of the Linacre professorship. In short, the treatment of man's structure as part of the general science of morphology remains necessarily the business of the professor of Comparative Anatomy. The exposition of the geography of the human body, in which the surgeon, and to some extent the physician, must be as expert and familiar as a townsman in the pathways of the city in which he resides and does his business—is the distinctive function of the teacher of "human anatomy" in a medical school. It is for this special purpose that we have just added to the excellent laboratories and museum already arranged and used for the study of anatomy in its widest sense, a new dissecting room and adjuncts adapted to the reception and proper treatment of human bodies.

It is to be hoped that the effort now made by the University to establish technical training in anthropotomy as an independent ffshoot of the Linacre professorship may be successful. The older laboratories and museum-collections of Comparative Anatomy and Craniology, which are attached to the Linacre professorship, do not need advertisement; they have been rendered famous by the scientific discoveries and researches of those who in the past have held that office. Of the new rooms for the study of anthropotomy, we have the expectation that they will in the future, under the care of successive lecturers in Human Anatomy, add to the attractions of the University as a centre of professional training, and justify the policy which has led us to the expenditure necessary for their erection.

E. RAY LANKESTER.

CELESTIAL PHOTOGRAPHY AT THE PARIS OBSERVATORY.

A DESCRIPTION of the work that is being done in connection with the photographic star chart and catalogue is given in *La Nature* by M. A. Fraissinet. We are indebted to that journal for the accompanying illustrations and the following information referring to them.

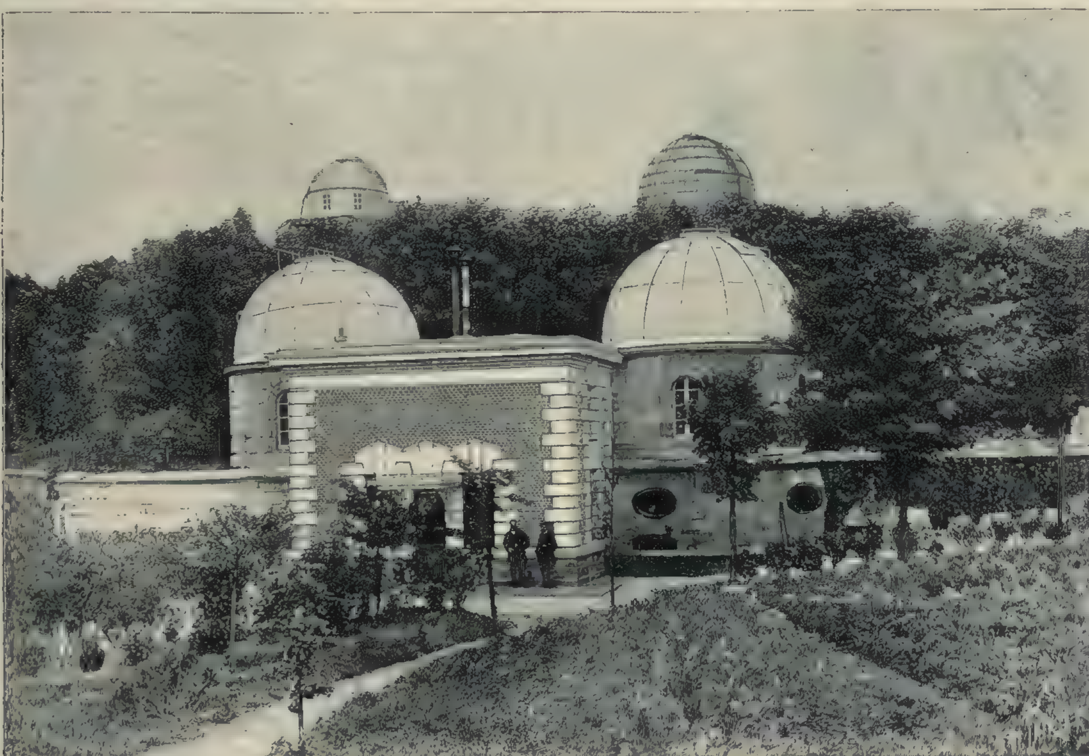


FIG. 1.—The part of the Paris Observatory devoted to the Photographic Star Chart.

A special bureau for the measurement of the stellar photographs designed for the catalogue was organised at the Paris observatory in 1892.

To accommodate the new service the building shown in Fig. 1 was erected. On the first floor of the new building a photographic laboratory has been established. The ground floor has been set apart for the service of the measurement of clichés organised by MM. Henry. This service is under the direction of Mdlle. Klumpke, who is assisted by four other ladies.

Two measuring machines were provided last year of the new kind devised by Gautier, and supplied to the French and some foreign co-operating observatories.

The instrument is illustrated by Fig. 2. It consists at the lower part of a fixed horizontal piece having two rails on which a carriage may be caused to slide by means of a screw. Under the face of the carriage inclined to the horizontal at an angle of 45° is another screw geared to a frame on which moves a circle carrying the fixed holder which receives the plate to be measured.

Each plate after it has been put in the holder can be subjected to three movements: a movement of rotation, which serves the purposes of orientation, and two rectilinear movements, one of which takes place on the horizontal and the other on the inclined plane. Each of the rectilinear movements can be roughly read off by means of the millimetre scales attached to the planes. Fractions of a scale division are determined by means of the micrometer screws. The head of each screw is divided into one hundred parts, and this is further divided into ten by estimation. Since, then, one turn of the screw corresponds to one minute of arc, it is possible to read to 0·6″ by means of the micrometer divisions.

It is hoped that in five or six years all the plates required from each observatory will have been obtained,

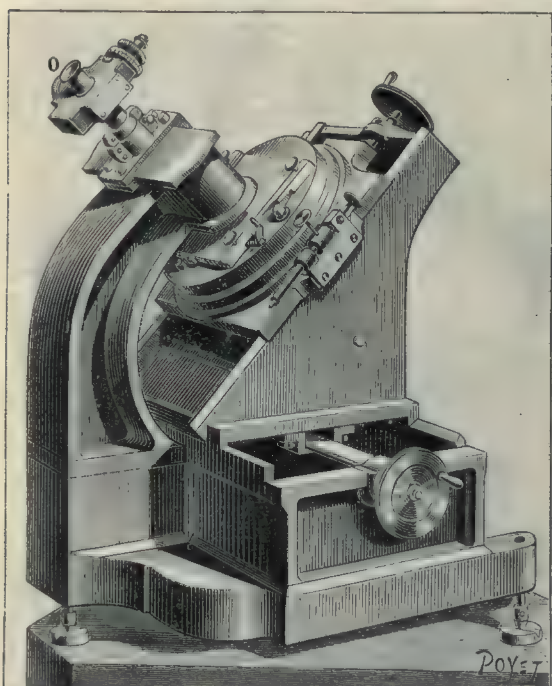


Fig. 2.—Instrument for Measuring Star Photographs. O, Observing Microscope.

but the measures can hardly be completed in less than ten years, and the computations to which they give rise will occupy about the same length of time. This rate of progress, however, cannot be regarded as slow for it must be remembered that the results will occupy forty ponderous volumes of one thousand pages, each page containing the positions of fifty stars.

When the immense labour involved is taken into consideration, one ceases to wonder that some of the co-operating observatories are unable to keep up with the measurements. It is to be hoped that lack of funds may not be allowed to prevent the obtaining of proper assistance in such cases, or to retard the publication of the results as soon as they are ready.

SMITHSONIAN INSTITUTION: HODGKINS FUND PRIZES.

In answer to inquiries, and in further explanation of statements made in the Hodgkins circular (Nature, vol. xlvii. p. 611), it may be added that *any* branch of natural science may offer a subject of discussion for the Hodgkins prizes where this subject is related to the study of the atmosphere in connection with the welfare of man.

Thus, the anthropologist may consider the history of man as affected by climate through the atmosphere; the geologist may study in this special connection the crust of the earth, whose constituents and whose form are largely modified by atmospheric influences; the botanist, the atmospheric relations of the life of the plant; the electrician, atmospheric electricity; the mathematician and physicist, problems of ærodynamics in their utilitarian application; and so on through the circle of the natural sciences, both biological and physical, of which there is perhaps not one which is necessarily excluded.

In illustration of the donor's wishes, which the Institution desires scrupulously to observe, it may be added that Mr. Hodgkins illustrated the catholicity of his plan by citing the work of the late Paul Bert in atmospheric electricity as a subject for research, which, in his own view, might be properly submitted for consideration in this relationship.

While the wide range of the subjects, which the founder's purpose makes admissible, cannot be too clearly stated, it is equally important to emphasise the fact that the prizes in the different classes can be awarded only in recognition of distinguished merit.

S. P. Langley.

NOTES.

Prof. Virchow was elected honorary president of the Berlin Medical Society on Monday.

The death is announced of Prof. Léon Lefort, vice-president of the Paris Academy of Medicine.

Prof. Schauta, of Vienna, has received the Cross of a Knight of the Order of the North Star from the King of Sweden.

A dispatch from Valparaiso announces that a volcanic eruption has occurred near Calbuco, causing great damage to that town.

We are glad to learn that Prof. von Helmholtz is recovering from the injuiries he sustained from falling down a companion ladder on board the *Saale*, while returning from his recent visit to America.

The Franklin Institute has received the sum of one thousand dollars from Mr. A. A. Boyden, to be rewarded as a premium to any resident of North America who shall determine by experiment whether all rays of light, and other physical rays, are or are not transmitted with the same velocity.

Miss Ormerod has received a report from her correspondent on crop insect pests in Norway to the effect that the Hessian fly is now for the first time recorded as occurring in Norway and doing damage to barley. Specimens of the infested straw, showing the presence of the flat brown chrysalis of the *Cecidomyia destructor*, were sent with the report.

Dr. J. W. Gregory has returned from East Africa after a very successful investigation of the geology and natural history of Mount Kenia and the neighbouring region. His observations, and the large number of geological, zoological, and botanical specimens collected during the expedition, add considerably to our knowledge of the character and capabilities of British East Africa.

With reference to the reported outbreak of cholera at Greenwich, Dr. Thorne Thorne reports that, whilst in certain important respects the materials that have been investigated suggested that cholera was in question, it now transpires that in every case examined one or more of the ordinary proofs as to this have been wanting, and Dr. Klein concludes that the outbreak is not one of true cholera.

AFTER the 1st of November the time of Central Europe, which is employed in Sweden, Germany, Austria, Hungary, Bosnia, and Servia, and is reckoned from the fifteenth degree of longitude, will be adopted upon Italian railway-systems. Railway time in Italy will therefore be exactly one hour in advance of Greenwich time, and 50 min. 39 secs. in advance of Paris mean time, the difference of time between Greenwich and Paris being 9 min. 21 secs.

THE passengers on board the North German Lloyd s.s. *Oldenburg*, which left Genoa for the East on the 23rd inst., include Dr. W. Kükenthal, Ritter Professor in the University of Jena, who proceeds, under the auspices of the Senckenberg Naturalists' Society, on a twelve months' zoological expedition to the Moluccas. After a short sojourn in Java, he will make Ternate his headquarters, exploring the surrounding islands, and especially the island of Halmahera. We are informed that Prof. Kükenthal was the elected one of fifty zoologists who sought the leadership of the expedition. The energy and endurance which he displayed in his recent investigations in the Arctic Seas led to the accumulation of rich material, and they justify an anticipation of good results from the present, less tropical, journey.

THE exhibition arranged by the Deutsche Mathematiker-Vereinigung at Munich, of models, drawings, apparatus, and instruments used in pure and applied mathematics, was closed on October 5. From a circular that has been issued by the Association we learn that the exhibition was in every respect successful. Owing to the support given by the Royal Bavarian Government and the Ministry of the Interior, it was possible to considerably extend the plans originally proposed. The success of the undertaking was largely due to the kindness of the many public bodies and private individuals who lent apparatus, &c., and have participated in the work, often at a pecuniary sacrifice. The committee of the Association desire to express their thanks to exhibitors and others who have supported them during the last two years.

THE following gentlemen have been nominated for election on the council of the London Mathematical Society for the session 1893-4:—Mr. A. B. Kempe, F.R.S. (President); Messrs. A. B. Basset, F.R.S., E. B. Elliott, F.R.S., A. G. Greenhill, F.R.S. (Vice-Presidents); Dr. J. Larmor, F.R.S. (Treasurer); Messrs. M. Jenkins and R. Tucker (Hon. Secs.). Other members—Dr. Forsyth, F.R.S., Dr. Glaisher, F.R.S., Dr. Hill, Dr. Hobson, F.R.S., Mr. Love, Major Macmahon, F.R.S., Mr. J. J. Walker, F.R.S. The new nominees are Lt.-Col. J. R. Campbell and Lt.-Col. A. J. C. Cunningham, R.E., in the place of Messrs. H. F. Baker and J. Hammond, who retire. The annual general meeting (November 9) will be made special for the consideration of the following resolution, which will be moved by the council: "That the London Mathematical Society be incorporated as a Limited Liability Company under Section 23 of the Companies Act, 1867; and that the Council be empowered to take the necessary steps to carry this resolution into effect." The presentation of the De Morgan medal, awarded by the council in June last, will be made at the same meeting, to Prof. Felix Klein, the medallist, who expects to be present to receive it in person.

WE have received the first part of the second half of vol. iii. of Cohn's *Kryptogamen-Flora von Schlesien*, devoted to the fungi, under the editorship of Dr. J. Schrœter. The present part commences the description of the Ascomycetes, and is occupied by a portion only of the first sub-order, the Discomycetes.

THE second part of vol. vi. of the *Journal* of the College of Science of the Imperial University of Japan is entirely occupied by an elaborate paper, by Prof. Sadahisa Matsuda, on the anatomy of the Magnoliaceæ. It is illustrated by four plates exhibiting the excellence of work to which we are now accustomed in the products of the Japanese press.

DR. R. A. PHILIPPI contributes to the *Verhandlungen* of the German Scientific Society of Santiago in Chile two interesting papers on the "Fauna and Flora of Chile and Argentinia." With regard to the flora he points out that, notwithstanding the wide difference between those of Chile and of Europe, the number of identical species is greater than Europe has in common with South Africa or Australia; while both the flora and fauna of Chile differ in a very remarkable way from those of Argentinia. Dr. Philippi argues from these facts that the mountain range of the Cordilleras must have been formed before the development of the fauna and flora of these countries.

AMONG other excerpts from the Transactions of the Academy of Science of St. Louis, vol. vi., that have recently been received, the following are of interest:—"The Opening of the Buds of Some Woody Plants," by Mr. A. S. Hitchcock. This paper records observations made during the spring of 1892. In "Flowers and Insects—Labiatæ" Mr. Charles Robertson gives an account of the pollinators of various Labiates. Of the twenty-three species described, nine have long-tongued bees as their principal visitors, and eight show special adaptation to bees in general. No species was found to be adapted to the lower hymenoptera, though ten species were visited by them. Diptera occurred as visitors of nineteen species, and butterflies on all but five species. The ruby-throated humming-bird only visited *Monarda, Bradburniana*, and *M. fistulosa*, and beetles were found only on the six least specialised flowers investigated. Mr. J. Christian Bay has prepared the materials for a monograph on Inuline, in the form of a list of papers on the subject, published up to the end of 1890.

DR. EDMUND NAUMANN, the well-known writer on Japan Geology, has just published an interesting paper in *Petermanns Mittheilungen* (Ergänzungsheft, No. 108), under the title of "Neue Beiträge zur Geologie und Geographie Japans." Three coloured plates are given—plate i. the crater of Shiranesan and views of Bandai, two volcanoes active within recent years; plate ii. a stereographic representation of the geology of Japan (scale (1 : 5,000,000); plate iii. the general contours of the country (scale 1 : 2,600,000).

JAPAN is possibly one of the best illustrations of the value of geological knowledge in throwing light and colour on the geographical features of a country. Dr. Naumann, in his account of the geological structure of the great mountain chain, emphasises the presence of a crystalline core throughout the whole length of the islands, and against it the sedimentary deposits may be said to have a zonal distribution. He proves that while there was prepalæozoic folding in these crystalline schists and gneisses, the main period of mountain-movement and the upheaval of the greater portion of Japan took place in early Mesozoic times. The intrusions of the enormous granitic masses are probably of late Mesozoic age, and since that time there have been several periods of volcanic activity, constant recurrences taking place along ancient lines of weakness. The result of the particular processes of mountain-making in Japan on the present configuration of its surface, and the correlation of the rocks with the various types of landscape, are then briefly described.

THE "Fossa magna" is an apt name given some years ago by Dr. Naumann to that curious well-marked depression between the north and south wings of the main island—a de pression bordered by the highest summits in Japan, and occupied by a girdle of volcanoes. Ed. Suess ("Antlitz d. Erde," bd. ii. p. 225) and the Japanese geologist, Harada, are of opinion that the mountains in the north and south wings belong to two independent chains which during the period of upheaval had been pushed against one another at this "fossa magna," and they compare the case of Hindu Kush and the Himalayas. Dr. Naumann still adheres to the view he had previously advanced, namely, that the mountains of the north and south wings form one chain, which after its upheaval was broken by a transverse fault along the "fossa magna," the transverse fault being of later date than the main longitudinal fault on the west or inner side of the islands and cutting through it. The eruptive activity and frequent subsidences within the "fossa" have merely taken advantage of this important tektonic break.

THE Report on the Botanic Gardens at Georgetown, British Guiana, for the year 1891–92, contains some interesting information on the meteorology of that colony for the year 1891. The rainfall was much above the average, though not so much so as in the two previous years. For the nine years ending 1888 the average fall was 80·5 inches, but for the three years ending 1891 the average fall has been 119·6 inches; the returns from various stations show that there is a gradual increase in the rainfall from the south to the north of the colony. The number of days on which the sun shone was 351, leaving only 14 days of unbroken cloudiness; the mean daily sunshine for the year was 7h. 13m. The maximum day temperature in the shade ranged from 84° in February to 90° in September and October. The minimum night temperature ranged from 71° to 74°, and the solar radiation from 148° to 157°.

A CAREFUL study of the vapour pressures of aqueous solutions has been carried out by C. Dieterici, of Breslau, who has communicated his results to *Wiedemann's Annalen*. The determinations were made for 0° C. by means of an apparatus designed for the appreciation of very feeble pressures. The gauge used was an aneroid box with a German silver disc, which has the advantage of yielding to a great extent without elastic fatigue. The motions of the centre of the disc were transferred to a mirror suspended in jewelled bearings by means of a light watchmaker's arbor, the connection being made by a cocoon thread, and the mirror being gently held in position by a small spiral spring. Deflections were measured by reflected scale and telescope. The gauge was fitted to a tube which could be filled with the vapour of the solution surrounded by melting ice, or could be exhausted at pleasure. The gauge and tube were enclosed in another air-tight space which could be filled with pure water vapour at 0° C. or exhausted. The pressure of the water vapour produced a deflection of 170 scale divisions, equivalent to 2·31 mm. of mercury. The author discusses at length the bearing of his results upon Van't Hoff's dissociation theory, and upon the kinetic theory of gases. The curves exhibiting the relation between degree of concentration and the corresponding vapour pressure have the common characteristic that with the concentration increasing from an infinitely dilute solution to about 26 in multiples of the normal solution, they commence at approximately the same angle, then fall with a steep incline, and finally tend to become parallel to the axis of abscissæ. At about 26 the curve of sulphuric acid cuts this axis, showing that the action between the acid and the water counterbalances the osmotic pressure necessary for evaporation. The other bodies investigated were glycerine, phosphoric acid, and the hydrates of potassium and sodium, enumerated in the order of decreasing vapour pressures.

THE current number of the *Philosophical Magazine* contains an account of the most recent determinations of the refractive indices of liquid nitrogen and air, carried out by Profs. Liveing and Dewar. Owing to the bubbles constantly rising from liquid nitrogen, the prism method could not be made to give accurate results. The refractive index was therefore determined by finding the angle of total reflection. The liquid nitrogen, or air, was enclosed in a cylindrical vessel containing two vertical plane-parallel plates of glass with a film of air between them. The light from an electric discharge or a monochromatic flame was sent through a slit into the vessel, a suitable portion being cut off by black paper screens, and an image of the slit was thrown upon the slit of a spectroscope by the glass vessel itself. The vertical plates were turned round a vertical axis till the extinction of the image indicated that the angle of total reflection had been reached. The refractive index thus obtained for sodium light was 1·226 in the case of liquid oxygen (the prism method gave 1·2236), 1·2062 for liquid air, and 1·2053 for liquid nitrogen at −190°, and of density 0·89. The nitrogen probably contained 5 per cent. of oxygen. The refraction constant of nitrogen is therefore 0·225 as determined from the liquefied substance. Mascart gives 0 237 for the constant as determined from gaseous nitrogen. The two results are in as fair an agreement as could be expected, considering the difficulties surrounding the measurements.

WIEDEMANN'S *Annalen de Physique et de Chemie* for October contains a paper, by R. J. Holland, on electrical conductivity of copper chloride solution. The solution, whose resistance was to be measured, was enclosed in a dumb-bell shaped glass vessel about 10 c.m. long, the electrodes, which had a surface of 2¼ sq. c.m., being fixed at the ends. In order to determine the mean section of the tube between the electrodes, it was filled with a solution of sodium chloride and the resistance measured, then using Kohlrausch's results for the resistance of the salt solution the mean section was calculated. The resistance was measured by means of a Wheatstone's bridge, with an alternating current and telephone. All the strengths of copper chloride solution examined show a regular, though slight, increase of conductivity at high temperature, this increase being different for solutions of different degrees of concentration. The maximum conductivity was obtained with a solution containing about 18 per cent. of the dried salt. The temperature coefficient varies with the degree of concentration, and attains a maximum value for a temperature of about 40° C. When the difference in concentration is taken into account, the results obtained agree very well with those obtained by Trötsch and Wiedemann, though they do not show so satisfactory an agreement with those obtained by Isaachsen.

L'Elettricista for October contains a paper by Dr. Monti, in which he gives the results of the experiments he has undertaken in order, if possible, to account for the fact that the values obtained by Macfarlane in 1877 for the difference of potential required to pierce a plate of paraffin were very much smaller than those obtained by Steinmetz and himself. Macfarlane found that the difference of potential required to pierce a plate of paraffin 3 mm. thick was 39,000 volts, while Dr. Monti finds that to cause a discharge to pass between two knobs 5 mm. in diameter through a layer of paraffin 1 mm. thick it requires a difference of potential of 155,000 volts. The author employed paraffin which melted at 54·76° C. The terminals were brass balls which were fixed within a glass tube about 10 c.m. long. Their distance apart having been measured by means of a microscope, the paraffin was melted and allowed to cool in a partial vacuum. It was then again melted and allowed to solidify under the ordinary pressure. By this means the formation of air bubbles within the paraffin was avoided, and it is to the presence of such air bubbles in the slab of paraffin employed by Macfarlane that Dr. Monti attributes the difference in the values obtained.

AN electrical method of fog-signalling, which has great possibilities before it, has been invented by an electrician in the employ of the Great Northern Railway Company. A wire is laid by means of a pipe from the signal-box to the various signals, at which points brushes composed of copper wire project some four or five inches above the side of the rail nearest the signal. To the foot-plate of the engine a similar brush is fixed, connecting with an indicator and bell on the engine. If the signal be at danger the two brushes coming in contact has the effect of ringing the bell, and indicating to the driver by means of a miniature signal fixed on his engine that the line is not clear. The arrangement can be switched off in fine weather. The process, which is in working order at Wood Green, has proved so satisfactory that the company have decided to fit up the suburban lines, and eventually the whole of their system.

THE report of the meeting of the *Société Helvétique des Sciences Naturelles*, held at Basle in September 1892, has just been published.

Natur und Haus, edited by Dr. L. Staby and Herr Hesdörffer, begins its second year with a number full of articles on a variety of scientific topics. The journal must help to popularise science in the Fatherland, for its contents—both text and illustration—are excellent.

THE second year's meetings of the University Extension Philosophical Society will commence on Friday, October 27, at 8 p.m., when Mr. Bernard Bosanquet will give an address on "Atomism in Psychology," at Whitelands College, Chelsea. Among other gentlemen who will read papers during the present year are Prof. Sully, Mr. G. F. Stont, Mr. C. S. Loch, and Mr. P. H. Wicksteed.

THE trustees of the Australian Museum have issued their thirty-ninth annual report. We are sorry to notice that there has been a slight falling off in the attendance of visitors during the year 1892. The number of visitors was 130,701, being fewer by 2144 than in the previous year. The average week-day attendance was 265, and that for Sundays 712.

THE following lectures will be delivered at the Royal Victoria Hall during November:—November 7, Mr. Francis Bond, on "Norway and the Norwegians"; November 14, Prof. H. G. Seeley, F.R.S., on "Skulls"; November 21, Mr. James Swinburne, on "The Mechanics of Street Toys"; November 28, Mr. Douglas Carnegie, on "The Philosopher's Stone, or the Royal Road to Health and Wealth."

A NEW and revised edition of "Our Reptiles and Batrachians," by Dr. M. C. Cooke, has been published by Messrs. W. H. Allen and Co. As the author remarked in the preface of the original edition, he aimed at producing "a popular volume on a rather unpopular subject," and not a work for the man of science. The fact that a new edition has been called for shows that the general public appreciate tales of snake-stones and the incarceration of frogs in blocks of granite; of the "toad's envenomed juice," and incombustible salamanders. However, in the reading of these accounts something is learned concerning the habits and characters of the lizards, snakes, newts, toads, frogs, and tortoises indigenous to Great Britain; so instruction is happily combined with amusement.

THE "Zoological Record for 1892," edited by Mr. David Sharp, F.R.S., and being the twenty-ninth volume of zoological literature, has just been published. The scope of the Record has been greatly enlarged, and an index of special subjects has been included in each department, in addition to the list of titles and the taxonomical arrangement according to genera. It has not been possible, however, to make a complete epitome of palæontological literature; indeed, Mr. Sharp thinks that palæontologists should undertake the compilation of a separate record. We are inclined to agree with this. Everyone knows that an incomplete record is of very little use; for valuable time may be wasted in searching through it for references which it does not contain. But if every branch of science had a publication which did for it what the "Zoological Record" does for zoology, scientific papers would be in a fair way of organisation.

SOME years ago Prof. Frank Clowes communicated to the Royal Society and to the Aberdeen meeting of the British Association the fact that there occurred in the neighbourhood of Nottingham a large area of sandstone, in which the cementing material was wholly crystalline barium sulphate. The subject was mentioned again in the Geological Section at the recent Nottingham meeting of the British Association, and several geologists gave instances of similar sandstone occurring in other parts of England. Prof. Clowes writes that he would be glad to learn of the occurrence of such sandstone in any locality, and to receive specimens for examination and chemical analysis.

WE have received part 4, vol. v. of the Transactions of the Norfolk and Norwich Naturalists' Society, and are glad to find that both financially and numerically the society is in a satisfactory condition. Of the 250 members many are non-resident in the county, and it is probably owing to their help that for a small subscription the society is able to issue a goodly publication consisting of more than 190 pages. The address of the president, Mr. H. B. Woodward, of the Geological Survey, deals mainly with the geology of the county, which presents many very interesting features, and he also contributes a memoir (with portrait) of the late Caleb B. Rose, one of the fathers of Norfolk geology. These memoirs of local naturalists of note form a marked feature in the society's publication, as also do the lists of the fauna and flora of the county, the twelfth of which, namely the Coleoptera, by Mr. Jas. Edwards, in which 1728 species are enumerated, is included in the present number. Amongst the other contributions are a very interesting paper on tortoises in domestication, by Sir Peter Eade, containing measurements and weights of two tortoises, taken annually since the year 1886; notes on the occurrence of the Siberian pectoral sandpiper and Sowerby's whale in Norfolk, on the Lapland bunting, the Holkham shooting parties at the commencement of the present century, on Norfolk slugs, and other matters of local and general interest.

IN these Notes on August 24, reference was made to some recent modifications in the method for staining the cilia of micro-organisms. Strauss mentions in the *Bulletin Médicale*, 1892, No. 51, that he has succeeded in colouring the cilia of the cholera spirillum, the spirillum Metschnikowi, and Finkler Prior's spirillum in a *living* condition. For this purpose broth cultures, from 1–3 days old, are employed, one needle-loop of which is placed on a microscopic slip and carefully mixed with a needle-loop of Ziehl's fuchsin solution diluted with water (1 : 3–4). A cover glass is then superposed, and the preparation examined under the microscope as rapidly as possible. The above-mentioned organisms become intensely red in colour, and many retain their motility for a short time, and at one of the pores may be seen the extremely thin corkscrew-shaped or wavy cilium-tinted pale red containing more highly coloured granules, which are disposed in longitudinal series in its interior. When the organism is no longer in a living condition, the cilia may still be seen although less distinctly, whilst numerous isolated and detached cilia may be seen moving with great activity in the fluid. Strauss has not so far been successful in exhibiting by this method the cilia of other organisms in a living condition.

It is usual in cases of thrush to recommend the use of alkaline substances in order to counteract the acidity of the mouth, which is generally supposed to favour the growth of the thrush fungus. Some recent researches of Marantonio ("Contributo alla biologia del fungo del Mughetto" Istituto d'Igiene di Roma, vol. xii. 1893, p. 199) show, however, that this fungus grows abundantly in strongly alkaline as well as in acid media. Experiments were made to ascertain what substances exerted a bactericidal action on this organism, special attention being given to those usually prescribed in the treatment of thrush. It was found that many of these were quite ineffective, on the other hand salicylic acid, amongst others, was highly efficacious; these laboratory experiments were, moreover, confirmed in actual practice, for extremely encouraging results were obtained when this substance was tried in some cases of thrush in children in one of the hospitals in Rome. In some hospitals it appears that thrush is endemic, and Marantonio was able to isolate out the organism of this disease from the dust in the interstices of the flooring of a children's ward; considering that the fungus can successfully resist the effects of desiccation over four and a half months, this fact is not surprising. The behaviour of this organism when exposed to sunshine was also investigated. Portions of vigorous agar-cultures were spread in thin layers on pieces of white cardboard, which were placed in glass boxes, some being preserved in the dark, whilst others were insolated for various lengths of time. It was found that thirteen hours' exposure to direct sunshine retarded the development of the fungus, whilst when prolonged for seventeen hours it was completely destroyed. The great mortality which prevails amongst children suffering from thrush should render these elaborate and carefully-conducted experiments of especial interest and importance.

Carbide of boron has been isolated by Dr. Mühlhäuser, of the University of Chicago, and is described by him in the current publication of the *Zeitschrift für Anorganische Chemie*. It proves to be an extremely stable substance, being capable of successfully resisting the action of almost all the usual solvents and reagents. Its composition has been ascertained by taking advantage of the fact that chromate of lead is capable of oxidising it at the usual temperature of a combustion furnace. The analytical data indicate the simple empirical formula BC, but its constitution is assumed to correspond to double that formula, namely B_2C_2 or $\begin{array}{c} C \equiv B \\ | \quad\ \ | \\ C \equiv B \end{array}$. Boron carbide was prepared by heating boric anhydride with the hard variety of carbon employed for making the terminals of electric arc lamps. The reaction proceeds in accordance with the equation: $B_2O_3 + 5C = B_2C_2 + 3CO$. Five parts of borax were dissolved in twenty parts of water, one part of sulphuric acid was added, and the solution allowed to cool. The crystals of boric acid which were formed during the cooling were separated by filtration, washed with water, dried, fused, and finally heated to low redness, by which they were dehydrated, and boric anhydride produced. The powdered boric anhydride was then mixed with the powdered electrode carbon, in the proportion of five parts of the former to eight parts of the latter, and the mixture disposed upon a suitable carbon support between the terminals of a powerful arc lamp. Upon the generation of the arc by means of a current of 350 ampères action almost immediately commenced, the mixture of boric anhydride and carbon fusing and evolving a considerable amount of gas with effervescence. The operation is concluded when the effervescence ceases, when the current should be switched off and the product allowed to cool. Carbide of boron is thus produced in the form of black graphitoidal spherules, frequently aggregated so as to resemble the shape of a bunch of grapes. The spherules possess a bright metallic lustre. They may be freed from traces of the ingredients of the mixture used in their preparation by heating for a few hours in a platinum crucible, then powdering, and repeatedly treating the powder with hydrochloric acid, water, a mixture of hydrofluoric and sulphuric acids, and finally once more with distilled water. The powder thus prepared yields numbers on combustion with chromate of lead which agree closely with the formula above given. Carbide of boron closely resembles graphite in outward appearance; it blackens the fingers in a similar manner, and the coating thus transferred possesses the same bright metallic lustre and greasy feel. Examined under the microscope it appears bluish black and transparent, and reflects light with chromatic effects. When heated to a high temperature the powder cakes together, forming a soft mass, which is readily malleable and capable of being rolled. At a very high temperature it completely fuses to a liquid much resembling a molten metal. It burns only with great difficulty in oxygen, but is combustible, as above stated, with chromate of lead. It is insoluble in all the ordinary solvents, but fused caustic or carbonated alkalies attack it with formation of borate of the alkali and liberation of carbon.

Notes from the Marine Biological Station, Plymouth.—Last week's captures include the Mollusca *Lima Loscombii* and *Pholadidea papyracea*, and the Schizopoda *Leptomysis gracilis* and a number of *Erythrops elegans*. The floating fauna is unusually rich in Diatoms and Dinoflagellates, and a few Radiolaria are still to be seen. The larvæ of *Polynoë*, *Chætopterus* and *Terebella* are fairly numerous, and *Cyphonautes* and larval Lamellibranchs are plentiful. On the other hand the larvæ of Decapoda (esp. of Brachyura) are scarce, and a few Ophiuria *Plutei* are the only representatives of the Echinoderma. The more oceanic forms (*Muggiæa*, *Podon* and *Evadne*, &c.) have of late become increasingly scarce. The Hydroid *Aglaophenia tubulifera* is now breeding, and a few *Erythrops elegans* contain late embryoes in their brood-pouches.

The additions to the Zoological Society's Gardens during the past week include a Wanderoo Monkey (*Macacus silenus*, ♀) from Cochin, presented by Capt. Morgan; two Macaque Monkeys (*Macacus cynomolgus*, ♂ ♀) from India, presented respectively by Mr. John Cook and Mr. Stanley Sinclair; a Chacma Baboon (*Cynocephalus porcarius*, ♀), two Common Quails (*Coturnix communis*) from South Africa, presented by Capt. F. Baker; two Manatees (*Manatus america*, ♀ *et juv.*) from Manatee Bay, Jamaica, presented by Sir Henry A. Blake, K.C.M.G.; a Black-headed Lemur (*Lemur brunneus*, ♀) from Madagascar, presented by Miss Hoare; a Rufous Rat Kangaroo (*Hypsiprymnus rufescens*) from Australia, presented by Kenneth Crawley, Esq., R.N.; a Kite (*Milvus ictinus*) from the Canary Islands, presented by Mr. E. G. Meade-Waldo, F.Z.S.; two Purple Porphyrios (*Porphyrio cæruleus*) South-east European, presented by Mr. Joseph S. Whitaker, F.Z.S.; a Turtle Dove (*Turtur communis*) British, presented by Miss Alice L. West; a Kinkajou (*Cercoleptes caudivolvulus*), a King Vulture (*Gypagus papa juv.*), a Common Boa (*Boa constrictor*) from South America, two Ospreys (*Pandion haliætus*) from Hayti, W.I.; two Rufous-necked Weaver Birds (*Hyphantornis textor*) from South Africa; a Dunlin (*Tringa alpinus*) British, purchased; a Burchell's Zebra (*Equus burchelli*, ♀), a Wapiti Deer (*Cervus canadensis*, ♀) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

A New Comet.—*Edinburgh Circular* (No. 40, dated October 19) informs us of the discovery of a comet by Mr. W. R. Brooks, of Geneva, N.Y., at 15h. 52m. local time, its place then being R.A. 12h. 21m. N. declination 12° 55′. The comet has also been observed at Hamburg, October 17, 17h. 5·8m. Hamburg mean time. R.A. 12h. 22m. 42·9s. Declination + 13° 25′ 24″. It has a tail, and is about as bright as a star of the ninth magnitude.

DETERMINATION OF GEOGRAPHICAL LONGITUDE.—In part 15 (August 1) of the *Zeitschrift für Vermessungswesen*, Herr C. Runge, of the Technical Hochschule, Hannover, gives a very interesting account of his results in determining geographical longitude with an ordinary camera. The negative from which the results were obtained, was taken on June 17, the camera being pointed to the new moon. Eight exposures were made one after the other, with intervals of about two minutes. Without moving the camera, and after an interval of about thirty minutes, another series of pictures was taken (on the same plate), the objects this time being some stars in Leo, which were allowed to record their trails on the plate for the period of about an hour and a quarter with regular intermittent breaks of five seconds. The times of exposure were noted with an ordinary watch, and the measuring of the plates made with an accurate micrometer. Dealing here only with the accuracy of the method, we may say that the declination of the moon can be determined to 20″, and in some cases with greater accuracy; in the example given the differences between the measured and calculated values were + 11″, − 19″, + 15″, − 6′. In the measuring of the moon-distance Herr Runge says that although this was the first trial, and the star-images were not all that could be desired, yet the accuracy was surprising, and can perhaps be still increased, even without the help of any "mechanische Hülpmittel." Since the above example was made he has obtained the geographical latitude and local time by this photographic means, and with excellent results. The instrument employed consisted of a simple camera with a so-called "gruppenantiplanet" objective, by Steinheil in München, with a focal length of 24 cm. The stop used for the above plate had a diameter of 17 mm.

ASTRONOMY AND ASTRO-PHYSICS AT CHICAGO.—A few of the many papers on astronomy which were read at the series of meetings that commenced at Chicago on August 22 appear in this month's *Astronomy and Astro-Physics*, and as they are too long for individual description, we give simply the titles of the papers and their authors: "Great Telescopes of the Future," by Alvan G. Clark. This deals with the subject completely from the object-glass point of view.—"A Field for Woman's Work in Astronomy," by Mrs. M. Fleming; "Engineering Problems in the Construction of Large Refracting Telescopes," by Worcester R. Warner. This is accompanied by a photograph taken by Mr. Burnham of the 40-inch Yerkes instrument, as exhibited at the Columbian Exposition.—"The Two Magnetic Fields surrounding the Sun," by Prof. Frank H. Bigelow; "The Constitution of the Stars," by Prof. Edward C. Pickering. This paper concludes as follows: "With few exceptions all the stars may be arranged in a sequence beginning with the planetary nebulæ, passing through the bright line stars to the Orion stars, thence to the first type stars, and by insensible changes to the second and third type stars"; "Concerning the Nature of Nova Aurigæ's Spectrum," by Prof. W. W. Campbell; "Preliminary Note on the Corona of April 16, 1893," by Prof. J. M. Schæberle, being a discussion of the facts gathered from the numerous photographs taken; "The Wavelengths of the Two Brightest Lines in the Spectrum of the Nebulæ," by Prof. James E. Keeler; and lastly, "Contributions on the Subject of Solar Physics," by Prof. E. R. von Oppolzer.

A NEW ASTRONOMICAL OBSERVATORY AT MANILA.—Manila already possesses a Government meteorological and seismographic observatory, and an important astronomical observatory will soon be established there. The chief instruments will be a novel photographic meridian instrument and a large Merz refractor (19·2 inches), the latter being provided with a photographic correcting lens. Father Algue seems to be taking the work in hand, and he proposes to institute a series of latitude observations in connection with a similar series to be carried on at the Georgetown Observatory, for the determination of the variation of latitude. The instrument at Manila will consist, according to *Astronomy and Astro-Physics* for October, of two telescopes in the same tube; or at least there will be two object glasses, one at each end of the tube, their foci coinciding. These will be of the same diameter, 6 inches, and focus 3 feet, the tube being equal to the sum of the focal lengths of the object-glasses. The photographic plate is placed in the focus of the two objectives, *i.e.* in the centre of the tube. The method adopted is that of Talcott, and during the observation of both stars the instrument is not moved. The upper objective throws the image of the first star on the upper side of the sensitive film, while by the help of a basin of mercury below, and the lower objective, the trail of the second star is recorded on the under side of the same film. Besides visual work the Merz refractor will be used for photographic observations of double stars, spectrographic work, photographic parallax, &c.

THE VISIBILITY OF VENUS TO THE NAKED EYE.—Principal A. Cameron, at Yarmouth, Nova Scotia, and M. Bruguiere, at Marseilles, have made a series of observations with a view of determining for how long a period the planet Venus can be seen in the day time without optical aid (*Trans. Nova Scotia Institute of Science*, vol. i. part 2. 2nd series). Beginning with the superior conjunction of February 18, 1890, Mr. Cameron saw Venus with his naked eye 26½ days after that date, and M. Bruguiere, in the same latitude, detected the planet 4½ days before the inferior conjunction of December 4, 1890; so that altogether she was visible to the unaided eye during 259 days. The elongation of the planet when first picked up by Mr. Cameron was 6¾°, and when M. Bruguiere saw her last in November, 1890, the elongation was nearly 9°, but the brilliancy was only 6½ per cent. of the mean greatest brilliancy.

MEYER'S CONVERSATIONAL LEXICON.—The popularity of this series of volumes can only be accounted for by the very judicious way in which the publishers have dealt with every branch of science, treating it fully, accurately, and in such language that it can be understood by the most general reader. Under the heading "Astronomy" is given an excellent and concise account of the early history and development of the science. This lexicon has reached its fifth edition.

GEOGRAPHICAL NOTES.

A CABLE has recently been laid between the seaport of Bundaberg, in Queensland, and New Caledonia. This line of 910 miles, although not very important in itself, is of some interest as possibly the commencement of a great Pacific cable which may ultimately unite Australia and Canada. Should this scheme be carried into effect the probable route of the cable would be from New Caledonia to Fiji, thence to Samoa, and by Honolulu and the Fanning islands to Vancouver.

THE last number of the *Bulletin* of the Paris Geographical Society publishes the list of awards of the society's medals, the bestowal of which was noticed in this column (vol. xlviii. p. 40), together with the reports of the awards, which were too lengthy to be read at the meeting in April. A notable fact connected with these prizes is the custom of recognising the value of original maps and books of geographical research, historical or critical, as well as the work of explorers.

AN amusing instance of the danger of commenting on geographical news without referring to a full report occurs in the last number of the *Revue Française*, a journal which is valued for its full and usually accurate record of recent and projected travels. In mentioning the fact of the discovery of Active Strait, near Erebus and Terror Gulf, by the Dundee sealers this spring, the editor adds parenthetically, "volcanoes of Victoria Land to the south of New Zealand"—a pardonable mistake, as the names of Ross's ships were perhaps too freely scattered over the Antarctic regions. But in this instance it happens, somewhat oddly, Erebus and Terror Gulf is in land named after a French and not a British monarch, being in Terre Louis Phillippe, south of the Falkland Islands.

THE full programme of the Royal Geographical Society's Evening Meetings for the Session 1893–94 has been published. In addition to the subjects intimated in this column last week, we note that papers are expected by Prof. Lapworth, F.R.S., on the ups and downs of the earth's surface; by Dr. J. W. Gregory, on his expedition to Mount Kenia; Mr. R. D. Oldham, of the Indian Geological Survey, on the geographical development of India; Mr. K. Grossmann, on a journey in Iceland; Mr. T. J. Alldridge, on journeys in the interior of Sierra Leone; Dr. H. R. Mill, on the survey of the English lakes; Mr. H. Warington Smyth, on journeys on the Upper

Mekong; Mr. W. H. Cozens-Hardy, on surveys and research in Montenegro; and Mr. E. J. L. Berkeley, on British East Africa. It is also hoped that the Prince of Monaco, Sir Archibald Geikie, and Mr. J. Y. Buchanan may contribute papers. If Mr. and Mrs. Bent return in time from their projected exploring journey in Hadramant, an account of their work will be looked forward to before the close of the session.

A NUMBER of the *Journal* of the Manchester Geographical Society just issued (January to June, 1893) contains a paper on the Yoruba country, Abeokuta, and Lagos, by the Rev. J. T. F. Halligey, which gives some vivid descriptions of native life and n.anners.

DR. GERHARD SCHOTT'S physical observations on a voyage in a sailing ship from Hamburg to the China coast and back are published as an Ergänzungsheft of *Petermanns Mitteilungen*. In the discussion of his work Dr. Schott takes account of previous researches on the parts of the ocean he traversed, and his paper is an interesting addition to our knowledge of oceanography. The memoir is divided into two parts: hydrography, including a discussion of surface temperature as affected by diurnal range, rainfall, and wind, the specific gravity of surface water, surface currents and drifts, and observations on waves; and meteorology, dealing with the instruments employed, the record of air-temperature, humidity, and cloudiness. The memoir is, of course, well illustrated by maps and diagrams.

THE THICKNESS AND ELECTRICAL CONDUCTIVITY OF THIN LIQUID FILMS.

IN August, 1883, an article was published in NATURE (vol. xxviii. p. 389), signed by Prof. Rücker and myself, giving an account up to date of our researches on liquid films. Since that time our work has from time to time as opportunity offered been continued and further results have been obtained, a brief account summarise the results to which attention was drawn in 1883. of which I now propose to give. It may be useful first to briefly

A cylindrical soap film when allowed to thin under the action of gravity shows in succession the tints of the various orders of Newton's Colours, and finally becomes black. The thickness of any part of the film may be determined (supposing the refractive index to be known) from the colour it exhibits when light is reflected from it at a definite angle. The mean thickness of a horizontal ring of the cylindrical film may also be determined by measuring the electrical resistance of the ring, and by assuming the specific conductivity of the film to be the same as that of the liquid in mass. In the case of a liquid consisting of a mixture of soap solution and glycerine with a little potassium nitrate added to increase the conductivity, we proved by comparing the thickness of a film obtained by the optical method with the thickness deduced from its electrical resistance, that down to a thickness of 374 $\mu\mu$ (micromillimetres)—corresponding to colours of the second order of Newton's scale—the specific conductivity of the liquid remains unaltered. When the film becomes thinner than 374$\mu\mu$, and exhibits the colours of the first order, estimates of its thickness derived from colour observations are less trustworthy, and when these colours are replaced by black, we only know from the colour that the thickness of the film has less than a certain maximum value. Assuming, however, the specific resistance to be unchanged when the film became black we showed that the thickness of such a black film does not differ much from 12$\mu\mu$.

Experiments were then carried out by the electrical method on a solution of oleate of soda (hard soap) containing 3 per cent. of KNO_3 but no glycerine. Black films made of this solution were found to have a mean thickness of 11·7$\mu\mu$, showing that the thickness of the black is practically the same whether the solution does or does not contain glycerine. As this result, however, depends upon the validity of the assumption that the specific resistance of a black film is the same as that of a large quantity of the liquid, it was desirable if possible to measure the thickness in question by a method free from the assumption involved in the electrical method. For this purpose an optical method depending upon interference phenomena (Phil. Trans. 1883, p. 652) was employed. Two glass tubes about 16 inches long and ¾ inch in diameter were placed horizontally side by side and were traversed by two interfering beams of light, the interference bands being produced by thick glass plates. The tubes were filled with plane soap films, each tube containing from 40 to 60 films and having its ends closed by pieces of plate-glass. After an hour or more, when the films had thinned sufficiently to appear black, the position of the central interference band in the field was noted, and its displacement when the films were broken, first in one tube and then in the other, carefully measured. From these measurements the average thickness of a black film could be easily deduced, the only assumption made being that the refractive index of the liquid is unaltered by the tenuity of the film. The average thickness of about 900 films was found to be 12·1$\mu\mu$. This result justified the assumption made in the electrical method with regard to the constancy of the specific conductivity of the liquid.

The results established before the recent work was begun were therefore as follows:—(*a*) The thickness of a black soap film formed of a solution containing one part of oleate of soda dissolved in 40 of water with 3 per cent. of KNO_3 added is about twelve micromillimetres. (*b*) It is practically the same when to the soap solution is added two-thirds of its volume of glycerine. (*c*) From this it follows that the specific conductivity of such a solution is the same whether the liquid be considered in large quantity or in the form of a minutely thin film. (*d*) The thickness of the black, though often varying from film to film, is always the same in the same film—*i.e.*, is independent of area and age. With regard to these results it may be said at once that they have all been repeatedly and completely confirmed by subsequent investigation.

We now come to the more recent work. Since in the earlier experiments the solutions were always of the same strength as regards soap, and always contained not less than 3 per cent. of KNO, it was important to determine whether the thickness of a black film is or is not dependent upon the proportion of soap or salt in the solution. The optical method was first employed. The strength of the soap solution being kept constant, viz. 2 grammes of hard soap to 100 cc. of water, the proportion of salt was diminished from 3 per cent. to zero. Under these circumstances, the mean thickness of a black film was found to steadily increase from 12 $\mu\mu$ to about 24 $\mu\mu$. A similar large increase in the thickness was found when the solution contained glycerine, or was made of soft instead of hard soap. When no metallic salt is present, and the strength of the soap solution varies, the thickness of the black increases as the solution becomes more dilute. Thus for a hard soap solution, when the percentage of soap was 3·3, the thickness was found to be 21·6 $\mu\mu$ and rose to 29·3 $\mu\mu$ as the percentage of soap diminished to 1·25. If, on the other hand, the solution contains as much as 3 per cent. of KNO_3, variation in the proportion of soap has little or no influence on the thickness of the black. This is shown by the following table:—

Hard Soap Solution, containing 3 per cent. of KNO_3.

Percentage of soap in the solution	2·5	2·0	1·66	1.14
Mean thickness of the black in $\mu\mu$	13·1	12·1	11·6	12·1

The results above given have been deduced from the optical method of measurement, and the question arises whether the large increase in the thickness of black films formed from an unsalted solution is real, or whether it is due to some incorrect assumption. The only point where error is possible is in the hypothesis that the refractive index is the same as that of the liquid in mass. The thickness of a film varies inversely as $\mu - 1$ (μ being the refractive index), and as the refractive index of the soap solution is 1·34, it would have to be reduced to 1·17 in order that the calculated thickness might be doubled. It appears therefore *à priori* extremely improbable that the mere addition of 3 per cent. of KNO_3 should so completely change the optical properties of the liquid that whereas if the salt be added the refractive index is practically the same in the thin films and in the liquid in mass, yet without the salt the refractive index should be as much as 13 per cent. less than that of the liquid in mass. It may further be mentioned that Drude (*Wied. Ann.* xliii. p. 169, 1891), by an optical method quite different from that employed by us, has compared the refractive indices of black and coloured films, of which the latter may unquestionably be taken as nearly if not quite identical with that of the liquid in mass, and has shown that they do not differ by more than 1 part in 140. Such a variation would not affect the apparent thickness of the films as measured by the optical method by more than 3 per cent., whereas, as we have seen, the presence or absence of the salt alters the apparent thickness by 100 per cent. On the whole, then, the evidence is very strong that the differences of thickness indicated by the optical method are not merely apparent but real, and this point may now be treated as established.

We now pass on to consider the thicknesses of black films as deduced by the electrical method. The method adopted was in all essentials identical with that previously employed and described (Phil. Trans. 1883, pt. ii. p. 645, NATURE, 1883, *loc. cit.*).

The apparent thickness of a black soap film as measured by the electrical method increases as the percentage of added salt diminishes, but in a far larger ratio than would be inferred from the optical method. If the proportion of salt be diminished to zero the thicknesses thus calculated are greater than the greatest thickness at which a film can appear black. Thus with a hard soap solution the apparent thickness rose from 10·6 $\mu\mu$ to 26·5 $\mu\mu$, as the percentage of KNO_3 added was diminished from 3 to 0·5, and became 148 $\mu\mu$ when the solution contained no salt, this number being the mean value derived from fourteen films, the individual thicknesses of which ranged from 79 to 240 $\mu\mu$. In another set of experiments made with a rather stronger soap solution, the apparent mean thickness of the black was 184 $\mu\mu$, the extreme values for six films being 84 and 250 $\mu\mu$. Similar results were derived from a soft soap solution, the mean apparent thickness obtained from the examination of twenty-three black films being 162 $\mu\mu$, and the extremes about the same as before, viz. 80 and 252.

Now a film 148 $\mu\mu$ thick (to take the smallest of the mean thicknesses given above) could not possibly appear black. According to Newton the beginning of the black occurs when the thickness is 36 $\mu\mu$, which is about one-fourth of the smallest mean value obtained from unsalted solutions. We are therefore driven to the conclusion that the close agreement between the results of the optical and electrical methods, which has again and again been proved when the solution contains 3 per cent. of KNO_3 does not hold in the case of unsalted solutions. The measured thicknesses cannot be true thicknesses, and therefore there must be a difference between the specific conductivity of a film, and that of the liquid from which it is formed.

Apart from this, however, is the fact that the apparent thickness varies considerably from film to film, although all the conditions are maintained as far as possible constant. This is certainly due in some cases to a real variation in thickness. We have frequently seen in the same film two different shades of black separated from each other by a definite sharp line, which is generally very irregular in form. The line which separates the black from the coloured part of a cylindrical film thinning in the normal way is always a horizontal circle. This is rarely the case with the boundary between the two black tints. Sometimes a patch of the darker black is completely surrounded by the other, sometimes the line of separation is sinuous, or stands higher at one point than at another. It is thus difficult to obtain comparative measures of the thicknesses of the two tints, as the method of experiment employed assumes the thickness of a cylindrical film to be the same at all points on the same horizontal circle. Such measures, however, as have been made indicate that the thickness of the thicker black is about twice as great as that of the thinner.

The two black tints are not always easy to detect or to distinguish from each other. If only one occurs it is almost impossible to say whether it is the thinner or thicker variety. Frequently the passage of an electrical current through a film, the black portion of which appears to be homogeneous, discloses the existence of the two different tints by producing or intensifying little white flecks which lie along the boundary between the two. On the suppression of the current the flecks become smaller or disappear, but the attention of the observer having been called to the boundary line, there is no difficulty in distinguishing between the regions on the two sides of it, the thinner appearing more intensely black than the other. We have never, when experimenting with solutions containing 3 per cent. of KNO_3, seen any indication of the two shades of black. If the added salt is reduced to 0·5 per cent., the phenomenon is seen occasionally; but with unsalted solutions it is of frequent occurrence. The two varieties of black in a soap film were noticed by Sir Isaac Newton, who remarks that sunlight is reflected from even the darker spots.

But to return to the question of the mean apparent thickness of a black film. As has been stated, the optically measured thickness differs little if at all from the true thickness. If the electrical thickness is approximately equal to the optical thickness, we may assume that the specific conductivity of the liquid is unaltered by the tenuity of the film. If they differ considerably the inference is that the specific conductivity has changed. Now in the case of an unsalted solution containing one part of soap dissolved in sixty of water the optical thickness is 27·7 $\mu\mu$, while the mean apparent electrical resistance is 160 $\mu\mu$. The specific conductivity is therefore greater in the film than in the liquid in mass in the ratio of 5·8 to 1.

A number of experiments have been carried out for the purpose of determining whether the change in the specific conductivity is a function of the thickness of the film, or is peculiar to black films. The result is to show that with an unsalted solution of hard soap the change begins when the film is comparatively thick. Thus, the ratio of the electrical to the optical thickness (which measures the proportional increase of conductivity) is 1·66 when the film exhibits the green of the second order (thickness = 641 $\mu\mu$); it is 1·98 at a thickness of 296 $\mu\mu$, 4·47 at 97 $\mu\mu$ (white of first order) and becomes 5·8 when the film is black.

When the solution contains 3 per cent. of KNO_3 we know that for the black films the conductivity is the same as for the liquid in bulk. That it remains constant under all circumstances is highly probable, though not absolutely certain.

We have now to inquire into the possible causes of the fact that a black film made of an unsalted soap solution appears to be about six times as great as it really is, or, in other words, that the specific conductivity of the film is six times as great as that of the liquid in mass. This increase might possibly be due to (1) evaporation or absorption of water by the film as it thins, (2) changes of temperature, (3) changes in the chemical constitution of the film by the electrolytic action of the current employed, (4) absorption of carbonic acid or of oxygen from the air. In considering these it must be borne in mind that our observations are based on a comparison between two solutions which differ from each other only by the addition to one of them of 3 per cent. of KNO_3. If, therefore, the change in conductivity were ascribed to any one of these causes it would be necessary to assume not only that the cause was competent to produce the change, but that its efficiency was very greatly modified by the addition of the salt. It is extremely improbable that evaporation or absorption of water, changes of temperature, or absorption of carbonic acid (if occurring in the one liquid), would produce the enormous observed change in the conductivity, while they were inoperative in the case of the other. We have not, however, been satisfied with *à priori* considerations, but have experimentally examined each of these possible causes.

With regard to the first, it is sufficient to say that all the precautions which experience has shown to be efficient in securing constancy of composition in the case of *liquide glycérique*—a liquid much more susceptible to changes of composition, due to variations of hygrometric state, than plain soap solutions—have been taken. We may be perfectly sure that the change in conductivity is not due to the loss or gain of water by the film when thinning.

Experiments have been made at various temperatures between 17° and 27° C., but there is nothing in the results obtained to indicate that the apparent thickness of the black either increases or diminishes as the temperature changes. Thus, to take four films out of many that might be selected, we have the following results:—

Temperature	18°·7	21	21°·1	26°·3
Apparent thickness of black film in pipe	171	237	201	135

There is no doubt that the relatively small changes of temperature which occurred in our experiments are not the cause of the large increase in the apparent thickness of a black film.

But the observed result might be due to change in the composition of the liquid caused by the passage of an electric current through the film. The current employed to measure the resistance of the film is always a feeble one; but in order to produce a rapid thinning, we have frequently passed a current from a battery of 28 Leclanché cells down the film from the moment of its formation. Such a current, though probably never exceeding 100 microampères, is passed for a long time, and might conceivably affect the specific conductivity of the liquid. As a specimen of the kind of results obtained, the following, derived from a soft soap solution, may be given. Each of the values of the thickness was obtained from a different film, and the number of cells indicated is that employed to pass a continuous current through the film from its first formation. The measuring current was small and intermittent.

No. of cells.	Apparent thickness of black film, measured electrically, in $\mu\mu$.
0 ...	150 171 148 150
14 ...	155 145 142
28 ...	150 157 179

The conclusion to be drawn from this table was confirmed by experiments in which transient currents from a Ruhmkorff induction coil were employed; they leave no doubt that the passage through a film of such electrical currents as we have used has no appreciable influence on the phenomenon under discussion.

To determine the possible influence of carbonic acid, or of oxygen, absorbed from the surrounding space comparative experiments were made. The apparatus not being air-tight, the plan was adopted of allowing a stream of air carefully freed from CO_2, or of pure oxygen, as the case might be, to flow through the film-box. The results obtained under these conditions, though in some respects not quite satisfactory, justify the assertion that neither the total (or almost total) absence of CO_2 nor a large increase in the quantity of oxygen in the neighbourhood of the film produces any appreciable change in the specific resistance.

It thus appears that a number of possible causes, to which the increase in the conductivity of a thin film might be due, prove on examination to have little or no influence. Although a satisfactory explanation is not at present possible, it will probably be found to depend upon the connection which subsists between the chemical constitution of a film and the surface forces which are brought into play, or are modified by its tenuity. Prof. J. J. Thomson ("Applications of Dynamics to Physics and Chemistry," p. 234) has drawn attention to this connection, and has shown that under certain conditions the chemical action in a thin film throughout which the forces producing capillary phenomena are active, may be totally different from the chemical action in the same substance in bulk. The experiment of Liebreich (*Berlin, Sitzungsberichte*, 1886) is often cited as illustrating this point. When solutions of chloral-hydrate and sodium carbonate are mixed in suitable proportions in a glass tube, chloroform is slowly precipitated as an opaque cloud. Close to the surface, however, and from 1 to 3 mm. below the surface, there is a space perfectly clear and free from chloroform. It is supposed that in this space either the chemical action does not go on, or that if it does chloroform is not deposited. The explanation is not very satisfactory, and in any case the "dead space" is too large to justify us in referring it solely to the action of surface forces. Again, there is no doubt that the surface of a film becomes altered by the action upon it of the surrounding medium, so that the outer layers have different properties from the rest of the liquid. Lord Rayleigh has shown that the surface tension of a soap solution when the surface is new is nearly the same as that of pure water, but diminishes rapidly by exposure to the air. Reinold and Rücker have proved that the surface tension of a cylindrical film is increased by giving the film a new surface (letting fresh liquid flow over it) and that from ten to fifteen minutes elapse before the old value is regained. Other properties of the surface-layer besides its tension may be modified where it is very thin, and the electrical conductivity may be very different from that of the interior liquid. Although the peculiarities of the surface-layer certainly are in some way connected with the main facts here considered, we have shown that they cannot all of them be explained by the simple theory of the formation of a pellicle of different conductivity from the rest of the film.

It is difficult to assign a reason why the addition of salt to the liquid should produce so great a change in the results. In part, the better conducting salt probably masks effects which, when soap alone is used, become predominant; but it is likely that, in part at all events, it actually prevents the changes to which the change in conductivity is due.

The optical method of investigation illustrates the controlling influence of the metallic salt when present in the solution. As we saw above, a small variation in the proportion of dissolved soap has a large effect upon the thickness of the black when no salt is present; but the quantity of soap may be doubled without influencing the thickness, provided the solution contain 3 per cent. of salt.

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SPONTANEOUS COMBUSTION.[1]

WHEN an inflammable substance ignites or becomes incandescent without the application of fire or other apparent cause, it has been customary to speak of it as spontaneous combustion, a term which I think I shall be able to show you presently does not correctly express the actions which lead to this apparently mysterious result.

Early in the eighteenth century a woman was found burnt to death under circumstances which gave no clue as to the cause of the accident, and in order to satisfactorily explain her death, the theory of spontaneous combustion was devised by the experts of the day, and was generally accepted at a time when little or nothing was known of what takes place during the process which we know as combustion; but as the years rolled on, men's views upon this important subject became wider and more exact, until, in the latter part of the last century, the great French philosopher Lavoisier, partly by his own experiments, and partly by the teachings of the work done by others, gave us a true knowledge of combustion and the changes which take place when a body is burnt, whilst the commencement of this century marked still further the advance of our knowledge in this direction, and also as to the conditions necessary for continuing the combustion or burning of any inflammable substance.

We now know that from the nature of combustion it is impossible for the human body to undergo spontaneous ignition or combustion in the way in which the novelists and scientific experts of the last century believed possible, but there are few amongst us who have not heard of, and even come across, cases in which large masses of coal, small quantities of oily rags, or waste, and hayricks which have been made from grass stacked before it was thoroughly dried, have ignited without any apparent cause, and have kept alive in our minds and on our tongues the term "spontaneous combustion"; and you must pardon me if I commence my lecture this evening by reviewing the teachings of Lavoisier's classical work, and then apply the conclusions we arrive at to those cases of spontaneous combustion which we meet with in our daily work.

The theory of combustion which was generally accepted during the last century, was that every combustible body contained within itself the products of combustion combined with a "something" called phlogiston, and when the substance was burnt, this phlogiston escaped, giving the flame or incandescence of combustion, whilst the products were set free. This theory could not, however, for long stand the test of exact experiment, and as soon as Black introduced the balance into scientific research, it was found that when any substance underwent combustion, the products weighed more than the body before it had been burnt, the reverse of what one would have expected had the phlogistic theory been correct.

During the last century lived Joseph Priestley, one of the most remarkable men this country has ever claimed as her own—a man so varied in his attainments, and so energetic in his life and labour, that he published over one hundred different works dealing with every conceivable subject, from theology to science; but it was in the latter field that he especially shone, and the greatest achievement of his life was the discovery of the gas which we now call oxygen, a discovery which he communicated to his friend Lavoisier.

Lavoisier at once saw the importance of the discovery which Priestley had made, and then conceived and carried out an experiment which has become historical as proving for the first time beyond doubt the fact that the air was not a simple elementary substance, but contained two perfectly distinct gases—oxygen and nitrogen.

Lavoisier placed in a long-necked retort about four ounces of mercury, and so arranged the apparatus that the air above the mercury in the retort should freely communicate with the air in a measured receiver, all contact with the outer air being prevented by standing the receiver in a vessel of mercury. He now heated the four ounces of mercury in the retort nearly to its boiling-point, and kept it at this temperature for twelve days and twelve nights. At first no change took place, some of the mercury merely distilling into the upper part of the apparatus and falling back again; but presently some little red specks began to appear on the surface of the metal, and increased in amount for several days, but at length ceased to form; and after continuing the heating for a day or two longer,

[1] A lecture to working men, delivered by Prof. Vivian B. Lewes at Nottingham, in connection with the British Association

in order to make sure that the action was completed, he allowed the whole apparatus to gradually cool down again to its original temperature.

Before starting the experiment he had carefully measured the air in the apparatus, which amounted to fifty cubic inches, and the first thing which he now noticed was that of this forty-two cubic inches only remained, and that this residual gas had lost all the most characteristic properties of air; a taper plunged into it was at once extinguished, a mouse placed in it died after a few moments; it would, in fact, neither support life nor combustion, and he recognised it as a gas discovered some three years before by Rutherford, and now called nitrogen.

He then collected the red film formed on the surface of the mercury, which weighed forty-five grains, and heated the powder in a hard glass tube to a higher temperature than that at which it had been formed, when it again broke up, leaving behind metallic mercury, and yielding eight cubic inches of a gas which had to an exaggerated extent all the properties which the air had lost—a gas which he at once recognised as being the oxygen or "vital" air which Priestley had discovered in 1774.

It was in this way that the air was shown to consist of the two gases, oxygen and nitrogen, and we know from experience that air is necessary for carrying on those cases of combustion which we ordinarily meet with, and the quickest way to extinguish a fire is to cut off the supply of air from it.

Having reached this point, the next question which suggests itself is, which of the constituents of the atmosphere is it which supports and carries on combustion, and how does it act in doing so? And the answer to these points can most readily be given in Nature's own words, by carefully translating the result of a few simple experiments.

Here are two gas jars, the one containing oxygen, the other nitrogen, and, taking a small ball of tow soaked with turpentine which is burning vigorously, I plunge it into the atmosphere of nitrogen, when it is at once extinguished, but on now relighting it, and plunging it into the oxygen, it burns far more fiercely than before, and emits a most brilliant light. If we continued experimenting in this way, we should find that everything tends to confirm the impression gained from our first experiment, and we soon learn, as Lavoisier did, that anything which will burn in air will burn with still greater vigour in oxygen, whilst nitrogen alone instantly stops the combustion of those bodies which require air to enable them to burn; indeed, we might go a step beyond Lavoisier's experiments, and find that many bodies not looked upon as combustibles, such as iron and zinc, burn with considerable brilliancy in pure oxygen; and it is from these facts that we came to look upon oxygen as our great supporter of combustion.

The enunciation of these truths by the great French philosopher was one of the most important steps in the history of science, but with increase of knowledge we find that we must still further widen our views with regard to combustion, and must take care not to fall into the error of looking upon those substances which will burn in air or oxygen as the only combustibles, and oxygen as the only supporter of combustion; we find, indeed, that these terms are purely relative, and a substance which we look upon as a combustible may, under altered conditions, become a supporter of combustion. Indeed, a body like coal gas, which burns in air or oxygen, will support in turn the combustion of air, and we can experimentally show that it is just as easy to have a flame of air burning in coal gas, as under ordinary conditions to have a flame of coal gas burning in air.

Again, we find that many cases of combustion will take place without the presence of oxygen or those substances generally looked upon as combustibles, and we can take a metal like antimony, and cause it to undergo brilliant combustion by throwing it in a powdered condition into an atmosphere of a gas called chlorine, although neither the metal nor the gas answer to our general ideas as to combustible or supporter of combustion.

If we examine carefully all cases of combustion, we find that in them we have a body with certain definite properties of its own, uniting itself with something else to form what we call the products of combustion, which are equal in weight to the sum of the weights of the two bodies uniting, and which have characteristic properties differing from those of the original substances, an action which we term one of chemical combination; and extended experiments show us that in order to obtain a true conception of combustion, we must look upon it as "the evolution of heat during chemical combination."

The rapidity with which chemical combination takes place varies to a very great extent with surrounding circumstances, and inasmuch as heat is very rapidly dissipated it often happens that where a chemical combination is slow, the heat produced by it is given off as rapidly as it is generated, so that the temperature of the mass becomes but little raised, and escapes detection by our senses. For instance, if I take a steel watch-spring, and having ignited a small piece of German tinder attached to the end of it, plunge it into a vessel of oxygen gas, the combustion of the tinder ignites the watch-spring, which burns away in the gas with the greatest brilliancy, and the evolution of heat is sufficient to fuse some of the metal, the result being that the watch-spring is converted into a chemical compound of iron and oxygen. If instead of bringing about the combination of the iron and oxygen as we have done in a few seconds, we allowed it to remain in moist air for two or three months, combination with the oxygen of the air would result, and the metal would rust away, and if the weight of metal had been the same in each case, and the same weight of oxygen had been combined with, exactly the same amount of heat would have been generated in each case; but in the rapid combustion of the metal, this heat, being all generated in a few seconds of time, would have made its presence perfectly manifest; whilst when the same action is spread over a long period, as in the rusting of the metal, the heat being dissipated as it is generated, escapes our notice; and there are many amongst us who would smile at the idea that the rusting of their garden railings was giving rise to any increase of temperature.

In this case the heat generated by the combination of the iron with oxygen was made manifest by raising the burning metal to a high temperature in the presence of oxygen free from the diluting action of the inert nitrogen which is mixed with it in the air; but we can do the same thing by taking the iron in a very finely-powdered condition, so that a very large surface shall be exposed to the action of the oxygen of the air. I have here iron in this condition, sealed up in a glass tube, and on opening and shaking out the finely-divided metal into the air, it at once enters into combination with oxygen, and the heat generated is sufficient to make it red-hot. If, however, the same weight of iron in a compact form, such as wire, be taken, a long period of time, extending perhaps over years, would be required for its conversion into oxide by air and moisture, and the heat generated would be spread over such a duration of time that it would be inappreciable, unless the conditions were such that the heat was unable to escape or the surface of metal exposed very large. A case of this kind occurred during the manufacture of the Mediterranean telegraph cable, which was enclosed in a strong casing of iron wire, and tightly coiled in water tanks, one hundred and sixty-three miles of cable being wound in a coil thirty feet in diameter. Owing to a leak in the tank which contained the cable the water ran off, leaving the wire casing exposed to air, and the moist metal oxidised so rapidly that sufficient heat was generated to form considerable quantities of vapour, and to give rise to serious fears as to the softening of the insulating material of the core.

Many cases of chemical combination with the oxygen of the air take place in nature, which are so slow that the heat evolved during the action escapes our senses, and indeed all cases of decay are processes of this kind, and the action is termed one of "slow combustion."

A tree left to rot upon the ground gradually disappears in the course of years, being mainly oxidised into gaseous products such as carbon dioxide and water vapour, and yet scarcely any evolution of heat is observed, although the same amount of heat is generated as if the tree had been cut into logs and burnt.

In all cases slow combustion is accelerated by increase of temperature, and the higher the temperature the more rapid becomes the chemical action, and all combustible bodies, at a certain temperature, undergo what is termed "ignition," that is to say, a temperature is reached at which slow combustion passes into ordinary combustion with manifestation of flame or incandescence, the chemical combination being then so rapid that the heat evolved is manifest to our eyesight, whilst a still greater increase in the rapidity of combustion will in some cases bring about the most rapid form of combustion, which we term "explosion."

Many substances are capable of undergoing all three rates of combustion. For instance, it can readily be proved that when organic substances containing hydrogen undergo decay, some of the hydrogen present unites with the oxygen of the air to form water, and the heat generated by the combination is spread over so long a period that at no one moment of time is it perceptible to the sense. If, however, hydrogen gas be confined under pressure in a gas-holder, and allowed to escape through a jet into the air, on being ignited it burns with an intensely hot flame, the heat energy of which can be converted, by suitable contrivances, into other forms of energy, such as mechanical force. In this case as much hydrogen is converted into water in the course of a minute as would have been formed in some years by the process of slow combustion, and the increase in calorific intensity obtained is solely due to the increased rate of combustion, the total thermal value of the hydrogen being the same, whether it is burnt by a slow process taking years, or a rapid one in a minute. If now the same volume of hydrogen be mixed with sufficient air to supply it with the oxygen required to convert it into water, and if a light be applied to the mixture, the hydrogen being side by side with the oxygen necessary for its conversion into water, combustion takes place with enormous rapidity, and the intense heat generated expands the vapour formed to such an extent that an explosion results.

We have now seen that during the decay or slow oxidation of combustible bodies, heat is generated, and that it is only necessary for this heat to reach a certain point, *i.e.* the point of ignition, for the little noticeable slow combustion to become ordinary combustion with its manifestation of flame and incandescence, and it is this action to which the term spontaneous combustion has been given.

When the combustible substance has a great affinity for oxygen, and at the same time a low point of ignition, spontaneous combustion will take place with great ease. Indeed, in some cases, such as that of phosphorus, we are obliged to prevent the access of air to the body if we wish to prevent ignition taking place, and we also find that the finer the state of division of the substance, the more readily will its spontaneous ignition take place, not because dividing the body up in any way lowers the point of ignition, but because the increase in the size of the surface exposed to the oxidising action of the air is so much increased, that the heat is generated with greater rapidity than it can be dissipated. If we take a piece of phosphorus, and expose it to the action of the air, it almost directly commences to give off white fumes, and if the weather is warm, it will in the course of a short space of time even ignite; in cold weather, however, it may be left until it has nearly all undergone slow oxidation without ignition. If, however, we dissolve it in the liquid called bisulphide of carbon, and pour some of this solution upon a piece of blotting-paper or linen, the carbon bisulphide, being highly volatile, will all evaporate, and leave the phosphorus in such a fine state of division that it will at once spontaneously ignite.

In practically all of the cases of spontaneous ignition which come under our notice, we have the heat evolved during the slow combustion kept in by the presence of a mass of non-conducting material, and this heat being unable to escape gradually grows higher and higher, the chemical combination becoming more and more rapid as the temperature increases, until we reach the point at which ignition of the mass takes place.

Sometimes, also, the increase in temperature necessary to bring about spontaneous ignition is partly due to physical actions. If a gas be suddenly compressed heat is always evolved, a fact prettily shown by the so-called fire syringe, in which the heat evolved by the compression of air is sufficient to ignite a piece of German tinder.

Certain bodies have the power of absorbing many times their own volume of gases, and in doing this they not only give rise to a certain increase in temperature, due to the compression of the absorbed gas upon their surfaces or in their pores, but they also increase the chemical activity of the gas so compressed.

Carbon is one of those substances which possess to an extraordinary degree the power of attracting and condensing gases upon their surface, this power varying with the state of division of the particular form of carbon used. The charcoal obtained from dense forms of wood, such as box, exhibits this property to a high degree, one cubic inch of such charcoal absorbing—according to Saussure—

Ammonia gas ...	90	cubic	inches
Sulphuretted hydrogen	55	,,	,,
Carbon monoxide	35	,,	,,
Ethylene—olefiant gas	35	,,	,,
Oxygen	9·25	,,	,,
Nitrogen	6·5	,,	,,

This absorption is very rapid at first, but gradually decreases, and is, moreover, influenced very much by temperature. It is at first purely mechanical, and itself causes a rise of temperature, which in the case of charcoal formed in closed retorts, as in preparing alder, willow, and dogwood charcoal for powder making, would produce spontaneous ignition if it were not placed in sealed cooling vessels for some days before exposure to air. The rate of absorption varies with the amount of surface exposed, and is, therefore, able to take part in this condensing action, so that when charcoal is finely powdered, the exposed surface being much greater, absorption becomes more rapid, and rise of temperature at once takes place. If, after it has been made charcoal, it is kept for a day out of contact with air, and is then ground down into a powder, it will frequently fire after exposure to the air for thirty-six hours, whilst a heap of charcoal powder of one hundred bushels or more will always ignite. It is for this reason that in making the charcoal for powder it is always kept, after burning, for three or four days in air-tight cylinders before picking over, and ten days to a fortnight before it is ground.

There are several very interesting points with regard to the spontaneous combustion of charcoal, which call for more attention than has yet been devoted to it. It is self-evident that the more porous a body is, the greater amount of exposed surface will be available for the condensation of gases, and the great power that charcoal has of absorption is undoubtedly due to its great porosity. Now the temperature at which wood can be carbonised varies very considerably, and wood will begin to char; that is to say, will begin to be converted into charcoal at temperatures very little above that of boiling water, and in the manufacture of some of the newer kinds of gunpowder the charcoal is formed by heating with superheated steam.

Charcoal formed at this low temperature, however, still contains large quantities of hydrogen and hydrocarbons, and is not nearly so porous as charcoal made at a high temperature; and although the diminution in porosity reduces the quantity of oxygen absorbed, yet another cause which tends still more to dangerous rise of temperature comes into play.

When a substance condenses oxygen upon its surface from the atmosphere, the gas is in a very chemically active condition, and will bring about chemical combination with considerable rapidity. For instance, if a piece of platinum foil be heated to redness, so as to drive off all gases from its surface, and be then allowed to cool until it ceases to be visibly red, and is held in a stream of mixed air and coal gas, or air and hydrogen, it again becomes red-hot, owing to the chemical combination of these substances upon its surface; that is to say, it has been able to condense these gases together and set up combustion.

If now charcoal be burnt at a high temperature, the carbon is in a dense condition, and resists to a considerable extent the setting-up of chemical action by the oxygen condensed and absorbed in its pores, but if it has been formed at a low temperature, this condensed oxygen will rapidly act upon the hydrocarbons and hydrogen still remaining in the mass, and will raise in this way the temperature to a dangerous point; and it is more than probable that very many unexplained fires have been brought about by beams and woodwork becoming charred in contact with flues and heating pipes.

It has been experimentally determined that when wood has been charred at 500° it will take fire spontaneously when the temperature is raised in the presence of air to 680°, and that when wood has been carbonised at 260° a temperature of 340° only is required for its spontaneous ignition.

If a beam is in contact during the winter months with a heated flue, or even steam-pipes, it becomes carbonised upon its surface, and during the summer, when the flue or pipe is probably not at work, it absorbs air and moisture, and during the next winter it again becomes heated and further carbonised, whilst the moisture and air are driven out, leaving the pores in a condition eminently adapted for the absorption of more air as soon as the temperature is allowed to fall, and in many cases sufficient heat is generated to cause the charred mass to smoulder and, when air is freely admitted to it, to burst into flame.

In the case of charcoal burnt at a higher temperature, it may be taken that the cause of heating is to a great extent physical, whilst in the low-burnt charcoal it becomes chemical as well as physical, and it is this chemical action which is the most dangerous, and acts in most cases of spontaneous combustion.

The spontaneous ignition of coal has been the cause of an enormous number of serious accidents, and the earliest theory as to its cause was that it was due to the heat given out during the oxidation of the pyrites or "coal brasses," which are compounds of sulphur and iron, and are present in varying quantities in nearly all coal. This idea has held its ground nearly up to the present time, in spite of the researches of Dr. Richters, who twenty years ago showed the explanation was an erroneous one, and even earlier, in 1864, Dr. Percy pointed out that the cause of spontaneous ignition was probably the oxidation of the coal, and that the pyrites had but little to do with it. Pyrites is found in coal in several different forms, sometimes as a dark powder closely resembling coal itself, and in larger quantities in thin golden-looking layers in the cleavage of the coal, whilst sometimes again it is found in masses and veins of considerable size; these masses, however, are very heavy and are carefully picked out from the coal, and utilised in various manufactures. The yellow pyrites, and even the dark varieties, when in the crystalline form, remain practically unaltered, even after long exposure to moist air, but the amorphous and finely divided portions will oxidise and effloresce with great rapidity, and it is during this oxidation that the heat is supposed to be generated.

Some coals that are very liable to spontaneous ignition only contain 0·8 per cent. of pyrites, and if we imagine this to be concentrated in one spot instead of being spread over the whole mass, and to be oxidised in a few hours, the temperature would rise only a few degrees, and under ordinary circumstances this rise in temperature would be practically inappreciable.

The oxidisation of masses of pyrites under certain conditions gives rise to the formation of ferrous sulphate and sulphur dioxide, with liberation of sulphur, and one might easily imagine that this free sulphur, which has an igniting point of 250° C., would play an important part in the action by lowering the point of ignition. This, however, could only happen with large masses of pyrites undergoing oxidation, and with the small amount of pyrites present in coal, supposing air were present in sufficient quantity to oxidise it, the sulphur formed would be converted into sulphur dioxide at temperatures as low as 60° C. This oxidation of sulphur at low temperatures is an action not generally known, but in my experiments I have found it takes place with considerable rapidity. The only way in which pyrites can assist the spontaneous ignition of coal is that when it oxidises, it swells and splits up the coal, thus exposing fresh surfaces to the action of the atmospheric oxygen.

I have carefully determined the igniting points of several kinds of coal, and find that

Cannel coal	ignites at	698° F.	= 370° C.
Hartlepool coal	,, ,,	766° F.	= 408° C.
Lignite coal	,, ,,	842° F.	= 450° C.
Welsh steam coal	,, ,,	870° F.	= 477° C.

So that it is impossible for the small trace of pyrites scattered through a large mass of coal, and slowly undergoing oxidation, to raise the temperature to the necessary degree.

When coal is heating, a distinctive and penetrating odour is evolved, which is the same as that noticed when wood is scorched, and the gases produced consist of nitrogen, water vapour, carbon dioxide, carbon monoxide, hydrocarbons of the paraffin series, and sulphuretted hydrogen, the presence of the latter gas showing beyond doubt that oxidation of the sulphur has nothing to do with the action.

Ever since coal has been generally adopted as a fuel, it has been recognised that great care was necessary in the storing and shipment of masses exceeding 1000 tons, and if the coal has been stored wet or in a broken state, firing or heating of the mass has frequently taken place. Much inconvenience and loss has been caused by this on shore, but the real danger has occurred during shipment, and owing to this many a vessel has been lost with all hands, without any record of the calamity reaching shore.

Owing to the greater facility for treating the coal when it becomes heated on shore in coal stores and gas works, absolute ignition only rarely takes place, and it is mainly from evidence obtained in the case of coal cargoes that we learn most as to the causes which lead to it.

Coal is a substance of purely vegetable origin, formed out of contact with air, by long exposure to heat and pressure, from the woody fibre and resinous constituents of a monster vegetation which flourished long before the earth was inhabited by man. Coal therefore may be looked upon as a form of charcoal, which having been formed at a temperature lower than that of the charcoal-burner's heap, and under great pressure, is very dense, and still contains a quantity of these constituents which, in the ordinary burning, are driven off as wood naphtha, tar, &c., and these bodies consist of compounds containing essentially carbon and hydrogen, together with a little oxygen and nitrogen, and form the volatile matter and hydrocarbons of the coal. Coal also contains, besides these, certain mineral bodies, which were present in the fibre and sap of the original wood, and these form the ash which is left behind on the coal being burnt. These mineral substances consist almost entirely of gypsum or sulphate of lime, silica, and alumina, together with some oxide of iron, which gives the colour to the reddish-brown ash of many coals, and which has been formed by the decomposition of the pyrites in the original coal.

The mineral constituents of coal are the only ones, with the exception of the pyrites, that play no part in the phenomena attending the heating and spontaneous ignition of coal, and we need therefore only regard the actions which take place when the carbon, hydrocarbons, and pyrites in freshly-won coal come in contact with air and moisture.

Certain kinds of coal exhibit the same power of absorbing gases which charcoal has, although to a less degree. The absorptive power of new coal due to this surface attraction varies, but the least absorbent will take up one and a-quarter times its own volume of oxygen, whilst in some coal more than three times their volume of the gas is absorbed, which gives rise to an increase in temperature, and tends to increase the rate of the action which is going on, but is rarely sufficient to bring about spontaneous ignition, as only about one-third the amount of oxygen being absorbed by coal that is taken up by charcoal, and the action being much slower, tends to prevent the temperature reaching the high ignition point of the coal.

All coal contains a certain proportion of hydrogen, with which some of the carbon is combined, together with the nitrogen and oxygen, forming the volatile matter in the coal. The amount of this volatile matter varies greatly, anthracite containing the smallest quantity, and cannel and shale the largest. When the carbon of the coal absorbs oxygen, the compressed gas becomes chemically very active, and soon commences to combine with the carbon and hydrogen of the bituminous portions, converting them into carbon dioxide and water vapour. As the temperature rises so this chemical activity increases, so that the heat generated by the absorption of the oxygen causes it to rapidly enter into chemical combination. This kind of chemical combination—oxidation—is always accompanied by heat, and this further rise of temperature helps the rapidity of oxidation, so that the temperature rises steadily; and this taking place in a large mass of coal, which from physical causes is an admirable non-conductor, will often cause such heating of the mass that if sufficient air can pass into the heap in order to continue the action the igniting point of the coal will be reached.

It has been suggested that very bituminous coal, such as cannel and shale, are liable to spontaneous ignition from the fact that heavy oils would exude from them on a rise of temperature, and that these, by oxidising, might produce rapid heating. Experiment, however, shows that this is not the case, and that the heavy mineral oils have a decided effect in retarding heating.

We can now trace the actions which culminate in ignition. As soon as the coal is brought to bank, absorption of oxygen commences, but except under rare conditions the coal does not heat to any great extent, as the exposed surface is comparatively small, and the largeness of the masses allows of the air having free access to all parts, so keeping down the temperature. After the coal has been screened and the large pieces of pyrites picked out, it is put in trucks. Here it begins to get broken up, owing to the many joltings and shuntings, and so offers a larger surface to the action of the air. When it has arrived at the ship, it is further broken up by being shot down the tips or shoots, and more harm is done at this than at any other period, for the coal is broken by reason of the distance it has to fall, and it has to bear the impact of every succeeding load falling upon it, and it rapidly becomes slack, so that the under part of the ship-load is a dense mass of small coal, which soon rises in temperature by reason of the large surface exposed to the air and the consequent absorption of oxygen. This sets up chemical combination between the oxygen absorbed by the coal and the hydrocarbons, and in some cases culminates in combustion.

It is found that the mass of coal exercises a most important action in the liability to spontaneous combustion, as although with 500 tons of coal to the cargo the cases of spontaneous combustion amount to only about ¼ per cent. when the bulk is increased to 2000 tons, cases of spontaneous combustion rise to 9 per cent., this being due to the fact that the larger the cargo the more non-conducting material will there be to keep in the heat, and also to the fact that the breaking-up of the coal and the exposing fresh surfaces will of course increase with increase in mass; and it is also found that coal cargoes sent to European ports rarely undergo spontaneous combustion, whilst the number of cases rise to a startling extent in shipments made to Asia, Africa, and America. The result is party due to the length of time the cargo is in the vessel, the absorption and oxidation being a comparatively slow process, but the main cause is the increase of heat in the tropics, which causes the action to become more rapid; and if statistics had been taken, most of the ships would have been found to have developed active combustion somewhere about the neighbourhood of the Cape, the action fostered in the tropics having raised the temperature to the igniting point by that time.

Moisture has a most remarkable effect upon the spontaneous ignition of coal. The absorption of oxygen is at first retarded by external wetting, but after a time the presence of moisture accelerates the action of the absorbed oxygen upon the coal, and so causes a serious increase of heat. The researches of Cowper, Baker, Dixon, and others, have of late years so fully shown the important part which moisture plays in actions of this kind, that it is now recognised as a most important factor. A very marked case of the influence of moisture came under my notice a few months ago. A ship took in a cargo of coal at a South Welsh port, the weather being fine and dry whilst she was loading at the main hatch, but wet whilst she was taking in the coal at the after-hatch, the result being that the temperature in a few days was uniformly about 10° higher in the coal that had been loaded wet, than in the dry portion of the cargo, spontaneous ignition being the final result at the after-hatch.

In order to prevent the spontaneous ignition of large masses of coal, it is manifest that every precaution should be taken during loading or storing to prevent crushing of the coal, and on no account must a large accumulation of small coal be allowed. Where possible the depth of coal in the store should not exceed 6 to 8 feet, and under no conditions must steam-pipes or flues be allowed so near the mass of coal as to give rise to any increase of temperature. These precautions would amply suffice to prevent spontaneous ignition in stored coal on land, whilst special precautions would have to be taken in the case of coal for shipment.

Perhaps the commonest case of spontaneous combustion is the ignition of oily waste or greasy cotton rags. Nearly all vegetable and animal oils have the power of slowly absorbing oxygen, and in some of them this goes on with considerable rapidity, with conversion of the oil into a resin, a property which gives them the power of drying, and causes a considerable rise of temperature. A mass of oil, however, only exposes a very small surface to the oxidising influence of the air, but when such oil comes to be spread upon any non-conducting fabric, the oxidisation is very rapid, and the non-conducting power of the fibre of the fabric prevents the rapid dispersion of the heat, with the result that even a small quantity of such oily substance will readily inflame.

There are plenty of well-authenticated cases in which even a handful of oily cotton waste, which has been used for polishing furniture, has ignited when thrown on one side, and caused most disastrous fires. Just twenty years ago Mr. Galletly read a most valuable paper before the Chemical Section of the British Association, in which he showed that the liability of oils to produce spontaneous combustion was in proportion to their tendency to dry. If a substance like cotton-waste be rendered oily with anything except the mineral oils, it acquires the power of taking up oxygen from the air, and this gives rise to heat. The oxidation is slow at ordinary temperatures, and accordingly it may be some time before the increase of temperature becomes manifest; but when this point is reached, the action proceeds with great rapidity, and the point of ignition is reached in a very short time, and then the mass bursts into flame. If the oily matter be placed in a warm position at first, spontaneous ignition may take place within a few hours, or even minutes. Galletly found that oily cotton at ordinary temperatures took some days to heat and ignite, whilst if placed in a chamber warmed to 130° to 170° F. (54° to 76° C.) the cotton greasy with boiled linseed ignited in 1 hour 15 minutes, and olive oil on cotton in 5 hours; and in a chamber heated to 180° to 200° F. (82° to 93° C.) olive oil on cotton ignited in two hours.

Cases of spontaneous combustion, due to this cause, have been more abundant than from any other, and cases are even on record where serious fires have resulted from sparrows using oily waste in the construction of their nests. In all well-regulated workshops the orders against allowing any accumulation of oily waste are very stringent, and the most reasonable precaution to be taken is that all oily material, when done with, should be thrown into a metal vessel containing water, or which, at any rate, can be either emptied of waste or filled with water at night. If a sheet of cotton be hanging in a warm room and is splashed with oil, a hole will often be found charred in the fabric by the next morning, whilst if a few drops of a drying oil be allowed to fall on powdered charcoal or lamp-black, ignition is almost certain to follow in a few hours.

Another common case of spontaneous ignition is that of haystacks which have been made up before the grass has been thoroughly dried, this being due to the sap left in the vegetable fibre undergoing fermentation, which being a process of oxidation gives rise to heat. This heat is kept in by the surrounding hay, which is an admirable non-conductor of heat, and gradually increases until the ignition point of the mass is reached, when the stack bursts into flame. In some cases the action does not go as far as this, and we often see the inside of a haystack charred to an almost black colour, showing that the action has stopped but little short of the point required to give active combustion, this being probably due to the stack having been very closely built, and the access of air to the centre being small, and in some cases, when such a rick is cut, the air coming in contact with the central portion causes active ignition. If hay has once been properly dried, and then becomes wetted with rain, spontaneous ignition hardly ever takes place, although the hay becomes mouldy, and it is evident that the action which leads to ignition of the hay is fermentation of the sap.

Having now discussed the more common cases of spontaneous ignition, and seen that in every case it is due to rise of temperature, brought about by chemical action until the igniting point of the substance is reached, we are in a position to understand the impossibility of spontaneous combustion taking place in the human body.

The process of respiration by which the tissues of the body used up in every action, voluntary or involuntary, are got rid of by a process of slow combustion, gives a normal temperature to the living body, and it might seem, at first sight, possible by preventing the escape of such temperature, to increase it to a point at which ignition might be possible; but we know by experience that the effect of swathing the body in non-conducting materials, so as to prevent the escape of heat from it, results in profuse perspiration, and before the living flesh could undergo combustion it would be necessary to drive from it the whole of the moisture which it contains.

The human body contains from 75 to 80 per cent. of its weight of water, and in order to evaporate this amount, an enormous amount of heat would be required, and life would have been impossible long before the necessary dryness of the mass had been arrived at. In fact, the moisture present in the body may be looked upon as its great safeguard against the effect of heat, and it is perfectly possible for a living man to remain in an oven which would roast a steak or cook an egg; the evaporation of water from the skin taking up so much heat that the temperature of the living flesh would never rise above a certain point until the moisture was exhausted. It used to be supposed that the cases of spontaneous combustion took place in people whose intemperate habits had caused the body to become saturated with alcohol, and that it was this substance which caused its ready ignition; but as Liebig pointed out, some forty years ago, the presence of the alcohol could have no effect, as if we take a sponge and soak it in spirits of wine and ignite it, the alcohol burns away and leaves the sponge untouched, and the same thing would undoubtedly happen in the case of the living flesh.

In this lecture I have tried to bring before you the important fact that spontaneous combustion merely means that the heat due to chemical actions taking place in any substance, heat which has been unable to escape has raised the temperature to the point of ignition, a point at which slow combustion passes into rapid combustion with manifestation of incandescence; and in speaking of spontaneous combustion, we must clearly remember that it represents merely the acceleration of an action which has been going on slowly and surely, although our senses may have been too deadened to detect it, and that if we wished to be hyper-critical, "Unaided Ignition," or "Natural Ignition," would be a far more correct term to apply to it than "Spontaneous Combustion."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The following appointments in connection with the scientific departments are announced:—Mr. Francis Darwin, Reader in Botany, to be Deputy Professor in the place of Prof. Babington, who is still unable to lecture; Dr. D. MacAlister to be Assessor to the Regius Professor of Physics; Dr. Hill, Master of Downing, and Dr. H. D. Rolleston to be Examiners in Anatomy; Dr. A. S. Lea and Prof. Schäfer to be Examiners in Physiology; Dr. W. J. Sollas and Mr. P. Lake (St. John's) to be Examiners in Geology; Mr. Skinner (Christ's) to be an Examiner in Chemistry; Prof. J. J. Thomson and Prof. G. F. Fitzgerald (of Dublin) to be Examiners in Physics; Mr. A. Sedgwick (Trinity) and Mr. W. Bateson (St. John's) to be Examiners in Zoology; Prof. Lewis and Mr. H. A. Miers to be Examiners in Mineralogy; Mr. Seward (St. John's) and Prof. D. E. Oliver to be Examiners in Botany.

Prof. Sir R. S. Ball has been appointed an Elector to the Isaac Newton Astronomy Studentships.

The Moderators and Examiners for the next Mathematical Tripos (Part I.) are Mr. Walsh (Jesus), Mr. Dawson (Christ's), Mr. Burnside (Pembroke), and Mr. Whitehead (Trinity). For the Second Part, Dr. Forsyth, Sir R. S. Ball, Prof. Lamb, and Mr. H. F. Baker (St. John's) are to examine.

Mrs. E. J. Moore, daughter of the late Colonel Fletcher, has presented to the University her father's valuable collection of Silurian fossils, in supplement of the Fletcher collection purchased many years ago for the Woodwardian Museum.

The Clerk Maxwell Studentship in Experimental Physics, of the value of about £180 a year, tenable for three years, is vacant by the resignation of Mr. W. Cassie, who has been appointed to a professorship at the Royal Holloway College. Candidates must be members of the University who have been a student for one term or more at the Cavendish Laboratory. The names of applicants are to be sent to Prof. J. J. Thomson before November 18.

A grant of £100 from the Worts Travelling Scholars Fund has been made to F. W. Keeble, Frank Smart student of Caius College, to enable him to pursue botanical research in Ceylon.

An examination for scholarships and exhibitions in Natural Science, of the value of £80 a year and under, will be held at Trinity College on Tuesday, October 31.

AT the annual meeting of the New Decimal Association, on October 18, Mr. Samuel Montagu, M.P., remarked that there was a prospect of the United States adopting the metric system as well as a decimal system of coinage. Efforts had been made to induce Mr. Acland to instruct inspectors to examine in the metric system in those schools where it was taught, and, in a letter received from the Education Department on the subject, it was said: "The Code does not prescribe knowledge of the metric system, but of the principles of that system—*i.e.* of the diminution of quantities by tenths, and their increase by tens, with examples sufficient to illustrate the conveniences of the system. Her Majesty's inspectors are required to satisfy themselves that the principles as thus defined are properly taught. It is proposed to issue a memorandum to inspectors on the point at an early date."

SCIENTIFIC SERIALS.

American Journal of Science, October.—On endothermic reactions effected by mechanical force, by M. Carey Lea. The object of this investigation was to find whether the blackening effects of pressure upon the silver haloids and other salts could be made immediately visible to the eye, instead of after the application of a reducing agent. For this purpose the pressure was increased to about a million pounds per square inch, or about seventy thousand atmospheres. This pressure was obtained by means of a vice actuated by a screw with six turns to the inch and a lever three feet long. The nuts had to be four inches in length to prevent stripping of the thread. The jaws were specially constructed, and faced with steel welded on. The materials experimented upon were wrapped in platinum or silver foil, which remained unaffected by the pressure. Silver sulphite and carbonate were moderately darkened by two days' pressure, and silver salicylate considerably so. Salts of mercury also showed pronounced effects, which prove that mechanical force can bring about endothermic reactions corresponding to those affected by light, heat, and other forms of energy.—Conditions of Appalachian faulting, by Bailey Willis and C. Willard Hayes. The authors discuss the antecedent conditions for the development, the mechanics of step-folds and thrust-faults as bearing upon actually observed Appalachian structure, and the direction from which the compressing force acted. They come to the conclusion that the latter was equal in opposite directions, and directed north-westward and south-eastward.—On the separation of copper from cadmium by the iodide method, by Philipp E. Browning. The copper was precipitated from a mixed solution by potassium iodide, and filtered through an asbestos felt, washed, dried at 120° C. and weighed. The filtrate and washings containing the cadmium were heated to boiling, and sufficient sodium carbonate was added to complete the precipitation. The precipitate was washed with hot water until free from sulphate or iodide. The crucible containing the cadmium carbonate was heated gently at first, then gradually to a higher degree until the white carbonate had changed to the brown oxide. The method, as tested by means of standard solutions, is fairly accurate, and it is simple in manipulation.—Also papers by Messrs. Foerste, Hidden, Wheeler, Eakins, Williams, Penfield, and Marsh.

THE *American Meteorological Journal* for October contains an account, by A. L. Rotch, of the establishment of a meteorological station at Charchani, near Arequipa, at an altitude of 16,650 feet, which is said to be the highest station in the world. A sum of money was left to Harvard College Observatory by U. A. Boyden, for the purpose of establishing an observatory at a high station, and owing to the remarkable clearness of the air at Arequipa, Peru, this situation was selected for the purpose. The establishment is fully equipped with instruments and is 8,050 feet above the sea; to the north east and ten miles distant is the quiescent volcano of the Misti, 19,000 feet in altitude, and twelve miles north rises Charchani, 20,000 feet high. The meteorological station now in question has been established just below the permanent snow line, and is supplied with self-recording aneroid and thermometers. The ascent from the permanent observatory, 8,600 feet below, can be made by mule in about eight hours, and an assistant is entrusted with the duty of visiting the station periodically to attend to the records. The results of the observations at both stations will be published in the Annals of the Harvard College Observatory, and will furnish a valuable addition to our knowledge of mountain meteorology.

In the same number, Prof. G. E. Curtis gives an analysis of the causes of rainfall, with especial relations to surface conditions. Among these a principal question is whether forestation increases and deforestation decreases the rainfall. The author considers that the influence of forests has been over-estimated, and that if they affect the rainfall, the amount has, in most cases, not been greater than the amount of probable error in the observations themselves, and therefore that the statistics give no assurance that the effect is not an error of observation. If the rainfall is increased it must be due either to an increase of evaporation, and its subsequent precipitation over the same region, or to the diversion of rain to the forest area, which might have fallen elsewhere.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 16.—M. Lœwy in the chair.—On the stability of equilibrium of the axis of the gyroscopic top, by M. H. Resal.—On the partial differential equation presented in the theory of the vibrations of a membrane, by Émile Picard.—On the crystallisation of water by decompression below zero, by M. E. H. Amagat. The experiments were performed with the apparatus provided with glass sights used for studying the solidification of liquids under pressure. But the conical sights mounted in ivory were apt to split into plates, and lose their transparency under high pressures. Cylindrical pieces mounted with marine glue were substituted, some of which resisted pressures up to 1800 atmospheres. The water enclosed in the steel cylinder was first solidified and maintained at a temperature below zero. By gradually raising the pressure, the ice was fused and made to disappear completely. On diminishing the pressure, crystals were deposited on the inner surface of the glass, just as in the case of bodies denser in the solid state when the pressure was raised. The phenomenon is, however, rather more difficult to produce. The solidification was especially retarded when care was taken to fuse all the crystals by pressure, but even when a few fragments were left no such beautiful crystals were obtained as in the case of chloride of carbon. It would be extremely interesting to follow up, for a certain number of liquids, the variation of the point of fusion under very high pressures; as the ratio of the coefficients of compressibility of water and of ice is unknown, it may be asked whether under sufficient pressures the density of ice does not exceed that of water, thus giving rise to a point of inversion which would assimilate the behaviour of water to that of other liquids, or whether other liquids show such a point of inversion in the opposite sense. This would explain certain appearances observed in the case of chloride of carbon.—On an extension of Riemann's method applied to equations of the second order to equations of any order, by M. Delassus.—On the third principle of energetics, by M. H. Le Chatelier. This is a reply to M. Meyerhoffer's criticism, and shows that the term capacity for energy is differently defined by the two authors. Thermodynamic theory is based upon two experimental principles and an hypothesis concerning the nature of heat. The latter may be eliminated by substituting for it the experimental principle which can be expressed as follows: It is impossible to extract energy from a system of bodies without making two at least of its constituents experience changes of opposite sense. From this the proportionality of work performed and heat consumed or generated is easily deduced. It is this proportionality which enables us to reduce the number of algebraic equations to two, sufficient to represent three distinct experimental principles.—On the electric conveyance of heat, by M. L. Houllevigue. The difference of potential between a conductor and iron is different accordingly as the iron is magnetised or not. One joint of a copper-iron couple was brought into a magnetic field, and the other left out. Since this arrangement could not give rise to a steady current without creating energy, an opposing electromotive force was to be expected between the variously magnetised parts of the iron. Such a difference of potential was, in fact, found, the balance being in favour of the less magnetised portions.—On some properties of the oxides of lead, by M. A. Bonnet.—On the interior temperature of bread coming out of the oven, by M. Balland. Experiments performed on various kinds of bread from different ovens show that the temperature of the crumb during baking reaches 100° or 102°, that of the crust being much higher. When beyond 100° the steam imprisoned by the crust is under a certain pressure. If this pressure is relaxed by the bursting of the crust, the temperature of the interior falls to 100°.—Observations of the phenomena of karyokinesis in the blastoderm cellules of the teleostea, by MM. E. Bataillon and R. Kœhler.—On the germination of the Ricinus, by M. Leclerc du Sablon.—A new enemy of the vine, *Blanyulus guttulatus*, Fabr., by M. Fontaine. This is a myriapod which invades the buds in numbers, ranging from five to ten per bud, forming balls of the size of a small pea. Washing with potassium sulphocarbonate and sulphuring the soil are remedies proposed.—On some phenomena relating to the movement of the sea near Bonifacio, by M. Nicol.

DIARY OF SOCIETIES.

London.

THURSDAY, October 26.

Institution of Mechanical Engineers, at 7.30.—On the Working of Steam Pumps on the Russian South-Western Railways: Alexander Borodin.

FRIDAY, October 27.

Physical Society, at 5.—On Air-Core Transformers: E. C. Rimington.—Two Experiments on the Rings and Brushes in Crystals, and Electrical Radiation in Copper Filings: W. B. Croft.

SUNDAY, October 29.

Sunday Lecture Society, at 4.—Savages and Barbarians: a Sketch of their Institutions and their Growth from Savagery to Barbarism: Prince Kropotkin.

THURSDAY, November 2.

Linnean Society, at 8.—A Contribution to the Phanerogamic Flora of Mato Grosso and the Northern Chaco: Spencer Le Marchant Moore.—On a New Freshwater Schizopod from Tasmania: G. N. Thomson.

FRIDAY, November 3.

Geologists' Association, at 8.—*Conversazione.*

BOOKS RECEIVED.

Books.—Plane Trigonometry: S. L. Loney (Camb. Univ. Press).—The Mummy: Dr. E. A. W. Budge (Camb. Univ. Press).—With the Woodlanders and by the Tide: a Son of the Marshes (Blackwood).—Romance of Low Life amongst Plants: Dr. M. C. Cooke (S.P.C.K.).—Eleventh Annual Report of the U.S. Geological Survey, Part i: Geology.—Eleventh Annual Report of the U.S. Geological Survey, Part ii.: Irrigation: J. W. Powell (Washington).—Measurement of Light and Colour-Sensations: J. W. Lovibond (Gill).—Results of Astronomical Observations made at Sydney Observatory, N.S.W. in the years 1879, 1880, and 1881: H. C. Russell (Sydney, Potter).—Horns and Hoofs, or Chapters on Hoofed Animals: R. Lyddeker (H. Cox).—The Municipal Technical School and School of Art, Manchester, Session 1893-94, Syllabus (Manchester).—Round the Works of our Principal Railways (Arnold).

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