[Supplement to Nature, November 30, 1893]

Nature

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

Vol XLVIII

Supplement to Nature
November 30, 1893

Nature

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

VOLUME XLVIII

MAY 1893 to OCTOBER 1893

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

London and New York

MACMILLAN AND CO.

RICHARD CLAY AND SONS, LIMITED
LONDON AND BUNGAY

INDEX

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

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

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 hypœlus*, 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 hypothecated. 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 anti-cyclonic 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 that 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 epithelia 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*, *Hyalinæcia tubicola*, *Calocaris macandreweæ*, *Pasiphæa sivado*, *Xantho tuberculatus*, *Ebalia tuberosa* and *E. tumefacta*, *Hippolyte spinus*, a new species of *Metopa*, *Munida* sp., *Isocardia cor*, *Lyonsia norvegica*, *Spirialis retroversus*, *Fissurella græca*, *Capulus hungaricus*, *Pleurobranchus plumula*, *Lamellaria perspicua*, *Dendronotus arborescens*, *Tritonia hombergi*, *Eolis tricolor*, *Eolis angulata*, *Actæonia 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*, *Gonothyræa 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.

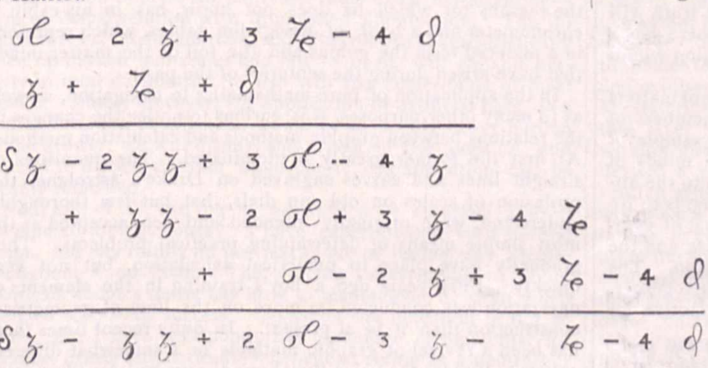
When men look back on their school days, they constantly feel some things they have always remembered and often applied came to them from their masters not as part of the regular course or as included in the work done for examination. It is just this outside illustrative position that I propose history 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.



③ − 2 ② + 3 ① − 4
② + ① + 1

⑤ − 2 ④ + 3 ③ − 4 ②
\+ ④ − 2 ③ + 3 ② − 4 ①
\+ ③ − 2 ② + 3 ① − 4

⑤ − ④ + 2 ③ − 3 ② − ① − 4

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

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

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 $\frac{1}{60}$ 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,

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

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 0·01 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 $\pm$ 0·02 per 1000, the limits of accuracy having been previously considered to be $\pm$ 0·10 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

$$P^m_n(\nu),\ Q^m_n(\nu),$$

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—

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

and

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

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 $\frac{\pi}{2}.\frac{\pi}{3}.\frac{\pi}{6}$

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

(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. iGeorges 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.—Notes on he 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. PAGE