THURSDAY, JUNE 9, 1887.

THE ZOOLOGICAL RESULTS OF THE "CHALLENGER" EXPEDITION.

Report on the Scientific Results of the Voyage of H.M.S. "Challenger" during the Years 1873-76 *under the Command of Capt. George S. Nares, R.N., F.R.S., and of the late Capt. Frank Tourle Thomson, R.N.* Prepared under the Superintendence of the late Sir C. Wyville Thomson, Knt., F.R.S., &c., and now of John Murray, one of the Naturalists of the Expedition. Zoology—Vol. XVIII. Parts 1 and 2, with a Volume of Plates. (Published by Order of Her Majesty's Government, 1887.)

VOLUME XVIII. of the Zoological Reports of the *Challenger* Voyage well merits to be called enormous, as it contains no less than 1800 pages. It contains but a single memoir, "On the Radiolaria," by Prof. Ernst Haeckel, of Jena, and is accompanied with a volume of 140 plates.

A great work like this demands more than a passing notice, for even in this age of scientific labour one stands amazed at the physical energy, not to refer to the scientific knowledge, that could have accomplished such a result. Ten whole years of the author's life were devoted to this monograph, which will ever be a worthy monument of a most enduring kind.

Some fifty years ago Meyen, and shortly after Ehrenberg, first described some forms of Radiolaria. Meyen has the merit of having observed and noted the first of these curious forms in a living state, but to Prof. Huxley we are indebted for the first accurate observations on some kindred forms met with by him during the voyage of the *Rattlesnake* in the tropical seas. Ehrenberg no doubt was the first to call attention to the exceedingly great numbers of forms that were to be found in the group, but although he was not ignorant of the researches of his colleague, Johannes Müller, whose memoirs were published in the same Academy's Transactions as his own, he never seems to have paid the slightest attention to them, nor does he even allude to the name given to the group by Müller, that of Radiolaria, by which they are now known.

Just twenty-five years ago Haeckel published his well-known "Monograph of the Radiolaria," which with its splendid atlas of plates, was, and is still, an indispensable work for the student. In this all the species known either by figures or descriptions were reviewed, and arranged in 15 families and 113 genera, of which latter 46 were new; the number of forms observed alive amounted to 144, most of which are figured, in a manner that has not, we think, been equalled, certainly not surpassed.

In 1862, Zittel described the first fossil Radiolaria from the chalk; in 1876, John Murray established the family Challengerida; and above all, in 1879, Richard Hertwig showed the essential differences in the formation called the "central capsule," and in accordance therewith divided the Radiolaria into six orders. From this on, with the exception of the various important works on the fossil forms by Emil Stohr, Dante Pantanelli, Butschli, Dunikowski, and D. Rust, the whole record has been filled in by Haeckel, and it has been almost exclusively based on the collections of the *Challenger*.

These Radiolaria, or Capsulate Rhizopoda, form a peculiar class of the Rhizopoda—Haeckel's "Protista." This class is exclusively marine, and, while possessing many of the features of the Rhizopods, differs from them in the possession of a peculiar "membrane" dividing the cell-body into two distinct parts—the "central capsule" or the internal part with the nucleus, and the external part or "extra-capsulum" with the calymma; the protoplasm of both parts communicates through fine pores, which pierce the capsular membrane. The central capsule is composed of three essential parts, viz. the central nucleus, the intra-capsular sarcode, and the capsule membrane. Besides these elements, the central capsule contains very commonly an internal skeleton, fat and pigment granules, crystals, and vacuoli. The outer part of the Radiolarian body is also constantly composed of the calymma, or a thick extra-capsular "jelly-veil." The matrix or maternal tissue of the external protoplasm and the pseudopodia again very commonly contains fat and pigment granules, the skeleton and vacuoli, and, in addition, "xanthellæ" or "zooxanthellæ," peculiar yellow cells which contain starch, and are unicellular yellow Algæ living as "symbiontes" in true symbiosis with a great number of Radiolaria. The skeleton may be either siliceous or acanthinic, and is sometimes wanting. The four sub-classes, as described in this Report, contain 20 orders; and these, 85 families, which include 739 genera, with 4318 species, of which latter 3508 are described as new.

Radiolaria occur in all the seas of the world, in all climatic zones, and at all depths. Probably under normal conditions they always float freely in the water, whether their usual position be at the surface or at a certain depth or near to the very bottom of the sea. Hitherto, no observation has been recorded which justifies the assumption that Radiolaria live anywhere upon the bottom of the sea, either attached or creeping. However able they may be to creep when they fall on a solid basis, they seem normally always to float freely in the water, with pseudopodia radiating in all directions.

As regards their local distribution and its boundaries, the Radiolaria show in general the same relations as other pelagic animals. Since they are only to a very slight extent, if at all, capable of active horizontal locomotion, the dispersion of the different species from their points of development is dependent upon oceanic currents, the play of winds and waves, &c. These passive migrations are here, however, as always, of the greatest significance, and bring about the wide distribution of individual species in a far higher degree than any active wanderings could do. Anyone who has ever followed a stream of pelagic animals for hours, and seen how millions of creatures closely packed together are in a short time carried along for miles by such a current, will be in no danger of under-estimating the enormous importance of marine currents in the passive migration of a marine fauna. The number of cosmopolitan species which live in the Pacific, Atlantic, and Indian Oceans is relatively large. In each of three great ocean basins, too, many species show a wide distribution. On the other hand,

there are very many species which are known only from one locality, and probably many small local faunas exist, characterised by the special development of particular groups. From the very richness of the material, Prof. Haeckel has found it impossible to work out completely the local distribution of all the species.

From the tropics the abundance of species seems to diminish regularly towards the Poles, and more rapidly in the northern than in the southern hemisphere; the latter also appears to possess more species than the former: a limit to Radiolarian life towards the Poles has not yet been found. The greater abundance of Radiolaria in the tropical seas is to be accounted for by the more favourable conditions of existence, rather than by any difference in temperature. One station (271) of the *Challenger* Expedition, situated almost on the Equator, in the Mid-Pacific, exceeds all other parts of the world hitherto known in respect of its wealth of these forms; and more than 100 new species are described from it. The fauna of the Pacific Ocean exceeds that of both the Indian and Atlantic, but the fauna of the Indian Ocean is that least known.

In reference to the bathymetrical distribution, it seems certain that numerous species of this class are found at the most various depths of the sea, and that certain species are limited to particular vertical zones, and are adapted to the conditions which obtain there. In this respect three different Radiolarian faunas may be distinguished—the "pelagic," "zonarial," and "abyssal." More than half of all the species known as recent belong to the last fauna.

The chapter on the geological distribution is full of interest. Radiolaria are found fossil in all the more important groups of the sedimentary rocks of the earth's crust. Whilst a few years ago their well-preserved siliceous skeletons were only known in considerable quantity from Tertiary marls, very many are now known to occur in Mesozoic, and a few in Palæozoic, strata. By the aid of improved modern methods of research, it has been shown that many hard siliceous minerals, especially cryptocrystalline quartz, contain numerous well-preserved Radiolaria, and sometimes these are composed almost entirely of closely compacted masses of such siliceous shells. The Jurassic quartzes (Switzerland), as well as the Tertiary marls (Barbados) and clays (Nicobar Islands), may be regarded as "fossil Radiolarian ooze"; and, since specimens have also recently been found both in Silurian and Cambrian strata, it may be inferred that Radiolaria are to be found in all fossiliferous sedimentary deposits, from the oldest to those of the present day. Among the Miocene Radiolaria, numerous species are not to be distinguished from the corresponding still living forms. On the other hand, those genera which are rich both in species and individuals (recent as well as fossil) present continuous series of forms which lead gradually and uninterruptedly from old Tertiary species to others still living, which are specifically indistinguishable from them.

As Chapter XI. of the introductory portion of the Report, Prof. Haeckel gives a very valuable account of the progress of our knowledge of the Radiolaria from 1862 to 1885. In his earlier monograph he had already given a critical discussion of the works which had appeared prior to 1862: we find here a full list of the publications from 1834 to 1884, in which list a little of the author's old trenchant style of criticism breaks out; for he has heaped together in an appendix, to which he gives a somewhat needlessly offensive name, "all the absolutely worthless literature, which contains either only long-known facts or false statements, and which may therefore be entirely neglected with advantage." While we would not, for all the Radiolaria in the sea, give the list of this "foul" literature, we may relieve the reader's mind by at once mentioning that the name of Ehrenberg does not appear in it, and that the value of the laborious works of the great but too self-reliant German in this field meets with all proper appreciation.

The unicellular nature of the Radiolaria was first established by Richard Hertwig in 1879, and was brought by him into conformity with our present histiological knowledge and the new reform of the cell-theory. Huxley, who was the first to examine living Radiolaria with any accuracy, declared, so long ago as 1851, that *Thalassicolla nucleata* was a unicellular Protozoon. Later, both Johannes Müller (1858) and Haeckel (1862), recognising the peculiar "yellow cells" which occur in many Radiolaria, in large numbers, as true nucleated cells, thought it impossible to maintain this view; and it was not until Cienkowski (1871) and Brandt (1881) had shown that these "yellow cells" did not form part of the Radiolarian structures, but are symbiotic unicellular Algæ, that it was possible to revive and demonstrate anew the unicellular nature of the Radiolaria.

From a morphological stand-point the individuality of the unicellular elementary organism is obvious in the solitary Radiolaria (Monobia); and the whole body with all its constituent parts, and not merely the central capsule, is to be looked on as a cell. But this unicellular organisation must be noted as differing from that of all other Protista, inasmuch as an internal membrane (capsule membrane) separates a central from a peripheral portion.

The membrane of the central capsule is invariably present at one period or another of the life of the organism. Karl Brandt, indeed, has recently stated that in some forms it is absent; but Haeckel has recognised its presence in over one thousand species, and even in some of those in which Brandt was unable to find it. It is often very delicate and may easily be overlooked, though the application of the proper reagents will render it always discernible. Those Radiolaria in which for a time it is absent are young of species in which the membrane is only formed immediately before sporification, and persists but for a short time.

All Radiolaria possess a nucleus, but they present two different conditions in respect of its behaviour, since in their young stages they are uninuclear, and in later stages they are multinuclear. Before the formation of swarm-spores the nucleus divides into many nucleoli. Thus the nucleus is pre-eminently the organ of reproduction and inheritance. The division of the originally single nucleus into many small nuclei may take place at very different periods, so that Haeckel divides the Radiolaria into the "precocious" and the "serotinous." Into the subject of the skeleton formation and that of phylogeny the space at our command will not allow us to enter; it will suffice to say that they are treated at great length and with consummate skill.

In such an onerous task as that of describing this mass of varied forms, one always, as the author observes, "runs the risk of either doing too much or too little in the way of creating species"; but he contents himself with the reflection that in the light of the theory of descent this danger is of little consequence.

In the carrying out of the troublesome duty of making the many thousands of required measurements, the author gratefully thanks his friend Dr. Reinhold Teuscher, of Jena, for the patient and careful manner in which he performed this part of the work. The figures of new species, about 1600 in number, which appear in the atlas accompanying the Report, were nearly all drawn with the camera, partly by Mr. A. Giltsch and partly by Prof. Haeckel; but the former has drawn all the figures on the stone in a very masterly way, so that the illustrations present a splendid series of beautiful forms, like the stars in the firmament for number, and surpassing these in the wonderful diversity and complexity of their outlines.

It was indeed a fortunate circumstance that so distinguished a naturalist, with such an intimate knowledge of the Radiolaria, should have been willing to undertake such a task, and exceedingly fortunate for science that he should have been enabled thus to finish it.

A GERMAN TREATISE ON THE VEGETABLE KINGDOM.

Die natürlichen Pflanzenfamilien. Von A. Engler und K. Prantl. (Leipzig: Engelmann, 1887, &c., being issued in numbers at irregular intervals.)

WITH the first three numbers of the above-named work, which are now before us, Profs. Engler and Prantl have embarked on an enterprise of some magnitude. The editors, having recognized the want of a comprehensive treatise, in German, on the Vegetable Kingdom, which should at once be scientifically sound, and yet be written in a style suitable for the use of those who are not professed botanists, have determined to meet that want. With this object they have enlisted the assistance of a number of collaborators: anyone who is conversant with the literature of Botany produced in Germany in recent years will see, on reading the list of names, that Dr. Engler has secured the co-operation of a very powerful staff, including many of the most prominent representatives of the science in that country.

With their aid the editors propose to produce a work, extending to some 5000 pages octavo: the whole is to be divided into five parts, one of which will be devoted to the Cryptogams, under the editorship of Prof. Prantl; one will treat of the Gymnosperms and Monocotyledons, and the remaining three of the Dicotyledons, under the editorship of Prof. Engler. The production of the several parts will proceed simultaneously, and they will appear in numbers, at intervals during the next five or six years: thus the distribution of the cost (which in itself is not excessive, considering the quality and extent of the work) over a lengthened period, will bring the book within the reach of a wide constituency.

The first three numbers will give some idea of what will be the scope and character of the work as a whole. One of these is the first instalment of the *Palmæ*, by Dr. Drude. It opens with twenty-six pages of text, illustrated by numerous carefully chosen and excellent woodcuts, on the morphology and anatomy of the vegetative organs, the inflorescence, fruit, and seed of the plants of this order; then follow notes on the distribution, affinities, and uses of the family, and finally its classification. A detailed description of the genera succeeds this general treatment, and it is illustrated by numerous good figures representing the habit of the plants, and dissections of their flowers: this will, in fact, be somewhat like an illustrated and abbreviated "Genera Plantarum," written in German, and in a semi-popular though sound style.

The second number issued contains the *Juncaceæ*, by F. Buchenau, and the *Stemonaceæ* and *Liliaceæ* by Dr. Engler. The subject-matter is treated in the same spirit as the above, and it may be assumed that this method will be pursued throughout the whole work.

But a more special interest attaches to the number which was third in its order of issue; and that on two distinct grounds: first, because from it we gain a more general idea of the plan and scope of the work, and secondly because it is chiefly the work, and probably the last work, of the late Prof. Eichler, a botanist whose loss will be very widely felt (see NATURE, vol. xxxv. p. 493).

The first pages of this number, written by Dr. Engler, give in brief the general plan of the whole work; the main lines of classification being those in common use, though some of the terms used have not as yet been generally accepted. They are as follow:—

I. Mycetozoa.
II. Thallophyta:
  (*a*) Schizophyta.
  (*b*) Algæ.
  (*c*) Fungi.
III. Embryophyta zoidiogama (= Archegoniatæ):
  (*a*) Bryophyta.
  (*b*) Pteridophyta.
IV. Embryophyta siphonogama (= Phanerogamæ):
  (*a*) Gymnospermæ (= Archispermæ).
  (*b*) Angiospermæ (= Metaspermæ).

Then follows the general treatment of the Gymnospermæ, of which four classes are distinguished, the Cycadinæ, Cordaitinæ, Coniferinæ, and Gnetales. It is worthy of note that here the fossil forms are taken into account, and Cordaitinæ, as well as fossil forms of the Cycadaceæ and Coniferæ, are described in their proper places. It will be unnecessary after what has already been said to follow the mode of treatment of the Gymnosperms further; suffice it to say that, while due prominence is given to the external morphology and classification, the results of recent investigation on the development of the sporangia and embryo find a place, *e.g.* those of Treub and Warming on the Cycads, and of Strasburger and others on the Coniferæ. A peculiar interest will attach to the pages on the morphology of the female cone in the Coniferæ, since this will be the last expression of the opinion of Eichler on a subject to which he had devoted special attention.

While extending a welcome to this new enterprise, we may compare it with other undertakings of a somewhat similar nature. Among the comprehensive classificatory works of recent years, the most prominent is

the "Genera Plantarum" of Bentham and Hooker; but the most ardent admirers of that solid book could not expect it to appeal to the laity: it is designed for the use of specialists, and they alone will use it. Between this and the illustrated text-books intended for students there has been hardly any intermediate in this country, though Lindley's "Vegetable Kingdom," a book which still holds its place as a classic, served in the past a part not altogether unlike that which Dr. Engler's book may be expected to serve in the future. It is, however, in France that the nearest approach has been made to the idea of Dr. Engler. In the "Traité de Botanique" of Le Maout and Decaisne we have a volume profusely illustrated, and dealing with the vegetable kingdom as a whole: the English translation of this, edited by Sir J. D. Hooker, is familiar to all British botanists. Again, the "Histoire des Plantes" of Baillon, which is still in progress, is a classificatory work of large size, well illustrated as regards external morphology, but somewhat deficient in description of the internal details: his "Dictionnaire de Botanique," which commenced in 1876, is also still in progress, and covers, in dictionary form, much the same ground as his "Histoire." These are, then, the chief illustrated and descriptive works with which Drs. Engler and Prantl will have to compete. If we may judge from the first three numbers, the competition, though keen, will be in favour of the new enterprise, and that chiefly on the ground that the authors of it take a more general view of the subject. They do not confine their task to the description and delineation of external form, classification, and distribution. While giving due prominence to these branches, they also incorporate the results of recent investigations of anatomy and development. F. O. B.

OUR BOOK SHELF.

Nomenclature of Colours for Naturalists, and Compendium of Useful Knowledge for Ornithologists. By Robert Ridgeway, Curator, Department of Birds, United States National Museum. Ten coloured plates, and seven plates of outline illustrations. (Boston: Little, Brown, and Co., 1887.)

THIS will be a very welcome volume to naturalists in general, and ornithologists in particular. We do not know that everybody will agree with the principles laid down by the author, but he has, at all events, brought together a considerable number of colours, and given them very definite names for purposes of comparison, and a mere glance at the coloured plates will show how very important it is that every variety of green shown in Plate 10, for instance, should have its special name and admit of easy reference.

The comparative vocabulary of colours, which occupies a considerable proportion of the first part, is also a very valuable combination, and should be in the hands of naturalists of all civilized countries, as we get the English, Latin, German, French, Spanish, Italian, Norwegian, and Danish equivalents of all the colours shown in the coloured plates, and a great many more.

The *pièce de résistance* in the part of the volume which has been prepared chiefly for the use of ornithologists is a glossary of technical terms. It seems to us to have been very carefully done. A study of the plates illustrating the various feathers of birds, and the various birds' eggs, with the attached nomenclature, is certain to lead to a gradually increasing care in description. There is no doubt that the book will prove of very great value to many naturalists.

English Tobacco Culture, &c. Edited by E. J. Beale, F.L.S. (London: E. Marlborough and Co., 1887.)

THIS little book will serve as an important guide to farmers in conducting experiments in the cultivation of tobacco. It gives a detailed account of the origin of the movement for determining whether tobacco could be relied upon as a farm crop in Great Britain, and, if so, whether it could be cultivated to yield a profit to the grower. These two questions, it is maintained, have been answered in the affirmative by the results of last year's experiments, but this conclusion is founded more upon the appearance of the plants than upon actual results in the production of good commercial tobacco.

Seventeen varieties of tobacco were grown last year in this country, and a full description is given of the plants of each variety, with well-executed illustrations, showing the general appearance and distinctive features of the fully-developed plants. For each description of tobacco grown an "Estimated Balance Sheet" has been prepared, and the anticipated profit, amounting in some cases to as much as £25 and even £27 per acre, is very encouraging for farmers who may think of undertaking experiments in tobacco cultivation.

Perhaps the most useful part of the book is that devoted to directions for conducting the several operations of tobacco culture. These include the preparation of the land; the sowing of the tobacco seed; the transplanting of the young seedlings; the transferring of the plants to the prepared ground; and their subsequent treatment until finally harvested and cured. Altogether the book is prepared with great care, and its publication at the present time is very opportune.

Life of Charles Darwin. By G. T. Bettany. (London: Walter Scott, 1887.)

THIS is one of the series of volumes entitled "Great Writers." It was not to be expected that Mr. Bettany would be able to tell us anything absolutely new about the illustrious man of science concerning whom so much has already been written. He has, however, succeeded in presenting in a bright and attractive style the leading facts of Darwin's career, and he has done good service by taking pains to show that Darwin was not only a great thinker and discoverer, but a man of a singularly pure and noble character. Mr. Bettany's exposition of the results of Darwin's labours is brief, but clear and accurate, and he tries to mark as distinctly as possible the various stages in the process by which the theory of evolution as Darwin conceived it was itself evolved.

LETTERS TO THE EDITOR.

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

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

Thought without Words.

MAY I demur to the Duke of Argyll's statement that monkeys and dogs have no true reasoning powers? Long and careful attention given to the action of animals consequent on true reasoning power, has led me to an opposite conclusion. I do not trouble you with instances, or could give very many; and I have frequently seen reasoning power exercised after obvious thought over the best course to pursue. Then, *are* animals speechless among themselves? I think not, and believe they speak freely to one another at needed times, in their own language. And I certainly with my own domestic animals can understand in a certain sense their language. I clearly know

what they ask for, or what they wish to call my attention to, from the tone of the voice and its modulations, and this is, I assume, language as regards them. On the main question, I should hold with Prof. Max Müller from my own personal experience. H. STUART WORTLEY.

South Kensington Museum, May 21.

I HAVE just noticed in a recent number of NATURE (May 12, p. 28) a letter from Mr. Francis Galton, in which he endeavours to prove that thought without words is by no means an impossibility. May I advance a small amount of confirmatory evidence which must, I think, have come within the notice of most people? This evidence is to be found in that peculiar state of mind produced when, as we say, we have a word "on the tip of the tongue." In this case the *idea* which the word, when found, will represent is most vividly present to the mind, but it is an idea only. No language is needed to make it recognizable even though, as oftens happens, the idea may be of the most complicated and abstract kind. HAROLD PICTON.

May 31.

Diatoms in the Thames.

IN NATURE, vol. xxxii. p. 223, you were good enough to publish a note from me respecting the occurrence in great profusion of small gelatinous bodies in the water surrounding the Isle of Sheppey. The same conditions prevailed at about the same time last year, and in all probability will reappear at the latter end of this month.

I have now to record that since the middle of April the sea hereabout has been what fishermen call "foul" from another cause. While the water has been unusually clear, in it have been floating an enormous quantity of diatoms. The most abundant is *Coscinodiscus concinnus*, the large disks of which can be seen by the naked eye in any sample of sea-water dipped at random. Indeed in bright sunlight they can easily be observed in the sea itself. The other forms are *Rhizosolenia setigera*, and *Eucampia zodiacus*.

At low water the sands lying between the Thames and the Medway have been coloured a rich dark brown by the diatoms left stranded there.

The effect on marine life seems to have been somewhat varied. Mollusks appear to have thriven on the abundant food; and as shrimps and whitebait have been found in abundance in their usual haunts, it may be presumed that they have not been much annoyed by the diatoms. On the other hand, the flat fishes have been greatly disturbed, and could not be found on the banks usually frequented. Some fishermen said they had gone right away, and would not return till the water ceased to be "foul." Yet this could hardly have been the case, as some have since been caught on the Essex flats gorged with young cockles.

During the past fortnight I have examined the water at various points around Sheppey, and have invariably found the diatoms. In using the tow-net during this period, I have been struck by the scarcity of animal life. Besides the diatoms, a few Noctilucæ, larval Spios, and two Isopods were all that I noticed. That at least some diatoms are obnoxious to fish was settled by Mr. Pearcey, who, in conducting tow-netting investigations in the Shetland Isles in 1884, found that in regions where large floating banks of the diatom *Rhizosolenia shrubsolii* (Cleve) occurred animal life was almost entirely absent; and Mr. Isaac C. Thompson, of the Liverpool Marine Biological Society, has recorded a somewhat similar experience in 1885 off the North Wales coast.

It will be interesting to ascertain from which direction these countless myriads of diatoms have reached the Thames, and within what limits they have been found. To this end I invite observers round the British coast to examine the water in their respective localities, and to publish the result.

In water obtained from the coast of Holland I could not detect a single diatom.

I have reason to believe that an abundant influx of the same character has taken place in previous years, but coming at a time of year when the weather is not often favourable for conducting marine observations, the facts have escaped scientific notice. W. H. SHRUBSOLE.

Sheerness-on-Sea.

P.S.—The above was written about a fortnight ago, and now (May 18). the gelatinous masses are beginning to appear.—W. H. S.

The Structure of the Nostochineæ.

I WAS glad to see in NATURE, vol. xxxv. p. 594, a suitable notice of Prof. Borzi's very interesting paper on the above subject. So far as regards the discovery of the continuity of the protoplasm in this group of plants, I should like to be allowed to state that in my paper "On the Constitution of the Cell-wall and Middle Lamella," read February 10, 1884, and published in the Proceedings of the Cambridge Philosophical Society, vol. v. part ii., I drew attention to the fact that in *Nostoc* I had observed a continuity of the protoplasm between adjacent cells. But I simply stated the bare fact, and my note was therefore even more pronouncedly "una brevissima comunicazione" than that of Wille's on *Stigonema*, to which Prof. Borzi refers.

Clare College, Cambridge. WALTER GARDINER.

Curious Phenomenon in Capillarity.

FOR some years past I have been in the habit, when putting up at obscure hotels and remote "dâk bungalows" during inspection tours, of putting a few drops of the cheap disinfectant known as "Little's soluble phenyle" into my tub before bathing. The bulk of the liquid, when dropped into clear water, diffuses downwards as a milky white emulsion, giving beautiful imitations of inverted cumulus clouds; but a small portion of it, perhaps some oily impurity in the mixture (which is sold under the trade mark C_6H_5, and should therefore presumably be a definite compound), instantly spreads out over the surface as a drop of oil would do, and then, strange to say, after the lapse of about half a second, and usually before the film has extended more than half-way across the tub, it again contracts. The contraction of the film proceeds until it is only two or three inches in diameter, after which its size appears to remain stationary; but about this time the distinct outline of the film usually disappears, owing to the gradual mixing of its substance with the water below—a circumstance which leads me to believe that the film is not caused by an oily impurity, but by a part of the "phenyle" itself, which possesses the property of emulsifying with water. Temperature seems to have no effect on the phenomenon, beyond perhaps modifying the rate at which the film expands and contracts, the effect being apparently exactly the same whether the liquid be added to a cold bath at 60° or to a hot one at 100° F.

Have any of your readers observed this phenomenon, or can anyone give a satisfactory explanation of it? According to the usual theory of the subject, the surface-tension of water in contact with air is greater than the tension of a phenyle-air surface *plus* that of a phenyle-water surface, and hence the film of phenyle spreads like one of oil. But after a time, when the phenyle gets partially emulsified, the sum of the tensions of the two phenyle surfaces must be greater than that of the water surface to make the film contract, and apparently after some further time a condition of equilibrium is established. Is there anything in the process of emulsification, or dividing a liquid up into minute globules suspended in another liquid, that will account for these changes of surface-tension?

Naini Tal, India, May 2. S. A. HILL.

Sense of Taste or Smell in Leeches.

I HAVE recently observed very well marked phenomena, similar to those described by Dr. C. O. Whitman (*Quart. Journ. Micro. Science*, vol. xxvi. new series, p. 409). I picked up with my fingers a stone from the soft muddy bottom of a shallow, torpid stream. Returning to the same spot a few minutes afterwards, I noticed a number of leeches (apparently *Hirudo* sp.) swimming near the spot. On the following day, suspecting that they had "smelt" or "tasted" my hand in the water, I first stirred the surface of the mud with a stick, but no leeches appeared; after the water was clear again I "washed my hands" in the water without disturbing the mud, and very soon a number of leeches came up and swam about. The soft mud in which they live is about a foot deep, and although the disturbance of the surface mud with a stick was not sufficient to bring them out, the "smell" or "taste" of my hands seems to have spread down and extended over an area of more than a yard.

Last year I had an opportunity on these hills of observing the very keen "scent" of the land leeches, who will come towards one's self or one's horse from the banks on either side of even a wide road. A. G. BOURNE.

Ootacamund, Nilgiris, April 11.

Lisping.

A CLERGYMAN, with usually an exceptionally distinct utterance, was observed one Sunday morning at the beginning of the service to speak with a pronounced lisp. After a time it wore off, and his speech became as clear as usual. Has it ever occurred to anyone what a very simple thing may cause a lisp? The case in question was owing to a tiny slice of lozenge sticking to the roof of the mouth just to the left of, and close to, the front tooth. This almost imperceptible impediment was sufficient to render the speech so indistinct as to resemble a marked lisp. Of course as the lozenge dissolved the lisp became no longer observable, and the speech assumed its ordinary clearness.

These being the facts, the question that occurs to every thoughtful mind is, If the cause of lisping be so simple, why cannot the remedy be as simple and yet effectual?

The answer I leave to be supplied by some of your scientific readers. A NON-LISPER.

ETIOLOGY OF SCARLET FEVER.[1]

AMONG the infectious or zymotic diseases there are two at any rate (namely, scarlet fever and diphtheria) of which it may be said that their spread is to a lesser extent dependent on defective domestic sanitation than is the case with some of the other zymotic diseases, as, for instance, typhoid fever. Indeed, it is maintained by competent authorities that scarlet fever and diphtheria do not invade the houses of the poor with faulty sanitation with greater frequency or with greater severity than those of the well-to-do, however perfect the sanitary arrangements. This view is based on the important experience gained during the past twenty years, viz. that epidemics of scarlet fever and diphtheria have been brought about by milk. I may here state by way of explanation that a fact well established, and needing no further comment, is that scarlet fever and diphtheria are, like small-pox, measles, whooping-cough, and typhus fever, communicable directly from person to person. This mode of infection, doubtless an important one, and coming into operation in single cases wherever the elementary rules of isolation and disinfection are transgressed, altogether sinks into insignificance when compared with the infection produced on a large scale, if a common article of diet like milk should become in some way or another the vehicle of contagium, as has been proved to be the case in a number of epidemic outbreaks. These epidemics, known as milk scarlatina, milk diphtheria, and I may add also milk typhoid, have this in common, that almost simultaneously, or at any rate within a short time, in a number of houses, having no direct communication by person or otherwise with one another, there occur sometimes singly, sometimes in batches, as it were, cases of illness: scarlet fever, diphtheria, or typhoid fever as the case may be. And it was this peculiar character which pointed to a condition which must have been common to all these households. On closer examination it was indeed found that all these households had this, and only this, in common, that they were all supplied with milk coming from the same source—that is to say, from the same dairyman. Other houses supplied with milk from a different source escaped; and further it was shown that, as soon as the consumption of the suspected milk ceased also, the epidemic, as such, came to an end, except of course the cases due to secondary infection from person to person. The Medical Department of the Local Government Board have had for years past their attention fixed on these milk epidemics, and in the Reports of the Medical Officer many of these are described with great detail; amongst these, Dr. Ballard's Report in 1870 on enteric fever in Islington, Dr. Buchanan's in 1875 on an outbreak of scarlet fever in South Kensington, and Mr. Power's on an outbreak of scarlet fever in St. Giles and St. Pancras in 1882, are specially to be referred to. Mr. Ernest Hart has tabulated all the outbreaks of milk epidemics that have been investigated until 1881, in vol. iv. of the Transactions of the International Medical Congress for 1881. Now, analyzing these outbreaks as far as they refer to scarlet fever, there are several of them where the assumption that the milk acquired the power of infection by contamination from a human source cannot be excluded. This infection if proven would stand on the same footing as if due to contagion from person to person, for it is clear whether the contagium is conveyed from one person to another by air, food, drink, or other articles, it always remains contagion from person to person. Now, in some of the epidemics tabulated by Mr. Hart, and recorded by subsequent observers, *i.e.* after 1881, this mode of milk contamination cannot be excluded, as I said before; but comparing the dates when the milk might be supposed to have become so contaminated with the dates when the milk has actually produced infection, it will be found that a certain discrepancy exists, and as will be shown later another mode of infection, viz. from a person affected with scarlatina to the cow, and through the cow to the milk and then to human beings, cannot be excluded either. There are other epidemics recorded in these tables, in which the mode of infection of the milk is not ascertained; and in a third set, the milk acquired infective power in some way or another, but certainly not from a human source. As an illustration of the first group of epidemics, *i.e.* probable contamination from a human source, I will refer to the table given by Mr. Ernest Hart on page 539:—

1881, April.	Keswick.	J. Robertson, M.D., M.O.H.	A dairy closely adjoined a house where scarlet fever had existed for several weeks. The cows were milked, every night and morning, into an open tin can carried across an open yard past the affected house.	The children who first caught scarlet fever in the locality played about the yard whilst in a state of desquamation.	On one particular day a general epidemic of scarlet fever broke out in the town, between thirty and forty families being invaded. All those suffering from the disease received their milk-supply from this particular dairy-farm. Some member of every family supplied had either a scarlatinal sore throat or scarlet fever on this day. Other families supplied from a different source escaped the disease.	A lodger had the milk raw for supper and was attacked. His landlady boiled her milk the same night and escaped.

[1] Lecture delivered by Dr. E. Klein, F.R.S., at the Royal Institution on Friday, May 27, 1887.

Now, mark this, that on one particular day the fever broke out. We will return presently to this point.

As an illustration of the second kind (viz. probably not from a human source), I will refer to the outbreak of scarlet fever in Oxford in the spring of 1882, recorded by Dr. Darbishire in the St. Bartholomew's Hospital Reports, vol. xx.

The substance of Dr. Darbishire's Report is this:—Three cows were kept by those who sold the milk, and nine houses, containing eighty-five persons in all, were supplied morning and evening; the milk was never stored, as there was generally barely enough at each milking for all the customers. In the house to which the cows and paddock belonged, there was a case of diphtheria in a young lady. She was removed to the infirmary on March 1. The cowman had a child ill with scarlet fever in his cottage from February 27 till March 3. On March 3, Dr. Darbishire had this child removed to the hospital and the cowman's cottage thoroughly disinfected; the cowman left his cottage to sleep in lodgings near, the care of the cows having been handed over to another man, engaged for that purpose. Now, if the milk had become infected from either of these two cases (one diphtheria and the other scarlet fever), this must have occurred for the first before March 1, for the other before March 3; and as the period of incubation of scarlet fever is known to be as a rule less than seven days, it follows that March 3, being the last day on which the milk could have received the contagium from a human being, March 10 would be the last day on which scarlet fever could have been produced by that milk, and the majority of cases of scarlet fever must have occurred before that day, as one cannot assume that in all these cases the period of incubation was protracted to such length as seven days. But mark what really did happen. Dr. Darbishire states that no case occurred till March 10, on which day 2 cases of sore throat and 1 case of scarlet fever occurred; on March 11, 1 case of sore throat; March 12, 2 of sore throat and 1 of scarlet fever; March 13, 4 of sore throat and 2 of scarlet fever; March 15, 1 of sore throat and 1 of scarlet fever; March 16, 2 of sore throat and 1 of diphtheria; March 17, 1 of sore throat; March 18, 1 of sore throat.

Now, all these cases were proved by Dr. Darbishire to have been caused by that milk. There occurred subsequently other cases, but these were traced to have been due to secondary infection from person to person.

This is a good illustration of a milk epidemic, in which the milk most probably did not receive the contagium by human agency. And there are other milk epidemics which on analysis of dates lead to the same conclusion. The infection of this milk was probably brought about as I shall show you hereafter in some other way.

As an instance of the third kind, viz. where milk has clearly not been infected from a human source, I will refer to Mr. Power's Report in 1882 on an epidemic outbreak of scarlet fever in St. Giles and St. Pancras. "The disease was distributed with a milk service derived from a Surrey farm. In this case two facts could be affirmed: the one that a cow recently come into milk at this farm had been suffering from some ailment, seemingly from the time of her calving, of which loss of hair in patches was the most conspicuous manifestation; the other that there existed no discoverable means by which the milk which had coincided with scarlatina in its distribution, could have received infective quality from the human subject." (Medical Officer's Report for 1885-86, pages v. and vi.)

The Medical Department of the Local Government Board, have from these facts drawn the conclusion that "distrust must be placed on the universally accepted explanation that milk receives infective properties directly by human agencies," and further that "the question of risk from specific fouling of milk by particular cows, suffering, whether recognized or not, from specific disease, was seen to be arising." This view received striking confirmation and proof by a report of an outbreak of scarlet fever that occurred at the end of 1885, and the beginning of 1886, in the North of London, which was investigated by Mr. Power; his report is published *in extenso* in the Report of the Medical Officer of the Local Government Board for 1886. I will here give you the substance of it. Mr. Wynter Blyth, Medical Officer of Health for Marylebone, "had last December observed a sudden outbreak of scarlatina in his district to be associated with the distribution of milk coming from a farm at Hendon, and had found reason for believing that the disease had prevailed exclusively amongst customers furnished with milk from that source." Mr. Power on a more extended inquiry found that a similar prevalence of scarlatina had occurred about the same time in other parishes in and near the metropolis that were furnished with milk from the same farm. By careful inquiry, Mr. Power could with certainty exclude any contamination of the milk from a human source, or that anything of the kind known as "sanitary" conditions could have had any concern with the infectivity of the milk. Mr. Power showed conclusively that only certain sections of the milk-supplies of this farm, and finally only certain cows from which these sections of milk were derived, had any relation to the observed results. "In the end," says the Medical Officer, "he has demonstrated, beyond reasonable doubt, the dependence of the milk scarlatina of December on a diseased condition of certain milch cows at the farm—a condition first introduced there in the previous month by some animals newly arrived from Derbyshire; and he finds strong circumstantial evidence for believing that the later phenomena of this dependence were brought about through the extension of the diseased condition of one set of animals to another set, after the fashion of an infection."

Now this disease, as it presented itself in some of these Hendon cows, consisted in the presence of sores in different parts of the skin with loss of hair in patches, ulcerations on the udder and teats, and a visceral disease, notably of the lungs, liver, kidney, and spleen, which, although milder in character, very much resembled the visceral lesions occurring in cases of human scarlet fever. By experiment it was shown that the matter of the ulcers of the udder is possessed of infective power, inasmuch as on inoculation into the skin of calves the same ulcers are reproduced; further, it was shown that in the ulcers of the cow there existed in large numbers a species of micrococcus, which, on being planted on artificial nutritive media, such as are used for the study of bacteria, produces in a few days a crop of micrococci, possessed of very distinct characters by which they are distinguishable from other bacteria.

When calves are inoculated from a cultivation of this micrococcus, they become, after an incubation period, affected with a cutaneous and visceral disease the same as the disease of the Hendon cows. From the blood of these animals the same microbe was recovered by cultivation.

To sum up, then, it has been shown that at this Hendon farm there existed certain cows affected with a communicable disease which, in many points of its pathology, bears a great resemblance to human scarlatina; further, that the milk of these cows gave scarlet fever to human beings; and, lastly, that a particular microbe was obtained from these cows, which in calves produced a disease similar to the one from which those cows were suffering. In order to complete the evidence thus far obtained, it was necessary to prove that scarlet fever in man is due to the presence and multiplication in the blood and tissues of the same micrococcus, and that this microbe, if obtained from human scarlet fever, produces in the cow the same disease as is produced by the micrococcus of the Hendon cows. Now, this proof has been satisfactorily given. In the first place, it has been shown that in the blood and

tissues of persons affected with scarlet fever there occurs the same micrococcus as was present in the cow, both being identical in microscopical and in cultural characters. In the second place, it was found that the action of this microbe on animals is exactly the same as the micrococcus found in the Hendon cows. Calves and mice, after inoculation or feeding with a trace of the growth of both sets of micrococci, become affected with cutaneous and visceral disease similar to human scarlet fever; in calves, the disease is of the same mild type as in the Hendon cows. I have lately ascertained that milch cows inoculated with the human scarlet fever micrococcus developed readily a disease identical in every respect with the Hendon disease, inclusive of the ulcers on the teats, and the sores and loss of hair in patches in different parts of the skin. Further, it was shown that from the blood and the tissues of these animals infected with one or the other set of cultivations, the same micrococcus was recovered. I will remind you that, in all infectious diseases which have been proved definitely to be associated with a particular species of microbes, this microbe introduced into a susceptible body thrives and multiplies, and thus sets up the diseased condition, differing of course with the different species of microbes. I think I may after this say that this microbe, *Micrococcus scarlatinæ*, is the cause of human scarlet fever; further, that it produces in bovine animals a disease identical with the Hendon disease and human scarlet fever, and that consequently, while the cow is susceptible to infection with human scarlet fever, it can in its turn be the source of contagium for the human species, as was no doubt the case in that milk epidemic from the Hendon farm.

I shall now give a striking piece of evidence well in harmony with what I have mentioned hitherto. In October 1886, Prof. Corfield forwarded to me certain tins of condensed milk, sold under the name of "Rose brand." This milk was under suspicion of having produced scarlet fever in a number of persons that had partaken of it. From one out of three tins of this condensed milk, I have obtained by cultivation a microbe which in every respect, morphologically and in cultures, is the same as the microbe obtained from the Hendon cows and from human scarlet fever. The action of the microbe of the condensed milk was also tested on animals, calves and mice, and it was found that it produced the identical disease that was produced by the microbe of human scarlet fever, and of the Hendon cows. I may add that this Rose brand of condensed milk is, like all condensed milk, obtained from cows' milk. The Rose brand is a cheap article, and meant for the poorer classes; probably it has not been sufficiently heated in the tins before sealing the latter; that this is so can be inferred from the fact that every tin of this brand which I opened contained some organisms. Thus, for instance, I find that one tin contained the scarlet fever microbe and another species of micrococcus; another tin contained a harmless species of micrococcus only; and a third tin opened contained a micrococcus and a species of bacillus.[1]

Another piece of interesting evidence concerning the *Micrococcus scarlatinæ* is this: there occurred during the beginning of this year a severe epidemic of scarlet fever in Wimbledon. This epidemic was also traced to milk coming from a particular farm. In one of the houses supplied with this milk there occurred cases of scarlet fever amongst human beings, and at the same time a pet monkey, who also consumed a good deal of the milk, became ill; it died after five days. I had the opportunity to make a *post-mortem* examination of this animal, and there could be no doubt about its having died of scarlet fever. From the blood of this monkey I obtained by cultivation the same micrococcus as was obtained from human scarlet fever, from the Hendon cows, and from the condensed milk. Experiments made on animals with this micrococcus of the Wimbledon monkey showed that the same disease is produced both by inoculation and by feeding.

It having been proved, then, that the cow is susceptible to infection with scarlet fever from man, the next important question is this, How does the milk of such infected cows assume infective power? Clearly in one of two ways: first, either the milk becomes infected by the milker during the process of milking, particles of contagium being rubbed off the ulcers of the udder or teat; or, the milk *per se* is possessed of infective power—that is, it being a secretion of a constitutionally diseased animal. From previous and from more recent observations, I am inclined to think that both views hold good.

I now come to the question, How is the spread of scarlet fever by milk to be controlled and checked? This question resolves itself into three parts. First, prevention of infection of the cow by man, directly or indirectly; second, prevention of infection of the cow by the cow; and third, destruction of the contagium of the milk of such cows.

As regards the first, all those rules which have been laid down to prevent infection of one human being from another, of milk or any dairy utensil by contact or otherwise with a person suffering from scarlet fever or coming from an infected house, apply also here; and this part of the subject comes under the general aspect of the proper sanitary management of dairies, which is acted upon in all well-managed dairies.

As regards the second, viz. prevention of infection of the cow from the cow, this is obviously more important and more difficult to be carried out. I say obviously, because one cow affected with the disease is capable of communicating it to others in the same farm, and when moved to another farm also to the cows there.

The disease in the cow being of a mild character is easily overlooked. The disease in the skin of the cow may be present and slight, or may be absent in its more conspicuous manifestation, whereas the visceral disease is of so mild a character that it requires an expert to diagnose it. When a cow shows the disease of the skin and on the udder well pronounced, such an animal will have to be carefully examined for visceral disease. I need hardly say that amongst the many cutaneous disorders of the cow, known and unknown, there may be one or the other which bears a resemblance to the cutaneous disorder occurring in scarlatina; such cutaneous disease must be carefully excluded before an animal is condemned; but, if visceral disease should be diagnosed as well, the animal should be carefully isolated and its milk should not be used. And it must be clear from this that every dairy should be permanently under the supervision of an expert, and in this the veterinary profession should be as eager for the work as the medical sanitary officers are, and for some time past have been. But judging from the attitude assumed by the veterinary authorities I am afraid the veterinary profession has not yet grasped the full responsibility that rests on them, both towards the general public and the dairy farmers. Instances are on record, when, on the milk from a particular farm having been proved or even suspected to bear any relation to a scarlet fever epidemic, the business of such farm became temporarily or even permanently suspended, and the pecuniary loss of the owner of such farm irrevocable. That the disease in the cow which I have described to you as scarlet fever is as yet unknown to the veterinary profession does not do away with the existence of such disease, and I venture to say that the fact of its being as yet unknown to and unrecognized by them should stimulate them to try to recognize it.

Now the third question, as to the destruction of the

[1] It is well known that no species of micrococci hitherto known are capable of surviving a temperature of 212° F., *i.e.* of boiling water; many of them are killed by an exposure to 180°–190° F.

contagium in the milk. This, I am glad to say, is very easily carried out. Heating milk up to 85° C. or 185° F., that is, considerably under the boiling-point, is perfectly sufficient to completely destroy the vitality of the microbe of scarlet fever. In harmony with these experiments on the influence of heat on the microbe of scarlet fever, I can quote, besides the observation given above by Dr. Robertson, also the following observations recorded by Dr. Jacob, Medical Officer of Health of High Ashurst and Headley, and reported in 1878, to this effect. Between June 1 and 7, there were fifteen cases of scarlet fever in three distant houses, the inmates of which had had no communication with infected persons, but had all been supplied with milk from a farm where a certain cowman worked. This cowman had in his family several children ill with scarlet fever. The cowman continued milking the cows during the illness of his children, though he did not himself have the fever, and the milk was not taken into his cottage; but the point which I wish to bring out is this, that other houses besides those in which scarlet fever had broken out had been supplied with the same milk, but no scarlet fever occurred in them, and why? because all these had consumed only the scalded milk.

I should therefore strongly urge that all milk should be boiled, or at any rate heated to at least 85° C. (that is 185° F.) before being consumed. Judging by the large number of cases of scarlet fever recorded in these milk epidemics, one is justified in saying that a considerable percentage of the total number of cases of scarlet fever would have been avoided thereby. Not all, because unfortunately the rules of isolation of patients suffering from scarlet fever are not always rigorously carried out, and therefore infection from person to person will occur. Nor would prevention of scarlatina by milk exclude scarlatina by cream,—cream cannot be easily subjected to heat; and in the epidemic of scarlet fever that occurred in South Kensington in 1875, and that was investigated by Dr. Buchanan, cream was the vehicle of the contagium. But considering the prominent position that milk occupies in every household with children, the possibility of infection with scarlet fever by raw milk deserves careful attention.

THE SECOHMMETER.

A CIRCUIT containing self-induction acts as if it had a larger resistance than its true one when a current is started in it, and a smaller resistance when the current is stopped. Hence, if balance be obtained with a Wheatstone's bridge in the ordinary way, the fact of any of the arms possessing self-induction, or of any one of the arms having a condenser attached to it, will produce no effect on the balance if the battery circuit be rapidly made and broken, provided that the rapidity of make and break be not too great for the currents in the arms of the bridge to reach their steady values each time that the battery circuit is made, and to die away each time that it is broken. If the currents have not time to reach their steady value when the battery circuit is closed, and to die away when it is broken, then self-induction in any one of the arms will produce a disturbance in the balance; but such a method of measuring a coefficient of self-induction would lead to very complicated formulæ, and is not worth developing with the view of obtaining a simple method of measuring self-induction.

It therefore occurred to us to consider whether, without employing such rapid makes and breaks as would prevent the currents reaching their steady values, the self-induction of a circuit might not be made to act as an apparent steady definite increase of the resistance of that circuit which could be measured in the ordinary way with a Wheatstone's bridge or differential galvanometer; and by this means the measurement of a coefficient of self-induction would simply resolve itself into the measurement of a resistance. And this problem we solved in the following way, in the spring of 1886:—

The coil, the coefficient of self-induction of which it is desired to measure, is placed in one of the arms of a Wheatstone's bridge, the three other arms consisting of ordinary doubly-wound resistance coils possessing no appreciable self-induction, and not only is the battery circuit rapidly made and broken, but, in addition, after each closing of the battery circuit the galvanometer circuit of the bridge is either short-circuited or broken, so as to cut out the galvanometer, and after each breaking of the battery circuit the galvanometer circuit is either unshort-circuited or closed again, so that the galvanometer is now operative again. In this way all the successive impulses of the galvanometer needle that are produced on starting the current in the coil with self-induction produce their *cumulative* effects, but the successive impulses of the needle that, under ordinary circumstances, would be produced on the needle in the opposite direction are cut out. Hence the self-induction possessed by one of the arms causes that arm to apparently increase in resistance by a definite amount depending on the coefficient of self-induction and the number of operations performed per minute. This apparent increase of resistance produces a deflection of the galvanometer which can be noted, and its value ascertained by comparing it with the deflection produced with steady currents when one or more of the arms of the bridge is altered by a known amount, as in making the Rayleigh test. But since the necessity of having to read the deflection limits the speed of performing the double make and break operation, in order that the spot of light may not be sent off the scale, we soon replaced this comparative deflection *cumulative* method by a much more sensitive *zero cumulative* method; and instead of reading the galvanometer deflection we re-establish the balance, and bring the needle back to zero, by altering one or more of the arms of the bridge, as in making an ordinary resistance test with a Wheatstone's bridge.

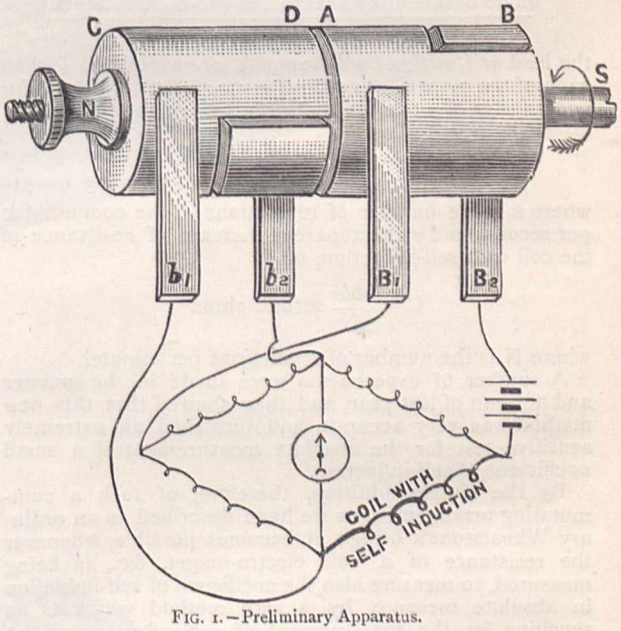

FIG. 1.—Preliminary Apparatus.

The first apparatus for enabling measurements of self-induction to be made in this way was constructed in the spring of 1886, under the superintendence of one of our assistants, Mr. Mather. It consisted of a double commutator, shown in Fig. 1, the spindle, S, to which the

commutators were locked by the nut, N, being rotated at any speed by a small electromotor, not shown in the figure, to which was attached a Young's speed indicator, which registered the speed of rotation at any moment. The brushes, B_1, B_2, b_1, b_2, were fixed to the baseboard and joined to the bridge, as indicated in the figure. When the double commutator was rotated by the motor (of which the speed was correctly adjusted by means of a Varley's flexible carbon-resistance), the portion A B caused the battery circuits to be periodically made and broken, while the other portion, C D, periodically short-circuited and unshort-circuited the galvanometer, so that the following cycle of operation, called for simplicity *one operation*, was performed any desired number of times per minute :—

Battery circuit.	Galvanometer short circuit.
Make.	While broken.
While made.	Make.
Break.	While made.
While broken.	Break.
Make.	While broken.

If we call

$$\frac{\text{angle between the slits in the two commutators}}{360^\circ}$$

the lead or l, so that l will be equal, for example, to $\frac{1}{4}$ when each of the cycle of operations given in the table lasts for one-quarter of a revolution, then we have shown that

$$L = \frac{l}{n}\sigma \text{ second-ohms},$$

where n is the number of revolutions of the commutator per second, and σ the apparent increase of resistance of the coil with self-induction, or

$$L = \frac{60l\sigma}{N} \text{ second-ohms}$$

where N is the number of revolutions per minute.

A number of experiments were made in the summer and autumn of last year, and they showed that this new method was very accurate and furnished an extremely sensitive test for the absolute measurement of a small coefficient of self-induction.

By the simple addition, therefore, of such a commutating arrangement as we have described to an ordinary Wheatstone's bridge, it becomes possible, whenever the resistance of a coil electro-maget, &c., is being measured, to measure also the coefficient of self-induction in absolute measure, by a zero method which is as sensitive for the measurement of self-induction as the ordinary Wheatstone's bridge method is for the measurement of resistance.

The instrument previously described requires an electromotor to drive it, and a speed-indicator to register its speed, hence it would be too cumbersome for every-day work. It therefore became necessary to devise commercial apparatus, and this was done as follows :—

Attached to the commutator of our self-induction apparatus is a box, B (Fig. 2), fitted with weighted elastic sides made of corrugated steel, which fly out more and more, under the action of centrifugal force, as the box is rotated faster and faster. A stout glass tube, G G', of comparatively small bore, open at both ends, is cemented into a collar in the axis of the box, and rotates with the box. The box is completely filled with mercury, and the tube partially, hence when the volume of the box expands as its sides fly out the length of the column of mercury in the tube diminishes, and the length of the column at any moment is a measure of the speed of rotation of the box. In the neck of the collar, C, in which the tube is cemented, there is a steel tap attached to an axial spindle passing through a tube inside the box, and projected out of this tube at the other end of the box. If this spindle be turned relatively to the box, the tap is opened or closed. At the commencement of the experiment the tap is opened, and the handle, H, is turned with the right hand, faster and faster, until, on depressing the key, K, with the left hand from time to time, the galvanometer needle is seen to be approaching zero, or the spot of light the zero position on the scale. The key may now be kept depressed, and on turning the handle a little faster a speed is at length reached producing exact balance—if the handle be turned faster, the needle or spot of light deflects to one side of the zero, if more slowly to the other—at this moment the trigger, T, is lightly touched with the left hand, and a spring is liberated. This has the effect of producing a resistance to the rotation of the tap-spindle, which previously was rotating freely with the rotating box, and the tap is thus turned off, cutting off the connexion between the mercury in the glass tube and that in the box. Consequently the mercury in the tube remains, even after the instrument is stopped, of exactly the same length that it had when the trigger was touched. The position of the end of thread of mercury in the tube is now read off on the scale attached, and the apparent increase of resistance of the coil, electro-magnet, or whatever it may be, divided by the number on the scale, gives the required coefficient of self-induction in second-ohms without any further calculation.

The instrument is, therefore, direct-reading.

At first, rotating commutators similar to those shown in Fig. 1 were employed with the apparatus shown in Fig. 2 ; next the brushes were made of a variety of different forms, so as to press *radially* on the rotating commutators to prevent the wear altering the lead, and thus changing the sensibility of the instrument ; but this form of commutator has at length been entirely superseded by the two oscillating arms, or brushes, A, A, worked by a cam. Each arm is composed of several pieces of hard copper, contact being made through the ends, as in many of the switches now used for electric-light work. The end of each brush alternately rubs on a flat piece of phosphor bronze, P, P, when it makes contact, and on a *flat* piece of glass or agate, g, when it does not. This form of commutator we found superior for our purpose to the double cylindrical one, since, with the two oscillating arms, the lead can be more easily varied for adjustment ; and this slight adjustment of the lead, we may here mention, forms the fine adjustment in the construction of this direct-reading instrument. Further, the slow wearing of this form of brush does not alter the lead ; consequently the value of the graduations of the scale remains constant.

The temperature adjustment of the instrument is effected by moving the scale until the zero is opposite the end of the thread of mercury when the instrument is at rest.

Following the precedent of naming an instrument after the name of the unit employed—for example, "ammeter," "voltmeter," "ohmmeter," "wattmeter,"—it seems desirable to call this instrument after the name of the commercial unit of self and mutual induction. The absolute electro-magnetic unit of self and mutual induction is 1 centimetre, a name used by all scientific nations. But the commercial unit of self and mutual induction is $99{,}777 \times 10^4$ centimetres, or the second-ohm, which is about 2·3 in a thousand less than 10^9 centimetres, or one earth's quadrant. Now, in spite of the difference between these two numbers, which, although small, it is a pity to lose sight of, the English word "quadrant" is not used in French, therefore it would not be well to suggest this word as the international name for the unit. Yet it is most important that some name should be universally adopted, since the use of simple familiar names has much to do with making people familiar with the laws of the

effect measured by the unit. The unit of electro-static capacity, the farad, has been called after the greatest experimental worker in electricity; it would therefore seem appropriate that the unit of electro-magnetic capacity should be called after Maxwell, the greatest mathematical worker in electricity. We do not, however, like to propose this, as we feel there might be difficulty in obtaining the general acceptance of the name of an Englishman, however great, unless it were sanctioned by an International Electrical Congress, or unless the man's name was intimately associated in men's minds with self and mutual induction. And Maxwell's large contribution to the subject of electro-magnetic induction is surrounded by his equally large contributions to all other branches of

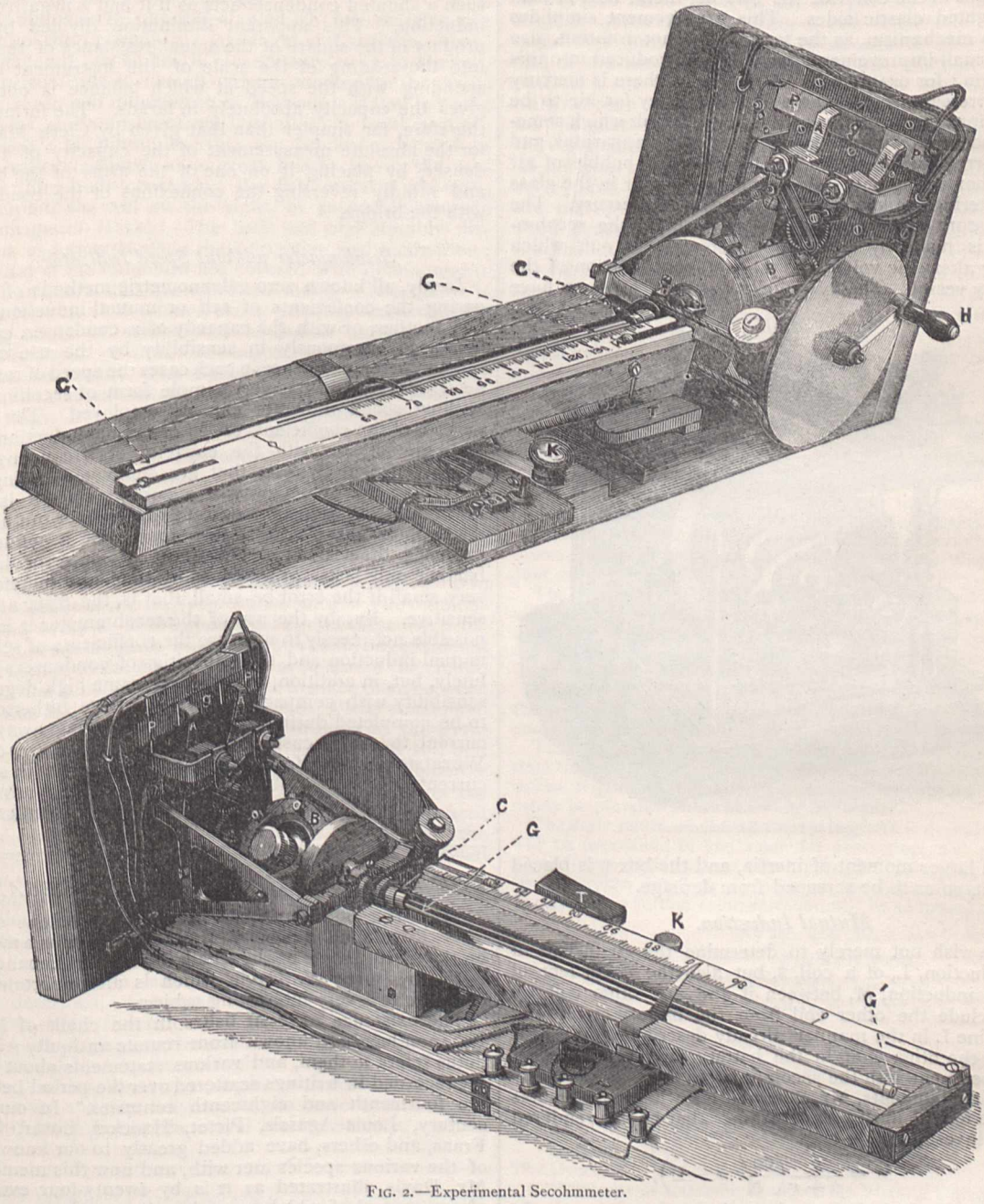

FIG. 2.—Experimental Secohmmeter.

electricity and magnetism—a giant surrounded by giants is not prominent. Coming to the last two years, we are glad that the leader and all those who have followed him in taking part in the widening of our ideas on self-induction are still with us. Hence we are driven to suggesting a temporary name for the unit, and as the first three letters in "second" are common to the name in English, French, German, Italian, &c., and ohm is also common, we venture to suggest "secohm" as a provisional name, and our instrument we will therefore call a "secohmmeter."

Unless the glass tube in the secohmmeter just described be rather long, either the sensibility or the range of the instrument must be limited; but a very long straight tube

would make the instrument inconveniently large, and a rapidly rotating *spiral* tube would probably break, from centrifugal force acting on those parts of the tube that were not on the axis of rotation. Hence, in the latest form of secohmmeter, Fig. 3, we have been led to employ a *stationary* spiral glass tube, G, with its end cemented into a stationary hollow steel conical plug fitting mercury-tight in the collar of the rotating metal box, B, with its weighted elastic sides. This arrangement simplifies the tap mechanism, as the tap now is not rotating, also many small improvements have been introduced into this last form: for example, at all the joints there is mercury under pressure, so that there is no tendency for air to be drawn into the apparatus at the joints, a fault which sometimes occurred with the earlier form of the apparatus, and led to irregularities in the readings from a bubble of air in the box acting on an air spring, or from air in the glass tube altering the length of the thread of mercury. The temperature adjustment in this last form of the secohmmeter is made by screwing a screw in or out, which slightly alters the volume of the stationary portion of the mercury vessel. The fly-wheel F has been made to have

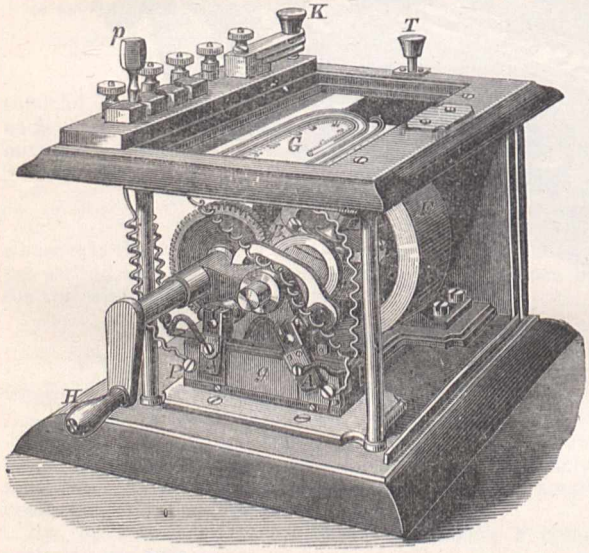

FIG. 3.—Improved Secohmmeter.

a much larger moment of inertia, and the box B is placed inside it, so as to be screened from damage.

Mutual Induction.

If we wish not merely to determine the coefficient of self-induction, L, of a coil, S, but also the coefficient of mutual induction, M, between it and any other coil, we first exclude the other coil from the battery circuit and determine L in the manner already described. We next include the other coil in the battery circuit, and repeat the experiment with the secohmmeter; then, as shown by one of our students, Mr. Sumpner (to whom our thanks are due for the most able assistance that he has rendered in this investigation)—

$$M = \frac{p}{p+r}\left(\frac{60\,l}{N}\,\sigma - L\right),$$

or if N_1 and σ_1 are the speeds and apparent increase of resistance in a first experiment, and N_2 and σ_2 in a second, we have

$$L = 60\,l\,\frac{\sigma_1}{N_1}$$

$$M = \frac{p}{p+r}\,60\,l\left(\frac{\sigma_2}{N_2} - \frac{\sigma_1}{N_1}\right),$$

where p is the resistance of the arm of the bridge opposite the coil S, and r the resistance of the arm joining p and S.

Capacity.

We have also shown that, if, instead of placing a coil with self-induction in one of the arms of the bridge, the arm be shunted with a condenser, there will be an apparent diminution of the resistance of that arm, since such a shunted condenser acts as if it had a negative self-induction. This apparent diminution divided by the product of the square of the actual resistance of the arm into the reading of the scale of the instrument corresponding with the speed at which balance is obtained gives the capacity absolutely in farads. The formula is, therefore, far simpler than that given by Clerk Maxwell for the absolute measurement of the capacity of a condenser, by placing it on one of the arms of the bridge and rapidly reversing the connexions of the condenser with the bridge.

Secohmmeter without Speed Indicator.

Lastly, all known zero galvanometric methods of comparing the coefficients of self or mutual induction with one another, or with the capacity of a condenser, can be increased enormously in sensibility by the use of the secohmmeter, and, since in such cases the speed of rotation need not be known, a very simple form of secohmmeter without speed indicator can be employed. The comparison of the coefficients of self or mutual induction with one another, or with the capacity of a condenser, is usually effected by tests that are completed during the growth or the dying away of a current, since it is only during the variation of a current that self or mutual induction, or the electro-static capacity of a condenser, evidence themselves. The effect of an error in the balance only lasts for a very short time, and therefore is very small if the error be small, that is, the tests are not sensitive. But by the use of the secohmmeter it is now possible not merely to measure the coefficients of self and mutual induction and the capacities of condensers absolutely, but, in addition, to secure the same high degree of sensibility with comparison tests that have hitherto had to be completed during the growth or dying away of a current that it is customary to obtain in the use of the Wheatstone bridge for measuring resistances with steady currents.

W. E. AYRTON.
JOHN PERRY.

THE FOSSIL FISHES OF MOUNT LEBANON.

THE last published part of the Transactions of the Royal Dublin Society (May 1887) contains a memoir on the fossil fishes of the chalk of Mount Lebanon, in Syria, by James W. Davis, which is an important contribution to a very interesting subject.

The existence of fossil fishes in the chalk of Mount Lebanon has been known from remote antiquity; Herodotus refers to them, and various statements about them are recorded in writings scattered over the period between the fourteenth and eighteenth centuries. In our own century, Louis Agassiz, Pictet, Haeckel, Costa, Botta, Fraas, and others, have added greatly to our knowledge of the various species met with, and now this memoir of Mr. Davis, illustrated as it is by twenty-four excellent plates, several of which are folding plates, brings up our knowledge of these remains to the most recent date.

For the chief material on which this memoir is based the author is indebted to the zeal and energy of the Rev. Prof. Lewis, who, during his residence in the American College at Beyrout, availed himself of every opportunity of collecting specimens of these fossils, and succeeded in accumulating a very large series of new forms. Many of these have been acquired for the British Museum Natural

History Department; the rest are in the possession of Mr. Robert Damon, of Weymouth. In addition to Prof. Lewis's collection, Mr. Davis has availed himself of the material already existing in the British Museum, chiefly from the fine collections of the late Sir Philip Egerton and the Earl of Enniskillen, the latter of whom, we notice, communicated this memoir to the Royal Dublin Society, of which he was a very old member.

The two principal localities in which fish remains are found in the Lebanon are at Hakel and at Sahel Alma. In order to reach Hakel, it is necessary to go to Djebail, the ancient Byblos, a small village situated on the coast, about seventeen miles north of Beyrout. Hakel is about six miles and a quarter from Djebail, in a north-easterly direction. M. Botta describes the locality as being in a deep valley, situated at a great height above the sea-level. The beds containing the fish remains are upon the slope of the hill on the right, in ascending towards the village of Hakel. The beds are considerably displaced, and vary much in their direction and inclination; the sides of the mountain are covered with debris, and it is in this debris that the fishes are found. The debris is in the form of thin foliated slabs, exhaling when struck a strong odour of sulphureted hydrogen; these contain irregular beds of flint, or siliceous limestone, which inclose the fossils. The Sahel Alma locality is situated below the convent of this name, which is about eleven miles from Beyrout. The convent is built on ground sloping rapidly towards the sea, the surface soil is covered with mulberry-trees, and beneath this is the marly chalk containing the fish remains. It is an argilo-calcareous stone, sometimes laminated, soft, and without appreciable odour. There are parts of a deep gray colour, almost resembling a plastic clay. The fish impressions occur in considerable numbers, both of species and individuals, mixed with some species of Crustacea. The species of fish found in the two localities are very seldom the same. The opinions of authors vary as to the geological age of these fish beds. Agassiz hesitated as to whether they should be considered as pertaining to the Jurassic epoch or to that of the chalk; whilst Haeckel was doubtful whether to place them between the chalk and the Tertiary formations. Pictet considered that the large number of extinct forms, and the great differences between the fauna of the fish beds and that existing in the sea at the present time, made it impossible to attribute the remains to a Tertiary period; on the other hand, the entire absence of ganoid fishes appeared to indicate that they are of a period anterior to the Jurassic, and that they must consequently have belonged to that of the Cretaceous period. Dr. Oscar Fraas places the beds as the upper ones of the Turonian group, corresponding to the chalk marl, and below the white chalk and the Maestricht beds.

No less than sixty-three new species are described by Mr. Davis, and a number of species of other authors are re-described. Extremely beautiful drawings of most of these, from the original specimens, by Miss E. C. Woodward, accompany the memoir, which will be received with interest by all palæontologists.

The printing and paper of this volume well deserve our praise, and are fully up to the style of the recent memoirs published by the Royal Dublin Society.

COMPLIMENTARY DINNER TO PROFESSOR TYNDALL.

WE are glad to be able to announce that a complimentary dinner is to be given to Prof. Tyndall on the occasion of his retirement from the Chair of Physics in the Royal Institution. Prof. Tyndall has still before him, we hope, many a long year of fruitful research, but it would have been strange if the present opportunity had been allowed to pass without an adequate expression of the gratitude which is felt by large classes of his countrymen for the services he has already rendered to science. His great reputation he has won by severe and long-continued labour, the value of which is most highly estimated by those who are most capable of forming a judgment on its worth. Prof. Tyndall has not only made additions to the sum of human knowledge; he has also done much to aid the process by which the English public are acquiring a new conception of the place that properly belongs to science in modern life, and of the need for applying scientific method to departments of thought and work from which it has hitherto been too often rigidly excluded. Moreover, by his popular expositions of the results of inquiry in the branches of physics he has shown that science, so far from being in any sense hostile to literature, can receive full justice only when it is handled by writers who are masters of literary expression. The books in which Prof. Tyndall has appealed to the general public have marked an era in the intellectual development of many of his readers, and his works will always serve to remind men of science of the possibility of presenting profound and accurate thought in luminous and attractive forms.

We print the letter which the Honorary Secretaries are now sending to the members of scientific Societies and to various representative men.

Science Schools, South Kensington,
June 6, 1887.

DEAR SIR,—The retirement of Prof. Tyndall from the Chair of Natural Philosophy in the Royal Institution affords a fitting occasion for a formal recognition of the great services which he has rendered to the cause of scientific progress.

Prof. Tyndall has therefore been invited to a complimentary dinner which will take place at Willis's Rooms on Wednesday, June 29, at 7 o'clock.

The chair will be taken by the President of the Royal Society, who, it is hoped, will be supported by a large and representative body both of scientific men and of others who appreciate the importance to the nation of scientific instruction and of the promotion of natural knowledge.

The Committee hope that you will be able to attend, and in this case we shall be glad if you will kindly fill up the accompanying form and return it to us at your earliest convenience.

Tickets will be 30*s.* each, and the Committee request us to state that it will be necessary to hold gentlemen who receive tickets responsible for that sum, even if they should unfortunately be prevented from attending the dinner.

The early return of the accompanying form is desirable, as it will be impossible to find room for more than 280 persons. Should more than that number apply, the Committee will, as far as possible, distribute the tickets in the order of application. In any case, a further communication will be addressed to you.

We are, dear Sir,

Faithfully yours,

J. NORMAN LOCKYER }
ARTHUR W. RÜCKER } *Hon. Secs.*

The following is a list of those who have up to the present consented to serve on the Committee:—

Chairman, Prof. G. G. STOKES, President of the Royal Society.

The MARQUIS OF SALISBURY, K.G., F.R.S., Chancellor of the University of Oxford.
The DUKE OF DEVONSHIRE, K.G., F.R.S., Chancellor of the University of Cambridge, and of the Victoria University.
The DUKE OF ARGYLL, K.G., F.R.S., Chancellor of the University of St. Andrews.
The Right Hon. JOHN INGLIS, D.C.L., LL.D., Chancellor of the University of Edinburgh.
The EARL OF ROSSE, F.R.S., Chancellor of the University of Dublin.
The EARL GRANVILLE, K.G., F.R.S., Chancellor of the University of London.
Sir F. ABEL, C.B., F.R.S., ex-President of the Chemical Society.

Prof. J. C. Adams, F.R.S., ex-President of the Astronomical Society.
Prof. W. G. Adams, F.R.S., ex-President of the Physical Society.
Sir George B. Airy, K.C.B., F.R.S., ex-Astronomer-Royal, and ex-President of the Royal Society.
Sir W. Bowman, Bart., F.R.S., formerly Secretary to the Royal Institution.
Sir F. Bramwell, F.R.S., Secretary to the Royal Institution, and ex-President of the Institution of Civil Engineers.
Prof. Cayley, F.R.S., ex-President of the British Association.
Prof. Clifton, F.R.S., ex-President of the Physical Society.
W. Crookes, Esq., F.R.S., President of the Chemical Society.
W. H. M. Christie, Esq., F.R.S., Astronomer-Royal.
Warren De la Rue, Esq., F.R.S., ex-President of the Royal Astronomical and Chemical Societies.
Prof. Dewar, F.R.S., Professor of Chemistry in the Royal Institution
Colonel Donnelly, C.B., Secretary to the Science and Art Department.
Prof. P. M. Duncan, F.R.S., ex-President of the Geological Society.
W. T. Thiselton Dyer, Esq., F.R.S, Director of the Royal Gardens, Kew.
Dr. Evans, Treasurer of the Royal Society, and President of the Society of Antiquaries.
Prof. Flower, F.R.S., Director of the Natural History Department, British Museum.
Prof. G. Carey Foster, F.R.S., ex-President of the Physical Society.
Prof. M. Foster, Secretary of the Royal Society.
F. Galton, Esq., F.R.S., President of the Anthropological Society.
Prof. Gamgee, F.R.S., Professor of Physiology in the Royal Institution.
A. Geikie, Esq., F.R.S., Director-General of the Geological Survey.
Sir W. Grove, F.R.S., ex-President of the British Association.
Dr. Hirst, F.R.S., ex-President of the Mathematical Society.
Sir J. Hooker, F.R.S., ex-President of the Royal Society.
Prof. Huxley, F.R.S., ex-President of the Royal Society.
Prof. Judd, F.R.S., President of the Geological Society.
Sir John Lubbock, F.R.S., ex-President of the British Association.
Hugo Müller, Esq., F.R.S., ex-President of the Chemical Society.
Prof. Odling, F.R.S., ex-President of the Chemical Society.
Sir Lyon Playfair, K.C.B., F.R.S., ex-President of the British Association.
Lord Rayleigh, Secretary of the Royal Society.
Admiral Sir G. H. Richards, K.C.B., F.R.S., ex-Hydrographer to the Navy.
Sir H. E. Roscoe, F.R.S., ex-President of the Chemical Society, and President-Elect of the British Association.
Prof. Balfour Stewart, F.R.S., President of the Physical Society.
General R. Strachey, F.R.S., President of the Royal Geographical Society.
Sir W. Thomson, F.R.S., President of the Royal Society of Edinburgh.
Captain Wharton, R.N., F.R.S., Hydrographer to the Navy.
Professor A. W. Williamson, Foreign Secretary of the Royal Society.

M. BOUSSINGAULT.

STUDENTS of agricultural chemistry have received with much regret the tidings of the death of M. Boussingault, one of the earliest and most eminent investigators in this branch of science. He was born at Paris on February 2, 1802, and obtained his scientific education at the School of Mines of St. Étienne. When little more than twenty years of age, he went as a mining engineer to Columbia, South America, where he remained ten years. During his residence in South America he made the acquaintance of Alexander von Humboldt, who warmly praised his work in chemistry, meteorology, geography, and astronomy. On his return to France, M. Boussingault was appointed Professor of Chemistry at Lyons. He married the sister of M. Lebel, who had been his fellow student at St. Étienne, and by his marriage he became, with his brother-in-law, joint proprietor of the estate of Bechelbronn, in Alsace. Here he set up the first laboratory that had ever been established on a farm, and carried on a long series of important researches.

From the time of his marriage, Boussingault generally spent about half the year in Paris, and the other half in Alsace. In 1836, he published a paper on the quantity of nitrogen in different foods, and on the equivalents of the foods, founded on the amounts of nitrogen they contained. This was his first important contribution to agricultural chemistry. It was soon followed by others, which secured for him, in 1839, the honour of being elected a member of the Institute. Among his publications in 1837 and 1838, were papers on the amount of gluten in different kinds of wheat, on the influence of the clearing of forests on the diminution of the flow of rivers, on the meteorological influences affecting the culture of the vine, and on the principles underlying the value of a rotation of crops. In connexion with this last subject he brought out many new facts, which seem to have been of essential service to Liebig. In 1843, much attention was attracted by a work entitled "Économie Rurale," in which M. Boussingault embodied the results of many of his original investigations. A translation, under the title of "Rural Economy in its Relations with Chemistry, Physics, and Meteorology," was published in this country, and made the author's name widely known among English agriculturists. In a review of this translation in 1845 the *Agricultural Gazette* described the work as "the most important and valuable book for farmers which the chemists of the present century had produced—not so attractive as the clever paragraphs of Prof. Liebig, but much more than compensating for want of brilliancy by solid worth."

In an excellent biographical sketch of Boussingault, printed in the *Agricultural Gazette*, January 6, 1879, it is pointed out that, although his attention was by no means limited to subjects bearing on agriculture, by far the greater number of his researches had relation to the problems it suggests. "Thus," says the writer, "the amount and condition of the combined nitrogen in the atmosphere, in the aqueous depositions from it, in rivers and springs, and in the soil, have been investigated. The amounts of nitrogen, phosphoric acid, &c., in different manuring substances have been determined, and their comparative values estimated accordingly. The question of whether or not plants assimilate the free nitrogen of the air has again and again been taken up, the weight of the evidence always serving to confirm the conclusion that they do not. Very recently, too, he has made experiments in regard to some functions of the leaves of plants. Lastly, in the sphere of animal chemistry, he has from time to time devoted himself to the elucidation of important points, such as the sources in the food of the fat of the fattening animal, the assimilation of mineral constituents, the question whether any of the nitrogen of the food or of the animal is exhaled, and so on." Most of the results of his investigations relating to agricultural chemistry are given in his work "Agronomie, Chimie agricole, et Physiologie," published in seven volumes, the first of which appeared in 1860, the last in 1884.

M. Boussingault received many honours from foreign Governments and from scientific Societies both at home and abroad. In 1878, the Council of the Royal Society awarded the Copley Medal for his numerous and varied contributions to science, especially for those connected with agriculture.

In 1848, Boussingault was elected a member of the National Assembly, where he sat as a Moderate Republican, and for a short time he was a member of the Conseil d'État. In 1851 he was dismissed, on account of

his political opinions, from his position of Professor at the Conservatoire des Arts et Métiers; but this step caused so much discontent among scientific men, and was so vigorously resented by his colleagues, who threatened to resign in a body, that the Government had to reinstate him.

He died on May 11, 1887, in his eighty-sixth year.

NOTES.

THE "Ladies' *Soirée*" at the Royal Society held last night was carefully prepared and largely attended. We shall refer at length next week to some of the objects exhibited.

THOSE who have made the arrangements for the great national ceremony at Westminster Abbey in connexion with the Queen's Jubilee cannot, it would appear, be congratulated on the manner in which they have discharged one of the most important of their functions. On so striking an occasion all the highest interests of the nation ought to be adequately represented; yet some of the most vital of these interests have been practically ignored. "A Student" has alluded to the matter in a letter to the *Times*, and his remarks seem to be worthy of attention. Having referred to the eminent fitness of Westminster Abbey for a ceremony of this kind, he says:—"I imagined gathered together there all the men who by their deeds, their discoveries, their inventions, their writings, or their noble lives and ideas, have helped during the Queen's reign to make England what she is at the present moment, and I imagined, too, that the list of the names of those present might be a roll fit to be handed down to the remotest posterity as an authoritative statement of England's most illustrious citizens in the present year. Proud that the English Government had resolved to act upon such a noble idea, I have been endeavouring to express my enthusiasm and gratitude to many that I have met, with the result that I have found either that my view of the Government's intention was perfectly wrong or that it is being carried out in such a manner that the thing promises to be an expensive and unworthy farce. I have been informed by some who should know *that among those who have already been invited hardly the name of any representative of literature, science, or art has been included.*"

THE Queen has intimated her intention of accepting the Albert Medal, which has been awarded to her by the Council of the Society of Arts. The Albert Medal is annually given for "distinguished merit in promoting arts, manufactures, or commerce."

ALL who remember the important aid rendered by Governor Sendall to the Government Eclipse Expedition to the West Indies last year will be glad to see by a recent *Gazette* that a C.M.G. has been conferred upon him. The same *Gazette* also included the name of Dr. Hector for the step of K.C.M.G. This is also another unexceptionable appointment. We are glad that the authorities at the Colonial Office are making such wise selections; the order of St. Michael and St. George bids fair to eclipse that of the Bath, the civilian distinctions connected with which seem more and more rarely to come in a scientific direction, and to be more and more limited to the spending rather than the thinking departments.

SOME important appointments have just been made at University College, London. Dr. William Ramsay, Principal of, and Professor of Chemistry in, University College, Bristol, has been appointed to fill the Chair of Chemistry, vacant by the resignation of Dr. Williamson; Dr. Sydney Ringer, F.R.S., has been made Holme Professor of Clinical Medicine, in succession to the late Dr. Wilson Fox; and Mr. Victor Horsley, F.R.S., succeeds Dr. Bastian (resigned) as Professor of Pathology.

WE referred lately (p. 87) to a Bill introduced into the House of Commons by Sir Henry Roscoe, empowering any School Board, local authority, or managers of a public elementary school, to provide day technical and commercial schools and classes. Mr. James Stuart has introduced a corresponding measure for the establishment of evening schools and classes which shall give instruction in continuation of that obtained in public elementary schools. The subjects to be taught include the elements of such portions of science as may be likely to be useful to artisans and other persons engaged in industrial and agricultural occupations; also elementary mechanics, mechanical drawing, the elements of art and design, the use of ordinary tools, commercial arithmetic, and commercial geography. For providing these evening continuation schools the powers of School Boards or other local authorities are to be in all respects the same as for providing ordinary public elementary schools. Further, there is to be the power of providing or contributing to the maintenance of laboratories or workshops in endowed schools for the purpose of carrying on classes under the Bill. The schools and classes thus provided are to be subject to the inspection of the officers of the Committee of Council on Education or of the Science and Art Department, and no scholar is to be admitted to a school or class who has not passed an examination in the sixth standard. It is also proposed that School Boards or other local authorities shall have power to provide evening schools and classes, either in connexion with "evening continuation schools" or not, for the purpose of giving instruction in a particular group of subjects, among which are arithmetic, geography, elementary science, drawing, wood-carving, and modelling. The conditions as to these schools and classes do not differ from those as to the continuation schools, except that the standard to be passed previously to admission is the fourth, not the sixth. For any of the subjects taught in evening schools or classes under the Bill the Committee of Council on Education are empowered to give grants on such conditions as they may lay down.

WE learn that the Bentham Trustees have purchased for presentation to the Library of the Royal Gardens, Kew, the unique collection of portraits of *Bromeliaceæ* which were accumulated during a life-long study of the order by the late Dr. Morren, Professor of Botany in the University of Liége. Some of the drawings, which are in all cases of life-size, were exhibited at the recent reception of the Royal Society.

IN an article printed in NATURE on January 13 (vol. xxxv. p. 248), Mr. D. Morris dealt with the important question of botanical federation in the West Indies. He again discusses this subject in the sixth Bulletin of Miscellaneous Information, just issued from the Royal Gardens, Kew. For the last hundred years the cultivation of the sugar-cane has been the only important industry in the West Indies, and the fall in the price of cane sugar has seriously affected the general condition of the population. It is estimated that one-half of the surface of these islands, with the exception of Antigua and Barbados, is better fitted for other cultivation than that of the sugar-cane. Fresh industries might therefore be safely started, and Mr. Morris is careful to point out that "by too close an adhesion to purely sugar-growing habits and methods the people act injuriously to their best interests and neglect the numerous resources at their command." It is, however, absolutely necessary that any new enterprises which may be undertaken shall be carried on by persons equipped with adequate knowledge; and no real progress can be made unless the people of the various islands provide themselves with small but good botanical establishments in connexion with the Botanical Department in Jamaica. Something has already been done in this direction. At Grenada a

Botanic Garden is in course of being established under the charge of Mr. W. R. Elliott; and, with the sanction of the Legislature, £100 has been granted for the formation of a botanical station at Dodd's Reformatory, Barbados. A botanical station, for which £300 has been voted, is being made near Castries, St. Lucia. Mr. Morris is of opinion that the prospects of the scheme for botanical federation in the West Indies are, upon the whole, very good. The recent appointment of Mr. William Fawcett to the post of Director of the Botanical Department at Jamaica appears, he thinks, to offer every hope of success to the scheme. "It is also anticipated," Mr. Morris says, "that, while granting valuable aid to the smaller islands, Jamaica, as a centre, will herself derive, both directly and indirectly, considerable benefit from such vigorous and systematic working as would naturally arise in her own area as well as from a larger interchange of plants and seeds with the neighbouring islands."

In connexion with the sixtieth meeting of German Naturalists and Physicians, which is to be held at Wiesbaden from September 15 to 24, there will be an important scientific exhibition. It is intended that the exhibition shall include the latest and best instruments and apparatus used in the study and in the teaching of science and medicine. The following are among the groups to be represented:—Surgery, physical diagnosis and therapeutics; ophthalmology, gynæcology; laryngology, rhinology, and otiatry; orthopædia, dentistry, chemistry, instruments of precision, with subdivision for microscopy; instruments and apparatus aiding instruction in natural history, geography, equipment for scientific travel, photography, anthropology, biology and physiology, hygiene, electro-therapeutics and neurology, and pharmacology. Applications are to be addressed to the Exhibition Committee, 44 Frankfurterstrasse, Wiesbaden.

On Friday, the 3rd inst., the work of constructing the canal which is to connect the German Ocean with the Baltic Sea was formally begun by the German Emperor. The ceremony, which took place at Holtenau, on the Bay of Kiel, consisted of the laying of the foundation-stone of a lock near the Baltic end of the canal. It is estimated that the total cost of the undertaking will be 156,000,000 marks (about £7,800,000). This sum has already been voted by the Reichstag and the Prussian Parliament. The canal is being constructed mainly for naval and military purposes, but in times of peace it will be open to the merchant ships of all nations. The German authorities calculate that it will be used annually by about 18,000 vessels, with a collective tonnage of 5,500,000, and yielding a revenue of 4,125,000 marks (about £206,250).

On Wednesday, the 15th inst., at 3 p.m., Sir H. W. Acland will distribute prizes to students at the Medical School of St. Thomas's Hospital. The ceremony will take place in the Governors' Hall.

Lord Cadogan has offered to present a site for the Free Public Library which is to be erected in Chelsea. He also promises to give £300 worth of books, to which Lady Cadogan adds a gift of £50.

On Tuesday evening a meeting, held in the lecture-hall of the Polytechnic Institution, Regent Street, decided that an effort should be made to secure the establishment of a Free Public Library in Marylebone. Prof. Huxley, who presided, said it was proposed that £20,000 should be raised to cover the cost of the site and building, and he was able to announce that £10,500 had already been promised. If they succeeded in their object, as he was sure they would, they could go to the authorities and the ratepayers and say, "We have done our part of a public duty, now perform yours."

The Corporation of London have voted a donation of one hundred guineas towards the thousand pounds required by the Bethnal Green Free Library Committee for the further development of the Institution.

On the 3rd inst. several shocks of earthquake occurred in Northern California and Western Nevada. They were distinctly felt in the Yosemite Valley.

During the earthquakes in the Sierra Madre, five persons were killed and nineteen injured at Bapipe (Sonora province), and five persons were killed at Oputa. Both towns were completely destroyed. The inhabitants, as well as those of the towns of Barceraca and Quasa, are living in the open fields, shocks being still felt continually. Some places which were quite dry formerly are now submerged.

The Oficina Central Meteorolójica de Chile is endeavouring to keep up and improve the meteorological service of the Republic. Vol. xviii. of its *Anuario*, containing the observations for the year 1886, has been recently published. The first observations published by the Office were for 1869, but for several years past the publication has fallen into arrears for want of sufficient funds. Since the re-organization of the Office in 1885, the *Anuario* has appeared in two-monthly parts, and the management of the service is now intrusted to a Committee composed of members of the Faculty of Sciences at the University of Santiago. There are now twenty-eight stations at which observations are being taken or in course of establishment; the most northerly station is Iquique (lat. 20° 12′ S.), and the most southerly Punto Arenas (lat. 53° 10′ S.), but there are none between this and Ancud (lat. 41° 52′ S.). Many of the stations are provided with the best instruments, ordered from Europe, and the Central Office has a complete outfit of self-recording instruments. The Astronomical Observatory at Santiago has also published meteorological observations, independently, from 1873–84, together with curves of the automatic records.

The *Annalen der Hydrographie und maritimen Meteorologie* for May contains a notice of a fall of volcanic ashes, at Finsch Harbour, on the eastern coast of New Guinea, which lasted from 7 a.m. till about 11 a.m. on February 5 last, and covered the country round with a thin layer of light-gray ashes. On February 2 the whole sky appeared gray, and at noon the sun was of a blood-red colour, while lunar halos and rings occurred for several nights. Captain von Schleinitz states that the north-west monsoon, which prevails at this season, had ceased for four days, and was replaced by fresh southerly winds, but made its appearance again at noon on the 4th. From this he concludes that the volcanic eruption which caused the fall of ashes might have occurred either to the north or south, as the fall did not take place with either the northerly or southerly wind, but during a calm, the ashes having remained suspended for some time. He thinks that a northerly origin is most probable, although they might have been carried thither from an easterly or westerly direction by an upper air-current, or that the volcanoes in Vulcan Island and Lesson Island may have shown unusual activity during the period in question.

The Monthly Weather Review, published by the Chief Signal Officer of the United States, and referred to in our issue of last week (p. 110), has now been received for the six months ending December 1886, making the series complete up to February 1887.

The recent cyclone in the Bay of Bengal, to which we referred last week (p. 110), did much injury both on sea and land. Commenting on the fact that the Viceroy has telegraphed to the Sheriff of Calcutta expressing the regret and sympathy felt by himself and the members of the Government, the Calcutta Correspondent of

the *Times* says :—"It is to be hoped that this sympathy will take the practical form of the authorizing an extension of the telegraph to the Andamans and Diamond Island. The latter locality is now recognized as the birth-place of cyclones, and the importance of getting early intimation of their approach cannot be over-estimated."

WE have to record the death of Dr. Karl Friedländer, Professor at the Berlin University, an eminent pathologist and anatomist; also of Dr. Alexander Ecker, Professor at the Freiburg University, a well-known anatomist and anthropologist, and founder of the Ethnographical Museum at Freiburg. Dr. Ecker died at the age of seventy.

THE General Meetings of the Geographical Society and the Botanical Club of Thuringia took place at Saalfeld on June 5.

THE largest Apicultural Meeting and Exhibition ever held in Germany will take place at Hanover from September 22 to 25.

THE Council of the Royal Meteorological Society are anxious to obtain photographs of flashes of lightning, as they believe that a great deal of research on this subject can be pursued only by means of the camera. In a letter which has been sent to persons likely to be interested in the subject, the Council express a hope that now the thunderstorm season is approaching, many photographers may be found willing to take up this branch of their art. It is pointed out that the photography of lightning does not present any particular difficulties. If a rapid plate and an ordinary rapid doublet with full aperture be left uncovered at night during a thunderstorm for a short time, flashes of lightning will after development be found in some cases to have impressed themselves upon the plate. The only difficulty is the uncertainty whether any particular flash will happen to have been in the field of view.

A NEW chlorobromide of silicon has been isolated by Prof. Emerson Reynolds from a large quantity of crude silicon tetrabromide. A current of dry hydrogen was first driven through the crude bromide to remove free bromine, and the residue, after shaking with mercury, was afterwards subjected to fractional distillation. An early fraction, that passing over between 140° and 144°, was separately collected, and, by repeated refractioning, was found to consist largely of a portion boiling at 140°-141°, which proved to be pure silicon chlorotribromide, $SiClBr_3$. This liquid fumes in the air, and, on addition of water, is decomposed into a mixture of silicic, hydrobromic, and hydrochloric acids. It is of considerable theoretical interest, inasmuch as it completes our knowledge of the following series of compounds, in which chlorine and bromine mutually replace each other, and the end members of which are formed by the tetrachloride and the tetrabromide of silicon respectively: $SiCl_4$, $SiCl_3Br$, $SiCl_2Br_2$, $SiClBr_3$, and $SiBr_4$. This series is now perfectly analogous to the one formed by the compounds of chlorine and bromine with carbon.

A NEW quantitative reaction of very wide application, by means of which any desired substitution of chlorine may be readily effected in a large number of hydrocarbons, is described by MM. Colson and Gautier in the last number of the *Annales de Chimie et de Physique*. It simply consists in heating in a sealed tube the calculated quantities of hydrocarbon and phosphorus pentachloride on the supposition, shown by analysis to be well founded, that the pentachloride is dissociated into the trichloride and free chlorine, which latter acts precisely like free chlorine. The great value of this means of substitution is at once seen to consist in the fact that, instead of the uncertain results obtained by the graduated use of free chlorine, it now becomes possible to obtain a quantitative yield, in an easily separable form, of the particular chlorine derivative desired. Thus, in order to obtain benzal chloride, the starting-point in the artificial preparation of indigo, it is only necessary to heat together to 195° for two hours in a closed vessel the calculated quantities of toluene and phosphorus pentachloride.

WE understand that the Rev. J. B. Lock intends to write a "Statics for Beginners" as a complement to the "Dynamics for Beginners" which was recently noticed in these columns. A Key is now being prepared, under Mr. Lock's superintendence, to his well-known "Arithmetic for Schools."

IN their report for the session 1886-87 the Council of the Institute of Actuaries say that the prosperity of the Institute has been fully maintained during the past year. Referring to the new offices at Staple Inn Hall, the Council trust that they have at last secured a permanent and suitable home for the Institute, corresponding to its higher dignity and its ever-increasing duties.

AN International Exhibition is to be held at Glasgow during the summer of 1888. The guarantee fund already exceeds £240,000, and is being increased. The objects of the Exhibition, as stated in the prospectus, are "to promote and foster industry, science, and art, by inciting the inventive genius of our people to still further development in arts and manufactures; and to stimulate commercial enterprise by inviting all nations to exhibit their products, both in the raw and finished state." Examples of the manufactures of Glasgow and the surrounding districts—chemical, iron, and other mineral products, engineering, shipbuilding, electrical and scientific appliances, and textile fabrics—will be shown; and similar and more varied exhibits may be expected from other parts of Great Britain and from the Continent. Promises of support have also been received from America, India, the Canadian, Australian, Cape, and other colonies. The site, which has been granted by the Glasgow Corporation, extends to sixty acres, and the buildings will cover about ten acres.

IN an article in the current number of the *Entomologist*, Mr. J. T. Carrington speaks of a phenomenon which has frequently puzzled him when hunting for insects on salt-marshes. He refers especially to the marshes of the River Medway. The tide often completely overflows the marshes, and for an hour or two turns the collecting-ground into an arm of the sea, with multitudes of rippling wavelets. During this period there is not a sign of an insect flying over the water. "As the tide recedes, and little islands of the taller plants appear through the water," says Mr. Carrington, "we notice the first indication of moths appearing. When the water has left the marsh we examine the wet and sloppy ground, and find multitudes of delicate Tortrices and plumes in perfect condition, flitting about as though nothing had happened to disturb their comfort. Now, where were these moths when the tide covered the marsh some two or three feet deep? One can hardly imagine they were under the water all the time, though there was not a sign of them over it. Many times have I watched this rising and falling of the tide, but never solved the problem."

IN the June number of the *Zoologist*, Mr. Murray A. Mathew describes what he calls "a strange capture of a hare." A neighbour of his in Pembrokeshire was crossing one of his fields late in the evening when he heard a hare crying. He went in the direction, expecting to find a hare in a trap, but was astonished to come across one attacked by a hedgehog, which was holding on to one of its hind legs. The hare (fully-grown) seemed paralyzed by fear, and allowed itself to be lifted up. Directly the hedgehog was shaken off the hare died, although the injury it had received from the bite of its assailant was but slight.

A NEW weekly newspaper, devoted more especially to the commercial side of the chemical and allied industries, is being

issued by Messrs. Palmer and Howe, of Manchester. It is called the *Chemical Trade Journal*, and is edited by Mr. George E. Davis. Two numbers have already appeared.

THE additions to the Zoological Society's Gardens during the past week include two Egyptian Jerboas (*Dipus ægyptius*) from Egypt, a Moorish Toad (*Bufo mauritanica*) from Tunis, presented by the Hon. Terence Bourke; a White-crowned Pigeon (*Columba leucocephala*) from the West Indies, presented by Lieut.-Colonel W. G. Dawkins; a Common Trumpeter (*Psophia crepitans*) from Demerara, presented by Mr. G. H. Hawtayne; a Crowned Horned Lizard (*Phrynosoma coronatum*) from Texas, presented by Mr. Claude A. Millard; two Egyptian Jerboas (*Dipus ægyptius*) from Egypt, deposited; two Cape Sparrows (*Passer arcuatus*), four Alario Finches (*Alario alario*) from South Africa, purchased; a Wapiti Deer (*Cervus canadensis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET 1887 *e* (BARNARD, MAY 12).—Dr. H. Oppenheim supplies the following improved elements for this comet in Dun Echt Circular No. 147:—

T = 1887 June 17·2209 Berlin M.T.

$\pi - \Omega$ = 15° 40′ 19″
Ω = 245 13 1
ι = 17 31 52
Mean Eq. 1887·0.
log q = 0·14288

Ephemeris for Berlin Midnight.

1887.	R.A. h. m. s.	Decl. ° ′	Log Δ.	Log r.	Brightness.
June 13	16 13 43	7 50·3 S.	9·6006	0·1432	1·5
15	16 18 17	6 20·5			
17	16 22 51	4 53·9	9·6077	0·1429	1·5
19	16 27 26	3 30·8			
21	16 32 1	2 11·4 S.	9·6182	0·1433	1·4

The brightness on May 14 has been taken as unity.

MINOR PLANET NO. 266.—This object has received the name of Aline.

THE PARALLAX OF α TAURI.—Prof. Asaph Hall has published in the *Astronomical Journal*, No. 156, a determination of the parallax of this star deduced from measures of the position-angle and distance of the eleventh magnitude companion made with the Washington 26-inch refractor between October 2, 1886, and March 15, 1887. The resulting values of the relative parallax are: from measures of angle, $\pi = +0''{\cdot}163 \pm 0{\cdot}0409$, and from measures of distance, $\pi = +0''{\cdot}035 \pm 0{\cdot}0431$. The mean value of the parallax of α Tauri from these observations is therefore $\pi = +0''{\cdot}102 \pm 0''{\cdot}0296$. It will be remembered that M. O. Struve recently published a determination of the parallax of this star, referred to the same comparison-star, and found $\pi = +0''{\cdot}516 \pm 0''{\cdot}057$.

MADRAS MERIDIAN OBSERVATIONS.—A volume of Madras astronomical observations at last! In 1887 Mr. Pogson publishes the results of the meridian circle work during 1852, 1863, and 1864. A prefatory epistle addressed to Sir M. E. Grant-Duff, late Governor of Madras, speaks of "the removal of certain arbitrary and suppressive restrictions which have prevented me and my predecessors from attempting anything of the kind for considerably more than thirty years past," but gives the reader no more definite information as to the reason of this unparalleled delay in publication, nor why the Madras Observatory should have thus fallen from the high position which it formerly held. The instrument with which the observations now published were made is a transit-circle constructed by Messrs. Troughton and Simms, in consultation with the late Mr. Carrington. The object-glass is of 5½-inches aperture, and the circle of 42-inches diameter. It was brought into use in May 1862, and was devoted to the observation of stars down to the fifth magnitude, the moon and accompanying stars, Mars and comparison stars at successive oppositions, minor planets, and as many stars of more than 120° N.P.D. as could be found, not less than the eighth magnitude. The present volume contains star places only. The ledgers and catalogues of mean places for each year are given separately and take up much more space in printing than is necessary for mere annual results. Altogether 227 stars were observed in 1862, 782 in 1863, and 1000 in 1864. A comparison between the Madras places of time-stars and those of the Nautical Almanac (on the R.A.'s of which those of Madras depend) shows a good agreement in R.A., but in N P.D. a mean excess of the former of +0″·7, which "renders it certain that the Polar Distances will require some further small correction before being formed into a final general Catalogue."

ASTRONOMICAL PHENOMENA FOR THE WEEK 1887 JUNE 12–18.

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

At Greenwich on June 12.

Sun rises, 3h. 45m.; souths, 11h. 59m. 29·5s.; sets, 20h. 14m.; decl. on meridian, 23° 9′ N.: Sidereal Time at Sunset, 13h. 37m.

Moon (at Last Quarter on June 13) rises, 0h. 5m.; souths, 5h. 13m.; sets, 10h. 30m.; decl. on meridian, 10° 32′ S.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Decl. on meridian. ° ′
Mercury ...	4 46 ...	13 16 ...	21 46 ...	25 12 N.
Venus	7 4 ...	15 6 ...	23 8 ...	21 21 N.
Mars	3 2 ...	11 9 ...	19 16 ...	22 7 N.
Jupiter... ...	14 57 ...	20 16 ...	1 35* ...	8 51 S.
Saturn... ...	6 6 ...	14 11 ...	22 16 ...	21 49 N.

* Indicates that the setting is that of the following morning.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·3 ...	81 16 N. ...	June 13,	0 55	*m*
			,, 18,	0 35	*m*
R Crateris	10 55·0 ...	17 43 S. ...	,, 15,		*m*
U Virginis	12 45·4 ...	6 10 N. ...	,, 13,		*M*
R Hydræ	13 23·6 ...	22 42 S. ...	,, 12,		*m*
R Boötis	14 32·2 ...	27 14 N. ...	,, 18,		*m*
δ Libræ	14 54·9 ..	8 4 S. ...	,, 18,	1 26	*m*
U Coronæ	15 13·6 ...	32 4 N. ...	,, 14,	21 31	*m*
U Ophiuchi... ...	17 10·8 ...	1 20 N. ...	,, 15,	1 0	*m*
W Sagittarii ...	17 57·8 ...	29 35 S. ...	,, 13,	1 0	*M*
R Scuti	18 41·5 ...	5 50 S. ...	,, 18,		*m*
β Lyræ...	18 45·9 ...	33 14 N. ...	,, 17,	2 0	*M*
R Delphini	20 9·5 ...	8 45 N. ...	,, 18,		*M*

M signifies maximum; *m* minimum.

Meteor-Showers.

	R.A. °	Decl. °	
Near β Lyræ	282	32 N.	
ζ Cygni	320	32 N.	
β Piscium	345	0	Very swift.

GEOGRAPHICAL NOTES.

IT may interest our readers to know that a full account of Baron Nordenskjöld's narrative of his very interesting journey across Greenland has been published in German by Brockhaus, of Leipzig, with numerous maps and illustrations. Doubtless, like the same explorer's previous narratives, it will soon appear in an English dress. We are assured that Nordenskjöld will not undertake any Antarctic expedition before 1888 or 1889, if, indeed, he undertakes it at all, which is highly doubtful. He has much to do still before the publications connected with the *Vega* Expedition are complete, and he has a variety of other work in hand which must be finished before he enters on any new undertaking.

THE paper read at Monday's meeting of the Royal Geograpical Society was one of unusual novelty and interest. It described the exploration which Mr. H. E. M. James, of the Bombay Civil Service, in company with two friends, made last spring and summer in Manchuria. The region explored extends from the Yellow Sea to beyond 45° N., and between 122° and 130° E. long. A considerable section of the journey was over virtually new ground, and as Mr. James is a careful observer, and, we believe, a botanist, and an accurate describer, his paper is of some scientific value. He has at least been able to add some precise features to our maps of the region. The paper contains

a useful general account of Manchuria and its history. Mr. James calls it the Manitoba of Asia. What with the depletion of the country for military service and the influx of immigrants from China, there is little of the old Manchu population left. Nearly all special Manchu customs have disappeared, and the language itself is now only spoken in a few remote valleys. Mr. James's party started from Newchang and went north to Mukden. Thence they went due east up the beautiful and well-wooded valley of the Hun. This is a particularly rich region, and is being rapidly colonized. The first day Mr. James began to collect he found no less than five kinds of lilies of the valley, and it was common to see whole hill-sides covered with masses of that flower. On account of the flooded state of the rivers, it took them a month to reach Mau-erh-shan, the furthest Chinese outpost on the Yalu, at the south foot of the Lao-ling Mountains. Thence they struck northwards across the mountains to the junction of the Sungari and Tang-ho, four days march. Here they looked in vain for the snowy peaks of 10,000 to 12,000 feet high, reported by previous writers on Manchuria; they were assured no such peaks existed in all the region. An official guided them back south-east to the Pei-shan Mountains, a sort of knot in which the Yalu, the Tumen, and the Sungari take their rise. For a long distance the route was over a succession of ranges covered with dense forests, with only at long intervals a hut of a ginseng cultivator, sometimes in the crater of an old volcano. Bogs also were frequent, and gave much trouble. It was the ninth day before they actually began to ascend the mountain itself. The lower slopes are covered with birch and pine, leading to a delightful grassy plateau dotted with trees, and rich open meadows bright with flowers of every imaginable colour. As they approached the needle-like peaks of Old White Mountain, the noise of underground streams was frequently heard. The steep sides of the two-peaked upper ridge shines white with disintegrated pumice-stone. On reaching the saddle and looking over the edge, the party found themselves looking down into a crater, at the bottom of which, about 350 feet below, was a beautiful lake, of the deepest and most pellucid blue. The lake was about 6 miles in circumference. The height of the mountain is not more than 8000 feet. The party then proceeded north to Kirin and Tsitsikar, through forests and swamps, and, lastly, across Mongolian steppes. Then, proceeding eastwards and southwards, the country to the east of the previous route was explored, Mr. James learning much by the way of the country and the people. Altogether the journey has been a fruitful one, and shows how much can be done for science by our Indian officials when they have the inclination and are properly trained.

WE have already referred to the remarkable journey of Mr. Carey in Central Asia. Information has now been received from him showing how the second year of his journey was passed. In May 1886 he started from Châklik, with the object of exploring some of the northern regions of Tibet. He passed south, across the Altyn and Chinan Mountains, and reached the foot of a high chain, which is probably the true Kuen-lun. Here he had to travel a considerable distance eastwards, through barren and difficult country, until an opening was found leading to the valley of the Ma-chu, the head source of the Yang-tse-kiang. After falling down the river some distance, Mr. Carey had to turn northwards again, and recross the Kuen-lun. He now found himself in the Tsaidam region, and made an interesting round journey from a place called Golmo and back to the same point, during which he saw a good deal of the nomadic Kalmucks and Mongols who inhabit the comparatively low valleys of Tsaidam. In the autumn, Mr. Carey made a second journey across the Kuen-lun, and then, again turning northward, struck straight across the Tsaidam country and the Gobi, to Sáchan and Hami, whence he travelled to Urumtsi in the Tian-shan. Thence the party left for Yarkand, whence a start was made on March 7 for Ladak. A great part of the ground traversed by Mr. Carey is new, and he and his assistant, Mr. Dalgleish, are the only Englishmen who have ever travelled through the entire length of Chinese or Eastern Turkestan.

M. CONSTANTIN NOSILOFF writes to the Royal Geographical Society of his intention to undertake this year a summer expedition to Nova Zembla. His object will be (1) to prepare a detailed map of the coasts and interior of the island; (2) to study the hydrography of the coast, and make observations regarding the movements of the ice in the Kara Sea, and in the straits leading to it; (3) to make meteorological observations, and to collect zoological and botanical specimens; (4) to study the ethnography of the Samoïedes.

THE ANNUAL VISITATION OF THE ROYAL OBSERVATORY.

THE Report of the Astronomer-Royal to the Board of Visitors, read at the annual visitation of the Royal Observatory on Saturday last, refers to the period of twelve months from 1886 May 21, to 1887 May 20, and exhibits the state of the Observatory on the last-named day.

The following are among the points of most general interest:—

I. Buildings and Grounds.

Above the extended portion of the upper computing-room, a dome 18 feet in diameter is to be erected, in which it is proposed to mount a Cooke 6-inch equatorial, a photo-heliograph tube being attached to the same mounting. The combined instrument will command a complete view of the sun throughout the day—an important consideration, as the work of the present photoheliograph is seriously interfered with by trees and the Lassell dome. The new instrument will be available for occultations, phenomena of Jupiter's satellites, and other occasional observations.

II. Astronomical Observations.

Transit-Circle.—The regular subjects of observation with the transit-circle are the sun, moon, planets, and fundamental stars, with other stars from a working Catalogue. On the conclusion of the observations for the Ten-Year Catalogue at the end of 1886, a new list of some 3000 stars was prepared, to include all the stars in Groombridge's Catalogue and in the Harvard Photometry, which had not been observed at Greenwich since 1867. The Annual Catalogue of stars observed in 1886 contains about 1665 stars.

The observations for the Ten-Year Catalogue, epoch 1880, were concluded at the end of 1886, special efforts being made in the latter part of the year to make the Catalogue as far as possible complete to the sixth magnitude inclusive. It is estimated that the Catalogue will contain about 4000 stars, all of which, with very few accidental exceptions, have been observed at least three times in R.A. and N.P.D., the total number of observations being about 40,000 in each element.

The following statement shows the number of observations made with the transit-circle in the twelve months ending 1887 May 20:—

Transits, the separate limbs being counted as separate observations	6366
Determinations of collimation error	304
Determinations of level error	410
Circle-observations	5983
Determinations of nadir point (included in the number of circle-observations	385
Reflexion-observations of stars (similarly included) ...	602

About 400 transits (included in the above number) have been observed with the reversion-prism, to determine personality depending on the direction of motion.

The value found for the colatitude from the observations of 1886 is 38° 31′ 22″·03, differing by 0″·13 from the assumed value; the correction to the tabular obliquity of the ecliptic is +0″·65, and the discordance between the results from the summer and winter solstices is −0″·25, indicating that the mean of the observed distances from the Pole to the ecliptic is too great by +0″·12.

The mean error of the moon's tabular place (computed from Hansen's lunar tables, with Prof. Newcomb's corrections) is +0·029s. in R.A. and +0″·34 in longitude as deduced from ninety-seven meridian-observations in 1886. The mean error in tabular N.P.D. is −0″·66, which would appear to agree with the observations of the sun in indicating that the mean of the observed N.P.D.'s is too great.

As regards the computations for the Ten-Year Catalogue, a large amount of preparatory work has been done in the application of corrections to the observations as printed to reduce them to a homogeneous system, and some progress has been made in the formation of the Catalogue results. The proper motions actually used have been thoroughly revised for every observation in the period 1877-86, and corrections applied where, as occasionally happened, different proper motions had been used in the same year. A comparison has been made of the R.A.'s of clock-stars as observed in the last ten years and as computed from the Nine-Year Catalogue, epoch 1872, with Auwers' recently published proper motions, the result of which is to show that the Greenwich observations are better represented by these than by the proper motions in use hitherto, and it has therefore been

decided to adopt Auwers' proper motions throughout. Preparations have accordingly been made for reducing the observations in the Ten-Year Catalogue to the epoch 1880, with Auwers' proper motions wherever available.

It has appeared doubtful whether the reading of the exterior thermometer placed near the north wall of the transit-circle room represents the true temperature of the external air as affecting the refraction for the sun and other southern objects in the daytime. A discussion of simultaneous readings of the exterior, front court, and meteorological standard thermometers, which is being made by Mr. Thackeray, shows systematic differences between the first and last at the time of observation of the sun, the mean monthly excess of the meteorological standard over the exterior thermometer for the ten years 1877–86 ranging from +0°·7 in December to +2°·1 in May and August and +2°·6 in September. The reading of the front court thermometer (which is at a distance from any building) appears to agree closely with that of the meteorological standard, and it has been adopted, from the beginning of this year, in computing refractions for the sun, moon, planets, and stars south of the zenith observed in the daytime, the exterior thermometer being still used for northern stars as probably representing better the temperature of the air on the north side of the transit-circle. The systematic differences in thermometer readings have a sensible effect on the position of the ecliptic as deduced from observations of the sun, the discordance in the results between the summer and winter solstices found when the reading of the exterior thermometer are used being rendered insensible when corrections are applied to reduce to the reading of the meteorological standard thermometer.

Altazimuth.—The total number of observations of various kinds made in the twelve months ending 1887 May 20 is as follows, the observations of the moon having been as usual restricted to the first and last quarters in each lunation :—

Azimuths of the moon and stars	356
Azimuths of the azimuth mark	208
Azimuths of the collimating mark	242
Zenith distances of the moon	181
Zenith distances of the collimating mark ...	240

The altazimuth observations are completely reduced to March 31, so as to exhibit errors of moon's tabular R.A., N.P.D., longitude, and ecliptic N.P.D., and the manuscript for the printer has been prepared to the same date.

Equatorials.—Various additions have been made to the Lassell equatorial with a view to making it available for astronomical photography and for general use. A delicate slow motion in R.A. (with differential wheels) and a firm N.P.D. clamping arm with fine motion in N.P.D. have been applied, the steadiness and general usefulness of the telescope being greatly increased by these additions. The Corbett 6½-inch refractor has been mounted below the tube of the reflector and parallel to it to serve as a directing telescope in taking photographs and also for observation of occasional phenomena. A camera to take circular plates 8¼ inches in diameter (giving a field 1° 58′ in diameter) has been mounted at the principal focus of the Lassell mirror, and some trial photographs of the moon, Procyon, Regulus, γ Leonis, and Præsepe, have been taken.

The construction of the new 28-inch refractor has been delayed by difficulty in obtaining the disks of glass. Messrs. Chance are engaged in removing a bunch of fine veins from the flint glass disk, and have every hope of being able very shortly to report the disk practically perfect ; and M. Feil's successor has successfully moulded a crown disk from which he believes that he has removed all defects.

The south-east and Sheepshanks equatorials are in good order. Some trouble has been experienced with the water-supply for the driving clock of the former instrument, and an alteration in the arrangements for maintaining the pressure has been made at the Kent Waterworks, since which the working has been found quite satisfactory.

The Cooke 6-inch equatorial is being mounted in the south ground for trial as to the practicability of using curved plates for stellar photography and other questions which have been raised at the Paris Conference on Astronomical Photography.

III. Spectroscopic and Photographic Observations.

For determination of the motions of stars in the line of sight, 206 measures have been made of the displacement of the F line in the spectra of 26 stars, and 20 measures of the *b* lines in 8 stars, besides comparisons with lines in the spectrum of the moon made in the course of the night's observations of star motions, or of the sky on the following morning, as a check on the general accuracy of the results. The observations of Sirius since the date of the last Report indicate that the apparent displacement of the F line (which was originally towards the red and subsequently towards the blue) is now insensible. The displacement of the F line in the spectrum of Algol has been measured as frequently as possible during the winter months, in order to ascertain if any evidence could be obtained of rapid orbital motion such as would result from the hypothesis of the variability of Algol being caused by the transits of a large satellite. A sufficient number of observations has not yet been obtained to allow a definite conclusion to be formed, but as far as the observations go there are indications of a variation of the motion in the line of sight corresponding to orbital motion, having the same period as that of the star's variability.

A photographic corrector, consisting of a concave crown and convex flint lens (in contact), placed about 30 inches within the focus, has been applied to the telescope of the south-east equatorial to correct the chromatic aberration of the object-glass for the photographic rays without alteration of the focal length. A Dallmeyer doublet (formerly used in the photoheliograph) has been employed to enlarge the primary image about 7½ times, so as to give on the photographic plate an image on a scale of about 0·45 inch to one minute of arc, or 15 inches to the sun's diameter. A number of trial photographs of Castor, γ Virginis, Venus, Jupiter, and Saturn have been obtained. The photographs of the double stars appear to be susceptible of very accurate measurement, and several of the photographs of Jupiter show the four satellites, the belts, and the red spot. A photograph of γ Virginis, showing the components widely separated, has also been taken at the primary focus, the Dallmeyer enlarging doublet having been removed. It is intended also to use the photographic corrector with the Dallmeyer doublet to obtain photographs on a large scale of sunspots, craters on the moon, and other objects of small angular dimensions. The field of view with the photographic corrector is necessarily very restricted.

For the year 1886, Greenwich photographs are available on 199 days, and photographs from India and Mauritius filling up the gaps in the series on 164 days, making a total of 363 days out of the 365 on which photographs have been measured, the record being thus practically complete for 1886.

As regards the photographic reductions :—

The Greenwich photographs have been measured in duplicate as far as 1887 April 28, and the measures have been completely reduced so as to exhibit heliographic longitudes and latitudes of spots and areas of spots and faculæ.

The photographs from India and Mauritius have been received from the Solar Physics Committee as far as March 10 and February 20 respectively, and these have all been measured, and the measures completely reduced.

IV. Magnetical Observations.

The observations have been continued on the same lines as in former years, changes in the magnetic declination, horizontal force, and vertical force being continuously recorded by photography and the absolute values of magnetic declination, horizontal force, and dip being determined from time to time by eye-observation. Earth currents in two directions nearly at right angles to each other are also photographically registered. For these last the ordinates have hitherto been measured on an arbitrary scale, and it appeared desirable to obtain the data for expressing this in terms of the accepted electrical units. The authorities of the Post Office Telegraphs have courteously given every assistance in regard to the requisite electrical measurements, and an electrical balance for measuring resistance, a standard cell, and a galvanometer of the Post Office pattern have been procured under their auspices. In October last, Mr. H. R. Kempe, of the Post Office Telegraphs, made some measures of the resistances of the earth current wires, but the conditions were not then favourable for insulation. Subsequently the wires were damaged in the snowstorm of December 26–27 last, and were temporarily repaired on January 25. It is believed that they are now restored to their normal condition, and arrangements are being made to obtain the value of the difference of electric potential between the two earth-plates on each line corresponding to a given length of ordinate on the photographic register. An experimental set of measures of resistance has been taken recently.

The following are the principal results for magnetic elements for 1886 :—

Approximate mean declination	... ...	17° 55′ West
Mean horizontal force...	...	3·9379 (in British units)
		1·8157 (in Metric units)
Mean dip		67° 26′ 38″ (by 9-inch needles)
		67° 26′ 45″ (by 6-inch needles)
		67° 27′ 40″ (by 3-inch needles)

The declination and horizontal force magnets were thrown into vibration by the earthquake shock of February 23, the extent of vibration being 20′ in declination and 0·004 of the whole horizontal force in that element. The motion commenced at 5h. 37·6m. Greenwich civil time, and a second double disturbance of much smaller amplitude (possibly accidental) was registered from 7h. 39m. to about 7h. 57m. At the request of M. Mascart, a copy of the photograph has been sent to him for discussion with other records of the earthquake which he is collecting. In view of the importance of the study of earthquakes, it appears desirable that a suitable seismograph should be procured for the Observatory.

V. Meteorological Observations.

The mean temperature of the year 1886 was 48°·7, being 0°·6 below the average of the preceding forty-five years. The highest air temperature in the shade was 89°·8 on July 6, and the lowest, 16°·5, on January 7. The mean monthly temperature in 1886 was below the average in January, February (6°), March, June, and December, and above the average in September, October, and November. In the period of 156 days from 1886 December 16 to 1887 May 20 the mean temperature was 3°·1 below the average of twenty years, the daily temperature being below the average on 115 days.

The mean daily motion of the air in 1886 was 291 miles, being 7 miles above the average of the preceding nineteen years. The greatest daily motion was 857 miles on December 8, and the least, 56 miles, on October 8. The recorded pressures in 1886, exceeding 20 lbs. on the square foot, were 27·6 lbs. on March 31, and 23·5 lbs. on December 9.

During the year 1886, Osler's anemometer showed an excess of about 17 revolutions of the vane in the positive direction N., E., S., W., N., excluding the turnings which are evidently accidental.

The number of hours of bright sunshine recorded by Campbell's sunshine instrument during 1886 was 1228, which is about twenty hours above the average of the preceding nine years. The aggregate number of hours during which the sun was above the horizon was 4454, so that the mean proportion of sunshine for the year was 0·276, constant sunshine being represented by 1.

The rainfall in 1886 was 24·2 inches, being 0·5 inch below the average of the preceding forty-five years.

VII. Chronometers, Time Signals, and Longitude Operations.

The number of chronometers now being tested at the Observatory is 225.

The first seven chronometers in the competitive trial of 1886 were exceptionally good, the first chronometer being superior to any we have previously had on trial, except the first in 1882.

For the annual trial of deck-watches, which commenced last November, fifteen watches were entered, and of these nine were purchased for the Navy, the first three being classed "A," or equal, in performance, to an average box-chronometer.

A supplementary trial took place in February and March, for which nine deck-watches were entered, and of these seven were purchased for the Navy, the first two being classed "A."

The watches in each trial were rated for a period of nine weeks, viz. two weeks (dial up) in the room at a temperature of 50° to 55°, four weeks in four different positions in the oven (dial up, pendant up, pendant right, pendant left, arranged symmetrically) at a temperature of about 80°, and three weeks (dial up) in the room. When the period of rating in any position was less than a week, weekly rates were inferred from the rate for the period by simple proportion.

In order to compare the performance of the several watches, "trial numbers," representing deviations in weekly rates, have been formed on the same general principles as for the chronometer trials. The trials in different positions introduce, however, a new element, and an arbitrary weight must be assigned to them in combining them with the trials "dial up." It has been considered that when the watch is worn in the pocket the pendant will generally be "up," and that not more than one-third of the deviation "pendant right" or "pendant left" is likely to have practical effect.

Putting a = Difference between greatest and least weekly rates "dial up,"

b = Greatest difference between one week and the next "dial up,"

c = Difference between weekly rates "pendant up" and "dial up,"

d = Difference between weekly rates "pendant right" and "dial up,"

e = Difference between weekly rates "pendant left" and "dial up,"

the quantity $c + \frac{d}{3} + \frac{e}{3}$ may be taken as the measure of the deviation in weekly rate due to positions in ordinary wear. Half weight has been given to this quantity in combining it with the trial number "dial up" $(a + 2b)$, on the assumption that the deck-watch would be usually lying "dial up" and that it would not be carried in the pocket more than eight hours a day on the average. Thus the quantity $a + 2b + \frac{1}{2}(c + \frac{d}{3} + \frac{e}{3})$, has been adopted as the trial number for deck-watches. It has been arranged that for the future all pocket chronometers and deck-watches rated at the Observatory after repair shall be tested in positions.

The automatic drop of the Greenwich time-ball failed on one day only during the past twelve months. On three days the ball was not raised on account of the violence of the wind, and on five days on account of accumulation of snow on the mast.

As regards the Deal time-ball, there have been twelve cases of failure owing to interruption of the telegraph connexions, and on three days the violence of the wind prevented the raising of the ball. For fourteen days after the snowstorm of December 26–27, no signals were sent to or received from the Deal time-ball tower, telegraphic communication being interrupted. There have been four cases of failure of the 1 p.m. signal to the Post Office Telegraphs.

The arrangements for hourly time-signals at Devonport to be given by a local clock, corrected daily by the help of a time-signal at Greenwich at 10 a.m., have been carried out under Captain Wharton's directions, and a return signal from Devonport (serving as a test of the accuracy with which the local clock was corrected) has been regularly received at Greenwich (at 13h. 0m. 39s. G.C.T.) since November 22, with the exception of 36 days following the snowstorm of December 26–27, when there was interruption of the telegraphic communication with the West of England, and of 23 days when no return signal was received. The failures occurred for the most part on Sundays. The plan appears to answer well, and it seems desirous that apparatus should be provided by the Government to enable the Committee of Lloyd's to establish hourly signals at the Lizard on the same system.

The new contact apparatus of the Westminster clock was brought into action on 1886 May 22, and the automatic signals from the clock have been received regularly from that date, except on three days following the snowstorm of December 26–27. The error of the clock was insensible on 25 per cent. of the days of observation, 1s. on 40 per cent., 2s. on 22 per cent., 3s. on 11 per cent., and 4s. on 2 per cent. On one day the signal was 15s. late, and on another day 10s. late.

A suggestion has been made that in view of the importance of the connexion of the British and Continental Surveys, the telegraphic difference of longitude between Greenwich and Paris, which was originally determined with great care in 1854, should be confirmed in order to complete the network of telegraphic longitudes which have been determined of late years by Continental astronomers. It seems desirable that Greenwich Observatory, which, under Sir G. B. Airy's direction, took such an active part in utilizing the telegraph for the determination of longitude, should now assist in completing the cycle. The necessary exchange of observers and signals could conveniently be carried out in the summer of next year, when the French geodetists will, I understand, be prepared for their share of the work.

The Report concludes with the following general remarks :—"As the result of an International Congress on Astronomical Photography held at Paris in April on the invitation of the

French Academy of Sciences, at which fifty-six representative astronomers from all parts of the world were present, a scheme has been approved for the formation of a photographic map of the heavens by the concerted action of a number of Observatories in both hemispheres. This scheme provides for two series of photographs, the one intended to contain all stars down to the fourteenth magnitude inclusive, and the other, taken with short exposure, specially designed to give accurate positions of brighter stars down to the eleventh magnitude, so that it may be possible to form an extensive Catalogue of reference-stars for the first series, and thus to give the means of accurately determining the position of any star on the photographic map down to the fourteenth magnitude. The instruments with which this work is to be jointly carried out are to be photographic refractors of 0·33m. (13 inches) aperture and 3·43m. (11 feet 3 inches) focal length, and the Directors of the following ten Observatories have already announced that they are prepared to take part in the enterprise: Algiers, Bordeaux, Paris, Toulouse, and Vienna in the northern hemisphere; La Plata, Melbourne, Rio de Janeiro, Santiago da Chile, and Sydney in the southern hemisphere. It seems fitting that Greenwich should take its share in a scheme which will in a few years so greatly extend our knowledge of the places of the fixed stars, and thus serve to carry out one of the principal objects for which the Astronomer-Royal was appointed.

"On a review of the work of the past twelve months, it will be found that the activity of the Observatory has increased in various directions. The number of meridian observations is much larger than usual; additions have been made to the work of the magnetical and meteorological branch; there have been continuous trials of chronometers and deck-watches (requiring special arrangements in each case), which have made large demands on my own time, as well as on that of Mr. Turner and of Mr. Lewis. Extraneous work in connexion with the Navy has also absorbed a good deal of time that would otherwise have been free for scientific investigations. Questions connected with gun-directors, mirrors for electric search-lights, and binoculars for the Navy, have continued to engage our attention, and since the date of the last Report 510 telescopes and 35 binoculars for the Navy have been sent to the Observatory for examination, whilst it is to be presumed that a further supply of 500 binoculars, now on order, will be forwarded here to be tested in due course.

"Whilst it seems desirable that such directly utilitarian work should be undertaken at the Observatory, as being the only existing Government establishment where it can be done efficiently, I feel it necessary to point out that the existing staff is inadequate for these extraneous duties in addition to the well-defined work for which the Observatory is primarily maintained. By great efforts, which can hardly be sustained for an indefinite period, the current reductions have been kept up, notwithstanding the large number of observations obtained in the last twelve months, but the ulterior discussions which are required to maintain the character of the Observatory as a scientific institution are falling further and further behind. Amongst other matters which I should wish to take up, if leisure could be found, I may mention the determination of proper motions of stars from the observations made at Greenwich since Sir G. B. Airy's appointment in 1835, an investigation which appears to come within the terms of the Royal Warrant directing the Astronomer-Royal 'to rectify the tables of the motions of the heavens and the places of the fixed stars.'

"The appointment of a clerk, which has presumably received the sanction of the Admiralty, will, when it is made, provide for the increase of office-work which has taken place of late years in regard to chronometers, accounts, stores, stationery, printing, &c., and if the maintenance of the telegraph-wires, batteries, &c., for communication of time-signals were undertaken by the Post Office Telegraphs as part of the distribution of time to the public, there would be some further relief. But to enable me to give time to extraneous questions referred to the Astronomer-Royal by the Government, it appears necessary that the Chief Asssistant and I should be relieved of certain mechanical work which might be intrusted to computers, and that further responsibility should be delegated to the Assistants. Proceeding on the lines which have been laid down by my predecessor, I believe that the maximum of efficiency at the minimum of cost would be attained if an increase of work were met by an increase in the staff of computers, with due recognition of the position of two or three senior computers, and of the increased responsibility of the Assistants."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—In Convocation on Tuesday, a grant of £4800, applied for by Prof. Clifton, for the extension of the Clarendon Laboratory by the erection of buildings for an Electrical Department, was refused by a large majority.

Twenty-seven men have entered for the final schools in Natural Science this year, of whom sixteen offer chemistry, four physiology, three animal morphology and physics, and one botany.

A course of medical teaching, including clinical demonstrations and elementary surgery, is to be given at the Radcliffe Infirmary during the first half of the Long Vacation.

Besides the lectures which we announced at the beginning of term, Mr. Arthur Evans, the Keeper of the Ashmolean Museum, is giving a course of lectures on "The Early Iron Age."

CAMBRIDGE.—The twenty-first Annual Report of the Museums and Lecture Rooms Syndicate states that during the year 1886 considerable progress has been made in arranging the various collections, but additional accommodation in the form of cases and cabinets is required in various departments, especially for botany and ornithology. Additional accommodation is urgently demanded for the teaching of physiology, pathology, and botany. It is also desirable that permanent arrangements for human anatomy and medicine should be taken into consideration without further delay, and that the work should be commenced as soon as possible after the present chemical laboratory is vacated.

Mr. J. W. L. Glaisher, F.R.S., and Mr. J. S. Nicholson, Professor of Political Economy in the University of Edinburgh, have been approved for the degree of Doctor in Science.

The University having been applied to by the Association for the Improvement of Geometrical Teaching to take some steps to give improved methods of teaching geometry fair play in their examinations, and the Association having sent a deputation to Cambridge to confer with the Board of Mathematical Studies, the latter Board have recommended that other proofs than Euclid's be accepted in the Previous Examination, no proof of any proposition occurring in Euclid being admitted in which use is made of any proposition which in Euclid's order occurs subsequently. They do not at present propose modifications in the syllabus of geometry for the Mathematical Tripos, because they are about to revise the schedule of Part I. as a whole.

The recent report on the local lectures scheme shows that a fair share of attention has been devoted to natural science—namely, thirty-five out of one hundred courses of lectures. The courses on "Work and Energy" by Mr. A. Berry, delivered at five centres in the Northumberland mining district, were very successful. There is distinct progress in the systematization of work, and the development of local centres; but there are many difficulties owing to lack of endowments. Attempts are being made to connect practical courses of instruction with the scientific lectures, but here again the lack of apparatus and laboratories is a serious disadvantage. An endowment fund of £1136 has been contributed, of which more than half is given by the Local Lectures and Examinations Syndicate. The chief purpose contemplated is the retention of the services of practised lecturers.

The class list of the Natural Sciences Tripos, Part I., just issued, contains the following names in Class I.: Anderson, Cai.; Barber, Chr.; Colbeck, Cai.; D'Albuquerque, Joh.; Dufton, S. F., Trin.; Dufton, A., non-collegiate; Elliott, Chr.; Francis, King's; Fry, King's; Grabham, Joh.; Groom, Joh.; Richardson, King's; Tennant, Cai.; Turner, F. M., Trin.; Waggett, Pemb.; Wagstaff, Sid.; Williams, Cai.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, May 28.—Prof. W. E. Ayrton, Vice-President, in the chair.—Dr. S. P. Thompson read a note on transformers for electric distribution. In the simple algebraic treatment of the dynamo several assumptions approximately true for well-made machines are made use of. The author finds that a similar set of assumptions for transformers greatly simplifies the algebraic theory:—(1) The iron, copper, and insulation are assumed good. (2) The reaction of the secondary on the primary (other than that desired) is small; thus, if the primary be

supposed to be supplied with constant mean current or constant mean potential difference, this is not to be altered by the current in the secondary. (3) No magnetic leakage; so that the coefficient of mutual induction is the geometric mean between their coefficients of self-induction. (4) The quantities of copper in the primary and secondary are to be equal. These assumptions are shown to be legitimate, and the ratios of the resistances, E.M.F.'s, currents, and coefficients of self-induction are expressed in terms of the ratio of the numbers of convolutions, which ratio is represented by $p = \frac{S_1}{S_2}$. From analogy with the dynamo it is shown that $E_2 = \frac{\omega M}{\sqrt{R_1^2 + \omega L_1^2}} E_1$, where $\omega = 2\pi n$, E_1 and E_2 the E.M.F.'s of the primary and secondary respectively, and R_1 and L_1 the resistance and self-induction of the primary coil. If R_1 be negligible, the above reduces to $E_2 = \frac{\omega M}{\sqrt{\omega^2 L_1^2}} = \frac{E_1}{p}$, since $\frac{L_1}{L_2} = p^2$, and $M = \sqrt{L_1 L_2}$. The latter part of the paper contains a general investigation of two neighbouring circuits both having self-induction, and it is shown that the effective resistance of the primary is increased, and the self-induction decreased by closing the secondary circuit. Mr. Kapp said the investigations assumed the coefficients of induction to be constants, and that the phases of current in primary and secondary were opposite. The former being by no means true, he asked, What values were to be taken? and he believes the phases of current are not opposite in ordinary transformers. Mr. Swinburne protested against the use of formulæ to calculate the inductions when the required data could be obtained much more accurately from Dr. Hopkinson's curves on magnetization of iron. He also thought the curve of sines did not nearly represent the current curve for ordinary machines. Mr. Bosanquet thought the effective magnetization of a transformer would be different from that of a dynamo, for, in the former, permanent magnetism was not utilized. In reply to Mr. Kapp and Mr. Swinburne the author pointed out that as the coefficients of induction enter in both numerator and denominator, it would not matter which set of values were taken if the resistance was small compared with ωL; and that self-induction tends to smooth out irregularities in the current curve. Prof. Ayrton described a method of regulating a series transformer devised by himself and colleague some two years ago, based on analogy with a compound dynamo. Referring to the variation of L with current, he sketched a curve connecting them, obtained by Mr. Sumpner at the Central Institution, and mentioned that the E.M.F. curve of a Ferranti dynamo is an exact sine curve. He believes problems involving alternating currents would be greatly simplified by using a new set of measurable quantities, such as will render the equations as simple as possible. At Prof. Thompson's request, Prof. Ayrton exhibited a lecture experiment illustrating the action of transformers. The secondaries of two ordinary induction coils were joined in series through long fine wires, and an incandescent lamp placed in the primary circuit of one, lighted up on completing the primary of the other coil in which a battery was placed.—On magnetic torsion of iron wires, by Shelford Bidwell. This is an account of experiments made on the twisting produced by sending a current along magnetized iron wires, and the author shows that Wiedemann's explanation of these phenomena (by assuming a difference in molecular friction at the polar and lateral surfaces of magnetized molecules), is unsatisfactory. The wires were magnetized longitudinally by means of a solenoid in the axis of which the wires were suspended. To obtain consistent results it was found necessary to demagnetize the wire between the observations. This is done by reversed currents of gradually decreasing strength, and a simple arrangement of rheostat and commutator devised for this purpose was exhibited. Two sets of experiments were made, in one of which the current in wire or solenoid was kept constant whilst that in the other was varied. The amount of twisting does not increase continuously when the currents are increased, but attains a maximum when the inclination of the helix, representing the direction of magnetization, is inclined at about 33° to the axis of the wire. When the current in the solenoid was kept constant and that in the wire increased, permanent deflections remained on stopping the current. For small currents in the wire this deflection was diminished on starting the current, whilst stronger currents increased the deflection. For some intermediate value of the current, no change took place, and this value was dependent on the current in the solenoid. Experiments were shown illustrating these phenomena.

Anthropological Institute, May 24.—Mr. Francis Galton, F.R.S., President, in the chair.—Dr. George Harley, F.R.S., read a paper on the relative recuperative powers of man living in a rude, and man living in a highly civilized state; in which he brought forward a number of hitherto unpublished, though mostly well-known facts, demonstrating that the refining influence of civilization had not been altogether the unalloyed boon we so fondly imagine it to have been. For the cases cited went far to demonstrate the fact that while man's physique, as well as his mental power, had increased during his evolution from a barbaric state into a condition of *biensèance*, his recuperative capacity, on the other hand, has materially deteriorated. In fact, it appeared from the examples cited that every appliance adding to man's bodily comfort, as well as every contrivance either stimulating or developing his mental faculties, while increasing his personal enjoyments materially diminishes his animal vitality; rendering him less able to resist the effects of lethal bodily injuries, or recover from them as well and as quickly as his barbaric ancestors, or his less favoured brethren.—Mr. G. L. Gomme read a paper on the evidence for Mr. McLennan's theory of the primitive human horde: and a communication by Mr. Samuel Gason on the Dieyerie Tribe of South Australia was also received.

Mineralogical Society, May 10.—Mr. L. Fletcher, President, in the chair.—It was reported that Mr. F. Pearce, of Maritzburg, Natal, and Prof. Albert Chester, of Clinton, N.Y., had been elected members in April.—The following papers were read:—Microscopical studies on some eruptive rocks from the Caucasus and Armenia, by Dr. Hjalmar Gylling, of Helsingfors.—Note on some specimens of glaucophane rock from the Ile de Groix, by Rev. Prof. Bonney, F.R.S.—On the crystalline form of kreatine, by Mr. L. Fletcher.—Note on francolite, by Mr. F. H. Butler.—On the meteoric iron seen to fall in the district of Nejed, in Central Arabia, in the spring of 1865, by Mr. L. Fletcher.—On a granite containing andalusite from the Cheesewring, Cornwall, by Mr. J. J. H. Teall.—Prof. J. W. Judd, F.R.S., exhibited some specimens and sections of tabasheer and other forms of opal, and made some observations thereon.

PARIS.

Academy of Sciences, May 31.—M. Janssen in the chair.—On the condition of stability in the movement of an oscillating system connected with a pendular synchronic arrangement, by M. A. Cornu. A solution is here offered of a problem which presents itself in the adjustment of certain apparatus of great precision employed in physics and astronomy: how to render the oscillations of a given mobile system, such as a pair of scales or a galvanometer, exactly synchronous with a corresponding periodical motion, such as that of a clock's pendulum, and the like.—On some crystallized metallic alloys of platina and tin, by M. H. Debray. Resuming his former studies of these alloys, the author here deals with those of platina and tin, with formula, $PtSn_4$; of rhodium, $RhSn_3$; of iridium, $IrSn_3$; and of ruthenium, $RuSn_3$. Osmium yields no alloy with tin, in which metal it crystallizes.—Progress of the Arago Laboratory, by M. de Lacaze-Duthiers. An account is given of the improvements lately introduced at this marine zoological station, which has been established at Banyuls. It is now fitted with a 7 horse-power steam-engine for supplying the aquarium with water, and with submarine electric lamps for studying the habits of the Mediterranean fauna.—On a fossilized tendril of *Nymphæa Dumasii*, Sap., by M. G. de Saporta. Although traces of rhizomes of Nymphæaceæ in various Tertiary formations are far from rare, the present fossil is specially remarkable for its great beauty and excellent preservation. Apart from the inner structure, which has been replaced by some amorphous substance, it retains all the exterior outlines of the organ down to the minutest superficial details.—Report on the velocities set up by the tides of the Pacific and Atlantic Oceans in a canal establishing free communication between these two basins, by M. Bouquet de la Grye. This is the Report of the Commission appointed last year at the request of M. de Lesseps to study the influence likely to be exercised on the Panama Canal now in progress by the regular rise and fall of the surrounding waters. It appears that the tidal currents, much stronger on the Pacific than on the Atlantic side, can

never exceed 2½ knots, and that this velocity will be reached only for a few hours at the equinoctial syzygies every year. It is incidentally stated that the Canal will be 72 kilometres long, 21 metres wide at bottom, with a slope of 45°, and a depth of 11·50 metres below the mean level at Panama, and of 9 metres below that of Colon.—Observations of Barnard's Comet (1887 *e*) made at the Algiers Observatory with the 0·50 m. telescope, by MM. Trépied and Rambaud. These observations give, in tabulated form, the apparent right ascension, the declination, and number of comparisons with other stars for the period from May 16 to May 24; also the positions of the stars and the apparent positions of the comet for the same period.—On simultaneous linear equations with partial derivatives of the second order, by M. Painlevé. Some remarks are offered in connexion with M. Goursat's recent paper on this subject, including the explanation of a different method for obtaining the same results.—On a melograph, by M. J. Charpentier. The apparatus here described and presented to the Academy have been devised and constructed for the purpose of offering a solution of the problem relating to the fixation of musical improvisations, and are applicable to the piano type of instruments.—On the vapour-tensions of liquid cyanogen, by MM. J. Chappuis and Ch. Rivière. While studying the compressibility of cyanogen the authors have had occasion to measure some maxima tensions of this gas, with results differing considerably from those obtained by Faraday and Bunsen. The discrepancies are attributed partly to the great difficulty of introducing cyanogen free from nitre into the barometric chamber; but chiefly to the manometric methods employed by those physicists, these methods being much inferior in accuracy to the open air manometer adopted by the authors.—On the reproduction of a carbonate of soda known as urao and trona, by M. Paul de Mondésir. These remarks are intended to throw some light on the subject of sesquicarbonate of soda, under which title are grouped various more or less unsatisfactory data and observations.—Action of selenious acid on the bioxide of manganese, by M. P. Laugier. During the course of his researches to discover an oxygenated product Se_2O_5 corresponding to S_2O_5, obtained by the action of sulphurous acid on the bioxide of manganese, the author has obtained some new compounds, here described, resulting from the combination of selenious acid with the sesquioxide of manganese.—On a simplified calcimeter, by M. A. Bernard. For the apparatus here described it is claimed that it possesses several advantages over that of Scheibler, although based on the same principle.—Researches on the relations existing between the spectrum of the elements of inorganic substances and their biological action, by Mr. James Blake. The author's further researches with over forty inorganic elements confirm his previous conclusions; all except nitrogen and potassium showing a definite relation between their biological action and their conditions of isomorphism.

BERLIN.

Physical Society, May 20.—Prof. Du Bois-Reymond, President, in the chair.—Dr. Gross spoke on the electrical condition of magnets during their magnetization. His experiments were made with Joule magnets. A cylindrical piece of iron was split along its axis, and the lower half of the cylinder surrounded lengthways by the spiral wire which conveyed the magnetizing current, completely insulated from it; the ends of the upper half of the cylinder were perforated by copper spikes, which were then connected by means of copper wires with a galvanometer so as to form a closed circuit. After this circuit, which included the upper half-cylinder, had been brought into electrical equilibrium, the magnetizing current (in the spiral surrounding the other half of the cylinder) was reversed, and the galvanometer gave a throw. The direction of the current thus indicated was always opposite to that of the magnetizing current passing along the inner surface of the half-cylinder. The speaker thought himself justified in excluding the possibility of this result being due to a simple inductive action of the magnetizing current on the galvanometer circuit, inasmuch as when the iron half-cylinder was replaced by one of copper the galvanometer then gave no throw. (In the discussion which followed it was remarked, in opposition to this view, that the resistance of the galvanometer was too great to admit of its indicating a simple induced current when experimenting with the copper half-cylinder.) Similarly, Dr. Gross is inclined to exclude as an explanation any induction of the magnet upon itself, and thinks that the cause of the current is the difference of potential between the inner and outer side of the cylindrical magnet. This point he proposes to investigate carefully in a future series of experiments.—Prof. Lampe criticised two papers which appeared last year in the *Repertorium für Physik*, of which one contained an explanation of gravitation, the other treated of the motion of a Foucault pendulum. The speaker pointed out very fully the mathematical and physical mistakes which had made it possible for the author of the first paper to regard gravitation as due to the rotation of the earth.—Prof. von Bezold gave an extremely lucid description of Sprung's balance-barograph.—Prof. C. W. Vogel communicated the most recent discovery in connexion with instantaneous photography, by which it is now possible to obtain instantaneous photographs not only at night but also in the darkest places. Messrs. Goedicke and Miethe have prepared a mixture of pulverized magnesium, chlorate of potash, and sulphide of antimony, which when ignited produces an explosive lightning-like illumination of such intensity that by means of it an instantaneous photograph can be taken. The speaker then gave a demonstration of the discovery by taking photographs of several persons present; he used the artificial light, of which each flash lasted one-fortieth of a second, and in a few minutes produced a picture during the meeting. The powders, as prepared by the discoverers, cost only a few pfennigs each, and will hence readily come into general use.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Papers and Proceedings of the Royal Society of Tasmania for 1886.—Guide to the Science of Photo-Micrography: E. C. Bousfield (Kent).—Questions on Physics: S. Young (Rivingtons).—Encyklopædie der Naturwissenschaften, Erste Abth. 51 Lief., Zweite Abth. 42 and 43 Lief. (Trewendt, Breslau).—Elements of Physiological Psychology: G. T. Ladd (Longmans).—Les Pigmées: A. de Quatrefages (Baillière, Paris).—Official Record, New Zealand Industrial Exhibition, 1885.—Report of the Metropolitan Board of Works, 1886.—British Dogs, No. 7: H. Dalziel (Gill).—Bees and Bee-keeping, vol. ii. Part 8: F. R. Cheshire (Gill).—Reports of Experiments with various Insecticide Substances (Washington).—Our Shade-Trees: C. V. Riley (Washington).—Bulletin of the Iowa Agricultural College, November 1886 (Iowa).—Report of the Felsted School Natural History Society, 1886.—Diseases of the Hair, &c.: J. Startin (Harrison).—International Journal of the Medical Sciences, April (Cassell).—Journal of the College of Science, Imperial University, Japan, vol. i. Part 2 (Tōkyō).

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