Nature

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE


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

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REVIEWS AND OUR BOOKSHELF.

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THURSDAY, MARCH 2, 1911.

RESEARCHES ON RADIOACTIVITY.

Traité de Radioactivité. By Prof. Mme. P. Curie. Tome i., pp. xiii+426. Tome ii., pp. 548. (Paris: Gauthier-Villars, 1910.) Price, 2 vols., 30 francs.

NO more effective illustration of the rapidity of advance of accurate knowledge of radio-activity can be taken than a comparison of the two books published on the subject by Mme. Curie, at an interval of seven years. The first, published as a thesis for the doctorate of science in 1903, was a small volume of 142 pages, and gave an account, not only of her own work, but of most of the important facts known in radio-activity at that time. The second, published at the close of 1910, consists of two volumes, containing in all nearly a thousand closely-written pages, and giving an orderly and systematic account of the large mass of data that has been accumulated in the interval. The remarkable rapidity of advance of this new branch of science largely results from two factors—the discovery and isolation of radium by Prof. and Mme. Curie, and the development of the transformation theory in 1903.

The discovery of radium gave an opportunity to the investigator of obtaining intensely radio-active material, in which the typical radio-active effects are shown on a very marked scale. The remarkable properties of radium attracted the attention of the scientific world, and gave a great impetus to the study of radio-activity. On the other hand, the transformation theory has proved an invaluable guide to the investigator in disentangling the apparently complicated processes occurring in radio-active matter. It offers a rational explanation of practically all the experimental facts that have been discovered, and has been instrumental in bringing to light a number of unsuspected relations of great importance.

This work represents, with additions, the course of lectures on radio-activity given by Mme. Curie in the Sorbonne. The first chapter is devoted to an account of the conduction of electricity through gases, and the second to a description of the methods employed in radio-active measurements. The latter contains a somewhat detailed account of the theory of the electrometer and of the quartz piezo-electrique devised by J. and P. Curie. Chapters iii. and iv. include an account of the general radio-active properties of uranium and thorium, and of radio-active minerals, and a very complete account of the methods of isolation of radium and polonium and other radio-active materials. This chapter will be read with especial interest, as it is largely an account of the author's well-known discoveries. The next three chapters deal with the radio-active properties of the emanations, and of the active deposits which are derived from them. A very full description is given of the methods employed in determining the molecular weight of the emanation by diffusion methods, and also a clear account of recent work upon the purification of the radium emanation, the determination of its volume, and of its physical and chemical properties. In chapter viii., after a review of the various theories proposed, the transformation theory is adopted, and the mathematical theory of successive transformations is given. Then follows a long chapter of more than 200 pages, giving a systematic account of the nature of the radiations from radio-active bodies, followed by a discussion of the general physical and chemical effects shown by the radiations, including the production of helium from radio-active matter, and an account of the experiments which have been made by Ramsay and others to test whether the radiations from active matter are able to transform inactive elements. After a discussion of the various experiments, Mme. Curie sums up as follows:—

"En résumé, on peut considérer qu'il n'y a pas encore actuellement de raisons suffisantes pour admettre que la formation de certains éléments puisse être provoquée à volonté en présence de corps radio-actifs. La production d'hélium reste acquise; mais elle est reliée à une propriété essentielle des éléments radioactifs et n'est pas influencée par l'intervention de l'expérimentateur."

Chapter xi. gives an account of the methods of measurement of heat emission of the radio-active substances, while the next four chapters deal with suc-

cessive transformations occurring in uranium, thorium, radium, and actinium, followed by an account of the origin of radium and the discovery of ionium, and the discussion of the general connection between the radio-active series. The last chapter is devoted to a consideration of the radio-activity of the earth and atmosphere.

An excellent portrait of Pierre Curie is given in the frontispiece. Several interesting reproductions are included at the end of the volume in illustration of the photographic effects of the various radiations. Carefully prepared tables are included in the text, giving the important radio-active constants, while a table of exponential values is added for convenience in calculating the decay and growth of the radium emanation.

In these two volumes, written in a clear and interesting manner, Mme. Curie gives a full and complete account of practically all the work of importance that has been done in radio-activity. It is a storehouse of accurate information. The author has shown judgment in the selection of data and in discussion of points at issue. The chemical methods of separation of radio-active products are in most cases briefly given, while a detailed account is included of the methods of separation of radium and of polonium. This is excellent so far as it goes, but it does not fill the pressing need at the present time of a practical book on the methods of separation and purification of the numerous radio-active products. Such an account should prove of the greatest value both to chemists and physicists, for it is becoming more and more important in many lines of work that the investigator should be able to separate and concentrate the various radio-active products. Such an account can only be written by an expert both on the physical and chemical side who has himself worked over the subject, for more than a compilation of chemical methods is required.

It is always a difficult matter in a work of this character, which treats of a rapidly growing subject, to give full credit to pioneer discoveries, and at the same time to do justice to later work of a more detailed and accurate character. Mme. Curie has, to a large extent, overcome this difficulty by giving a fairly detailed account of the original experiments, and a more condensed statement of subsequent work.

There is very little to criticise and much to admire in this notable work. It is remarkable what little difference of opinion exists among radio-active workers on the interpretation of the main phenomena. This is no doubt mainly a result of the general adoption of the theory of atomic disintegration, for on this theory only one explanation is in most cases admissible. While there is a general agreement on the fundamental points, there is naturally room for wide difference of opinion on matters still under investigation. This is well illustrated by the conflicting views that are at present held on the difficult question of the nature of the emission and of the absorption of the β and γ rays by active matter. The advocacy of rival views on such questions is in many cases a great advantage, for it gives an incentive to a more accurate and complete investigation of the problem under consideration.

While the reviewer finds that he is in substantial agreement with all the main conclusions of Mme. Curie, there are a few minor points to which attention may be directed. Mme. Curie includes radio-uranium as a possible product of uranium, although a note of interrogation is attached. She certainly makes a better case for its existence than is given in the original publication; but until more definite information is forthcoming it does not appear desirable to include it in the uranium series. The products radium E_1 and radium E_2 are retained, although later work of Antonoff has indicated conclusively that only one product of period about five days which emits β rays can be present. The discovery of ionium is credited to Rutherford and Boltwood; it should be Boltwood. The original suggestion that lead is a final product of the transformation of radium is attributed to Rutherford. It should be Boltwood. The term "radio-active induite" is used widely throughout the work. While the use of this expression is historically justified, it is a misnomer, especially when used in reference to radio-active *matter* deposited from the emanation. The term "active deposit," which has come into general use, is a very convenient substitute, and it is desirable that the original names, "induced," or "excited," activity, should disappear from the literature.

The lack of a name- or subject-index is a serious drawback to the usefulness of this treatise. The references to literature are incomplete, the name of the journal and the year of publication alone being given.

As an account of a youthful branch of science, the present treatise may appear somewhat lengthy; but it must not be forgotten that the subject of radio-activity now covers a very wide field of work. It has to treat, not only of the nature of remarkable types of radiation which are emitted, but also of the origin and physical and chemical properties of more than a score of new transition elements. In addition, it has to deal with the distribution of radio-active matter in the earth and atmosphere, and its bearing on atmospheric electricity and on problems connected with geology. Unless this treatise is to become unwieldy in size, it will be necessary in future editions, where much new work has to be included, to adopt a policy of more rigid selection and compression of the experimental data to be discussed. No doubt as our knowledge of the various questions becomes more definite, it will not be so difficult as at present to give a complete review of theory and experiment within reasonable limits of space.

The present work will be read with the greatest interest by all workers in radio-activity as an authoritative account of the subject from one who has made notable contributions to its history. The book is essentially written for the investigator rather than for the ordinary student, and will be of the greatest service to the former as a complete and accurate review of all important publications on the subject. Every reader will recognise the great labour and patience involved in writing a complete treatise on such a rapidly growing subject, and Mme. Curie is to be congratulated on the success of her efforts.

This treatise is a noteworthy contribution to the

literature of this new and fascinating field of scientific inquiry, and redounds to the credit of Mme. Curie, and to the nation which has taken such a fundamental and prominent part in the development of radioactivity.

E. R.

DYNAMO-ELECTRIC MACHINERY.

The Dynamo: Its Theory, Design, and Manufacture. By C. C. Hawkins and F. Wallis. Fifth edition. Re-written, revised, and enlarged. Vol i., pp. x+542. Vol. ii., pp. viii+543–1134. (London: Whittaker and Co., 1909.) Price 21*s.* net, two vols.

THE increase in the size of Messrs. Hawkins and Wallis's book is a good indication of the progress that has taken place in the practical development of the dynamo. Little or no addition has been made in the interval to the fundamental theory of direct-current and alternating machines; an immense advance has been made in the mastery of the thousand and one details of selection of materials and methods of construction of machines for different purposes.

Vol. i. is mainly theoretical, and contains statements regarding the physical facts and theories on which electric generators and motors are based. The treatment of the magnetic circuit, of self-induction and alternating currents, the classification of dynamos, the magnetic properties of iron, and so forth, strike one as exceedingly satisfactory. In general there is a clear perception of what constitutes a proof of a theorem and what a mere illustration or representation of results. It is possible to frame graphical proofs of theorems of electromagnetism, as of dynamical theorems regarding stresses in the members of a girder, and it is a good thing to do so; but many so-called graphical "proofs" are mere illustrations of results which have been so far only satisfactorily established by analysis. The graphical representation displays to the eye connections of things set forth in equations, and so far as possible this should be done in all departments of mathematical physics; but the student should not be led to imagine that he has got to the root of the matter, when he realises that $\sqrt{R^2+n^2L^2}$ is the length of the hypotenuse of a right-angled triangle, the lengths of the sides of which are R and nL. As it seems to us, Messrs. Hawkins and Wallis have given a very happily blended analytical and geometrical discussion.

The analogy of inductance and capacity to inertia and the slackness of a buffer spring, of the electro-kinetic energy $\frac{1}{2}Li^2$ to the kinetic energy of a carriage, and the analogy of the dissipation of this kinetic energy, when the carriage is brought to rest by collision with the buffers, to the break of a circuit containing a condenser, gives a clearer idea of what happens than general statements, and we should have liked to see some such practical "engineering" illustrations in the chapter on self-induction.

Then it is a little difficult to distinguish, as the authors seem to do on p. 69, between "the current itself," and the magnetic field which it produces. Is it not all one phenomenon? One may try to distinguish between the current—the motion of electrons (or, as someone has illuminatingly called them, the essential singularities that are at the root of all electrical action)—and the magnetic field, but is it possible to do so really? One cannot have a vortex filament in an infinite fluid without the irrotational flow which constitutes its field. It may be said that by twisting the outward and inward wires of a circuit together or by putting one inside the other, a field can be avoided; but the assertion is only true for space external to the conductors. A field can only be avoided altogether by making the going and returning conductors absolutely coincident, in which case there is no current.

The molecular theory of magnetism may possibly require modification in view of still more modern theories of the electrical constitution of matter; but it has done much service in clarifying the ideas of students of magnetism, and it still substantially fits the facts. How often did one find in elementary books the higgledy-piggledy arrangement of molecular magnets pictured, to explain to the reader the constitution of a body in the neutral state? It never seemed to occur to the writers that these magnetic molecules must act on one another, and that the perfectly fortuitous arrangement was unlikely to have been set up, or to remain if it were. The closed chains were in the minds of many; the exhibition of Ewing's model made clear how these closed chains led to the observed magnetisation curves.

During the last year or two much further work on magnetic induction in iron and alloys has been done, and on the influence of treatment of different kinds: it will be for the dynamo builder and user to examine whether any part of the work is likely to be of use to them. But no doubt for a long time the knowledge that has been accumulated of the constants of steel of different kinds, in stampings of different thicknesses, will be sufficient for their needs.

Chapters xiv. and xv. of the first volume, on "Field-Magnets" and "The Ampere-Turns of the Field" respectively, are exceedingly instructive and interesting, and are, of course, of great importance, for the proper design of a dynamo or motor for a given specified purpose depends entirely on a due appreciation of the principles laid down in every sound discussion of this subject.

In vol. ii., after a discussion of armature reaction which seems adequate, a long chapter (110 pages) is given on "Commutation and Sparking at the Brushes." This important subject is very fully dealt with, apparently with a thorough appreciation of all that has been done on the subject of commutation and the factors on which sparking at the brushes depends, and also of the quantitative laws of the matter so far as these have been theoretically and empirically compiled.

Chapters follow on the "Design of Continuous-Current Dynamos and Alternators," and these are based on a full description of all the various forms of armatures and field-magnets in use in the various types.

The book, if a little heavy (in avoirdupois), is beautifully printed and magnificently illustrated with 594 pictures, diagrams, and cuts of different sorts, and reflects credit on authors and publishers alike.

A. G.

RÖMER'S ADVERSARIA.

Ole Römer's Adversaria, med Understöttelse af Carlsbergfondet udgivne af det Kgl. Danske Videnskabernes Selskab. By Thyra Eibe and Kirstine Meyer. Pp. v+271. (Köbenhavn: Bianco Lunos Bogtrykkeri, 1910.)

AMONG astronomers Ole Römer (1644–1710) occupies a peculiar position. He was held in high repute among contemporary men of science, as may be seen from the fact that Newton and he were the first astronomers to be enrolled among the eight foreign associates of the Paris Academy of Sciences, and were elected on the same day. To posterity he is known as the discoverer of the gradual propagation of light, and as the man who introduced the use of (if he did not invent) the transit instrument and the transit circle. And yet his published writings only fill a few pages, and the observations he made with instruments far superior in design to those of his time, were not printed, and nearly all of them perished not long after his death. There is, therefore, every reason to welcome the publication of his common-place book, which has been brought out just two hundred years after his death.

Like every other book of its kind, the present book of Adversaria deals in a scrappy way with a great variety of subjects, and it shows what chiefly occupied Römer's mind, especially during the last ten years of his life. We see him as a practical astronomer, as a physicist, and as a man who had for many years served his country well by reorganising the system of weights and measures, getting the Gregorian calendar introduced, and preparing a uniform system of land taxation. But though these various occupations, which gradually came to fill most of his time to the great loss of science, are now and then alluded to in the present volume, they do not fill many pages in it. It looks as if Römer was in the habit of taking refuge in his commonplace book when he wanted to refresh his mind after his hard work as Burgomaster and Chief of Police of Copenhagen. To give a full account of the contents of his notes is not possible in a limited space: we can only give the reader some idea of the kind of subjects dealt with. An important section on thermometers, dating from 1702, has already been described in NATURE, (vol. lxxxii., p. 296). Römer appears to have been the first to construct thermometers with two fixed points, marking the temperatures of melting snow and of boiling water, and he was the inventor of the scale known as Fahrenheit's.

Turning to astronomical matters, we find Römer to have been a follower of Descartes in his views on the construction of the universe, though his own discovery about light did not exactly harmonise with Cartesian ideas. He inquires at what distance a planet or satellite would have to be from the central body according to the third law of Kepler in order that its period of revolution may equal the period of rotation of the central body. In the case of a planet he finds the distance equal to 37 semidiameters of the sun, in the case of a satellite of the earth 6½, and for a satellite of Jupiter 2 semidiameters of the respective planet. This, he thinks, may be made to agree with the vortex theory by assuming that radiation from the central body impedes the rotation of the ether, and this radiation, being naturally much more powerful from the sun, causes its influence to be felt at a much greater distance than that at which the radiation of a planet is perceptible. He shows himself interested in solar phenomena by calculating the apparent position of the sun's axis, and of the path of sun-spots for every 7½° of longitude of the sun, having first determined the inclination of the sun's equator and the place of the node with fair accuracy from his own and La Hire's observations. It will be remembered that the sun's equator was in those days often used as a fundamental plane or Via Regia of the solar system. He calculates the transit of Mercury of May, 1707, from Kepler's elements and observations by Hevelius of the transit of May, 1661. He calculates the solar eclipse of September 13, 1708, for Copenhagen, and Holum in Iceland, and gives rules for the prediction and graphic representation of an eclipse. The transit instrument in the prime vertical, of which he had introduced the use, is employed for the determination of the vernal equinox of 1702, and he examines the consequences of errors of observation in the transit, and shows how to determine the error of collimation by reversing the instrument.

The above examples, which could easily be multiplied, will show that the two ladies who have edited this book have done good work by bringing it to light. There is a useful index and an excellent table of contents, and every care seems to have been taken to produce an accurate edition of the old manuscript. The few Danish words or sentences occurring here and there might have been translated in foot-notes for the convenience of readers not acquainted with that language. J. L. E. D.

GALL-FLIES AND OTHERS.

Das Tierreich. Eine Zusammenstellung und Kennzeichnung der rezenten Tierformen. Edited by F. E. Schulze. 24 Lieferung. Hymenoptera. Cynipidæ. By Prof. K. W. von Dalla Torre and Prof. J. J. Kieffer. Pp. xxxv+891. (Berlin: R. Friedlander and Son, 1910.) Price 56 marks.

THIS work forms a worthy volume of the series of zoological works published under the general title of "Das Tierreich," by Messrs. R. Friedlander and Son, of Berlin. It is an extension of the two volumes by Dr. Kieffer in André's "Species des Hyménoptères d'Europe et de l'Algérie." Dealing as it does with the Cynipidæ of the whole world, and containing descriptions of all the known genera and species, the book is indispensable to students of the Cynipidæ. Theodore Hartig was the pioneer of the scientific study of the group. He placed the classification on a proper basis, and was the first to point out the threefold habits of the species—gall-makers, inquilines, and parasites. After him came Giraud, Schenk, and, above all, G. L. Mayr, who made the identification of the galls easy by the publication of beautifully illustrated works on the species of Central Europe, as well as a monograph on the guest-flies (Synergi).

Then came the epoch-making discovery by Dr. Adler of the existence of alternations of generation—that a spring bisexual form was followed by an autumnal unisexual one, the two forms having totally different galls.

The volume commences with a list of the authors who have published separate works, and of the titles of the journals and transactions of scientific societies in which papers have appeared, the total number being 252, beginning with Malpighi in 1675. The titles of papers in magazines and transactions are not given. If they had we should have had the names of T. A. Marshall, E. A. Fitch, Prof. J. W. H. Trail, and other workers at British cecidology, besides the seven British authors given in the catalogue. We notice that while the list contains the French translation of Adler's papers, no mention is made of the English one by Mr. Standen. Next we have a "systematic index" of the genera and species, followed by the descriptions of the subfamilies, genera, and species, the whole concluding with a good index of the genera and species, but not of the plants, and a "Nomenclator generum et sub-generum." There are no figures of entire insects, but there are some illustrating the structure in the introduction, while there are 398 wood-cut illustrations of galls.

The authors divide the family into ten subfamilies and 126 genera, besides two doubtful ones; describe fully 1281 species, as well as 102 subspecies; in addition there are 212 species which have been too briefly described for recognition, and of which the original descriptions are reprinted. Some changes in generic nomenclature are made. Allotria, West., and Xystus, Htg., its synonym, are suppressed, both being preoccupied. In place of them Dr. Kieffer adopts Charips, a MS. name of Haliday, first used by Marshall. The name of Diplolepis is revived after long disuse, it replacing Dryophanta. On the other hand Ashmead considers it to be the same as Diastrophus. The system of subgeneric names and trinomials for the species with well-marked varieties is adopted. Thus we have Eucœla and Cothonaspis, both with nine subgenera, the latter being genera with Foerster and Ashmead. This method, in some cases, leads to a species having four names, *e.g.* we have *Eucoila Psichacra Marshalli Marshalli* for the typical form of Cameron's species, and *Eucoila Psichacra Marshalli rufo-notata* for the variety.

An interesting fact in the biology of the parasitic Cynipidæ is that some species are found in ants' nests. Long ago Westwood bred *Charips victrix* from the rose aphis, and as many other species of the same genus have also been bred from plant-lice, it might fairly be concluded that the genus was a beneficial one. There is now, however, reason to believe that Charips is a hyperparasite, destroying, not the aphis, but the beneficial Braconid which preys on it. If that is so the species must be looked upon as injurious. The present writer has seen *Charips victrix* ovipositing in plant-lice killed by Aphidius, which pupates in the lice, the bodies of which become dried, inflated, and are attached to the leaf by the parasites. *Cothonaspis zig-zag* is another injurious hyperparasite, it destroying *Phora aeletiae*, the parasite of the injurious cutworm of the cotton. Among the habitats of the Parasitica is the sea-shore, where two British semiapterous species are found at high-water among seaweed.

It is curious how the Cynipidæ form their galls on certain plants more than on others. The oak in Europe and in North America is the predominant food-plant. In Europe *Quercus pedunculata* harbours ninety-nine species, *Q. pubescens* seventy-nine, and *Q. sessiliflora* ninety-six. After the oak come the Rosaceæ—Rosa, Rubus, Potentilla. The poppy has two species in the fruit and one in the stem. It is remarkable that the willows, on which there are so many dipterous and saw-fly galls, have not one species of Cynipidæ attached to them.

As regards the distribution, Dr. Kieffer gives some curious examples of the unequal manner in which some genera are distributed in Europe and North America. Callirhytis has four species in Europe, in America fifty-two. Rhodites has twelve Palæarctic and seventeen Nearctic, while Lytorhodites is exclusively Nearctic, as is also Amblybolyps with twenty-four species. A few species are found in Europe and North America, *e.g.* our "begeguar" and *Aulax latreillei* on *Glechoma hederacea* as in Europe, while *Rhodites eglanteriae* is recorded from the West Indies. Solanum should be deleted from the list of food-plants, it being now known that the galls of *Tribalia batatorum* came from the rose and not from the potato. Ashmead is no doubt correct in considering Tribalia to be identical with Lytorhodites.

There are one or two points in the work which concern our British species—Aulax, Hartig, is split up into two—Aulax (Kieffer retains the old, incorrect spelling, Aylax) with *latreillei*, Kief. (*glechomae* of Cameron's monograph), *hypochoeridis*, *papaveris*, *minor*, *scabiosae*, and *Fitchi*; and Aulacidea with *hieracii* and *graminis*. We doubt if *Cynips kollari*, our common "marble gall" fly, is dimorphic, and that *Andricus circulans* (a Turkey-oak species found in Britain only in Kew Gardens) is its sexual form. Our own experiments appear to show that it is agamic, while, if *A. circulans* were its sexual form, it surely should be equally common and as widely distributed.

In conclusion, we have to congratulate cecidologists on the appearance of this admirable and thorough work, which will be as useful to the beginner as to the advanced student in all parts of the world.

P. C.

THE CRYSTALLISATION MICROSCOPE.

Das Kristallisationsmikroskop und die damit gemachten entdeckungen insbesondere die der flüssigen Kristalle. By Prof. O. Lehmann. Pp. iv+112. (Braunschweig: F. Vieweg and Son, 1910.) Price 3 marks.

PROF. LEHMANN is gifted with the pen of a ready writer, and has in recent years poured forth such a voluminous stream of papers and books dealing with the subject of mobile crystals in its many aspects that considerable overlapping and repetition necessarily exists in them. Such criticism may be levied also against the present little book, which first

saw light in the pages of a *Festschrift*, issued by the Technische Hochschule in Carlsruhe, to commemorate the fifty-third birthday of the Grand Duke of Baden. It does, however, contain detailed descriptions of the latest forms of the microscope which have not appeared in print before, and would, moreover, be welcomed for the sake of the interesting historical account of Prof. Lehmann's researches, which spares the student of the subject the difficulty and trouble of hunting up a series of papers published at various dates and in various periodicals.

Nearly forty years have elapsed since Prof. Lehmann, while still a student, first devised a form of microscope by means of which substances could be observed at higher than ordinary room temperature, and the phenomenon of crystallisation watched in actual operation. The results of the research thereby rendered possible were, as is well known, unexpected and startling, and the meaning and even the reality of the observations were for long the subject of considerable discussion and dispute. Other workers have, however, in recent years entered the field, who on the whole have confirmed the accuracy of Prof. Lehmann's observations, and there can be no doubt but that the old ideas regarding crystals and crystallisation needed extensive modification. The investigations are discussed in chronological order in the present book, but since we noticed them less than two years ago (NATURE, 1909, vol. lxxix, p. 286), we shall not recur to them here. With each step some improvement in the instrument or some additional facility suggested itself until it reached the most recent form, which is provided with water jackets, powerful heating arrangement, means for reading the temperature, and a camera, and even a kinematograph, for giving a faithful record of the phenomena. The descriptions of the different forms are elucidated by excellent illustrations.

The last chapter of the book might with advantage have been omitted. Discussions of one's claim to priority of discovery, and the proper appraisement of one's work rarely serve a useful purpose, and are to be deprecated.

HEAT-ENGINES.

The Steam-Engine and other Heat-Engines. By Prof. J. A. Ewing, C.B., F.R.S. Third edition, revised and enlarged. Pp. xvii+604. (Cambridge: University Press, 1910.) Price 15*s*.

IN this, the third edition, Dr. Ewing has thoroughly revised his well-known text-book, and to some extent he has rewritten certain chapters; for example, the chapter on steam turbines is new, and the greater part of that devoted to gas and oil engines. The most important departure, however, is that in dealing with the properties of steam the author has accepted the characteristic equation of Callendar along with the steam tables derived from it by Mollier. The old steam tables were based chiefly on Regnault's well-known experiments, and it has been recognised that they involve inconsistencies and errors. Prof. Callendar, whose first paper on the subject was published in 1900, has devised a method of treatment which is free from inconsistencies, and gives, when expressed in the form of tables, results which agree with all the most recent experiments, at any rate, between the temperatures of 0° C. and 200° C. Possibly Callendar's equation will not give such a close approximation to experimental results for pressures lying beyond the upper of these two limits of temperature. In the form of an appendix, Dr. Ewing has added a brief account of Callendar's characteristic equation, and of Mollier's readjustment of the constants. Dr. Ewing has also decided to adopt the Centigrade scale throughout the whole of his book.

In chapter v., which is devoted to entropy, the author describes Dr. Mollier's graphic methods of representing the properties of steam. By the aid of these diagrams the engineer has placed at his disposal a simple method of solving the problem of determining the state of steam which is expanded adiabatically from any initial condition whether superheated or not, and of determining the greatest theoretical output obtainable from steam when the initial condition and the lower limit of temperature are assigned.

Chapter viii., on steam turbines, is an entirely new chapter, and will be found of great assistance by all engineers who are interested in the design and working of the steam turbine. The whole subject of the design of the steam turbine is fully discussed both from the theoretical and from the practical side.

The last chapter is a new one on gas and oil engines. The efficiency of the ideal cycle is worked out on the assumption of constant specific heat, and the author then discusses the problem of the variation of specific heat with temperature, or in other words, the relation between the internal energy of the gas and its temperature, and discusses the effect of this variation upon the efficiency of the ideal engine working on the ordinary gas engine cycle.

In its present form Dr. Ewing's book will undoubtedly be the text-book most frequently consulted by all engineers who have to deal with steam and other forms of heat engines. T. H. B.

GEOLOGICAL NATURE-STUDY.

The Earth and its Story. By Dr. A. R. Dwerryhouse. Pp. 364. (London: C. H. Kelly, n.d.) Price 5*s*. net.

THIS book has the same title, and covers the same ground, as one issued by Prof. A. Heilprin in 1896. What Heilprin did for young American readers, Dr. Dwerryhouse does, with even greater lucidity of expression, for beginners and unprofessional naturalists in the British Isles. His book is sent out by the publishers in good clear type, and is illustrated by photographs and maps printed in a brown tint on separate sheets of thick art paper. In this respect it has an advantage over all the elementary geological text-books that we know. Moreover, it is by no means a simple text-book. It is the work of a field-observer, who wishes to bring the results obtained by geologists home to any intelligent reader. Even fossil specimens are photographed, which gives them, for the author's purpose, a desirable air of reality, though the process will find less favour with

the student of generic forms. A coloured geological map of the British Isles is also included.

We have mentioned the illustrations at the outset, since the greater number are the work of the author, and he depends much on them in the physiographic portion of the book. Those of glacial phenomena seem especially excellent. May we, however, mildly protest once more at the translation of *roches moutonnées* as "sheep-back rocks" on p. 103?

The use of parts of British Ordnance maps to illustrate geographical features is in pleasant keeping with what has been done in recent text-books in America. But we venture to question whether a book of this kind should deal with geological history by means of a summary of stratigraphy as known to us in the British Isles. Would it not seem better to widen the view of the beginner by letting him know something of the great features of life-progress on the earth? The unconformities mentioned on p. 218 have no importance, except for the specialist in western Europe; nor are the names Lewisian and Torridonian at all comparable in value with those of the other systems classified in the table, which relate nowadays to no one special country. The real interest of the Carboniferous flora is not conveyed by the statements on p. 269; nor is the development of flowering plants fairly represented on p. 311, in view of discoveries outside our islands.

This introspective point of view, which has been impressed on us for fifty years by university curricula, forces the general reader to meet such things as Coniston Limestone, Blae Wyke Beds, Kimeridge Clay, and Lower London Tertiaries, and leaves him ignorant of the Permo-carboniferous ice-age, and of the immensely interesting development of life-forms and existing land-areas throughout Cainozoic times.

Dr. Dwerryhouse, however, deals excellently with the Pleistocene ice-age, taking here a bold wide survey. As minor criticisms, we do not like the term "Ammonoid" on p. 293, as applied only to forms intermediate between Nautiloids and "the Ammonites." Something seems omitted in the account of the origin of columnar structure on p. 317; the "forces acting at right angles to *ab* and towards 1 and towards 2" are just as "equal and opposite" as those differentiated from them by these terms. The whole point seems to lie in their directions.

It will be seen that this attractive book admirably fulfils its purpose. Any limitations in the last few pages cannot for a moment be ascribed to narrowness of outlook in the author. G. A. J. C.

OUR BOOK SHELF.

British Weights and Measures. As Described in the Laws of England from Anglo-Saxon Times. By Col. Sir C. M. Watson, K.C.M.G., C.B. Pp. xii+107. (London: J. Murray, 1910.) Price 2*s.* 6*d.* net.

THIS is an account of the history of weights and measures in England from the time of the Anglo-Saxons to the present day. It is meant to be of a popular character, and is written in an attractive manner, but as it includes the results of independent researches by the author, it may be of some interest to archæologists as well as to the general public. Sir Charles Watson appears to be an opponent of the introduction of the metric system in this country, and his book is in part intended to show that our present system rests on the experience gained by many centuries of legislation, and accordingly should not be abolished hastily in favour of a system of foreign origin and of comparatively recent date.

An interesting account is given of the various "pounds" which have been in use in England. The author is of opinion that the term "troy weight" is derived from an old English word "troi," signifying a balance, and that "avoirdupois" was a generic word used with respect to articles of considerable weight relatively to their value, which were sometimes weighed by a kind of Danish steelyard, or desemer, known as an "auncel." His identification of the gallon of Edward I. with the wine gallon of Queen Anne is not very convincing. He gives a good account of Gunter's chain, which he considers an excellent example of the kind of improvement that can be made with advantage in a system of weights and measures without introducing a new standard of measurement.

On the whole, the author is to be congratulated on having produced an eminently readable book on a subject which is often treated tediously. Some of his suggestions for the simplification of the British system given in the concluding chapter are deserving of consideration, but the proposal to abolish apothecaries' weight would be unlikely to meet with support in the professional circles mainly concerned.

On p. 24, line 8, "three-quarters of a yard" should apparently read "a yard and a half."

Newcomb-Engelmann's Populäre Astronomie. Vierte Auflage. In Gemeinschaft mit den Herren Prof. Eberhard, Prof. Ludendorff, Prof. Schwarzchild, herausgegeben von Prof. P. Kempf. Pp. xvi+772. (Leipzig: W. Engelmann, 1911.) Price 14 marks.

PRACTICALLY a generation has passed away since Newcomb's "Popular Astronomy" was first published. Many popular works have appeared since, but they have not supplanted the original work in its entirety, or provided a better model to which continual extensions could be added.

The main intention of the author has been kept in sight in the present edition. He did not cater for the professional investigator or the special student, but he aimed at placing before the general reading public a condensed view of the history, methods, and results of those portions of astronomical research that possessed a popular and philosophic interest. Like the last edition, the present has been entrusted to the staff of the Potsdam Observatory. This is fitting, since it is precisely in the department of astrophysics—the direction to which the energies of the Potsdam astronomers are more specially devoted—that the greatest progress has been made and the greatest need for revision exists. But other astronomers have ably co-operated. Prof. Schwarzschild has rewritten the section on the determination of orbits, and revised the chapter on cosmogony. Seeliger supplies the most recent details on the distribution of stars; Prof. Kobold revises the cometary statistics; Dr. Schweydar writes on the figure of the earth, and discusses recent hypotheses concerning its internal constitution. In this section we should have been glad to see more extended references to the work of Hecker.

Other sections which have been rewritten or extended are those on stellar parallax (Ludendorff), physical constitution of stars (Eberhard), motions of stars

(Ludendorff), variable stars (Kempf), new stars (Eberhard). On the general scaffolding that Newcomb contrived, later artists, it will be seen, have created a more complete and elaborate building.

Gehirn und Rückenmark. Leitfaden für das Studium der Morphologie und des Faserverlaufs. By Dr. Emil Villiger. Zweite auflage. Pp. vii+278. (Leipzig: W. Engelmann, 1910.) Price 12.80 marks.

WHEN the first edition of this book was reviewed in NATURE some four years ago, we then admired the lucidity of its style, and the excellent manner in which the author, Dr. Villiger, of Basle, arranged his description of the structure of the central nervous organ. The new edition is a considerable improvement upon the old. Beginning with a concise account of the embryology of the brain and spinal cord, the author proceeds to describe the gross anatomy of the brain, and illustrates his text by numerous excellent photographs and diagrams.

The second part of the work, dealing with the course of the various nerve-tracts and with the cranial nerves, is a model of luminous exposition. Many new diagrams have been substituted for those in the original edition.

The chief difference, however, is in the addition of an entirely new third part, consisting in a collection of more than fifty sections of the brain-stem. One set of these sections forms a series extending from the anterior end of the corpus callosum down to the corpora quadrigemina. The other series traces the structure of the various parts from the caudal end of the medulla oblongata upwards to the mid-brain. Each figure is accompanied by a full and descriptive text, so that the reader is provided with a fairly complete topographical atlas. Dr. Villiger's book bears the stamp of an expert teacher. It is difficult to give an adequate account of its many good points, and we trust that ere long it will become available to English readers in an authorised translation.

Thoughts on Ultimate Problems. Being a series of Short Studies on Theological and Metaphysical Subjects. By F. W. Frankland. Pp. xii+101. (London: David Nutt, 1911.) Price 1*s.* 6*d.* net.

THIS collection of studies on philosophical and religious subjects has now reached a fourth edition, which is sufficient proof that the author's treatment of profoundly important matters has appealed to a wide circle of readers.

LETTERS TO THE EDITOR.

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

The Stinging Tree of Formosa.

THE stinging effect of the common nettle (*Urtica dioica*, L.) is so well known that even a cursory reference to it seems to be superfluous. This stinging power of Urticaceæ is found to culminate in the genus Laportea, which exhibits in certain species a most virulent effect enduring for some days, or even months, in response to a light touch on one of the leaves.

During my botanical tour in the southern part of Formosa in 1909 I observed, in the district of Kōshun, an endemic species of the stinging tree (*Laportea pterostigma*, Wedd.) growing not infrequently in the mountainous districts of that part of the island, where it is called by the natives "Chiao-jen-kou," meaning "Man-biting-dog." It is mentioned in the revised edition, completed in 1747, of a Chinese book, the *T'ai-wan-fu-chi*, or a "Topography of Tai-wan Prefecture [in the Island of Formosa]," vol. xviii., fol. 21,[1] where we observe the following statement:—

"'Chiao-jen-kou.' . . . This tree attains to a height of more than ten feet, with the leaves long and large, resembling those of the tobacco-plant, and furnished with stinging hairs, which, when they sting a man, enter the hair-follicles and become so irritating that if lightly rubbed the colour of the skin becomes red, and the pain continues for a day and a night, after which it ceases."

Dr. Augustine Henry, in his "List of the Plants of Formosa" (Trans. Asiat. Soc. Jap., vol. xxiv., Suppl., p. 88), has already made a reference to this tree, as well as to the *T'ai-wan-fu-chi*, by stating that it is "a small tree, the leaves of which sting violently, known colloquially and in the Gazetteer as 'Yao-jen-kou' [='Chiao-jen-kou']; " he refers to it again (*loc. cit.*, p. 12), saying that "the 'Stinging-Tree,' a species of Laportea, is very unexpected in its effects on anyone ignorant of its quality." Reference is also made to this tree in an article, by the same gentleman, on the "Botany of Formosa," published in the *Kew Bulletin*, 1896, p. 70.

My botanical friend who accompanied me during the greater part of my tour in Formosa, and has had considerable experience in connection with the flora of that island, told me the following anecdote when we both saw before us the stinging tree growing wild in the southern part of the island:—

"A Japanese traveller who happened to be alone in some mountainous district in Formosa, rubbed unconsciously a part of his body with a leaf of this tree, which stung him so violently that he ran in madness and cried in agony of pain, and it took a day or so before he recovered. In examining some leaves collected from the same tree, they were identified as belonging to those of 'Chiao-jen-kou.'"

After hearing the above anecdote, I suggested a Japanese name, "Mamushi-no-ki," or "Viper Tree," as a warning to all who hearing this name that they should not dare to touch the leaves in future. As I remember that I observed myself a small tree, partly cut down, close to a cottage situated near the coast in the small harbour of Tai-han-roku, it appears to me that this tree is not uncommon in the southern part of Formosa.

In Messrs. Forbes and Hemsley's "Index Floræ Sinensis," ii., p. 472, and in Drs. Matsumura and Hayata's "Enumeratio Plantarum Formosanarum" (Tokio, 1906), p. 382, this tree is enumerated, but no reference is made to its remarkable stinging effect. In Mr. Kawahami's useful "List of Formosan Plants," recently published by the Formosan Government, a Japanese name of "Irakusa-no-ki," or "Stinging-Nettle-Tree," has been newly coined. In consequence of its powerful effect of stinging, the Japanese name of "Ira-no-ki," or "Stinging Tree," might be more appropriate.

There are some other species of Laportea which exhibit, even when slightly touched, a remarkably poisonous effect. In Engler and Prantl's "Die natürlichen Pflanzenfamilien," iii., 1 Abteilung, p. 106, the following statement concerning *Laportea crenulata*, Gaud., of eastern India, is to be found:—"Bei leiser Berührung mehrere Tage dauernde Schmerzen hervorrufend." Weddell (in De Candolle's "Prodromus," xvi., par. 1, p. 85) made the following reference with regard to the stinging effect of the same species:—"Quod ad vires nocuas stimulorum attinet vid. monographiam meam [*i.e.* Weddell, 'Monographie de la famille des Urticacées,' in 'Archives du Muséum d'Histoire Naturelle,' ix., 1856]." In the *Gardeners' Chronicle*, 1882, vol. xviii., p. 465, we find the following extract from *Knowledge* concerning the stinging effect of this species:—"The Stinging Tree of Queensland, Australia, is a luxurious shrub, pleasing to the eye

[1] The revised edition, above referred to, of the *T'ai-wan-fu-chi*, has now become very rare in Japan. In 1895, when Formosa was ceded to Japan, some wood-blocks of the *T'ai-wan-fu-chi* were found to exist in Taihoku, and consequently a new impression was made by the order of the Formosan Government. But soon afterwards these wood-blocks were destroyed by a conflagration, with the exception of a few blocks, which are now preserved in the Government Museum at Taihoku. Even the new impression is now out of print, so that it is not too easy to obtain a copy in Formosa. I, however, lately secured a complete copy of an old (*i.e.* Chinese) impression in Tokio.

but dangerous to the touch. It grows from 2 or 3 inches to 10 or 15 feet in height, and emits a disagreeable odour. Says a traveller: 'Sometimes, while shooting turkeys in the scrub, I have entirely forgotten the stinging tree till I was warned of its close proximity by its smell, and have often found myself in a full forest of them. I was only once stung, and that very lightly. Its effects are curious. It leaves no mark, but the pain is maddening, and for months afterwards the part when touched is tender in rainy weather, or when it gets wet in washing, &c. I have seen a man who treats ordinary pain lightly rolling on the ground in agony after being stung, and I have known a horse so completely mad after getting into a grove of the trees that he rushed open-mouthed at everyone who approached him, and had to be shot. Dogs when stung will rush about whining piteously, biting pieces from the affected parts.'" Mr. N. E. Brown, of the Royal Gardens, Kew, made an interesting contribution (*Gard. Chron., loc. cit.*, p. 567) of his personal experience concerning the virulent effect of the sting of this species in the palm-house at Kew.

TOKUTARO ITO.

Tokio, January 25.

The Sailing-Flight of Birds.

SINCE Mr. F. W. Headley urges (February 16, p. 511) readers of NATURE to make observations on the flight of the albatross, possibly a few remarks may be of interest from one who, as a student of aërodynamical problems, has carefully watched such wonderful performances.

One point which has always struck me is that the albatross almost invariably flies in immense circles, ever varying in size and direction. Sometimes the bird will be high overhead, then, swooping down on a curve, will skim closely over the tops of the waves, then suddenly rising again will float away to perhaps half a mile off, gradually sweeping around, and perhaps again attaining a considerable elevation. It seems quite impossible to decide, from observation, whether the elevation is gained from uptending winds. Without doubt, the bird takes every advantage of each puff or eddy he can find, but he does *not* progress, as in Mr. Mallock's figure, steadily from wave to wave, rising and falling with the waves. Nor does he, so far as one can judge, invariably rise when facing the wind, and *vice versa*. That albatrosses, as well as other birds, seem always to soar in circles, may be due to the circumstances that, for instance, in following a ship, they have to circle round and round in order to keep near it, not being able to fly at such a slow speed as that of the ship (and therein is a hint to our cross-Channel aviators). So too vultures and eagles may soar around, not wishing to depart from the district which they are watching. But the question to which I have long wished for a reply is, "Can birds soar in a straight line?" I remember many years ago seeing, on the Nile, flocks of pelicans gliding along on outstretched wings. Now these birds were progressing up the river, performing actual journeys, but I cannot remember whether they were actually soaring in a straight line all the time.

I have frequently noted, what is patent to all, that in calms there is no true soaring; also I feel sure that there is no kind of motion of the wing such as Mr. Hearn suggests. One thing is certain, and that is that a soaring bird, especially the albatross, always progresses at great speed. Having once obtained the initial impulse, there is so very little head resistance offered to forward motion by the bird that the speed slackens but little. He progresses, as described by Langley, in the manner of a skater skimming over thin ice, travelling so fast that the ice has not time to break.

Much of interest on this matter is to be found in the old annual reports of the Aëronautical Society. In that for the year 1868 there is an interesting discussion in which Mr. Young is quoted as saying that he had noticed "the hollow form of birds' wings; these were not planes; indeed, a little consideration would show that the curved surface is better than a true plane. . . . He concluded that the best means of flight is by a curved wing." A great deal has been said on this subject during the last few years, but how many have read these old, and often instructive, discussions?

B. BADEN-POWELL.

The Non-simultaneity and the generally Eastward Progression of Sudden Magnetic Storms.

Fact.

IT will be necessary, first, to my regret, to direct attention to some further errors in Dr. Krogness's communication in NATURE, December 8, 1910, p. 170, to which I made reply in the issue of January 5, p. 306. He questioned the correctness of our time of beginning of the disturbance, May 8, 1902, as recorded on the horizontal intensity curve at Potsdam, viz. 12h. 0m. Greenwich mean civil time, whereas his determination for the same station was 11h. 58m. In my reply, I stated (*idem*, p. 307) that Dr. Krogness must have made an error somewhere, for, upon repetition of our time scalings, based upon the data supplied us by the Potsdam Observatory, we got our identical result. I next wrote to the Potsdam Magnetic Observatory and requested that the time be scaled with all possible accuracy from the *original* magnetogram. Under date Potsdam, January 20, 1911, Dr. Venske gives the time in question as 11h. 59·7m., hence within 0·3m. of our time, but differing 1·7m. from that of Dr. Krogness.

Furthermore, in compliance with a circular request, I am receiving almost daily from observatories over the whole globe fresh data on the fifteen sudden disturbances, July 29, 1906, to September 25, 1909, first investigated by Mr. R. L. Faris for the five Coast and Geodetic Survey observatories. It will be recalled that Mr. Faris's data had furnished important testimony on the question as to the strict simultaneity of abruptly-beginning disturbances. Both Drs. Chree and Krogness have attempted to break down this testimony, but the data received thus far from other observatories are bearing out the conclusions previously drawn.

Table I. contains the time data for the very same dis-

TABLE I.—*Greenwich Mean Civil Times of beginning of Disturbances in the United States and at Potsdam.*

No.	Date	United States	Potsdam		P–U		Direction
			Krogness	Venske	K	V	
		h. m.	m.	m.	m.	m.	
20	1906, July 29	19 56·12	57	56·5	+0·88	+0·38	E.
24	1907, July 10	14 22·92	22·5	23·2	−0·42	+0·28	E.
25	Oct. 13	7 42·36	42·5	43·7	+0·14	+1·34	E.
28	1908, Sept. 11	7 20·82	20·3	20·7	−0·52	−0·12	W.
30	Sept. 28	8 42·00	42	42·6	0·00	+0·60	E.
31	Sept. 29	1 31·68	31·8	32·0	+0·12	+0·32	E.
	Algebraic mean				+0·03	+0·47	
	Numerical ,, ...				±0·35	±0·51	

turbances chosen by Dr. Krogness. Confining our attention to the horizontal intensity disturbance curves, just as he does, we have first the mean time of beginning as derived from the five Coast and Geodetic Survey observatories (Faris's data, the means being formed by Dr. Krogness; for the last disturbance the record at Sitka was missing, so that in the mean only four observatories are embraced). Next is given the times of beginning for the Potsdam Observatory, first as derived by Dr. Krogness and employed in his communication (*idem*, p. 171), next as recently scaled by Dr. Venske at Potsdam, using the *original* magnetograms. Forming the differences P (Potsdam), U (United States), it is seen that for the Krogness scalings there are three plus differences, two minus ones, and one zero, resulting in an algebraic mean of but +0·03m. The case is, however, different for the next column, which depends upon the Venske, *i.e.* the *original* data of the Potsdam Observatory; there are now five plus differences and but one minus, the algebraic mean being +0·47m. or 0·44m. higher than that of Dr. Krogness. These differences (P-U) are small quantities, to be sure, but the interesting point is that, in every instance, for the Venske figures they are in the same direction as determined by me from the five Coast and Geodetic Survey observatories alone, and as published in *Terrestrial*

Magnetism, vol. xv., p. 231, Table VIII., Nos. 20, 24, 25, 28, 30, 31. The letters E (motion of disturbance eastward or plus motion) and W (minus or westward motion) given in the last column are as taken from Table VIII. spoken of; note how the plus sign is linked each time with E and the minus with the W. Surely the most captious critic will hardly contend that this is mere chance.

As judged by the Venske data, Dr. Krogness's time scalings are in error from −0·5m. to +1·2m., and, on the average, +0·43m., his general tendency being to measure the Potsdam time *too low* by almost 0·5m. It must hence not be surprising that he failed to detect the generally eastward progression in the times between the United States and Potsdam, and was, instead, led to negative results; the difference of half a minute is precisely on the order of the required quantity.

Dr. Krogness, in his communication (*idem*, p. 171), unwittingly revealed also that the time scalings of his chief —Prof. Birkeland—were likewise untrustworthy. In order to get some definite information regarding the methods employed, Prof. Birkeland was next appealed to directly, but unfortunately in a reply received from him he failed to answer my question. It is recommended that all time data which appear in Prof. Birkeland's vol. i. (Norwegian Aurora Polaris Expedition, 1902–3) be used with extreme care by anyone who wishes to look into the matter of simultaneity of abruptly-beginning disturbances. I am not surprised now that Prof. Birkeland was unable to reach any definite conclusion himself on this interesting and important question, for his data lacked the necessary refinement.

Since I am on record as believing that no implicit reliance is to be placed upon simply one observatory, no matter how excellent its instrumental equipment and methods may be, Table II. is next given for the fifteen

TABLE II.—*Greenwich Mean Civil Times of beginning of Disturbances in North America and Europe.*

No.	Date	North America	Europe	E–N	Direction	
					U.S. and Europe	U.S. alone
		h. m.	m.	m.		
20	1906, July 29	19 56·15	56·52	+0·37	E.	E.
21	Aug. 7	13 38·50	38·78	+0·28	E.	E.
22	Dec. 21	21 30·70	30·87	+0·17	E.	E.
23	1907, Feb. 9	14 12·72	12·79	+0·07	E.	E.
24	July 10	14 22·85	22·79	−0·06	W.	E.
25	Oct. 13	7 42·50	44·17	+1·67	E.	E.
26	1908, Mar. 26	17 41·25	41·65?	+0·40?	E.?	W.
27	Aug. 19	0 14·35	14·31	−0·04	W.	W.
28	Sept. 11	7 20·87	20·47	−0·40	W.	W.
29	,, 11	21 47·48	46·51	−0·97	W.	E.
30	,, 28	8 41·97	42·20	+0·23	E.	E.
31	,, 29	1 31·20	32·56	+1·36	E.	E.
32	1909, May 14	4 55·40	56·77	+1·37	E.	E.
33	Sept. 25	8 39·70	38·43	−1·27	W.	W.
34	,, 25	11 41·80	40·33	−1·47	W.	W.
					9 E.	10 E.
	Mean of positive values			+0·66	6 W.	5 W.
	,, negative ,, ...			−0·70		
	Mean regardless of sign			±0·68	For a great circle arc of 75°	
	,, ,, ,, ...			±0·82	For a great circle arc of 90°	
	,, ,, ,, ...			±3·3	For a complete circuit	

disturbances spoken of above; in this all the observatories are embraced the data of which have been received to date, February 10, excepting one the time scalings of which differ occasionally 10m. or more from near-by institutions, and are doubtless subject to some error. The "North American group" embraces the six observatories Honolulu, Sitka, Baldwin, Agincourt (Canada), Cheltenham, and Porto Rico, the mean geographic position being 36·3° N., 101·7° W., of Greenwich; the "European group" gives the mean times for the seven observatories Stonyhurst, Greenwich, Uccle, Wilhelmshaven, Munich, Potsdam, and Katharinenburg, the mean geographic position being 52·4° N., 13·6° E., of Greenwich. It will be noticed that Kew is not included, for the simple reason that, although Dr. Chree scaled the required data some months ago, he has not yet published them nor forwarded them to me. The Greenwich data were received the earliest of all, viz. January 23, and those of the distant Observatory of Katharinenburg on February 9. The numbers attached to the various entries in Table II. correspond to those in my Table VIII. (*Terr. Mag.*, vol. xv., p. 231).

The last two columns ascribe the direction of progression of the disturbance according to the sign of the difference E–N, plus meaning east. First the direction is given as derived from the present investigation, which depends upon data over the region from Honolulu, 158° W., to Katharinenburg, 60·6° E., and next as obtained previously from the five Coast and Geodetic Survey observatories alone (Honolulu, 158° W., to Porto Rico, 65·4° W.). Comparing the two columns, it is seen that only in three cases out of fifteen, viz. Nos. 24, 26, and 29, do the letters clash; in other words, in 80 per cent. of the cases the directions, as determined from the limited portion covered by the United States observatories, agree with those now gotten for a considerably larger region. Moreover, Nos. 24 and 29 exhibit the interesting fact that while the disturbance each time progressed eastwardly in Europe just as it did in the United States, yet the mean time of occurrence for each is less in Europe than in North America. These are precisely similar cases to the disturbance of May 8, 1902, which seemingly began in the Atlantic and Europe, and then travelled eastward, being felt last in the United States. When the data for the observatories in Asia are available, the actual direction of progression of the two disturbances Nos. 24 and 29 will be known better. This shows, as I have already pointed out, how important it is to know approximately the region where the disturbance originated (cf. *Terr. Mag.*, vol. xv., p. 20). The result from No. 26 is more or less doubtful, evidently the point of beginning being not sufficiently sharp at all stations; three of the observatories mark their times doubtful, and two omit giving them.

Both columns unite in showing that the eastwardly progressing disturbances predominated over the westwardly ones in the ratio of about two to one. The average difference E–N, regardless of sign, is 0·68m., which was the average time required for a disturbance to pass from the mean position of the North American group to that of the European, or over a great circle distance of 75°. If the disturbance continued to progress at this rate, and were to make a complete circuit of the earth, it would take 3·3m., hence on the order of the quantities already announced. The linear velocity here concerned would be about 200 km. per second.

The available data on the non-simultaneity and progression of abruptly beginning disturbances have now been subjected to so many severe tests that it is difficult to see how anyone with an open mind can any longer doubt that some important discoveries concerning magnetic disturbances have been made. I should, indeed, be glad to be informed of any other facts in terrestrial magnetism which have stood as well the tests applied.

Dr. Chree, unfortunately, in his paper before the British Association last summer, and again before the Physical Society of London on November 11 last (Proceedings, vol. xxiii., part i., December 15, 1910 [49]), devotes chief attention to pointing out difficulties in explanation. He seems more concerned in determining why, according to his ideas, the phenomenon should not be rather in finding out whether it *is*. One of the chief purposes of my paper was to arouse further investigation on the part of others. Dr. Chree could not have done better than immediately to have published his own data in the same open manner that Mr. Faris had done. Instead, he labours to discredit the Coast and Geodetic Survey observations, and withholds his own from public scrutiny. In half the interval of time between the first and second presentation of his

paper, had Dr. Chree chosen, he could have had at his command data from Europe and Asia which, combined with his own, would have served admirably to have tested the main contentions. He might thus have been credited with a really helpful contribution to the subject; but no such attempt has been made.

In view of the discussions which have arisen with regard to time data from present magnetograms, I have made request of each observatory for a statement of the method employed. From the reports thus far received, it is found that no institution has made a more earnest attempt to allow for all sources of error than is the case at the Coast and Geodetic Survey observatories. It is evident that in several instances equal care, for one reason or another, is not given by others, but, judging from the fresh interest aroused by the present investigations, there is every reason to expect considerable improvement hereafter. This may be a sufficiently useful end to have achieved, even if nothing else had resulted from the researches.

Theory.

The hypothesis of ionic currents which I have employed in the study of magnetic disturbances thus far treated is based on the existence of a primary set of electric currents circulating around the earth overhead. Quoting from my paper No. 1 (*Terr. Mag.*, vol. xv., pp. 122–3):—

"Since magnetic observations made at various points on the Earth's surface have revealed the existence of a definite system of atmospheric electric currents, it follows at once that if the atmosphere is made more conducting at any point, an extra current will be started and set in motion by the pre-existent electromotive force or its equivalent. The direction followed by the new current depends upon its origin, upon the direction of the electromotive force at that point, and upon the deflecting effect of the Earth's magnetic field and of the Earth's rotation on the electric carriers. In other words, while we shall look chiefly to extra-terrestrial agencies for ionising the air and thus splitting it up into carriers of positive and of negative charges, we look to the atmospheric electric field and to the Earth's rotation for furnishing the energy necessary to drive the ions over the Earth and by their motion produce the effects observed during a magnetic storm."

In No. 3 (*idem*, vol. xvi., p. 34) I summarise the evidence available regarding the outside electric field as based upon the harmonic analyses of the earth's magnetic condition by Adams, Schmidt, and Fritsche. I show that its general characteristics are very similar to the supposedly internal magnetisation of the earth. The outside currents, if negative ones, would have to circulate around the earth from west to east, hence in the same direction as the rotation of the earth. Starting with these currents, I find it possible to account for the earth's own magnetisation if the earth's average magnetic permeability is on the order of 135 as referred to air and for a magnetising force of about 0·0024 C.G.S. This value, while seemingly large, is not impossible, judging from the experiments of Lord Rayleigh and of C. Baur on iron, using small magnetising forces. Furthermore, it must be borne in mind that we are absolutely ignorant as to what effect the great pressures existing at but a few kilometres below the surface may have on the permeability of magnetisable substances—possibly the effect of increased temperature with depth may be completely annulled by the comparatively more rapid increase in pressure.

In brief, I have set up the hypothesis that the earth is chiefly an electromagnet, the magnetising currents being outside, and consisting of negative electric currents circulating overhead in the same general direction as that of the earth's rotation. I follow out the consequences, and show that this hypothesis harmonises with the Gaussian analysis, from which it had been hitherto almost universally concluded that the magnetising causes must be contained chiefly *inside* the earth.

By thus putting the magnetic state of our planet primarily in the control of *outside* electric currents, many of the outstanding problems of terrestrial magnetism are greatly simplified. Any variation, periodic or spasmodic, in the intensity and direction of the magnetising currents must, of course, be followed almost immediately by corresponding changes in the earth's magnetisation. It thus becomes clearer now how, in the space of but a few minutes, such great changes can occur in the magnetic condition of our planet as are experienced during magnetic storms. Anything that will cause a change of conductivity in the strata containing the outside currents will evoke changes in the latter, which in turn are revealed in effects on our magnetic needles. There may be many such causes—the theory need not restrict itself to any one, as, for example, kathode rays.

Analysing the type of disturbance of which the one of May 8, 1902, may be taken as typical, it is seen that we have before us but a miniature reproduction of the earth's own magnetisation. In brief, a system has been found which will produce magnetic disturbance effects precisely similar to the permanent magnetic effects referred to the earth (*idem*, vol. xv., pp. 25–30, 117, and vol. xvi., pp. 33–48).

The type of disturbances which Prof. Birkeland refers to "equatorial" currents is thus found to be merely a general disturbance of the entire magnetic condition of the earth, of such a simple character that the first harmonic may give a sufficiently complete representation of the observed perturbations. The theory advanced in my papers is that the same electric-current system which may have to be held accountable for the production of the earth's magnetisation will also suffice for the production of the disturbances considered. I propose the name, therefore, of "simple magnetic perturbation," in place of Prof. Birkeland's "equatorial magnetic perturbation," adding the words "positive" or "negative," just as he does, according to whether the general effect is to increase momentarily the earth's magnetisation or to decrease it. Prof. Birkeland and I are not in agreement as to the direction in which the outside currents must go to produce the observed magnetic effects (*idem*, vol. xvi., pp. 33–48).

The careful reader will not fail to observe that the theory, as above briefly outlined, is considerably different from that which Dr. Chree imputed to me on p. 51 of his paper cited above. Furthermore, the calculation which he says he is unable to follow, although others have done so, was merely a preliminary attempt to account for the observed progression of sudden disturbances and to get some idea as to the order of the altitude at which the supposed currents would have to circulate. If Dr. Chree has something better to offer I shall be glad to know it. Such interest is being manifested now on all sides, that it will doubtless not be long before a fairly satisfactory theory will be forthcoming. Someone must make the attempt, however, to rear a structure; not all of us are willing to rest contented with merely pulling down. One correspondent has hit upon another promising clue, which is at present being tested. In the meanwhile, I believe our hypotheses have amply justified themselves by the many new questions raised and the fresh incentives given to investigation.

L. A. BAUER.

Washington, D.C., February 10.

Postscript.—From NATURE of February 2, just received, it is noticed on p. 461 that Prof. Schuster presented a paper before the Royal Society on January 26 entitled "The Origin of Magnetic Storms," in which a critical examination is made of the theory that magnetic storms are caused by streams of electrified corpuscles ejected from the sun. Prof. Schuster, after various calculations, reaches the following conclusions:—

"If magnetic disturbances are produced by rays emanating from the sun, it can therefore only be in an indirect manner. We may imagine that the injection of corpuscles ionises the upper portions of the earth's atmosphere, and consequently renders the already existing electromotive forces more effective, or we may imagine that the approach towards the earth's magnetic field of highly conducting material containing ions of both kinds acts by induction. The effect of such induction would primarily be an increase in the horizontal and a diminution of the vertical forces, while the currents induced in the earth, tending to diminish the horizontal forces, would, owing to the inertia, die out more slowly, so that a semi-permanent effect would be left after the storm."

It will be seen that the theory as set forth in my paper above is entirely in harmony with Prof. Schuster's conclusions; it is, in fact, largely based on his previous re-

searches. He and I are in agreement that the real origin of our magnetic disturbances is to be referred primarily to an outside electric system situated somewhere in our own atmospheric regions. I go one step further, and place in the same region the chief origin of the earth's own magnetisation.

In conclusion, it will be well to point out that the method used in my Table II. above to get the average rate of progression of sudden disturbances does not accentuate the actual time differences between distant stations, but tends rather to diminish them, as was the case with storms Nos. 24 and 29. In brief, as I have already hinted, the precise method of grouping of stations cannot be a fixed one, but must vary with the region in which the disturbance originated. When the data from the remaining parts of the globe have been received, this matter will become more evident. L. A. B.

Washington, D.C., February 13.

Colliery Warnings.

MAY I say a word about colliery warnings to point out that it is not the high barometer that is of any importance, but the dryness of the air? It happens in our country that the high barometer and dry air generally come together.

Gas explosions in coal mines are trivial, and they occur on an average of more than one per day. It is when there is sufficient dust to make the explosion spread over a big area that an explosion is serious, almost without exception. Dry air is the danger, and should be the basis for "colliery warnings." JOHN HARGER.

University Club, Liverpool, February 21.

IN all collieries more than 600 or 700 feet in depth the air is always dry—somewhat drier in cold than in warm weather—and, consequently, coal-dust is always present in the workings provided there is no natural "seepage" of water into them. In these circumstances, the one essential element of a great explosion is always present.

Blasting shot, when fired under certain conditions, and comparatively small volumes of explosive gas when ignited, will always raise and ignite coal-dust the quality of which, as regards its contents in volatile matter and ash, lies between certain upper and lower limits. On the other hand, shots are always being fired, and larger or smaller accumulations of explosive gas are always being formed here and there in mines of this class, quite irrespective of weather conditions.

All that can be said as regards the influence of weather is that, other things being equal, a coal-dust explosion is more likely to occur in cold weather, when the mines are driest, than in warm weather, when they are not so dry, and with a falling rather than with a steady or rising barometer.

These subjects were fully discussed at the very inception of the coal-dust question, and Mr. Harger might do well to study what was then said about them.

As the issuer of "Colliery Warnings" so frequently advocates that special attention be paid to the condition of mines when the barometer is rising rather than when it is falling, I may perhaps be allowed, in this place, to correct a statement which lately appeared in a letter to NATURE, written by "The Author of the Warnings," to the effect that Mr. R. H. Scott and I were amazed (*sic*) to find that fire-damp was frequently reported to have been found in mines even when the barometer was steady and rising. We were not amazed, for we knew by the actual experience of one of us that, in consequence of falls of roof, damage to trap-doors, stoppings, brattices, and so on, which are amongst the commonest incidents in mining, the ventilation often becomes so stagnant at certain critical points that the air becomes explosive at or near these points before the defects can be rectified.

As a matter of fact, the principal province of the firemen is to guard against this very contingency. Consequently, when we saw appearances of fire-damp reported time after time with a steady or rising barometer, we experienced no surprise, but, perhaps rather unfortunately, considering the use the "Author of the Warnings" has made of the sentence in which we merely recorded a fact without further comment, we did not stop to explain what passed in our own minds at the time, but proceeded in the next following sentence to show that, when the records of a large number of mines were compared, the effect of these casual irregularities was practically eliminated altogether. It would have been fairer if the "Author of the Warnings" had quoted one more sentence (Quarterly Journal of the Meteorological Society, October, 1874).

W. GALLOWAY.

The Hydrogen Spectrum.

THE colour of the light which is emitted from the capillary of a vacuum tube containing pure hydrogen is the familiar vivid, deep pink, the prevailing tint being due to the predominating brilliance of the red line (Hα). When the same capillary is viewed from one end, however, the colour is a very pale pink, indeed, nearly white.

This interesting effect appears to be due to the different relative intensities of the lines Hα and Hβ in the two cases, for while Hβ (and probably each of the other lines in the primary series) has an intensity appropriate to the length of the column of gas in the capillary, Hα appears to suffer reduction.

In the course of some observations on the secondary spectrum of hydrogen, during which I had occasion to use the tube when placed against the slit of the spectroscope in the usual way, and also end on, I was greatly interested in this apparent variation in the intensities of the lines mentioned. The explanation which suggests itself is that Hα is weakened by absorption in traversing the column of gas (although this distance is only about 5 or 6 cm. in my tube), but it is difficult to understand why this absorption should be specially selective for Hα and not equally effective in the case of Hβ, which is also a very brilliant line, and to which one would imagine the same argument would apply. There appears to be no reason for attributing the effect to polarisation.

I have seen no notice of this effect, but I imagine it must be quite familiar to spectroscopists, and perhaps one of them who has devoted special attention to the hydrogen spectrum may be able to throw some light on the matter.

CHARLES W. RAFFETY.

Beechcroft, 2 Park Hill Road, East Croydon, Surrey, February 22.

Life and Habit.

ON p. 505 of NATURE for February 16, in a review of a new edition of one of Samuel Butler's books, these words appear:—"therefore the apparently unpractised but perfect pecking of a newly-hatched chick proves that the chick has done it before," &c.

Now, I have tried many experiments with chicks hatched out singly and away from a hen, but never has any chick attempted to peck until shown how to or made to walk over food which tickled its toes, and my opinion is that a chick might die of starvation while surrounded by food unless taught what to do. They are quick to take a hint, and will imitate the motion and action at once if a bent finger be worked up and down like the head of a bird when pecking; and, if once they feel a bit of food within their beaks, they know what to do with it as well as a new-born babe knows how to suck when anything is placed in its mouth, though they have never done it before. W. H. M.

February 20.

YOUR correspondent's remark is interesting, but, of course—as he himself indicates in connection with the babe—it does not invalidate Butler's argument. It can hardly be doubted that observation and imitation do not cover the ground, and that there is something calling for explanation in what is called "instinct"—a word which, it must be admitted, only disguises our ignorance of what it is. Butler's theory that "heredity is memory" is at least worth consideration. THE REVIEWER.

FOREST LIFE IN INDIA.[1]

IN these pleasant pages the author looks back cheerfully upon some of the events of thirty-five years in the Indian Forest Service, from the less responsible stage of assistant-conservator of forests, seeking the bubble reputation even in the tiger's mouth, to the more severe and formal stage of inspector-general, full of wise saws and modern instances. Of the gloom and monotony of existence far from the busy hum of men, and of the great and manifold dangers that surround life in a tropical jungle remote from all medical resources, he prefers, like a good Briton, to say nothing, though he must know all about them, and could no doubt make moan if he chose.

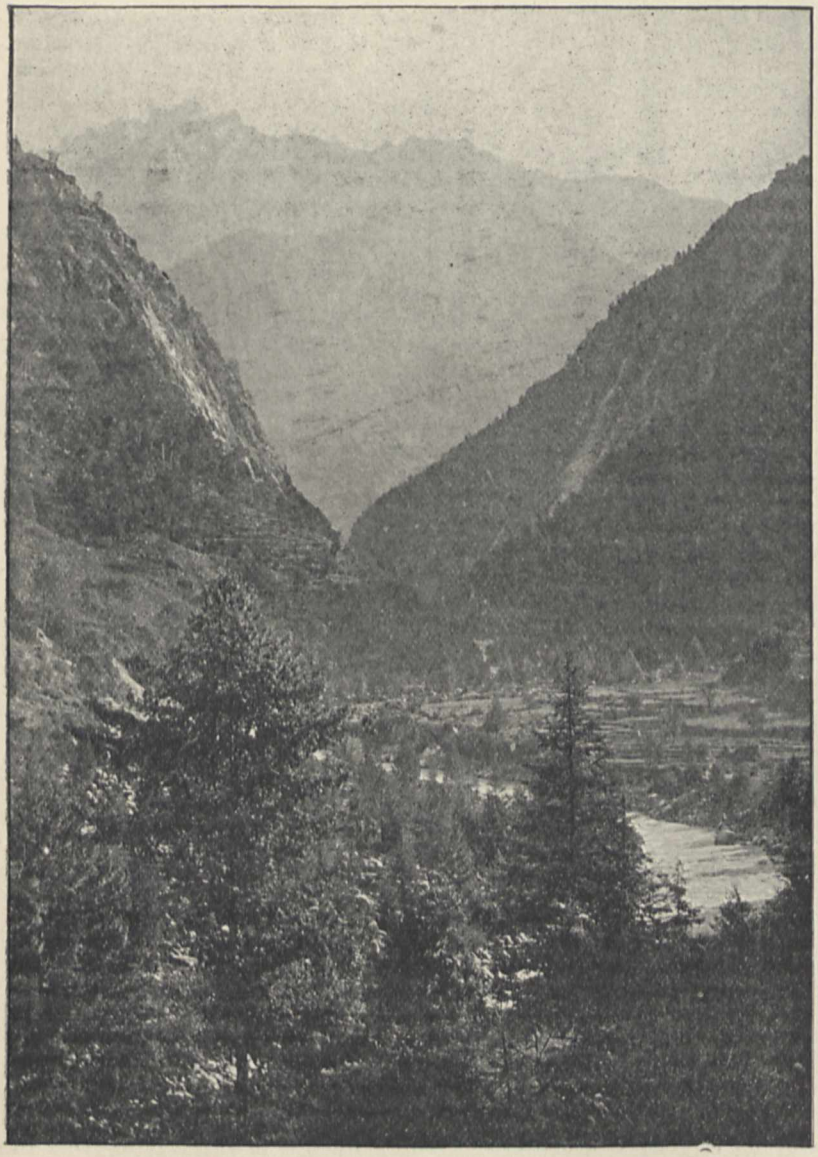

FIG. 1.—The Baspa Valley. From "Forest Life and Sport in India."

In the chapters covering the author's earlier terms of service as a junior executive officer in Oudh, and on the Nepal frontier, the moving incidents of sport predominate, and we are told much—though nothing, perhaps, very new—of the ways of the beasts that perish by the rifle. There are several accounts of the author's own experience of man-eating tigers; some, of course, tales of woe and death, but one—telling how an Indian peasant woman, with nothing but a sickle in her hand, attacked and beat off a man-eater that had seized her husband—might, if the heroine's name were known, be immortalised in the archives of the State.

With the advent of greater official responsibility the full tide of sport begins to ebb, and we are introduced to those questions of organisation and policy, which are the chief care of an administrative officer, and reveal the more serious purpose of the book. All these questions are treated with skill and tact. Among other things, we learn how far-reaching reforms of various kinds were effected, sometimes in the face of official indifference and misunderstanding; how native opposition to any interference with misconceived and misdirected "natural rights" was gradually overcome, so that suspicious villagers and destructive wild-men were at length converted into the ready tools of the forest conservator; and how institutions for the higher training of the forester are becoming engrafted on the educational system of the country. In short, we get from this excellent book not only a good idea of a forest officer's work in every grade, and of the main line of development of the Indian Forest Department, but also an insight into the many ways, direct and indirect, whereby well-managed forests contribute to a country's welfare.

This being one of the chief lessons of the book, we think that the author errs when, in discussing the relation of forest to ground-water, and so to agriculture, he speaks of forestry and agriculture as simple industries in comparison with the "*more important* manufactures that add to the national wealth." Surely at a time like the present, when England has grown all one-sided by neglect of agriculture, and whole masses of Englishmen deafened by machinery and blinded by smoke are in danger of losing their bearings, it were pity if a man who has lived half a lifetime in the precincts of Demeter did not boldly assert that as long as workmen require bread and butter and meat, so long must their most important accomplishments in the way of manufacture and all their additions to the national wealth wait upon the sturdy yeoman, who, like another Atlas, bears the civilised world upon his shoulders.

As a good Anglo-Indian of the olden style, the author thinks of his native subordinates and native servants as fellow-men, and always speaks kindly of them, and he regards red-tape with a noble aversion. On the other hand, he probably overrates the value of

[1] "Forest Life and Sport in India." By S. Eardley-Wilmot, C.I.E. Pp. xi+324. (London: Edward Arnold, 1910.) Price 12*s.* 6*d.*

the so-styled "expert specialist" of recent device; we have heard of this sort before, notably in connection with Indian agriculture, where he has been weighed and found—not altogether infallible. Life is compromise, and perhaps the best expert for India still is the service-man with a particular natural bent; the author almost admits this in his remarks upon the Forest School at Dehra Dun.

Much might be said of the illustrations, from

FIG. 2.—A "Fire Line" in the Gonda Forests From "Forest Life and Sport in India."

photographs by the author's wife, that adorn the book. Some of them stir the heart "like the sweet sound that breathes upon a bank of violets."

DISTINGUISHED ANIMALS.[1]

IT may be said at once that any parent, guardian, uncle or aunt, who is on the look-out for a suitable gift-book to present to intelligent boys and girls, will find what he wants in Mr. Perry Robinson's "Of Distinguished Animals." A better school prize could not be given. But it is not quite the type of book suited for a review in NATURE, nor was its original prototype—a series of articles—quite up to what is expected now by the readers of *The Times*, which in the course of the year 1909 published a large proportion of this book under the title of "Studies in the Zoological Gardens."

This class of writing on natural history is somewhat out of date for grown-up readers, and, above all, subscribers to *The Times*. That *The Times* should deal with zoology or any other "ology" is what one would expect of it from time to time, but articles which it might publish on zoology, anthropology, botany, or horticulture, should invariably be written by specialists who can bring new facts to our notice and place before us convincing, perhaps startling, deductions. Otherwise, it may be said without peevishness that mature readers to-day are becoming a little tired of the "literary" treatment of such subjects, especially those connected with biology. The truth is of itself so marvellous, so spectacular, and interesting (if rightly put) that we do not wish for references to what imperfectly educated poets and prose writers thought of this or that beast or plant before the twentieth century, unless, of course, anything can be extracted from old writings throwing a fresh light on questions of geographical distribution, domestication, and the inter-relations between man and other forms of life.

The work under review is abundantly supplied with some of the best photographs that have ever been published of beasts, birds, and reptiles. But it does not contain much original matter in its letterpress, which is avowedly a long string of quotations intended to illustrate a number of remarkable types of beast, bird, and reptile, to be seen in the London Zoological Gardens. Not many of these quotations are new to the practised student of zoology, and a few of them are not quite true either in the facts they relate or in the deductions to be drawn from them. In the reference to the gorilla (p. 129), the assertion that the "gorillas" alleged to have been brought back by Hanno, the Carthaginian, from the west coast of Africa, "can hardly have been other than baboons," is not one which can be maintained, if the statements relating to Hanno's expedition are carefully considered in connection with the critical remarks thereon in Sir Thomas Bunbury's "History of Ancient

[1] "Of Distinguished Animals." By H. Perry Robinson. Pp. x+234. London: W. Heinemann, 1910.) Price 6*s*. net.

Geography." All that we know of this subject makes it nearly conclusive that Hanno's expedition reached as far as Sherbro Island, at the eastern limit of the Sierra Leone district, and that the wild, hairy men and women brought back by his people were the chimpanzees which still inhabit the forests of the Sherbro district. The Carthaginians were well enough acquainted with the baboon (which in those times was found not only in Egypt, but in the Tunisian Sahara), and would not have remarked on it with the same emphasis as they did, evidently, in connection with the chimpanzee skins.

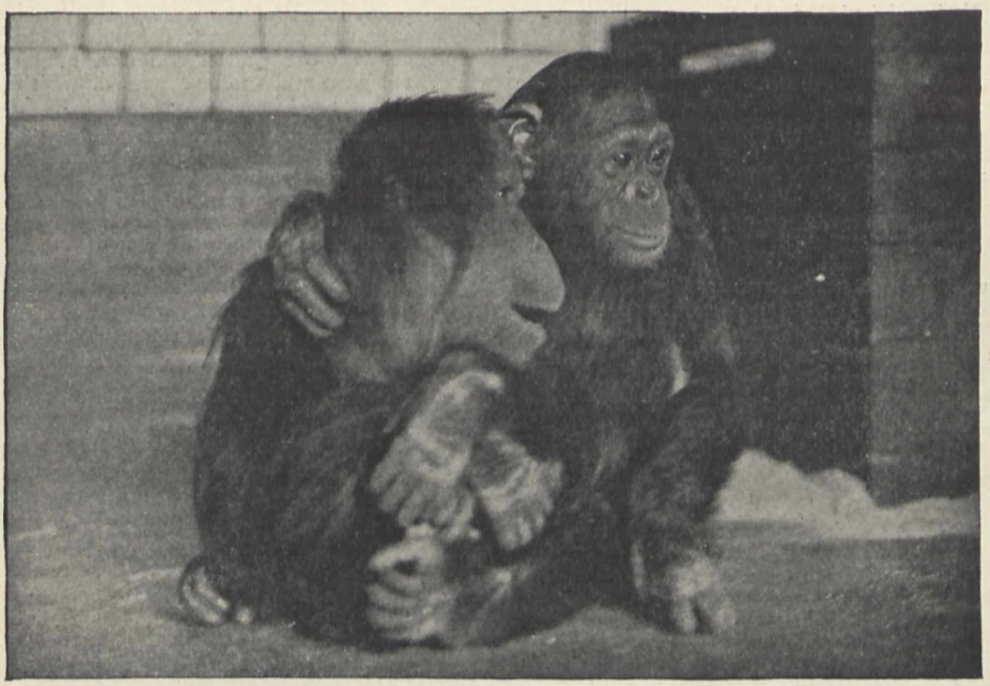

FIG. 1.—Two Baby Anthropoid Apes." From "Of Distinguished Animals."

An allusion is twice made—not necessarily with credence—to Rudyard Kipling's story of "Bertran and Bimi." The theme of this was that a German residing in the Malay Archipelago possessed a huge orang which was so jealous of his newly-wedded wife, that upon the woman being left alone one day it tore away the thatch of her house, entered her bedroom, dragged her from the bed, and destroyed her. Here is an instance where "literature" steps in and tries to improve on fact, with disappointing results. Mr. Kipling's story was based on a real incident which occurred (to the knowledge of the present writer) in South Africa, where a huge Chakma baboon really did, in like circumstances, kill, or attempt to kill, the young wife of his master. Anyone who knows baboons and their extraordinary jealousy might well believe in the truth of such an incident, but as applied to the orang utan—to anyone who knows the

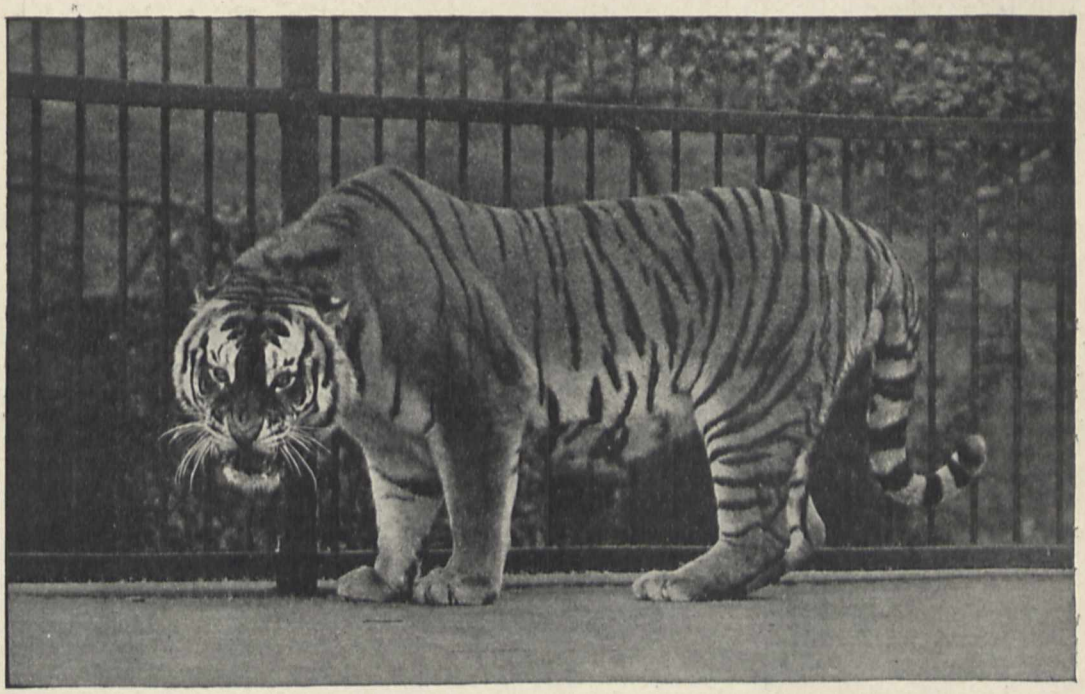

FIG. 2.—Siberian Tiger. From "Of Distinguished Animals."

orang—it is unbelievable and inapposite, and consequently is one of the few unconvincing stories in Kipling's otherwise admirable and truthful studies of the East.

But the author of "Distinguished Animals" cannot be held responsible for Mr. Kipling's rare slip in accuracy, and it is pleasanter to assert the general interest which the work under review possesses (apart from its remarkably good illustrations) for those who are not well acquainted with the history and habits of that marvellous collection of living creatures to be seen in Regent's Park. H. H. JOHNSTON.

THE KANGRA EARTHQUAKE OF APRIL 4, 1905.[1]

DESTRUCTIVE earthquakes are, fortunately, rare events, and when a civilised country is visited by one, the talk of investigating and of writing the report, which is now considered obligatory, falls necessarily on someone who has often more regular occupation. Hence it comes that we have to wait years for a connected account of a great earthquake, and that which visited the Punjab on April 4, 1905, is no exception; after the lapse of more than five years, with all the dignified delay, and, it must in fairness be added, all the thoroughness worthy of a great Government, the report on this earthquake, by Mr. C. S. Middlemiss, has appeared.

Nor could the memoirs have appeared more opportunely. The glamour of the great disaster which followed on the Californian earthquake, the remarkable character of the earth-movements which took place along the length of the San Andreas fault, and especially the fact that a very large part of the peculiarities of distribution of the shock seemed explicable on the hypothesis that fault and earthquake were related as cause and effect, have all given impetus to the popular notion that earthquakes are always a necessarily due to fracture. Yet even where faulting is observable there are generally indications that the fault is certainly not the sole cause, if it may be properly regarded as a cause of the earthquake; and now we have an account of a shock comparable in extent and violence with the Californian earthquake examined with great care and thoroughness of which the reporter writes that:—

> it may come as a surprise to many to be assured that the Kangra earthquake presents no evidence at all in support of this view: not a single railway has recorded any damage to the track, not a single road or path has been deflected, raised or lowered, no rivers or streams have changed their courses or been temporarily dammed up—except as due directly to landslips from slopes of such steepness that they might as easily have occurred after a heavy torrential rainstorm.

The greater part of the report is taken up with details of damage done to buildings, the sensations of observers and other stock subjects, in all of which little or nothing of novelty can be found; but when we come to the discussion of the cause of the earthquake there is much that is interesting and suggestive. The author, after discussing the nature of the origin, finally adopts the conclusion that there were two centres of origin, one in the Kangra valley and the other in the Dehra Dun. He points out that these two regions lie in imbayments of the great faulted boundary between the rocks of the Himalayas proper and the Tertiary beds originally formed as fringing deposits of Himalayan débris.[1] Moreover, it is just in these imbayments that an exceptional development of coarse boulder deposits indicates the position where great rivers issued from the mountains, where sedimentation was in excess, and where, in the subsequent compression and folding of strata, irregularities of packing might be expected to occur. So the conclusion is reached that the earthquake was a tectonic one, due to a sudden rupture or release of

FIG. 1.—Fallen Rock near Manoli. From "The Kangra Earthquake of April 4, 1905."

[1] Memoirs of the Geological Survey of India, vol. xxxviii. "The Kangra Earthquake of April 4, 1905." By C. S. Middlemiss. Pp. x+409+xxi+30 plates. (Calcutta: Geological Survey; London: Kegan Paul and Co., Ltd.; Berlin: Friedländer and Sohn, 1910.) Price Rs. 5.

[1] NATURE, March 1, 1906 (vol. lxxiii., p. 418).

strain at two places where the strain was specially great owing to resistances to the well-established forward march of the overthrusting foot of the Himalayan range.

All this is perfectly clearly put, the argument is logically arranged, and the conclusion is perfectly orthodox; but yet we must confess that in reading Mr. Middlemiss's description we were struck by many indications of the absence of direct connection between earthquake and geological structure. The principal focus of maximum intensity extends from the sub-Himalayan area across the great boundary fault, which is by far the grandest structural feature of the region; and the subsidiary focus in the Dehra Dun shows no tendency to a concentration of violence along any particular line or connection with any known structural feature, and from this area some observations are recorded which seem to be of importance so far as the origin of earthquakes is concerned. An old line of levelling from Saharanpur to Mussooree was gone over again after the earthquake with the result that although the relative levels of the extremities of the line were unchanged, it was found that the intervening bench marks in the Dehra Dun and the Siwaliks showed an elevation of from 4 to 5 inches. As no alteration in the relative level of Dehra Dun and Mussooree had been noticed when this section was re-levelled in May, 1904, it is practically certain that the change took place at the time of the earthquake. Now if the results are examined it may be noticed that elevation was not confined to one station, as might be expected had it been due to shifting of the opposite sides of a fault, but is rather a general bulging upwards, such as might be produced by a sudden increase in volume of the material underlying the region of greater violence of shock.

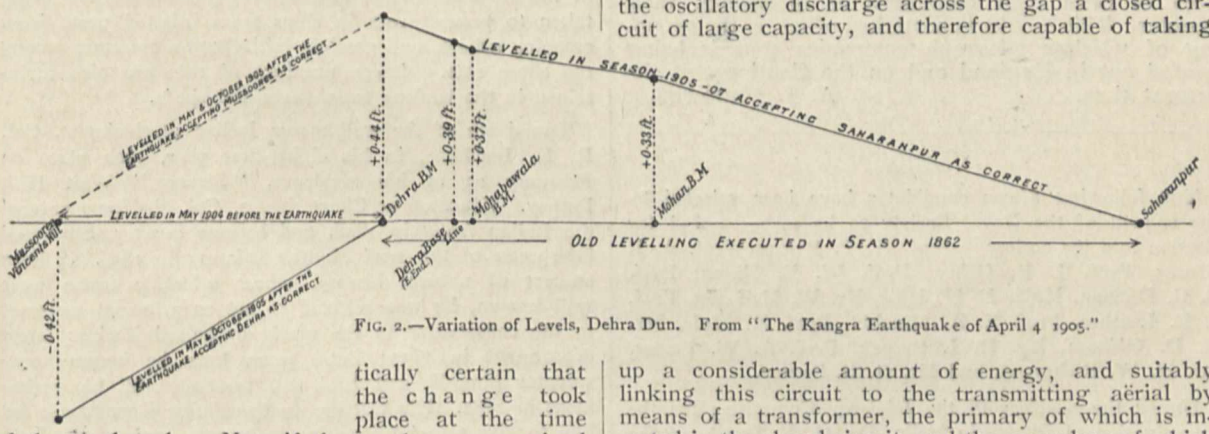

FIG. 2.—Variation of Levels, Dehra Dun. From "The Kangra Earthquake of April 4 1905."

These, however, are matters of inference and interpretation, and whatever may be the ultimate trend of thought as concerns them, the memoir under review will stand as an important contribution to knowledge which will have to be studied and reckoned with by all who attempt to deal with the vexed question of the nature and origin of earthquakes.

WIRELESS TELEGRAPHY SYSTEMS.

THE action brought by Mr. Marconi and Marconi's Wireless Telegraph Co., Ltd., against the British Radio-Telegraph and Telephone Co., Ltd., for infringement of patent No. 7777 of 1900, concerning improvements in apparatus for wireless telegraphy, has been concluded, and Mr. Justice Parker delivered judgment on February 21 in favour of the plaintiffs.

The patent in question refers to an arrangement of the sending and receiving circuits in such a manner as to make telegraphy possible over increased distances by means of spark methods. In the methods in which spark-dischargers are used, a spark is caused to bridge the gap by the application of a direct-current or alternating-current supply, and it is arranged that the discharge thus produced should form part of a circuit in which high-frequency oscillations may be set up. This circuit must contain a capacity and inductance, and the charge and discharge of the capacity taking place through it will be of an oscillatory nature if the resistance of the cricuit be not greater than $\sqrt{\frac{4L}{K}}$, where L and K represent the inductance and capacity of the circuit. When the resistance is greater than this value, the discharge is not of an oscillatory nature, and is therefore unsuitable for the production of waves for wireless telegraphy.

In early methods of working the gap was placed directly between the aërial and an earth-plate, and the discharge produced by connecting an induction coil across the gap. The oscillating circuit consisted of the spark-gap and the capacity and inductance of the aërial, and the energy that could be radiated was small owing to the very small capacity of the aërial. The receiving circuit consisted of an aërial connected to earth through a coherer, which formed part of a relay circuit actuating a Morse printing instrument.

The improvement constituting the subject-matter of the patent under discussion consists in providing for the oscillatory discharge across the gap a closed circuit of large capacity, and therefore capable of taking up a considerable amount of energy, and suitably linking this circuit to the transmitting aërial by means of a transformer, the primary of which is inserted in the closed circuit, and the secondary of which is connected in the aërial. By this means oscillations of great energy are able to be set up in the closed circuit, and if the aërial circuit be tuned to have the same frequency of oscillation as this circuit, and be loosely coupled to it by the transformer, long trains of waves of a single frequency will be radiated by the aërial, which is, in virtue of its open circuit, a good radiator of the energy gradually supplied to it by the good oscillator formed by the closed circuit.

A similar idea underlies the arrangement adopted for the receiving circuit, in which a good absorber consisting of an open circuit containing the aërial is linked by a transformer to a poor radiator, and consequently a good accumulator of energy consisting of a closed circuit.

The apparatus of the British Radio-Telegraph Co. is substantially similar to that described above, with the exception that the oscillating and radiating circuits at the transmitting end, and the receiving and storing circuits at the receiving end, are connected by means of a single-coil transformer or auto-transformer instead of a two-coil transformer, as is used in the Marconi arrangement.

A considerable portion of the proceedings was occupied in the discussion whether the use of a single-coil transformer in the place of a two-coil transformer constituted an infringement or not, and the judgment

upheld the contention of the Marconi Co. that the two kinds of transformers are electrically equivalent, and that the apparatus of the defendants was an infringement of their patent.

The defence disputed the validify of the contested patent, and attempted to prove anticipation, basing the contentions principally on the patents granted to Sir Oliver Lodge and Prof. Braun. It is indeed a fact that the apparatus described by both these inventors contain examples of inductive couplings between the aërial and the oscillation-generating circuits, but it was successfully argued that neither of them had claimed the special kind of loose coupling or the tuning of the circuits that are essential to the satisfactory working of the Marconi system, and are fully set out in the Marconi patent specification. Other scientific investigators were mentioned, such as Henry, Tesla, and Elihu Thomson, who have employed coupled circuits, but their use of a transformer merely to raise the potential of the electrical oscillations produced by the discharge of Leyden jars was not able to be proved to constitute an anticipation or prior user of the essential features of the patent that has now been upheld.

The decision in this case has created a situation the outcome of which it is difficult to foresee, but there is no doubt that a number of companies now working systems similar to that of the Marconi Company will need to close their operations or to change their systems. This will have a marked effect on the grouping of wireless telegraph companies that is being carried out in England and on the Continent at the present time. A. J. MAKOWER.

NOTES.

THE following fifteen candidates have been selected by the council of the Royal Society to be recommended for election into the society:—Prof. H. T. Barnes, Prof. A. J. Brown, Prof. J. B. Cohen, Prof. W. E. Dixon, Prof. F. G. Donnan, Major E. H. Hills, Dr. W. H. Lang, Prof. J. B. Leathes, Prof. E. A. Minchin, Prof. R. Muir, Mr. R. D. Oldham, Mr. R. I. Pocock, Prof. A. W. Porter, Mr. H. W. Richmond, and Mr. G. G. Stoney.

UNDER the auspices of the Advisory Committee for the Investigation of Plague in India, Dr. G. F. Petrie, of the Lister Institute, left London on February 20 *en route* for Harbin, where he intends to prosecute investigations into the spread of pneumonic plague in Manchuria. Opportunities for extended research into this highly contagious and extremely fatal form of plague infection have only rarely presented themselves, and as all available information points to the fact that the disease in Manchuria is almost exclusively of the pneumonic type, it is hoped that Dr. Petrie's investigations may shed some light on the factors which determine the incidence and spread of this particular variety. With matters of administration and sanitary measures Dr. Petrie will not be concerned. As one of the bacteriological experts whose work in Bombay (1905–7) proved conclusively the *rôle* played by the rat flea in transmitting bubonic plague from rat to man, Dr. Petrie obtained an intimate acquaintance with the disease in its epidemiological and bacteriological aspects, and recently he has been engaged, at the request of the Local Government Board, in determining the extent of the rat infection in Suffolk. The precise form which Dr. Petrie's investigations will assume in Manchuria cannot be determined until the local conditions prevailing in the plague-stricken area and the facilities available for scientific inquiry are known. Dr. Reginald Farrar, one of the medical inspectors of the Local Government Board, is also on his way to Harbin as the British representative on the International Plague Commission convened at the request of the Chinese Government.

IN the Prussian Diet of February 18, Prof. Kirchner, a well-known epidemiologist and administrator in the service of the Ministry of the Interior, is reported to have said that, during the last few weeks, three cases of plague had occurred in London, the infection being conveyed by ship-rats. This statement has been officially denied, and it is probable that Prof. Kirchner had in mind the two isolated cases of plague which occurred in ships on the Thames four months ago (see *The Times*, October 14 and 15, 1910). With the exception of a few imported cases on ships arriving at the docks, no cases of plague have been reported in London since the year 1679. An interesting account of such imported cases in recent years is to be found in *The Times* of February 20. With regard to rat infection, three rats which had probably escaped from a ship were examined at the London Docks in November last, and two of them were found to be suffering from plague, but at present there is no evidence of the existence of a plague epizootic among rats in the London Docks area. The destruction of rats, which was instituted in 1908 owing to the existence among them of a disease declared to be a mild form of plague, is still carried out at the London Docks, and careful precautions are being taken to prevent rats in ships from infected ports from escaping ashore, and possibly initiating an epizootic among the shore rats. Large numbers of cats are also maintained in the various warehouses and sheds.

THE death of the well-known Indian pteridologist, Col. R. H. Beddome, in his eighty-first year, took place on February 23 at his residence, "Sispara," West Hill, Putney. Educated at Charterhouse, Col. Beddome entered the Indian Army in 1848, and became quartermaster and interpreter of the 42nd Madras Infantry in 1856. A keen student of natural history, whose scientific tastes were well known, he was selected to act as principal assistant to the conservator in the newly organised Madras forest department in 1857; three years later he became conservator himself, and held this position until his retirement in 1882. His transfer to the Forest Department led him to give especial attention to botany, more particularly with regard to forest needs, and led to the preparation of a work on "The Trees of the Madras Presidency," published in 1863, followed by an excellent "Flora Sylvatica" of southern India, two quarto volumes, with plates and descriptions of 400 species, published between 1869 and 1874. A professional "Report upon the Nelambur Teak Plantations" was published by Government in 1878. His leisure, however, was given to the systematic study of other groups of plants, one of his earliest papers, published in 1859, being an interesting attempt to reduce to order the south Indian species of the difficult genus Impatiens. In 1863 appeared Beddome's important work "The Ferns of the Madras Presidency," a quarto volume of descriptions and plates which at once stamped him as an authority of this family. The issue between 1865 and 1870 of a similar work on "The Ferns of British India," with descriptions and figures of species not dealt with in the earlier work and the Supplement to that work issued in 1876, only served to confirm the position of authority he had been by common consent accorded. But ferns did not entirely absorb his attention, for between 1869 and 1874 Col. Beddome issued a volume of "Icones Plantarum," with descriptions and figures of 300 interesting species from southern India and Ceylon. Before he left India, he placed students of ferns under a further obliga-

tion by the preparation of "Handbook of the Ferns of British India," embodying his rich store of information regarding the family, illustrated by reduced copies of the illustrations to his own earlier and more costly works. This handbook appeared in 1883, immediately after his retirement.

THE King of the Belgians has made a donation of 500*l.* to the funds of the Liverpool School of Tropical Medicine.

M. EUGÈNE TISSERAND has been elected a member of the Paris Academy of Sciences in succession to the late Prof. Tannery.

BY his will, M. Auguste Loutreuil, the son of a small French farmer, who later became a wealthy contractor in Russia, has left 284,000*l.* towards the promotion of science in France. The University of Paris will receive 100,000*l.*, the Academy of Sciences 140,000*l.*, the Pasteur Institute 4000*l.*, and a sum of 40,000*l.* is to provide a fund for scientific research.

DR. BASHFORD DEAN, professor of vertebrate zoology at Columbia University, who was curator of the department of ichthyology and herpetology of the American Museum of Natural History from 1903 until last year, when he resigned, has accepted an invitation to resume that post.

PROF. F. B. LOOMIS, of Amherst College, Mass., will start early in July, accompanied by three of his students, on an expedition to Patagonia. Their principal purpose will be to collect fossils and study the geological problems of the country between the Santa Cruz and Deseado rivers. The expenses of the expedition will be met by the "class" of 1896.

AMERICA has lost one of her pioneers in physical training by the death of Dr. Edward Hitchcock, in his eighty-third year. Since 1861 he had been professor of hygiene and physical education at Amherst College, which gave him at the same time a general oversight of the health and exercise of its students. His work in that capacity had a wide influence, and within twenty years after his appointment fifty American colleges had organised departments of hygiene on similar lines. Dr. Hitchcock was the author of text-books on physiology and anatomy.

A BILL to prohibit the sale, hire, or exchange of the plumage and skins of certain wild birds was read a first time in the House of Commons on February 22. In introducing the measure, Mr. Alden said the Bill had been before a Select Committee of the House of Lords and had been approved unanimously, while in the last Parliament there were only two members who were against it. Twenty-one of our colonies are in favour of the Bill, and possess powers to prevent the export of the plumage of rare birds.

WE learn from *The British Medical Journal* that a lectureship has been established by the National Health Society as a memorial to the late Lady Priestley, who was one of the original members of the committee when the society was started some thirty years ago, and attended all the meetings until within a few months of her death. Three lectures have been arranged for March, the first by Sir E. Ray Lankester on living microbes, the second by Sir Almroth Wright on bacteriology and hygiene, and the third by Mr. Stephen Paget on Pasteur and his work.

A NEW biology and botany section has been added to the Bristol Museum. The new room has been provided by Lady Smyth, and is to be known as the "Dame Emily Smyth Room." The room has been made especially strong in its exposition of the kitchen-garden, fruit-tree, and agricultural pests of the west of England. At the opening ceremony on February 21, the curator, Mr. H. Bolton, said the authorities look forward to the economic biology department becoming practically useful to the farmer, to those who possess orchards, to the small growers, and to every man who loves plants and flowers and cultivates them for his pleasure or profit.

THE summary of the weather for the first eight weeks of the present year, issued by the Meteorological Office, shows that the rainfall for the period was deficient over the entire kingdom except in the north and west of Scotland. The greatest deficiency in any district is 2·83 inches in the south of Ireland, and this is closely followed by 2·74 inches in the south-west of England and 2·53 inches in the Channel Islands. In the Midland counties the deficiency for the two months amounts to 1·81 inches, and in the south-east of England to 1·56 inches. The largest aggregate rainfall for the period in any district is 10·80 inches in the north of Scotland, and the least 1·95 inches in the Midland counties. The rainy days range from 39 in the north of Scotland to 22 in the Midland counties. The mean temperature and the duration of bright sunshine are both in fair agreement with the average. At Greenwich the mean temperature for January was slightly below the normal, and in February it was above the normal to about the same extent, so that the mean of the two months is in absolute agreement with average conditions. Frost occurred in the shade at Greenwich on eight nights, both in January and February. Gales and strong winds were experienced frequently during February over the entire country, and there was a marked preponderance of westerly winds.

BEFORE the Royal Geographical Society on February 27 Dr. W. T. Grenfell, C.M.G., described the most important features of Labrador, a land still hardly known beyond its borders. The Vinland of the Norse sagas, its resources are great, but the polar current dominates its climate, and its southern latitude provides it with a short summer, which has not the continuous sunshine of Alaska and other places farther north. Cold soil and the dryness of the winds cause the stunted nature of many plants, a larch at the south end of Labrador being but 9 inches high and three-eighths of an inch in diameter, though it showed thirty-two years' growth. Except by Prof. R. A. Daly and Mr. A. P. Low, no serious geological investigation has been undertaken; mineral deposits seem to be abundant, but such prospectors and others as have visited the region have worked but for short periods. On the evidence of beaches and glacial deposits, Labrador was said to be rising, possibly as much as 15 or 20 inches per century according to some estimates. The coasts are still but imperfectly charted, and parts are dangerous, but harbourage is plentiful, and the numerous islands and the narrow waterways furnish many facilities for coastal navigation.

IN a former issue of NATURE it was announced that, in connection with the Royal International Horticultural Exhibition to be held in the grounds of Chelsea Hospital in May, 1912, there is to be a scientific section, and a congress will be arranged for the discussion of horticultural education and matters of scientific interest. A special committee has been appointed to look after these subjects, and the first meeting has been held. The chairman of this committee is the Rt. Hon. A. H. Dyke Acland, P.C., and Mr. F. J. Chittenden will act as honorary secretary. The members include Mr. E. A.

Bowles, chairman of the Royal Horticultural Society's scientific committee, Prof. W. Bateson, F.R.S., Prof. Bayley Balfour, F.R.S., Sir Thomas Elliott, K.C.B., Mr. Anderson Graham, Prof. Bretland Farmer, F.R.S., Mr. George Gordon, Mr. H. Rider Haggard, Sir Everard im Thurn, K.C.M.G., Dr. D. Jackson, Dr. F. Keeble, Mr. Donald MacDonald, Mr. W. Marshall, Mr. F. W. Moore, Mr. Spencer Pickering, F.R.S., Lieut.-Colonel D. Prain, C.I.E., F.R.S., Dr. A. B. Rendle, Mr. T. A. H. Rivers, Mr. A. G. L. Rogers, Prof. E. S. Salmon, Mr. A. W. Sutton, Prof. Somerville, Mr. H. J. Veitch, Prof. S. H. Vines, F.R.S., and the Rev. W. Wilks. Whilst the exhibition will be one of the chief spectacular attractions of the London season of 1912, the unique opportunities afforded by the presence of experts from every country will be utilised to the fullest extent for the advancement of horticultural science.

THE Colonial Office announces that, to further the work of the African Entomological Research Committee, Mr. Andrew Carnegie has placed at the disposal of the committee a sum of 1000*l.* a year for three years to defray the cost of sending a few suitably qualified young men to the United States to study the practical applications of entomology. Three of these Carnegie scholars have been selected, and two are now at work in the States. The fact that Dr. L. O. Howard, chief of the Bureau of Entomology at Washington, is interesting himself, is a guarantee that all facilities will be given to the scholars, and the scheme will be of great value to British administration by providing well-trained entomologists for employment by the different Colonial Governments. The research committee was appointed in June, 1909, to promote the study of the insects which spread disease in Africa. Lord Cromer is its president, and it includes eminent authorities on entomology and tropical medicine. The scheme has been taken up by the African colonies and protectorates, and the material already received at the committee's office in the Natural History Museum at South Kensington has increased our knowledge of the insect pests of Africa. The collections of insects, after being identified and recorded, are being distributed to the schools of tropical medicine, universities, museums, or other institutions where they are likely to be of value. Further particulars may be obtained from the secretary of the committee, Mr. Guy Marshall, British Museum (Natural History), South Kensington, London.

A BILL to promote the earlier use of daylight in certain months yearly, and for other purposes relating thereto, has been introduced into the House of Commons by Mr. Robert Pearce. The chief clauses of the measure are as follows:—(1) From 2 o'clock in the morning Greenwich mean time in the case of Great Britain, and Dublin mean time in the case of Ireland, of the third Sunday in April in each year, until 2 o'clock in the morning Greenwich mean time in the case of Great Britain, and Dublin mean time in the case of Ireland, of the third Sunday in September in each year, the local time shall be in the case of Great Britain one hour in advance of Greenwich mean time, and in the case of Ireland one hour in advance of Dublin mean time, and from 2 o'clock in the morning Greenwich mean time in the case of Great Britain, and Dublin mean time in the case of Ireland, of the third Sunday in September in each year until 2 o'clock in the morning Greenwich mean time in the case of Great Britain, and Dublin mean time in the case of Ireland, of the third Sunday in April in each year, the local time shall be in the case of Great Britain the same as Greenwich mean time and in the case of Ireland the same as Dublin mean time. (3) Greenwich mean time as used for the purposes of astronomy and navigation shall not be affected by this Act. (4) This Act shall apply to the United Kingdom of Great Britain and Ireland, and may be cited as the Summer Season Time (Great Britain and Ireland) Act, 1911. We have on several occasions expressed the opinion that the changes contemplated by the Bill are unnecessary and undesirable, and we trust that the measure will meet the same fate as that of previous attempts at so-called "daylight saving."

THE London County Council is doing good service to anthropology by developing the Horniman Museum at Forest Hill. It has now published, at a nominal price, under the title of "A Handbook to the Stages in the Evolution of the Domestic Arts," a useful introduction to the science of technology, prepared by the curator, Dr. H. S. Harrison, under the advice of Dr. A. C. Haddon. Curators of provincial museums might well consider the advisability of adapting this to the collections under their charge.

IN the tenth number, vol. ii., of the Memoirs of the Asiatic Society of Bengal, recently issued, Mr. H. H. Hayden, of the Geological Survey of India, under the title of "Notes on some Monuments of Afghanistan," describes, first, some of the Buddhist Topes near Kábul, and has been able to correct a mistake of James Fergusson in his "History of Indian Architecture," who confuses the Munár-i-Surkh with the Munár-i-Chakri. It is regrettable to learn that the platform of the latter is in so ruinous a condition that, if immediate action be not taken, this interesting monument will inevitably fall. It may be hoped that the Viceroy may be able to put some pressure upon the Afghan authorities in order to avert this catastrophe. He also gives an interesting series of photographs of the celebrated Buddhist carvings at Bámián, and is able to give some new information about them. Occasion was also taken to photograph the tomb of the Emperor Bábar, who died at Agra in A.D. 1530 and was buried at Kábul. It is now possible, for the first time, to give in Persian and English the inscription on his tomb.

IN a sixth report on research work, Dr. A. C. Houston, director of water examination, Metropolitan Water Board, gives details of an investigation on the comparative vitality of "uncultivated" and "cultivated" typhoid bacilli in artificially infected samples of raw river water, with special reference to the question of storage. In a previous investigation on the same subject (see NATURE, vol. lxxviii., 1908, p. 377) it was found that in raw river water inoculated with ordinary laboratory cultures of the typhoid bacillus, in one week there was a percentage reduction in the number of bacilli of 99·9, but that a resistant minority of bacilli persisted up to nine weeks in the inoculated water. In the present work the raw river water (5 litres, kept in a partially stoppered bottle in a cellar) was inoculated with typhoid bacilli obtained by centrifugalising the infected urine of a carrier case which had come under the observation of Prof. McWeeney, of Dublin. In this way typhoid bacilli derived directly from the patient, without artificial culture, were added to the water, as would be the case in the natural infection of a water supply. At the end of one week after inoculation, examination showed that the initial number of 770,000 typhoid bacilli per c.c. of water was reduced to 4 per c.c.—a reduction of more than 99·99 per cent. Five subsequent examinations made from the fourteenth to the thirty-fourth day after the commencement of the experiment failed to isolate the typhoid bacillus from 100 c.c. of

the water. A second similar experiment gave corroborative results. In addition, Dr. Houston on several occasions drank half a pint of the water after the twenty-third day without ill effect! In another experiment water was inoculated with the typhoid bacillus derived from the same source, but cultivated for several generations on artificial media. The organism in this case was isolated up to the sixth week after inoculation into the water. The conclusion, therefore, is that "uncultivated" typhoid bacilli rapidly perish in raw river water, and that even a week's storage of raw river water is an enormous protection against typhoid infection from such a source.

IN the *Museums Journal* for January Dr. R. F. Scharff, of the National Museum of Ireland, Dublin, describes a dry system of macerating bones for use as exhibits. Formerly this was effected in water tanks, which proved so offensive on sanitary grounds that it was necessary to discontinue their use. Dr. Scharff has now discovered that the object can be satisfactorily attained by covering the bones with dry sea-sand, the bacteria almost wholly performing the work of maceration. Small skeletons are enclosed in boxes filled with sand, and the task of rearranging the bones when they are clean is thus greatly facilitated.

IN *Novitates Zoologicae* for December, 1910, vol. xvii., p. 445, pls. viii., ix., the Hon. Walter Rothschild gives coloured plates of the sea-elephants of Guadaloupe Island and the Falklands. The former is identified with the typical Juan Fernandez sea-elephant described by Linnæus as *Phoca leonina*, which appears to make periodical migrations from that island to Guadaloupe and back. Despite the much greater length of the proboscis in the males of the Juan Fernandez as compared with the Falkland animal, the author points out that other forms indicate a transition in this respect between the extremes, and he therefore proposes to regard all the local forms as races of a single species. This is, perhaps, the most satisfactory conclusion of a problem which has given rise to a considerable amount of discussion and confusion.

THE former existence of one imported giant land tortoise in Ceylon has long been known to naturalists, but it is remarkable that it should have been left to a casual correspondent of an English journal to supply evidence of the occurrence of a second. The first specimen, according to a letter from Mr. Pearson, director of the Colombo Museum, in *Spolia Zeylanica* for December, 1910, was found in Colombo when Ceylon was first occupied by the British in 1796. It was then living in the grounds of a villa called Uplands, in Mutwall, near Colombo; in 1894 it was removed to the Victoria Park, where it survived only a week. It is now preserved in the Colombo Museum, and is identified by Mr. Pearson with *Testudo gigantea* of Aldabra. The length of the shell is 40 inches. In *Country Life* of July 9, 1910, appeared a photograph of a giant tortoise living at Matara, near Galle, taken by Mr. Stanley Mylius, which is reproduced by Mr. Lydekker in an article on giant tortoises in *Science Progress* for October, 1910. That specimen, which is referred to *T. gigantea*, the author thought might be distinct from the Colombo tortoise, and that it is so is indicated at the close of Mr. Pearson's letter. In Mr. Lydekker's article the length of the shell is given as 53½ inches, and it may be that this refers to the Matara specimen, in regard to which Mr. Pearson hopes to obtain further information.

RECENT observations by Prof. S. O. Mast (*Journ. Exper. Zool.*, vol. ix., No. 2) on the reactions of *Amoeba proteus* to light show that a sudden and sharp increase of light intensity causes retardation or cessation of movement; if the intensity be maintained constant for a few moments, the movements of the Amœba begin again. A gradual increase in intensity produces no response, so that the reaction to light depends primarily on the rate of change of intensity. Blue rays (430–490 $\mu\mu$) are nearly as efficient as white light in producing reactions, but violet, green, yellow, and red produce only slight effects. The author suggests that, as other organisms respond most definitely to light of other colours—violet, green, yellow, or red—it is probable that different photo-chemical changes are associated with the reactions to light in different organisms. Prof. Mast has given, in the *Psychological Bulletin*, vol. vii., pp. 267–80, an abstract of literature, of the year 1909, on the behaviour of lower organisms, including a summary of the discussion on the subject of tropisms by Messrs. Bohn, Loeb, Jennings, and Darwin at the International Congress of Psychology, held at Geneva.

THE *Zentralblatt für Physiologie* (Bd. xxiv., No. 17) is almost entirely occupied by an excellent summary, extending over fifty-two closely printed pages, of the numerous papers read before the eighth International Congress of Physiologists, held at Vienna on September 27–30 last. The number also contains three short original contributions. In the first of these Fr. Kutscher gives the results of his examination of the aqueous extract of mushrooms, which he found to contain arginin, cholin, betain, and a hitherto unknown base, the formula of which is similar to that of histidin, with the addition of three methyl groups; but the organic bases form only a very small portion of the extract, the physiological action of which depends on other substances present. T. Kinoshita concludes, after a series of analyses, that normal, fresh human urine contains only a trace of trimethylamine, but, on standing, this substance is formed during some fermentative process. E. Berlin describes a new synthesis of γ-homocholin, starting from β-aminopropylalcohol. Issued with this part of the *Zentralblatt* is a further portion (pp. 177–317) of the Bibliographia Physiologica (third series, vol. v., Nos. 3, 4), prepared by the Concilium Bibliographicum in Zürich, which, with the two preceding parts, contains the titles of papers published in 1909. These are arranged in the usual sections, according to the subjects of which they treat, and there is, at the end, an author-index to the contents of the whole volume.

To the Transactions and Proceedings of the Perthshire Society of Natural Science for 1909–10 (vol. v., part ii.) Mr. R. Dow contributes a life of David Douglas, of Scone, who introduced into Great Britain no fewer than seven species of American conifers, among which *Abietia Douglasi*, although originally discovered in Nutka Sound during Vancouver's voyage round the world, was named in his honour. Douglas was born at Old Scone in 1799, and, after being employed at the Glasgow Botanical Gardens, started in 1824 on a botanical expedition to the banks of the Columbia River and the neighbouring districts. Thence he travelled southwards to California in 1831, and two years later left America for the Sandwich Islands, where he died, as the result of an accident, in 1834. In 1847 a monument was erected to his memory by public subscription in Scone churchyard. Although they were not introduced into Great Britain until considerably later, *Sequoia sempervirens* and *S. gigantea* (the so-called Wellingtonia) were practically discovered by Douglas, the notices of them by Archibald Menzies in 1795 and 1796 being very imperfect.

IN the February number of *Petermanns Mitteilungen*, with which *Globus* is now incorporated, Dr. V. Paschinger discusses the results of an investigation of the snowline in different regions. The present article is but a summary, since the full discussion is to be published later, but the main results are here given. The principal determining factor he considers to be temperature, except in regions where the snowfall is exceptionally heavy, when precipitation is more influential climatically. For a certain number of places he has been able to compare the position of the snowline in different years, and finds that generally in the northern hemisphere at the beginning of the 'seventies it occupied a position of minimum altitude, and has reached a maximum level since 1890.

THE results of Dr. K. Sapper's journey in the island of South Mecklenburg of the Bismarck Archipelago, undertaken in 1908 for the German Colonial Office, are published in the third Erganzungsheft of the *Mitteilungen aus den deutschen Schutzgebieten*. The topography and physical conditions of the island and others near it were principally studied, but the climate, the densely wooded nature of the region, and the short time available only admitted of a rapid reconnaissance, while the botany and zoology could be scarcely attempted. Using the charts of the German Admiralty as a basis, compass and aneroid were used to determine the land features, which are given in orographically coloured maps; but these, for the above reasons, can only represent the general relief of the island without claiming accuracy of detail. Geological investigation was rendered difficult by the vegetation, and gravel in the stream-beds furnished specimens of rocks which were not otherwise met with. Oligocene limestones and glauconitic sandstones were found; but most of the sedimentary rocks, consisting of sandstones, limestones, tuffs, and clays, are considered to be Pleistocene. Diorite, syenite, gabbro, and granite were met with, but a far larger area is occupied by the younger eruptive rocks, principally andesite.

IN NATURE, vol. lxxix., p. 234, M. Paul Macey's descriptions of subterranean waterways in Indo-China were referred to. He now supplements his paper in *Spelunca* by an illustrated account of the "Tunnels naturels du Laos" in *La Nature*, 1911, p. 102. We are surprised that he gives no reference to his previous paper, where his adventures and explorations underground were described so cheerfully.

HERR H. HABENICHT, of Gotha, has circulated a pamphlet, "als Manuskript gedruckt," entitled "Spuren der Eiszeiten in Norddeutschland und Versuch ihrer Deutung" (Gotha: Andreas Perthes, 1910). It is accompanied by an excellent map in colours. The author directs attention to the absence of true terminal moraines along the margin of the northern glacial drift in its most southerly extension. The deposits in this region, unlike such moraines, show curved forms that are convex towards the north, while their terminations reach down into the valleys that notch the Thüringian, Saxon, and Sudetic border. The author believes that the facts require the occurrence of a great flood between two ice-ages, whereby the deposits of the older ice-age were swept into their present positions against the southern hills. An interglacial diluvium was thus deposited; but an older one also exists. Loess was formed in pre-glacial times during an epoch of continental elevation, and of consequent dryness through remoteness from the sea. A catastrophic falling in of the surface swept the sea water over this, and led to the formation of an old diluvium. Then followed the first ice-invasion, a second uplift and a steppe epoch, and a second general sinking and "Sturmflut des Weltmeeres." The consequent rains brought on the second ice-age, when the glaciers only reached the Baltic region. The mixture of the remains of Arctic and tropical or steppe animals is attributed to flood-action. It is clear that Buckland's early views have lived on, in spite of the conversion of their author.

IN a paper contributed to the Spanish Institute of Civil Engineers (Barcelona: Guinart et Pujolar), Dr. Paulino Castells Vidal describes an ingenious balance for finding the real roots of an algebraic or similar equation. This apparatus consists of a horizontal shaft on which are attached cams in the form of equiangular spirals or similar curves, from which may be suspended weights representing the coefficients of powers of x in an algebraic equation; on the other hand, the arms of the levers formed by the cams are for different values of the angular coordinate proportional to the values of 1, x, x^2, for different values of x. Consequently, when the apparatus has come into a position of equilibrium, the pointer attached to the shaft at once gives a real root of an algebraic equation the coefficients of which are the weights of the loads suspended from the cams.

WE have received the reprint of a paper, by Mr. Cyril F. Lan-Davis, read before the Optical Society last December, and reprinted from *The Optician and Photographic Trade Journal*, dealing with the theory of the iris diaphragm. Hitherto these useful optical accessories have been mainly designed by trial, with the result that in many cases it has been stated to be impossible to give sufficiently large ranges of aperture for the requirements of modern lenses and their fittings. The author now shows how the problem can be treated by the methods of elementary geometry, and the conditions for maximum range of aperture, as well as for other important requisites, such as a long scale with equal divisions, can be made the subjects of exact calculation. Neglecting the dimensions of the pins which carry the leaves, it is shown that the maximum aperture obtainable is 0·823 of the diameter of the diaphragm itself, and that for this twenty-five leaves are required. This is a good example of a problem where a little mathematics may save a great deal of random experimenting.

INTENDING purchasers of microscopes and microscopic apparatus will be well advised to consult the list issued by Messrs. R. Winkel, of Göttingen, obtainable from their London agents, Messrs. H. F. Angus and Co., 83 Wigmore Street. Attention is specially directed to the microscope stand No. 1*d*, the fluoride objectives that originated in Göttingen, and an excellent series of complanatic eyepieces giving a particularly flat field. The general workmanship and finish compare favourably with those of other leading makers. The object marker is a new piece of apparatus similar in shape to an objective, and in place of which it is inserted, for marking a circle round any desired spot on a slide. The type supplied for marking covered objects is provided with a diamond point set in a mount that can be rotated.

IN the September (1910) number of the Journal of the Franklin Institute, Philadelphia, Mr. J. H. Dellinger, of the Bureau of Standards, made a preliminary announcement of an interesting relation he had discovered between the electrical resistivity, the coefficient of increase of the resistivity with temperature, and the density of specimens of copper of all makes submitted to the bureau for test. According to Mr. Dellinger, the product of the three quantities mentioned is constant for all specimens of copper

at 20° C. This result, according to a paper by Dr. S. Lindeck, of the Reichsanstalt, which appears in the January number of the *Verhandlungen der Deutschen Physikalischen Gesellschaft*, is confirmed and extended to very impure coppers and to aluminium and iron by the tests made at the Reichsanstalt during the past five years.

ACCORDING to notices to hand from the Société française de Physique, the *Journal de Physique* is in future to be published by the society, and the three-monthly *Bulletin des Séances* is no longer to be issued. The increased cost is to be met by an increase of the subscriptions to 25 francs for resident and 20 francs for non-resident members. The first issue of the *Journal de Physique* under the new conditions, which appeared early in January, contains a *résumé* by Messrs. Cotton and Mouton of their work on the magnetic double refraction of pure liquids, to which we referred in these columns in November last. The abstracts of papers which have appeared in other periodicals occupy about twenty pages, and seem thoroughly good, but as they nearly all relate to papers published in the early months of 1909, it is evident that much requires to be done before the journal can claim that it is placing the present state of the various branches of physical science before its readers.

WITH reference to an offer recently made to the Calcutta University by the Hon. the Mahárája of Cassimbazar of 20,000 rupees, for the purpose of editing and translating Sanskrit texts dealing with astronomy and mathematics, Dr. G. Thibaut stated, at the meeting of the Asiatic Society of Bengal on February 1, that he will shortly explain the present state of knowledge of Indian astronomy and mathematics, and point out what remains to be done in the way of publishing and translating. In this connection he will deal shortly with the following points:—the successive stages of the development of astronomy and mathematics in India; the characteristic features of each stage; the question whether the astronomical and mathematical knowledge possessed by the ancient Hindus originated in India or was borrowed in part or in its entirety from some other nations (Greeks or Babylonians); the use which has been made of certain data of an astronomical nature met with in the *Veda*, for determining the age of the *Veda* or of Indo-Aryan civilisation.

COMMENTING on the *Waratah* wreck inquiry, *Engineering* for February 24 states that the most important point which emerges from the finding of the Court appointed by the Board of Trade is the recommendation that a committee of experts should be appointed to arrive at some conclusion concerning the minimum stability requirements of different types of vessels at sea. Curves showing these requirements might be utilised for preparing rules for the guidance of shipowners in the stowage of cargo in each ship with greater precision than is now possible. Our contemporary states that it has been the practice with experienced builders, among whom should be classed the builders of the *Waratah*, to supply owners with full information regarding the stability of the ship under all conditions of loading, and with instructions as to the disposition of the ballast, in order to ensure the continuance of satisfactory conditions. But there is no certainty as to whether or not these conditions are scrupulously fulfilled by the officers responsible for the ship. The proposal to institute a committee for the formulation of rules is satisfactory in itself, but something more is required in order to ensure that the rules will be carried out most carefully.

A CONTRIBUTION from the Jefferson Physical Laboratory, Harvard University, appears in the Proceedings of the American Academy of Arts and Sciences for January, giving an account of some experiments on the action of mercury on steel at high pressures. Amagat in 1893 described a case in which mercury was forced by a pressure of 3000 atmospheres in a fine spray through 8 cm. of cast steel, in which no flaw could be afterwards detected with the microscope. In the experiments now described, twelve similar test cylinders were cut from a bar of Krupp's special chrome nickel steel. Six of these were tested under mercury pressure, and the others were tested with a glycerin and water mixture, with ether, and also CS_2. Five of the cylinders tested with mercury burst at pressures from 3000 to 4750 kilograms per square cm.; one burst at 10,250 kilograms per square cm. None of the cylinders tested with other fluids burst, even under pressures of 24,000 kilograms per square cm. Soft steel cylinders show this effect hardly at all, owing to the interference of the lower yield point of the material. Examination of the fracture seems to establish the fact that the lower strength of hard steel cylinders under mercury pressure is owing to amalgamation. Amalgamation once started, it spreads with great rapidity throughout the metal. Two causes hasten the rapidity of the action: one is the natural affinity of mercury and steel, the other is the straining action of the pressure, tending to open the pores. The latter view is strongly supported by the fact that, in the fractures, amalgamation was observed to be most rapid in the direction in which the pores were most distended.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES FOR MARCH:—

March 2. 5h. 58m. Venus in conjunction with the Moon (Venus 2° 20′ N.).
4. 10h. 22m. Saturn in conjunction with the Moon (Saturn 1° 39′ S.).
9. 17h. 23m. Neptune in conjunction with the Moon (Neptune 5° 22′ S.).
10. 21h. 40m. Mars in conjunction with Uranus (Mars, 0° 23′ S.).
18. 14h. 8m. Jupiter in conjunction with the Moon (Jupiter 1° 47′ N.).
20. 1h. 0m. Mercury in superior conjunction with the Sun.
21. 5h. 45m. Sun enters sign of Aries. Spring equinox.
24. 16h. 49m. Uranus in conjunction with the Moon (Uranus 4° 39′ N.).
25. 12h. 3m. Mars in conjunction with the Moon (Mars 4° 15′ N.).
28. 17h. 50m. Venus in conjunction with Saturn (Venus 2° 25′ N.).
30. 12h. Neptune stationary.
,, 18h. 51m. Mercury in conjunction with the Moon (Mercury 2° 22′ N.).
31. 23h. 15m. Saturn in conjunction with the Moon (Saturn 1° 58′ S.).

A REMARKABLE METEOR.—Mr. W. F. Denning writes:—"On February 19, at 9h. 24m., a brilliant meteor was seen by Mr. and Mrs. Wilson from Reigate, Surrey, and by Mr. Peecock from Stowmarket. The object was a very exceptional one for its slowness of flight. At Stowmarket the meteor is described as having a bright reddish-yellow head, with a glowing tail about 15 degrees long streaming behind. It was traced from low in the south-west to low in the north-east. It was in full view for thirty seconds or more.

"At Reigate only the last 27 degrees were observed from just north of Coma Berenices to close to Arcturus. It was the slowest meteor ever witnessed by the observers, who counted sixty, equal to about thirty seconds, while it descended. It showed a bright head, and a yellow tail marked its path.

"The object probably had its radiant south of Orion, and its course lay from about the English Channel, south of Devon, to the coast of Holland. The whole of the path traversed must have been about 520 miles, but the heights cannot be exactly determined from the materials. Another good description of the apparent flight would be very valuable. The night was clear, and many persons in the south-eastern counties must have had a fine view of the phenomenon."

THE PHOTOGRAPHIC SPECTRUM OF NOVA LACERTÆ.—In No. 4473 of the *Astronomische Nachrichten* Dr. Max Wolf reproduces and describes the photograph of the spectrum of Nova Lacertæ which he took with the Zeiss two-prism spectrograph (exposure 90m.) on January 13. At first glance the spectrum consists of seven broad bright bands, of which six are accounted for by the hydrogen lines Hβ–Hη; the seventh has a wave-length of about 463 μμ. The nova spectrum declines abruptly in intensity at about λ 360, not extending nearly so far into the ultra-violet as do the spectra of the Orion stars. The order of brightness of the broad bands is Hγ, Hδ, 463, Hε, Hβ, Hζ, Hη. Dr. Wolf gives the wave-length measures of the different parts of each band, and also finds other faint bands having their centres at the wave-lengths 451·3, 447·4, 443·4, and 405·8; three other broad, faint bands have their maxima at λλ 427·3, 425·6, and 422·9.

RECENT OBSERVATION OF HALLEY'S COMET.—To *The Observatory* (No. 432) Prof. Barnard sends the following observation of Halley's comet on January 8, at 21h. 30m. 56s. G.M.T.:—R.A. = 11h. 47m. 16·65s., apparent dec. 18° 24′ 44·3″ S. The comet was 32·8″ diameter, round, and slightly condensed, but had no nucleus. With the 40-inch refractor, its magnitude was estimated to be 13 or 14. Prof. Barnard hopes to be able to follow the comet for the greater part of the present year, and this will provide an enormous arc, over which the comet has been observed during the present return; the determination of its path during this revolution will thus be considerably simplified. In April next the comet will be as far from the sun as is Jupiter.

SEARCH-EPHEMERIDES FOR WESTPHAL'S COMET (1852 IV.).—In No. 4475 of the *Astronomische Nachrichten* Herr A. Hnatek publishes three search-ephemerides for Westphal's comet, which may be found during the coming spring or summer. The three ephemerides are based on the assumptions that the period of the comet may be sixty, sixty-one, or sixty-two years respectively, and each covers the period April 10 to September 7. The rediscovery is doubtful, however, for the calculated magnitudes lie between 10·3 (August 28, 1911) and 13·4.

OBSERVATIONS OF THE ZODIACAL LIGHT AND THE GEGENSCHEIN.—Herr Banachiewicz describes a brilliant apparition of the zodiacal light, seen at Kasan on January 26–27, in No. 4474 of the *Astronomische Nachrichten*. The light extended to Saturn, and the middle of its pyramidal form passed over the stars δ, ε, and ζ Piscium. As compared with the Milky Way, the light appeared of a slightly reddish hue, and, so far as the two phenomena can be compared for brightness, was about equally bright.

Observations of the counterglow, or gegenschein, were made by Mr. Innes, Mr. and Mrs. Wood, and Mr. Worssell at the Transvaal Observatory during September and October, 1910, and are published, with sketches, in No. 5 of the Circular. Mr. Innes reports that on September 24, 25, and 26 the counterglow was, and had been, remarkably distinct, lying along the ecliptic as a lens-shaped mass about 10° broad and about 90° long; in spite of the sky-illumination from electric lights and veld fires, visitors were able to see the phenomenon immediately their attention was directed to it. Mr. Worssell gives its approximate limits on October 4 at 9h. 40m. (G.M.T.) as N. +17·5°, S. −4·5°, preceding, 0h. 5m. and following 1h. 20m., thus making the position of the centre R.A. 0h. 32m., dec. +5½°.

THE MURNPEOWIE METEORITE.—The annual report of the South Australian School of Mines for 1909 contains a very interesting description of the iron meteorite discovered in August of that year. The discovery was made by some boundary-fence repairers working near Murnpeowie, Lat. S. 29° 35′ L. and Long. 139° 54′. Mr. L. Laybourne Smith, the curator of the museum, says the country at this place is flat and devoid of stones. The object is a siderite weighing 2520lb., its greatest height 35 inches. The chemical composition has not been determined. Mr. Smith is making inquiries with a view to finding the date of the fall. "Australian bushmen are very observant, and this isolated 'rock' would not have been overlooked in a position less than half a mile from where the fencers were working. The holes also would fill with sand in a few years. It is probable, therefore, that the Murnpeowie meteorite is a recent arrival."

INTERNATIONAL HYGIENE EXHIBITION, DRESDEN, 1911.

FOR some months past very conflicting statements as to the attitude of the Government towards the International Hygiene Exhibition to be held in Dresden have been made, but we are now assured that the President of the Board of Trade has given it his blessing, and that some of those who have hitherto held aloof, owing to some misunderstanding, have expressed their approval of the movement. It is to be hoped, therefore, that Great Britain will be properly represented in what promises to be one of the most important scientific exhibitions and congresses of modern times. This exhibition is not merely for the advertising of trade products, nor is it intended that it should compete in any way with such trade exhibitions as, for example, that to be held at Turin. Rather is it to be a collection of apparatus and appliances, so arranged and classified that experts or others interested in matters pertaining to hygiene may study, compare, and contrast the most modern and best hygienic contrivances.

Our German cousins, with their genius for organisation and attention to detail, have spared neither trouble nor expense in laying solid foundations, and it now rests with other countries to assist in the building of an adequate superstructure. Great Britain can ill afford to be behind in a race in which, hitherto, her lead has been pre-eminent; and although she must do voluntarily, through individuals and private organisations, what by other countries is done by the State, it is to be hoped that now all misunderstanding has been cleared away a united effort will be made, not only to raise the rest of the necessary funds, but to send sufficiently imposing exhibits.

Some idea of the thoroughness of the work that is being done may be gathered from the fact that a "News Bureau," from which is issued what may be called a small newspaper—*Hygieia*, has been formed in connection with the exhibition. Of this leaflet, Nos. 16, 18, and 19, all of them published in January of this year, may here be referred to. The first deals with the department of "statistics," and not only affords an indication as to the objects of the promoters of the exhibition, but serves as a guide to would-be exhibitors as to what is most likely to be of use and interest to the "public" whom this exhibition is expected to attract. We are told that the collection of statistics brought together by the German Government has cost something like 350,000*l*., that games and their influence on health will be illustrated, and that the various implements employed in carrying on these games will be fully set forth. The hygiene of civilised life will naturally receive most attention, but the method of life of savage tribes will also be demonstrated—dwellings, food, mode of life, and the like, of bushmen, Australian aborigines, primitive Indians, North American Indians, all being illustrated. One of the leaflets is devoted almost entirely to milk, under such headings as hygiene of milk; exhibits of apparatus and methods for the bacteriological investigation of milk; models, drawings, and photographs to show the dangers arising from dirty milk; the proper treatment of milk practicable even in small dairies; methods of sterilisation and milk inspection; and the hygiene of butter and cheese. Hygienic cowhouses and fittings, and the best methods of keeping cattle in dairies, and so on.

Another leaflet, No. 19, deals with subjects very different in character—the action of light and special forms of light, such as the ultra-violet rays, the action of radium, and radio-active substances; and then darts off suddenly into an entirely new region, where exhibits and statistics con-

cerning sick clubs, insurance against illness, and many of those other schemes promoted by the German Government, the importance of which is now being so fully realised in other parts of the world, are to be on view.

It is to be hoped that now the matter has been taken up, those interested in British sanitary science and the scientific aspects of hygiene generally, will spare no effort to make the British exhibit, in part at least, worthy of those great leaders of sanitary science who, shortly after the middle of the last century, did so much, not only for Great Britain, but also for other civilised countries.

THE RUSTING OF IRON.

THE problem of the atmospheric corrosion of metals is a very old one. So long ago as 1769, only three years after Cavendish had demonstrated the solubility of chalk and magnesia in water charged with "fixed air" or carbonic anhydride, it was shown by T. Lane, an apothecary of the City of London, that "water impregnated with fixed air will dissolve a considerable quantity of iron, and thereby become a strong chalybeate" (Priestley, "Experiments on Air," 1772). Lane records (Phil. Trans., 1869, l., 218) that "the clear water . . . decanted from the filings and ochrous sediment . . ., being exposed to the open air, presently threw up a party-coloured pellicle, and deposited a yellowish sediment."

In this way the foundations were laid for the theory of rusting put forward in 1888 by Crum Brown, according to which the action consists essentially in the dissolution of iron by carbonic acid, and subsequent precipitation from the solution of ferrous bicarbonate of ferric hydroxide formed by the interaction of the ferrous salt with atmospheric oxygen; the separation of the rust is accompanied by the liberation of the carbonic acid, which is thus set free to attack a further quantity of iron.

The correctness of Crum Brown's theory was confirmed by Moody's observation (Trans. Chem. Soc., 1906, lxxxix., 720) that iron which had been cleaned with chromic acid could be kept for long periods in contact with water and air in a glass tube from which all traces of carbonic acid were carefully excluded. Friend (Proc. Chem. Soc., 1910, xxvi., 179) has confirmed this observation by condensing water distilled from an alkali upon an iron tube cooled by circulating water.

In a paper which has recently appeared in the Journal of the Chemical Society, Messrs. Lambert and Thomson have arrived at conclusions differing somewhat from those of Moody and Friend. By electrolysing ferric chloride between electrodes of pure iridium foil, a specimen of iron was obtained which gave a crystalline nitrate entirely free from the violet colour which usually characterises this salt and ordinary ferric alum; the nitrate was transferred to an iridium boat, ignited, and reduced in a stream of hydrogen in a silica tube at 1000°. The metal thus obtained (which appears to have been so pure as to be acid-proof, like the redistilled zinc prepared some years ago in Sir William Ramsay's laboratory) was found to be unacted on by purified oxygen and purified water, but when platinum vessels were used in preparing the iron, the metal was found to be oxidised in the course of two or three hours, and a similar result was observed in the case of commercial iron, whether it was cleaned with chromic acid or not.

The different results thus obtained may very possibly be attributed to a difference in the vessels in which the iron was exposed to the action of water and oxygen. The dominant factor in promoting the atmospheric corrosion of iron is undoubtedly carbonic acid, but there is no reason to suppose that the part of the carbonic acid might not be played by any other acid strong enough to act upon the iron, though weak enough to be liberated by oxidation from the ferrous to the ferric state. Silicic acid, the immediate homologue of carbonic acid in the periodic classification of the elements, might very possibly be capable of producing a like effect, and, if so, the use of silica tubes would be likely to promote rusting to a far larger extent than tubes made of glass. The use of silica tubes by Messrs. Lambert and Thomson in an experiment in which one of the main objects was to eliminate acid impurities is a change of which the advantages are very questionable. The soluble (alkaline) matter dissolved out from ordinary glass does not suffice under normal conditions to prevent rusting from taking place in glass vessels, but it is noteworthy that under the conditions of Moody's experiments contact with the actual (acid ?) surface of the glass was sufficient to cause the metal to rust, whilst Friend has recorded a similar effect produced by particles of slag embedded in the iron. T. M. L.

ECONOMIC GEOLOGY IN THE UNITED STATES.[1]

THE three bulletins referred to below have been issued by the United States Geological Survey, which, at all times keenly alive to the importance of economic geology to the nation, has of late years been paying particular attention to the study of the mineral resources of the United States. The two first bulletins give an elaborate and detailed account of the geology of one of the most important oil-producing regions of central California. Very little accurate geological work had been done here previously, so that the present bulletins form a useful contribution to general stratigraphical geology as well as to the special geology of oil-bearing regions. There is nothing that calls for particular notice in these bulletins; the oil appears to occur in strata of the customary type of Eocene, Lower and Middle Miocene age. Both reports are elaborate and full of detail, and the report on the Coolinga district is noteworthy for the amount of palæontological information that it contains and for the admirable manner in which some of the fossils referred to have been illustrated in the accompanying plates.

The third of these bulletins deals with an entirely different subject, namely, the methods recently introduced by the United States Government for the purpose of placing its system of purchasing its coal supplies upon a scientific basis. The method is roughly as follows:—For each coal the moisture, ash, and calorific value (expressed in British thermal units) are determined upon samples taken with all due precautions. The bids of the various samples are sent in on official sealed forms. In order to compare these, all the tenders are reduced to the same ash value by selecting as standard the coal containing the lowest percentage of ash; for each 1 per cent. of ash above this figure, 2 cents per ton is added to the tender price. From this price thus adjusted, and from the calorific power as determined, the cost per 1,000,000 B.T.U. is calculated for each coal offered, and as a general rule the contract is awarded to the lowest cost as thus ascertained. As the heat value of the coal is determined upon the coal as received, there is no necessity to determine the percentage of moisture that it contains. When a tender has been awarded to a contractor, he is expected to maintain the quality of the coal delivered at approximately the same standard as that upon which the contract was awarded. For this purpose careful samples are taken from each delivery; when the samples have been drawn, payment of 90 per cent. of the amount of the account is made forthwith, the balance being kept in hand until the samples are reported upon. The price is corrected for variation in calorific power, by multiplying by the number of B.T.U. in the sample and dividing by the number of B.T.U. upon which the contract was based. Similarly for each 1 per cent. less of ash in the sample of the coal delivered, a premium of 2 cents per ton is paid, and for each 1 per cent. of ash more a deduction is made in accordance with a published schedule, an increase up to 2 per cent. of ash not being, however, penalised. Of course the contract note contains clauses under which a delivery containing an excessive amount of ash, dust, or sulphur may be entirely rejected.

It will be seen that this system of coal purchasing is novel, and interesting to a wider public than that directly concerned with the supply of coal to the various departments of the United States Government. H. L.

[1] Department of the Interior. United States Geological Survey Bulletins. (Washington, 1910.)

(1) Geology and Oil Resources of the Coolinga District, California. By Ralph Arnold and Robert Anderson. Pp. 354.

(2) Preliminary Report on the McKittrick-Sunset Oil Region, Peru, and San Luis Obispo Counties, California. By Ralph Arnold and Harry R. Johnson. Pp. 225.

(3) The Purchase of Coal by the Government under Specifications; with Analyses of Coal delivered for the Fiscal Year 1908–9. By George S. Pope. Pp. 80.

THE AFFINITIES OF SCHIZOTRYPANUM.

IN a recent number of the *Archiv für Protistenkunde* (vol. xx., p. 361), Dr. M. Hartmann makes an important addition to our knowledge of *Schizotrypanum cruzi*, the trypanosome of human beings discovered by Chagas in Brazil (see NATURE, August 4, 1910). Chagas described a process of multiple fission ("schizogony"), taking place in the lung capillaries, of forms not enclosed in cells (NATURE, *l.c.*, p. 143, Fig. 2, *b–e*). In addition to this type of multiplication, Hartmann finds another process of schizogony within hypertrophied endothelial cells of the lung, as a result of which the cell contains some twenty or more small, pear-shaped organisms, each with a distinct kinetonucleus and trophonucleus, but no flagellum. The chief interest of this discovery lies in the very great resemblance of these intracellular forms of Schizotrypanum to those of *Leishmania donovani*, the parasite of Kala Azar; in fact, anyone, looking at the figure given by Hartmann, might suppose that it represented a preparation of Leishmania. Similar forms are stated to have been found in the heart-musculature and brain of human beings that have died from "Schizotrypanosomiasis" (*sic*), *sit venia verbo!*

In view of the resemblance, in certain phases, between Schizotrypanum and Leishmania made known by Hartmann, attention may be directed to some remarks by Donovan, one of the discoverers of the parasite of Kala Azar, in the "Annual Report and Statistics of the Government General Hospital, Madras," for the year 1908 (published 1909), p. 31. Donovan casts doubt on the view advanced originally by Rogers, and further supported by Patton, that the parasite of Kala Azar is transmitted by the bed-bug; and gives reasons for believing that another bug, *Conorhinus rubrofasciatus*, is the insect which propagates the disease. It would be remarkable if both Leishmania and Schizotrypanum proved to be transmitted by species of the genus Conorhinus, the one in India, the other in Brazil. The etiology of Kala Azar is a problem which calls urgently for investigation.

E. A. M.

THE ORGANISATION OF TECHNICAL EDUCATION AND RESEARCH.[1]

VERY few words of mine are needed to emphasise the interest and the importance of this annually recurring ceremonial at which the varied educational work of the City and Guilds Institute receives recognition, well-merited recognition, from successive Lord Mayors.

We gather from the brief *résumé* of the work which has been read by Sir J. Watney that the various agencies combined under the control of the institute continue to flourish, the students increase in number, their work rises in quality, and the importance of the institution grows greater year by year.

The City and Guilds Central Technical College completed its twenty-fifth session in July, and now has at work 412 students. In the twenty-five years, 1512 students have taken the complete course and 1066 have been awarded the diploma. Out of 306 internal degrees conferred in the faculty of engineering in London University, 157 have been obtained by students of the college; and the percentage in honours has been a high one, 56 per cent. first class, 42 per cent. pass.

The year has been marked in that the relations with the Imperial Technical College have been made definite by the appointment of a delegacy, under the immediate control of which the City and Guilds College is placed, and which contains representatives of the Imperial College, the Institute, and the Goldsmiths' Company. The delegacy, I am informed, held their first meeting last month.

I will not attempt to review in like manner the year's results for the other branches of the institute. Numbers of young men—some of them not so young now—owe their success in life to the training received at the Finsbury Technical College from the inspiring teaching of its accomplished head, Prof. S. P. Thompson, and his able staff; and here I should like to thank Prof. Thompson for his recent brilliant addition to our scientific biographies. Had he done nothing else, and this is far from being the case, his life of Kelvin would have left future generations deep in his debt.

I know less, perhaps, of the other work of the institute, but I know enough to be grateful to the committee and its officers for the large contribution to the advance of knowledge they have made by their efforts in the past.

The choice of a subject for an address of this kind is not quite easy, and yet it ought not to be very difficult for a man whose life is now bound up with the business of science to find a theme on which to speak to an audience in this centre of industry and commerce—the connection of science and industry is an obvious, perhaps even a hackneyed, one. Nevertheless, I am going to trespass on your patience with some aspects of the question as they appear to me.

Not many years ago it would have been said that the connection was a slight one. Science dwelt in a realm apart from industry and commerce; her votaries were men who sought the truth without a thought of the gain the search might bring to humanity, or the wealth it might discover for the seeker.

It was enough for them to arrive at some new law, to roll back a little space the veil that shrouds the mysteries of Nature and to penetrate her shrine. Long may there be such men; the humbler students of science, those who try to interpret her teachings for the good of men, could advance but little without the torch of truth carried by these their leaders. But it is realised now that there are many ways in which science can further industry. Let us look at two of these.

It is sometimes said our German cousins are more scientific than ourselves, and that this is the reason of their great material progress during the past fifty years. In a sense this is true; not that they have made greater discoveries or have contributed more to the sum of human knowledge, but they did realise at an earlier date than we the value of science as a factor in industrial and commercial progress. They showed their appreciation of its importance by the establishment, in the first place, of technical colleges and universities where students could be trained to apply science to the needs of daily life, and in the second of institutions like the Reichsanstalt and the Versuchsanstalt, where researches on matters bearing on the application of science to industry could be carried out on a fitting scale.

The colleges and universities which in the past twenty-five years have grown up in our cities show that we have begun to appreciate the need and to make some notable endeavours to supply it. For the success of these endeavours, no small debt is due to those great City Guilds which, with well-judged munificence, have devoted such large funds to the work of education, not only here in London, but also in the ancient universities and in many other parts of the country.

This gathering to-night, with its long list of prizes and awards, is a speaking testimony to the value of their work in London. The wise leaders of the City Guilds realised that by the work of education they could best advance the welfare of our country and carry on under present conditions the task which previously they performed by means of the apprenticeship system.

Let us look into this educational work in its modern form. It received a notable impulse a few years ago by the establishment of the Imperial College of Science and Technology. That college was founded with a very definite purpose—to afford to English students the opportunity for the highest study and research in any branch of science bearing on industry. Two methods at least were open to the founders, and of these they chose the more difficult. It is our English plan to let our old institutions develop gradually, so as to meet new needs. The committee responsible for founding the Imperial College might have established something quite new; they decided rather to combine three great agencies existing at South Kensington into one, thus coordinating work already in progress, while maintaining the individuality of the constituent institutions. The Royal College of Science, the Royal School of Mines, and the City and Guilds Technical College still exist, but, combined as they are under one governing body of the Imperial College, their

[1] Address delivered at the prize distribution of the City and Guilds of London Institute on February 17, by Dr. R. T. Glazebrook, F.R.S.

influence on education and on progress, great as it has been in the past, must be multiplied manifold.

Time is necessary to solve the many problems that arise, but a visit to South Kensington, where, by the generosity of Messrs. Wernher, Beit and Co., and the trustees of the Bessemer fund, splendid new buildings are rising rapidly for the Royal School of Mines, and by the munificence of the Goldsmiths' Company the engineering laboratories of the central institution are being so greatly enlarged, is enough to show some of the first-fruits of the work.

The method which has been adopted for controlling the work of the Central College by means of a delegacy representing the Imperial College, the City and Guilds Institute, and the Goldsmiths' Company, is full of promise, and the path whereby the whole can develop into the great institution planned by its founders seems clear.

Much is still necessary before that development can be complete. In the first place, we must encourage research. The Central Technical College has a splendid record among its professors—Henrici, Unwin, Ayrton, Armstrong. Nor will the work of the younger men—Dalby and Mather—be less distinguished in the future. Still, more remains to be done in the way of post-graduate study and students' research. I do not overlook the notable efforts made lately in connection with the railway engineering course, but I would urge those in whose hands control lies so to organise the teaching that men, professors, or students who have the power to carry on research, should be free to use it. You cannot successfully command a professor to make discoveries. You can arrange his surroundings so that the power that is in him should have full opportunities of action.

Secondly, we must not attempt in the Imperial College to do elementary work which can be done equally well elsewhere. The Central Technical College has always done rightly in selecting its students with care. Its success, and the fact that the students now number as many as the college can hold, increase its power of selection; the conditions of entrance may be raised gradually; they are still very low compared with the great German technical schools; and thus the whole character of the work may be improved.

Thirdly, the Imperial College must not remain isolated. The agencies at work in London applying science to the wants of industry, not merely teaching the rudiments, but advancing the boundaries between the known and unknown, are numerous; they include the University Colleges, with their distinguished professors and their large classes of students; the polytechnics and technical schools, where, day and night, educational work of the highest value is being eagerly pursued.

Is it impossible to conceive some scheme by which the labours of all these agencies for technical instruction should be coordinated and linked up with the work of the Imperial College as a centre, to which, to repeat what I said in an address I delivered to the Association of Technical Institutions, students only of proved capacity were admitted, where the staff and students were free to conduct original investigations, and through these to learn new truths, where scholars and prizemen from the various technical institutions of London were collected, and where the teachers in the polytechnics and other colleges were freely welcomed to carry out their researches and to advance learning?

In close connection with this there should be a number of colleges organised so as to provide teaching for the less advanced stages of the course, selected with due regard to geographical conditions.

Beyond these would come those polytechnics which were engaged chiefly in evening classes for the worker, each, if possible, with one special department organised so as to provide teaching and means for research of an advanced character, linked up to the central institution, the Imperial College, in such a way that the teachers felt a common interest in promoting the welfare of that institution, and turned naturally to its professors as their leaders in the search for truth.

There is one essential more. This group of institutions—the Imperial Technical College and its associated colleges—must possess the power itself of granting degrees in technological science to its students who have gone through its course and passed the proper tests without reference to any external academic body. To secure this may be difficult, but it must be done. In Germany it was recognised some years ago that the degree courses of the older universities did not afford the student of technology the training he required, and new universities—technological universities they are called, though the phrase may be a misnomer—have been established in many of the great centres of industry.

Here in England, outside London and the old universities, our course has been different. The new universities in Manchester, Liverpool, Birmingham, and elsewhere, have each a faculty of technology along with those of arts and science, law and medicine, and their constitution allows them to do this with success, for in no case is the control in the hands of an academic body—an unwieldy Senate representative of all and every conflicting interest that can conceivably be brought in. It rests with a compact council, consisting mainly of business men, keen to raise the standard of education in their cities because they realise that on that progress turns.

It may be possible to reorganise London University as an assemblage of faculties, each practically independent in its own sphere, each controlled by its council, a small body of men containing some few representatives of the teaching staff. This council, within the scheme, would be the supreme body of the faculty; subordinate to it would be the general board of studies, representing all the teachers, and the special boards dealing with the various subjects of study in the faculty. Each faculty should award its own degrees and be free to determine, with the lines of the general scheme, the conditions under which those degrees should be granted.

There would need to be advisory committees of representatives of several faculties for work in which more than one faculty was concerned, and a small body, independent of the faculties, to settle disputes which might arise.

Under such a scheme the Imperial College would become the centre of the Technological University for London, and then for the Empire, a body like its governing body, but modified so as to include representatives of the other institutions which would form with it the technological side of the University in London, would become the council of that faculty; the teachers in the various subjects represented in the faculty would form the various special boards of studies, and representatives of these special boards would become the general board of studies of the faculty.

Whether this be a possible scheme or not it is not for me to say, but I would venture to put forward three propositions:—

(1) That a combination of the technological departments of existing institutions and schools into an independent technological faculty is necessary.

(2) That in such a faculty a definite value should be given to technical education in each London school.

(3) That the technological faculty should confer degrees under conditions to be laid down by the faculty.

I am aware I have wandered into debatable ground. I trust I have not erred beyond forgiveness in so doing. The task before Sir Alfred Keogh, the rector of the Imperial College, in bringing to success some scheme such as this is no easy one. It will lighten it immensely if you can assure him that in his task he has your own support and that of the men to whose active help the success of the City and Guilds Institute is so largely due.

You may rest assured that in this way you are assisting in no small degree to render the advances of science available for the promotion of the best interests of our nation, in strengthening our position in the world, and in carrying on that great work of education in which the City Guilds have taken so admirable a share.

But there is another aspect of my subject, the relation of science to industry, for which I have left too little time. A second way in which science may help industry is, as I have said, by the establishment of institutions where scientific questions bearing on industry may be studied.

The National Physical Laboratory is such a place, and when the chairman of the committee invited me to speak

here to-night, he said he wished me to tell you something of the work of the laboratory.

It is a big work, for the subject is big. The laboratory was founded some ten years since as a public institution for standardising and verifying instruments, for testing materials, and for the determination of physical constants.

Its staff now numbers about 140 persons, its expenditure during the past year was more than 28,000*l.*, and towards defraying that expenditure more than 15,000*l.* was received in fees for work done.

During the past eleven years, if we exclude the aëronautical work, 49,000*l.* has been contributed from public funds towards capital expenditure, while 54,000*l.* has been raised from private sources. In the same period, the annual grants from the Treasury for working expenses have been 57,750*l.*, while the receipts from fees, private donations, and subscriptions have come to 105,380*l.*

Instruments of all kinds were examined, among them in 1910 were 27,500 thermometers, 4000 telescopes, 1600 binoculars, electrical apparatus, measuring apparatus, optical appliances, photographic lenses, opticians' testing lenses (these numbered 5000), and taximeters. The value of the instruments sent for test is nearly 1000*l.* for each working day of the year.

Nor is this half of the work. Researches of all kinds of interest to industry and manufactures are in progress. Papers have been communicated to engineering and scientific societies which have aided in the solution of many important technical problems, and investigations are now in progress which will help still further.

The laboratory is controlled by a committee appointed by the Royal Society and representing the great scientific and technical societies, and the general scheme of research is approved by them. But besides these public investigations, each day brings us inquiries from private firms and manufacturers as to matters on which they want our help or our advice.

The home of the laboratory is at Teddington, in Bushy Park, and there, round the old Royal residence, Bushy House, the modern buildings needed for the work are being slowly and painfully raised. For some of these funds have been provided by the Government; others we owe to private generosity to men like Sir Andrew Noble, Sir John Brunner, Mr. Yarrow, who has just built for us an experimental tank for naval research at a cost of 20,000*l.*, Sir Julius Wernher, whose generous gift of 10,000*l.* has rendered it possible to commence the erection of a laboratory for metallurgical research, or to those of the city companies, the Goldsmiths', the Drapers', and others, who have listened to our appeal.

Meanwhile, we live from hand to mouth; the deficit this last year, on a total expenditure of nearly 30,000*l.*, was about 200*l.*, and now we are appealing for funds to build an optical laboratory, a library, and reading room, with other offices for our work.

We shall not appeal, I know, in vain, because Englishmen at last are realising that organised scientific effort is an essential factor in the country's progress; you students who in the various colleges of this institute have learnt something of what science is, what scientific effort can do, in time some of you will become the leaders of industry. See to it, then, that those institutions to the work of which your success is due are made ever more efficient through your generous support.

PROGRESS REPORT OF THE CARNEGIE INSTITUTION OF WASHINGTON.

THE ninth annual report of the Carnegie Institution of Washington, in which the numerous activities of the institution during 1910 are described, is now available. The volume runs to 275 pages, and contains also five well-reproduced plates. As usual, the report includes the articles of incorporation of the institution, its bye-laws, the minutes of the meeting of the Board of Trustees, the report of the president of the institution, that of the executive committee, as well as detailed reports on the numerous investigations and projects of the institution.

The president's report presents in order a review of the work of administration of the institution, a *résumé* of the investigations carried out during the year, and a summary of the publications authorised and issued during the year ending October 31, 1910. The subjoined extracts from the report will serve to illustrate the increasing importance of the research work undertaken under the auspices of the institution.

Work of Administration.

The more noteworthy events in the history of the institution during the past year are the dedication, in December, 1909, of the Administration Building; the inauguration at that time of an annual series of semi-popular lectures explanatory of the researches of the institution; the inauguration on the same occasion of a series of periodical exhibits of the work accomplished by the departments of investigation and the divisions of publication and administration; the successful completion of the first voyage (of 8000 miles) of the non-magnetic ship *Carnegie*, and the beginning of a second cruise, which is expected to require three years, by this novel craft; and the fourth conference of the International Solar Union, held at the Solar Observatory of the institution on Mount Wilson, California, from August 29 to September 4, 1910.

It appears that since its organisation in 1902 upwards of twelve hundred individuals have contributed in one way or another to the promotion of the researches and the publications undertaken by the institution. During each of the past five years about five hundred individuals have thus collaborated. Ten independent departments of research and the divisions of publication and administration, each with its staff and assistants, have been organised and established within the institution itself. In addition to these larger departments of work, numerous special researches, in aid of which upwards of seven hundred grants have been made, have been carried on by research associates and other individual investigators. For the departments of research, two astronomical observatories, five laboratories, and a non-magnetic ship have been built and equipped.

The following list shows the departments of investigation to which the larger grants were made by the trustees, and the amounts allotted from those grants by the executive committee during the year:—

	£
Department of Botanical Research ...	6,946
Department of Experimental Evolution ...	8,194
Department of Economics and Sociology...	2,000
Geophysical Laboratory	10,204
Department of Historical Research ...	4,540
Department of Marine Biology	5,414
Department of Meridian Astrometry ...	7,131
Nutrition Laboratory	5,276
Division of Publications	1,800
Solar Observatory	23,144
Department of Terrestrial Magnetism ...	15,384
	90,032

Résumé of Investigations of the Year.

Work in the ten specially organised departments of research in the institution has gone forward during the year with increasing vigour and with increasing productivity. But while the existing status of departmental affairs is in general highly satisfactory, it appears essential again to direct attention to the fact that with present income and current economic conditions no further expansion of departmental appropriations can be expected. It may be necessary, on the contrary, to curtail research in the departments in order to keep the aggregate expense of the institution within income. It need not follow, however, that this prospective diminution in financial outlay will cause a corresponding diminution of productivity, for work of investigation, like work along other novel lines, is usually most costly in the preliminary stages.

The headquarters of the Department of Botanical Research are located in a desert area where the facts of plant life are exhibited, in general, in their simplest, though often extreme and highly specialised, relations. During the year the director of the department has continued his investigations on the water-balance of succulent plants, on the conditions of vegetable parasitism, on the variability in plant species induced by chemical treatment of their seeds, and on the influences of climate on plant organisms.

In collaboration with Prof. Ellsworth Huntington, the director has begun a general climatological study of the region about Tucson, giving special attention to the factors and effects of the Santa Cruz and Asuncion river systems. Dr. Cannon has given attention especially to his elaborate investigation of the root systems and habits of desert plants. For the purpose of extending the range of his studies in this fundamental subject, he visited the Sahara Desert, and will spend most of the year in that advantageous field for both comparative and direct observations. Dr. Shreve, while occupied with the more general problem of the relation of plants to climate in the United States, has also carried on special investigations of the vital statistics of plants in the vicinity of the desert laboratory, of the vegetation in the Santa Catalina Mountains, and of the physiological characteristics of the lace-fern family of plants. Observations on the phenomena presented in the drying up of Salton Sea, and especially on the influx of vegetation over the bared strands and islands of this slowly retreating body of water, have been continued during the year.

So many converging lines of fruitful research are now being pursued by the Department of Experimental Evolution that it is difficult to summarise fitly its current progress. From the abstract scientific point of view, the most interesting feature of this work is found in the introduction of statistical and other quantitative methods, whereby biology is now passing from the first to the next higher stage in the development of a science. From the more popular points of view, the work in question is of special interest by reason of its bearing on the economics of plant and animal breeding, and by reason of the light it is certain to shed on the laws of human heredity.

The principal steps which have been necessary, and in large degree preliminary in the development of the work of the Geophysical Laboratory, are four in number, namely, provision for correct temperature determinations over the entire range involved in the processes of rock formation; provision for like determinations of the chemical reactions of these processes; provision for precise microscopic, optical, and crystallographic measurements; and provision for the quantitative applications of high pressures to rock masses and rock constituents. In supplying the desiderata just indicated for its own special work, the laboratory has already achieved results of prime importance also to many other fields of physical and chemical science. Thus, two contributions of great import to general physics and chemistry have been brought out during the past year. The first of these is a determinate extension of the scale of temperature measures from about 300° C. to about 1600° C. This is a fitting supplement to the classic work on thermometry begun more than thirty years ago under the auspices of the International Bureau of Weights and Measures. It must take rank, in fact, with the fundamental advances in the technique of thermometry. The other contribution is a determination of the system of compounds which may arise in combinations of the three most important oxides entering into the composition of rocks, namely, silica, lime, and alumina. This system is of special economic interest, since it includes, among many other compounds, the hitherto much studied but baffling Portland cement. The complexity of the investigations required to analyse this system is indicated by the facts that it involves the interaction of fourteen minerals and the formation of sixteen ternary eutectics, or substances the melting points of which are lower than those of the primary constituents.

Two emergencies seriously affecting the Department of Marine Biology, and calling for prompt action, have arisen during the year. One is due partly to the gradual abandonment by the U.S. Navy of the supply depôt and wireless station at Tortugas, where the department's laboratory is situated, thus rendering communication between Key West and the laboratory less certain and frequent than hitherto. The curtailment of this source of aid generously extended by the Navy to the laboratory during the past six years has forced upon the department the necessity of providing better independent transportation than that afforded by its best boat, the *Physalia*. Accordingly, plans and specifications for a 70-foot twin-screw boat were prepared during the summer, and on authorisation by the executive committee, a contract for the construction of this proposed vessel was let, with the expectation that the contract will be completed in July next. The other emergency arises from the damage to the laboratory caused by the hurricane of October 14–18, 1910. The extent of this damage is not definitely known at present, but steps have been taken to get trustworthy details at the earliest practicable date, so that estimates of the expense required to restore the building may be ready for submission to the Board of Trustees before their next meeting. It is gratifying to note that the opportunities afforded for intensive research by the laboratory are so highly appreciated that applications for its privileges are already more numerous than can be granted.

Capital progress has been made during the year in the large and exacting undertaking which the Department of Meridian Astrometry has so successfully started. Work at the observatory in Argentina has gone forward at an unprecedented rate, and with such a degree of thoroughness and completeness as to give assurances that this part of the enterprise will be completed within the next year. While the supplementary observations of the positions of the stars are going forward in the southern hemisphere, arrangements for the final computations of these positions are proceeding at the Dudley Observatory; for the formidable task of observation must be followed by a still more formidable task of computation. Preliminary to the grand catalogue of stellar positions projected by the department, there has been issued by the institution during the past year, as Publication No. 115, a catalogue of 6188 stars for the epoch 1900.

Although the Nutrition Laboratory has been occupied less than two years, and is not yet fully equipped, it has already produced contributions of fundamental importance to our knowledge of the chemistry, physics, physiology, and pathology of nutrition. Its experience, like that of all the laboratories of the institution, affords an impressive demonstration of the productivity attainable by concentrated effort along determinate lines of research. Construction and installation of additional equipment, the prosecution of investigations, and the publication of results have gone forward simultaneously during the year. One new calorimeter has been completed, another partly constructed, and various auxiliary apparatus for use with these and the earlier equipments have been supplied. Similarly, respiration apparatus for men, respiration apparatus for dogs, and many improvements in the calorimeter section of the laboratory have been made. Several pieces of apparatus have been acquired also by purchase abroad, and the efficiency of the machine shop has been improved by the addition of a precision lathe.

The work of the Solar Observatory is now so extensive and so varied that it is somewhat difficult to summarise even in its salient aspects. In addition to the observatory proper, with its four principal telescopes and much auxiliary equipment on Mount Wilson, there are the physical laboratory and the instrument shops at Pasadena, along with special divisions devoted to the work of computations and construction respectively. By way of equipment, several large pieces of apparatus for the new tower telescope, for the 60-inch telescope, and for the 100-inch grinding machine have been made at the shops. The towers for the new 150-foot tower telescope, begun a year ago, are now finished, along with the well, 75 feet deep in the rock below, which forms a part of the telescope tube of this novel instrument, now essentially complete except for its spectroscopic attachments, still under construction at the shops. Some preliminary trials made recently with this instrument indicate that it will fulfil the sanguine expectations entertained in respect to its capacity.

The more striking events of the year in the Department of Terrestrial Magnetism refer, naturally, to the non-magnetic ship *Carnegie*, which was off on her first cruise at the close of the previous fiscal year. She was then at Falmouth, England, where her determinations of the magnetic elements were compared with independent determination made at the permanent magnetic observatory of that port. She proceeded thence, November 9, 1909, to Funchal, Madeira, thence to Hamilton, Bermuda, and thence, under tempestuous conditions which proved her seaworthiness, to Brooklyn, N.Y., where she arrived February 17, 1910. Here she had her copper sheathing applied by the constructors, as required by their contract,

and was overhauled and refitted for a three years' circumnavigation cruise. In all essential respects this vessel has proved more effective than was anticipated. It has been demonstrated that even in rough weather the three magnetic elements may be determined with a precision little short of that attainable in a fixed observatory. Thus she was able to discover on her first cruise errors of unexpected magnitude in the best sailing charts of the north Atlantic, and she is certain to attain at least an equal degree of precision in all future ocean work. By crossings of her own tracks and by connections at all available ports having magnetic observatories, it will be practicable to exclude the possibilities of any important errors in this work. Similarly satisfactory progress has been made also in the land work of the department during the year. The expedition in Africa, from the Cape to Cairo, undertaken by Dr. Beattie and Prof. Morrison as temporary associates, was completed early in the year, a total of 348 stations having been occupied. Mr. Pearson continued work in Turkey in the early part of the year, until relieved by Mr. Sligh, who extended the work to Palestine, Syria, Arabia, Mesopotamia, and the islands of Rhodes and Cyprus. Up to the end of July of this year, these two observers had occupied a total of forty-seven stations. Another observer, Mr. Stewart, left Washington early in June to begin extensive work in South America, proceeding in the launch *El Imán*, provided especially for work along the Amazon and its tributaries. Additional observations are reported also from Canada and from various European countries in which initial determinations or instrumental comparisons have been made.

The publication of twenty-three volumes has been authorised during the year by the executive committee, at a total estimated cost of 7980*l*.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Sir George H. Darwin, K.C.B., F.R.S., has been nominated to represent the University at the celebration in September of the secular jubilee of the Royal Frederic University of Christiania.

The special board for medicine report that an examination in psychological medicine and its cognate subjects, if established, could not fail to raise the present standard of efficiency in applicants for asylum posts, and that it would lead to the provision of appropriate courses for the training of those who wish to advance our knowledge of psychiatry. The board accordingly recommends that such an examination be held once in the year, and that a candidate who passes both parts of the examination to the satisfaction of the examiners be entitled to a diploma testifying to his competent knowledge of psychological medicine.

OXFORD.—The report lately published of the School of Geography gives evidence of much activity. It mentions with regret the resignation of Sir Clements Markham from the committee of the school, adding that the University owes much to Sir Clements Markham for his efforts to promote the teaching of geography in Oxford during a quarter of a century. The generous gift from Sir Abe Bailey of 250*l*. a year for five years has enabled the committee to provide increased accommodation in Sir Henry Acland's house in Broad Street, thus relieving pressure on the Old Ashmolean building. More rooms are in preparation, and should be ready by Easter; meanwhile, in addition to the quarters specially assigned to the staff and students, a general reading-room has been opened, where any member of the University may consult books or maps. The committee again points out the need for an endowment for the teaching of geography in the University. Towards this, Lord Brassey and Mr. Douglas Freshfield have each offered to contribute 500*l*., provided an adequate additional sum can be obtained from other donors. Courses of lectures have been given by Prof. Herbertson, Dr. Grundy, Mr. Allorge, Mr. Beckit, and Miss MacMunn. Mr. O. G. S. Crawford, Keble College, has been appointed junior demonstrator and librarian. The geographical scholarship for 1910–11 was awarded to Mr. B. W. Baker, University College.

Prof. E. B. Tylor, F.R.S., has deposited on loan with the committee for anthropology a substantial portion of his library, to be used for the purposes of anthropological study within the University. The library will be housed, for the present, at Acland House, Broad Street.

SHEFFIELD.—The council, at its last meeting, made the following appointments:—Dr. Sinclair White, to the professorship of surgery in the University, in succession to Mr. R. J. Pye-Smith, resigned; Mr. George Stanfield, to the post of demonstrator in engineering; and Mr. Ll. Lloyd, to the post of assistant curator of the zoological museum.

MR. W. BUCHANAN, senior lecturer to Faraday House Electrical College, London, has been appointed professor of electrotechnics at the School of Mines (Transvaal University), Johannesburg.

A FRIEND of Sir William Ramsay's, who desires to remain anonymous, has promised 2500*l*. towards the fund of 50,000*l*. required for the building of the new chemical laboratories at University College. The same donor will give a further sum of 2500*l*. provided the sum of 50,000*l*. is raised before Easter. The fund now stands at 31,277*l*.

A VACATION course for the study of the structure, development, and ecology of marine algæ (Plankton and Benthos) will be conducted by Dr. O. V. Darbishire at the Dove Marine Laboratory, Cullercoats, Northumberland, during the Easter vacation. Instructions will also be given in the various methods of collecting, mounting, fixing, and cultivating marine algæ. Further information may be obtained from Dr. Darbishire, Armstrong College, Newcastle-on-Tyne.

WE learn from *Science* that the U.S. General Education Board has made conditional grants as follows:—Brown University, 20,000*l*.; Carleton College, 20,000*l*.; Colorado College, 10,000*l*.; Dakota Wesleyan University, 10,000*l*.; Denison University, 15,000*l*.; Fisk University, 12,000*l*.; Mount Holyoke College, 20,000*l*.; Randolph-Macon College, 10,000*l*.; Swarthmore College, 15,000*l*.; and Wesleyan College for Women, 10,000*l*. From the same source we gather that the Bill increasing the annual appropriation from the State of Vermont to Middlebury College by 152*l*. has been signed by the Governor. This will make the State appropriation to Middlebury 3200*l*. a year, beginning on July 1. The increase is "to provide additional instruction in the departments of pedagogy, in forestry, and in scientific branches related to the industries of Vermont." It is also stated that a gift of 10,000*l*. to Cornell University by Mrs. Florence O. R. Lang, of Montclair, N.J., will be used in the construction of a new building to house the shops of the Sibley College of Mechanical Engineering.

THE University of Christiania will, in the beginning of September next, celebrate its centenary, having been founded by King Frederic IV. in 1811. Prof. K. Birkeland has kindly given us the following information relating to this celebration. Instructions have recently been sent to 226 universities or similar institutions of higher education, and to 113 learned societies, each being invited to send one delegate. It may be mentioned that the programme for the official festivities, as at present proposed, includes a reception banquet for the foreign delegates on September 4, while the actual centenary festivities will take place on Tuesday, September 5, and Wednesday, September 6. On the Tuesday, Björnstjerne Björnson's Cantate, "Lyset," will be rendered. This will be followed by the address of welcome to the foreign representatives of universities and academies, replies from groups of these representatives, and the presentation of addresses. On the Wednesday, honorary degrees and promotions will be conferred. A medal, struck in commemoration of the centenary, and various publications, will be distributed. The president of the festival committee is Prof. Brögger, rector of the University. The students have also appointed a committee, which is issuing thirty invitations for student delegates from other universities.

MR. JESSE COLLINGS has introduced into the House of Commons a Bill, which is influentially backed, to afford further facilities for the creation of Small Holdings. Side by side with the granting of further facilities to those who are desirous of becoming smallholders is a movement,

initiated by Mr. Collings, for promoting agricultural education and nature-study in public elementary schools. Local education authorities may provide and maintain means and facilities for the purpose of giving instruction in any of the following subjects:—nature-study; fruit, flower, and vegetable growing; poultry- and bee-keeping; budding, pruning, and grafting; cow- and pig-keeping; milking; rotation of garden crops; nature and properties of soils; use of manures; knowledge and choice of seeds; structure, life, and food of plants; action of birds and insects on crops; choice and use of simple tools; packing fruit, vegetables, and other produce for market. The importance of these legislative proposals, from a small-holder's point of view, lies in the fact that they are designed to interest the children in rural districts in the occupations which ought, naturally, to constitute their after-life. The Festival of Empire is devoting ten acres and some thousands of pounds to demonstrating along practical lines how the successful cultivation of small holdings may reclaim agricultural and rural districts. The aims and objects of the Small Holdings and Country Life Section of the Festival have the approval of the Board of Agriculture and Fisheries, and experts are assisting in its conduct and management under the auspices of various agricultural and cooperative organisations.

THE very representative Conference on Industrial Training, held at the Guildhall on Tuesday, February 28, was opened by a sympathetic message from his Majesty the King. The following resolution was passed by an overwhelming majority:—"That the national system of industrial, professional, and commercial training should be established, to which the children shall pass as a matter of course (unless the parents are prepared to undertake their future training), and without interval for a definite period, to be thoroughly trained for entry into the particular calling for which they are best fitted, such training to be under fully qualified instructors." The passing of this resolution marks an important change in public opinion, and indicates a strong feeling that the school age should be extended to about sixteen years of age, and that the education given during, say, the last three years of school life should, whilst not neglecting the general education, be a preparation for the particular occupation the child intends to follow. In the past it has been the practice to regard education as suitable only for those who intend to follow clerical occupations. The work of trade schools and of technical institutes has, however, shown that much may be done in schools and institutes under skilled instructors to prepare for, and supplement, the deficient training of the workshop; but hitherto this has been done mainly in the evenings. It is now recognised that much better results would be obtained if the pupils received some sound practical training in the daytime at the end of their ordinary elementary-school career. Indeed, the changed methods of production due to the introduction of machinery, and to the consequent subdivision of labour and decay of apprenticeship, has made some change in our system of training a necessity.

THE second volume of "Statistics of Public Education in England and Wales" has now been published (Cd. 5506). It deals with the financial statistics of the years 1908, 1909, and 1910. The net total expenditure of the Board out of the Parliamentary Vote, after deducting appropriations in aid, was, for 1909–10, 13,638,424*l*., as compared with 13,485,233*l*. in 1908–9 and 13,272,624*l*. in 1907–8. The grants to meet expenditure in respect of elementary education amounted to 11,095,420*l*., as against 11,039,281*l*. in 1908–9 and 11,023,121*l*. in 1907–8. Grants for secondary schools amounted to 610,435*l*., as against 506,107*l*. in 1908–9 and 342,393*l*. in 1907–8; for pupils in prepartory classes, pupil teachers, and bursars, 143,413*l*. in 1909–10. Technical institutions, day technical classes, schools of art, art classes, and evening and similar schools and classes absorbed 512,475*l*., as against 493,927*l*. in the previous year; maintenance grants for training colleges, 460,985*l*.; and building grants for training colleges and hostels, 60,102*l*. The Imperial College of Science and Technology in 1909–10 received 20,000*l*., the Geological Museum and Geological Survey 20,893*l*., and the Committee on Solar Physics 2119*l*. The only change of any importance in the present volume consists in the inclusion of tables giving particulars as to the salaries of supplementary, student, and pupil teachers on the staff of ordinary elementary schools. In previous years the salaries of certificated and "uncertificated" teachers alone were dealt with. It appears that in 1908–9 the average salaries of certificated teachers in Wales were: men head teachers, 146*l*. 9*s*., men assistant teachers, 113*l*. 19*s*. 11*d*., the corresponding amounts in the case of women being 109*l*. 16*s*. 9*d*. and 82*l*. 8*s*. 4*d*. In England the average salaries were higher for certificated teachers. Men head teachers earned, on the average, 173*l*. 11*s*. 2*d*., and men assistants 124*l*. 7*s*. 3*d*. The amounts for women certificated teachers were 120*l*. 17*s*. 7*d*. and 90*l*. 3*s*. 8*d*.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 23.—Sir Archibald Geikie, K.C.B., president, in the chair.—Miss M. **Robertson**: Transmission of flagellates living in the blood of certain fresh-water fishes. The goldfish in a pond at Elstree have for some years shown an infection of trypanosomes in their blood. Quite recently, trypanoplasma has also appeared. Upon investigation is was found that the leech *Hemiclepsis marginata* occurred in the pond, and effected the transmission of the parasites. A large number of these leeches were obtained from the Grand Junction Canal reservoir, which is only a short distance from the pond. The young of these were hatched out in captivity, and it was ascertained that the flagellates are not passed from parent to offspring. The parent leeches were invariably infected with trypanosomes derived from the fish in the reservoir, which frequently showed these parasites in their blood. The trypanosomes of perch, bream, and goldfish were found to complete their cycles in Hemiclepsis, and could be transmitted to clean goldfish by means of leeches. The specimens used in these experiments were always young laboratory-hatched Hemiclepsis. The trypanosomes of pike and rudd also complete their cycle in this leech, but the opportunity of passing these two forms into goldfish did not present itself. The cycles of the trypanosomes derived from these different sources are apparently identical. The main features are as follows:—The trypanosomes taken into the crop of the leech along with the blood multiply very rapidly, undergoing a marked change of form. After some days, slender forms begin to arise. These increase in number, and at the end of digestion, some time after the blood has quite disappeared, they come forward and lie in the proboscis-sheath in very large numbers. The form found in the sheath is a very slender, long creature of quite definite type; division has never been observed in this phase. When the leech feeds once more, these individuals are inoculated into the fish. The proboscis-sheath is always cleared of trypanosomes by one feed. After a clean feed the slender, inoculative type of trypanosome disappears from the crop of an infected leech, and the infection is carried on by short, broad forms. Conjugation has never been observed. If water is added to the blood of fish containing trypanosomes, the flagellates divide after a number of hours, probably in response to lowering of osmotic pressure in the fluid in which they find themselves.—Dr. B. B. **Boltwood**: Report on the separation of ionium and actinium from certain residues, and the production of helium by ionium. At the end of 1907 the Royal Society lent to Prof. Rutherford certain actinium residues, which were part of the material remaining after the separation of the radium by Messrs. Armet de Lisle, of Paris, from uranium residues acquired by the Royal Society. These residues, in weight 20 kilograms, contained a large quantity of lead, and were a very heterogeneous mixture of elements. A preliminary examination made by Prof. Rutherford showed that actinium was present, and also a small quantity of radium. The amount of ionium, however, was much less than the theoretical amount to be expected if all of it had been removed with the actinium. The preliminary work of concentration was done by Messrs. Tyrer and Co., under the direction of Prof. Rutherford and Mr. Greenwood. This material was given to the writer for further concentration, and the paper

contains an account of the methods employed in the separation of the actinium and ionium. The ionium was finally obtained mixed with 1·8 grams of thorium oxide. The activity of this oxide, due to the ionium it contained, was about 3000 times that of an equal weight of uranium oxide. By counting the α particles from a thin film by the scintillation method, the amount of ionium present with the thorium was found to be equal to the amount in equilibrium with 5·3 milligrams of radium in a radioactive material. The actinium was finally concentrated to about 10 grams of material, which gave a final activity about 20,000 times that of uranium oxide. It was estimated that the amount of actinium separated was equivalent to the amount in equilibrium with 30 milligrams of radium in a mineral. Special experiments were made to test whether ionium was transformed into helium. The presence of helium was determined by its spectrum, and the volume produced was measured. The investigation showed that helium is produced by ionium as well as by all other products which emit α rays.—J. A. **Gray**: The secondary rays produced by β rays. Secondary γ rays are produced in different materials by the β rays of RaE, the greater in amount, the greater the atomic weight of the radiator. The γ radiation observed from a preparation of RaE can be greatly increased by a suitable disposition of the active matter and apparatus.—W. R. **Bousfield** and W. Eric **Bousfield**: The specific heat of water. The object of this investigation was to obtain a basis curve for the specific heat of water, for comparison with specific-heat curves of aqueous solutions. Former observers, using different methods, have obtained widely varying curves; thus for the specific heat of water at 80°, in terms of the 15° calorie, the following figures have been given, showing differences of 1 per cent.:—Barnes, 1·0014; Regnault, 1·0081; Lüdin, 1·0113. For the values in joules of the 15° calorie the following have been found:—Joule, 4·174; Griffiths, 4·198; Barnes, 4·184. The first part of the present investigation is concerned with the determination of the mechanical equivalent of heat in terms of the mean calorie from 13° to 55°, by a method of continuous-flow calorimetry. Mercury thermometers were used which could be read to 0·005°. An interval of 40° was taken, so that an error of 0·01° would not vitiate the result by more than 1 in 4000. Through a Dewar vessel containing about 3 litres of water, in which was an electric heater, there was passed a current of water, entering at about 13° and passing out at about 55°. The vessel was immersed in a bath kept at same temperature as contents of vessel. The top of the vessel was closed by a platinum box kept 10° higher. The electric heater, and the resistance used in series with it for determining the current by help of a battery of standard cells, were of novel type. Each consisted of a spiral glass tube of small bore, into the ends of which are sealed platinum electrodes. The tube is connected with a thermometer tube, so that the spiral forms a thermometer bulb. By calibrating the resistance against the reading of this thermometer tube, the resistance is accurately known, even when a current is passing. This type of resistance enabled the authors to surmount a difficulty apparently never considered by previous investigators. They have found that when a heavy current passes through an ordinary standard resistance, the resistance of the standard depends, not only on temperature, but also upon strength of current. This effect may be conveniently called the "thermoid" effect. The authors believe a liquid mercury resistance is free from any such effect. The continuous-flow experiments gave for distilled water $J_{13}^{55}=4{\cdot}182$. To get the curve for J from 0° to 80°, a weighed quantity of water was heated from 0° to 80° by stages which gave J_0^{13} J_{13}^{27} J_{27}^{25} J_{55}^{80}, the mean specific heats over the intervals. For this purpose, the capacity of the calorimeter was obtained from the value of J_{13}^{55} previously determined, and a separate research on the specific heat of glass was carried out in order to obtain the variation of capacity with temperature. From these an equation for the value J_0^{θ} was obtained, and then the value of J from point to point, from the equation

$$J=\frac{d}{a\theta}(\theta]_0^{\theta}),$$

The authors thus obtain

$$J=4{\cdot}2085-0{\cdot}003022\theta+0{\cdot}00007833\theta^2-0{\cdot}0000004906\theta^3,$$

which gives for the value of the 15° calorie 4·179. The resulting curve corresponds closely with that obtained by Lüdin by the method of mixtures, and differs considerably from that obtained by Barnes by continuous flow with platinum thermometry.—Prof. C. **Niven**: The measurement of specific inductive capacity. The paper contains an account of work undertaken to determine the specific inductive capacity of liquids by the method of resonance. The frequencies of the discharge of condensers with air and with liquid as dielectric were compared by the cymometer and dielectric constants of the liquids deduced. With some liquids, notably with water, the question is complicated by the conductivity of the liquid. The conditions of discharge through a conducting liquid are therefore first determined, and the condition of resonance between the two resonating systems found. This is shown to be of a simple character, reducing practically to what it would be if the conduction through the liquid were neglected. In some cases, water, for example, it is impossible to set up oscillations directly, but by interposing in the circuit of the condenser another of considerable capacity, the oscillations may be obtained. When the capacity of this interposed condenser is relatively very large, it has no appreciable effect on the frequency of the oscillations produced, which are thus those of the liquid condenser alone. Owing to the rapid variation of the specific inductive capacity with temperature, special arrangements had to be made to keep the liquid at a constant temperature while measurements were being made. The results of a number of determinations at different temperatures are given for water and alcohol.

Zoological Society, February 7.—Prof. E. A. Minchin, vice-president, in the chair.—Dr. W. N. F. **Woodland**: Structure and function of the gas-producing mechanism ("red body") found in connection with the gas-bladders of many teleostei (Physoclisti and Physostomi). After summarising some of the principal facts known concerning these subjects, the author discussed various theories already advanced to account for the details of gas-production, and showed that the most satisfactory hypothesis was a combination of the views of Jaeger and of Nusbaum and Reis, supplemented by additional facts and suggestions then advanced in the paper.—Prof. J. C. **Ewart**: Skulls of oxen from the Roman station at Newstead, Melrose. The author stated that examination of the skulls from Newstead lent support neither to the descent of all European cattle from the Urus (*Bos primigenius*) nor to the descent of all European, Indian, and African breeds from the Asiatic Urus (*B. nomadicus*). He dealt with the evidence to be derived from the maxillæ, the occiput, and the temporal fossæ, and stated his conclusions as follows:—(1) That the Celtic shorthorn (*B. longifrons*) is probably more intimately related to the zebu of India (*B. indicus*) than to the European Urus (*B. primigenius*). (2) That long premaxillæ are usually correlated with an occiput of the *B. primigenius* type, while short premaxillæ are usually correlated with an occiput of the *B. acutifrons* type. (3) That polled black Galloway cattle and polled white "wild" Cadzow cattle are intimately related to the Urus, that flat-polled Aberdeen-Angus cattle probably include amongst their ancestors an ancient Oriental race now represented by, amongst others, a Syrian breed with rudimentary horns, and that round-polled cattle may belong to a still more ancient Oriental race descended from *B. acutifrons* of the Punjab Siwaliks.—G. P. **Farran**: Copepoda of the family Corycæidæ collected by Sir John Murray and Dr. C. W. Andrews at Christmas Island. The collection, though small in bulk, was exceedingly rich in species, and the genus Corycæus was especially well represented. A new genus was proposed, and several new species were described and figured.—H. R. **Hogg**: Some New Zealand spiders. The paper was based on a small collection sent by Prof. Charles Chilton, of Christchurch, New Zealand. Twelve species and eleven genera were represented in the collection, and a new local variety of *Tetragnatha ferox* and four new species were described.—Oldfield **Thomas**: Mammals collected in the provinces of Kan-su and Sze-chwan,

western China, by Mr. Malcolm Anderson, for the Duke of Bedford's exploration of eastern Asia. This collection, from a region hitherto almost unrepresented in the British Museum, was perhaps the finest that had ever come from China, at least so far as small mammals were concerned. Forty-seven species were included, represented by 350 specimens, presented, as on previous occasions, to the National Museum by his Grace.

Royal Microscopical Society, February 15.—Mr. Plimmer, president, in the chair.—E. **Heron-Allen** and A. **Earland**: New or rare species of Foraminifera found in the shore-sands of Selsey Bill, Sussex. The authors directed attention to the identity of the fossil Foraminifera of the Bracklesham beds with the living species found in Australian shore-sands. Recent specimens of *Bolivina durrandii* (Millett) and *Pulvinulina vermiculatis* (Brady) were shown, the only other known records being as regards the former from the Malay Archipelago and as regards the latter from tropical and subtropical seas. In addition to these, *Miliolina suborbicularis* and *M. rotunda*, *Dextuluria inconspicua*, var. *jugosa*, *Bolivina torterosa*, *Uvigerina asperula*, and *Sagrina dimorpha* were recorded as new to Britain. Schlumberayer's unique genus and species, *Hinderina brugesii*, was recorded from the Eocene clays, also the first fossil records of *Bulimina subtues* and *Discorbina polystomilloides*. The new species recorded were *Pulvinulina haliotidea* (H.-A. and E.) and *Nomionina quadriloculata* (H.-A. and E.). Microscopical specimens of these were also exhibited.—Lees **Curties**: A new dark-ground illuminator. This was made to the instructions of Mr. Nelson; it was so constructed as to work with slips ranging from 0·8 to 1·2 mm. in thickness, and gave a perfectly dark field with a Zeiss apochromatic 4 mm. lens of 0·95 N.A. The illuminator was provided with a fixed central stop, and also with a slot for utilising the apparatus as an oblique illuminator. A small dot placed on the front lens served for the purpose of centring the condenser to the optical axis.

Linnean Society, February 16.—Mr. H. W. Monckton, treasurer and vice-president, in the chair.—Mrs. L. J. **Wilsmore**: Some Hexactiniæ from New South Wales.—Rev. Canon **Norman**: Three species of harpactid copepoda.—The following papers were communicated by Prof. J. Stanley Gardiner:—Mr. **Hirst**: Report on the Araneæ, Opiliones, and Pseudoscorpiones.—G. A. **Boulenger**: List of the batrachians and reptiles obtained by Prof. Stanley Gardiner on his second expedition to the Seychelles and Aldabra.—Miss Mary J. **Rathbun**: The marine Brachyura from the Indian Ocean collected in 1905. It dealt with a large collection comprising 245 species and subspecies, 34 species and 3 subspecies being regarded as new to science, with 3 new genera. The results showed no connection with the West African crab-fauna.

Institution of Mining and Metallurgy, February 22.—Mr. Edgar Taylor, president, in the chair.—A. Beeby **Thompson**: The relationship of structure and petrology to the occurrence of petroleum. After describing the general structure of the important oilfields of the world, the author deals briefly with some of the local features which tend to modify the distribution of petroleum, as, for instance, the existence of faults in the strata, abrupt changes from oil-saturated sands to hard rock that is impervious to liquids, the lenticular distribution of oil sands, and the presence of water. Among the influences which have a bearing upon the distribution of oil in an operated field is the tendency of oil to follow certain channels, which probably represent lines of weakness that existed in the early ages of development, when high gas pressures were experienced. On this account, it is sometimes found that wells drilled at a later period in proximity to wells of large production will yield a comparatively small amount. In any case, the active development of a rich oilfield in which large volumes of gas are released must almost necessarily produce in course of time some changes in the distribution of the underlying petroleum. The author is at pains to show that with the development of oil sources are encountered some of the most wonderful and fascinating natural phenomena, and that no branch of mining is attended with greater interest or makes greater demands on the resources and ingenuity of the engineer in charge.—A. L. **Shrager**: Shaft sinking against water in fissured ground by cement injection. This paper comprises a brief description of a method of sinking shafts in water-bearing ground, the general result of which is practically to form a cofferdam of cement around the proposed site of the shaft. The particular shaft described in the paper was one sunk in a coalfield in the Pas de Calais basin, and full details are given, not only of the work carried out, but also of the cost, labour, and quantities of material involved.

CAMBRIDGE.

Philosophical Society, February 6.—Prof. Hobson in the chair.—J. J. **Lister**: The distribution of the Megapodidæ in the Pacific. The genus Megapodius consists, according to M. Oustalet, of some nineteen species. The distribution of fifteen of these extends almost continuously from Borneo to the New Hebrides and from the Philippine Islands to Australia. It thus covers an area in which the land masses are nowhere very remote from one another. There are, however, four outlying species far removed from the rest of the genus, namely, in Niuafou in the Tonga Group, the Pelew Islands, the Marianne Islands, and the Nicobar Islands. As the birds are incapable of long flight, the question arises, How is the distribution of the outlying species to be accounted for? It has been suggested that it may indicate the existence of a former land area by which all these remote islands were at one time connected. The object of this paper is to show that there is a good deal of evidence, negative and positive, to support the view that these outlying species may have reached their present habitats by the agency of the natives, by whom the eggs are highly valued as food. Niuafou is an active volcano 3½ miles in its longest diameter. The other birds inhabiting it are of species common to the Tonga Islands, though four, found in the other islands, are apparently absent from it. The birds are "protected" by the chief, and they exhibit a partial albinism, though in very varying degrees. The native name for the bird is *Mallow*, identical with that of the Solomon Island species and with that generally used by Malay hunters throughout the East Indies. The nearest species of the genus (in distance, but not in affinities) is that of the New Hebrides, some 900 miles to the west, no megapode being known from the intervening Fiji Islands, which consist of much larger and more ancient land masses. With regard to the Pelew Islands, Semper gives evidence showing that they consist of raised coral rock investing a volcanic basis formed by a submarine eruption in late Tertiary time. Quoy and Gaimard, the naturalists of the *Uranie*, visited the Marianne Islands in 1818–20, and state that the species there found was domesticated by the natives. M. Oustalet considers that there are undoubted affinities between this species and that from the Pelew Islands, and it is evident from the published figures that there is a close resemblance between the latter and the Niuafou bird. Wallace has expressed the opinion that the Nicobar bird has probably been introduced by the Malays. There is evidence that the species found in the Solomon Islands exists in some places in a domesticated or semi-domesticated condition. As the natives of the Pacific Islands were in the possession of fowls, dogs, and pigs when they were first visited by Europeans, the supposition that in some of their wanderings they may have carried megapodes with them, and thus established the outlying species in their present habitats, appears not improbable.—J. **Romanes**: Note on *Strongylocentrotus lividus* as a rock-borer. The specimen exhibited, which was collected on the west coast of Ireland, shows three echinoids occupying holes which they have excavated out of the solid rock. In cases previously described, the material which was removed appears always to have been much weathered. In this instance, however, the rock, which is a slate, is quite fresh, and as it is quite free from calcareous matter, the action must have been of a mechanical rather than a chemical nature.—A. J. **Grove**: Exhibition of sketches of a peculiar tracheal system of a mycetophilous larva (Diptera).

MANCHESTER.

Literary and Philosophical Society, February 7.—Mr. Francis Jones, president, in the chair.—Prof. W. Boyd **Dawkins**: The origin of the Roman numerals I.–X. It was suggested that these numerals were derived from a system of numeration employed by the inhabitants of Crete

during the Minoan civilisation. This conclusion was based on a comparison of the Roman numerals with a set of Minoan numerical symbols.—Prof. A. H. **Gibson**: The manner of motion of water flowing in a curved path. The conclusions which would appear to be justified as a result of the experiments described are:—(1) that whenever flow takes place past a curved solid surface, whether this is exposed to water on its concave or its convex side, the motion, except for the slowest velocities, is unstable; and (2) that in the fluid itself curvature with the velocity greatest on the *inside* of the path tends to stability, while curvature with the velocity greatest at the *outside* of the path tends to instability. Another fact which the experiments appear to indicate is that the tendency to eddy formation in the relative motion of a fluid and solid surface is greater, for a given relative motion, when the fluid, as a whole, is moving past a stationary surface than when the surface is moving through still fluids. This receives indirect confirmation from experiments by Stanton, Beaufoy, Froude, Dubuat, and Morin on the resistance of plane surfaces when moving through still water, or when held stationary in a moving stream.—Miss Margaret C. **March**: Studies in the morphogenesis of certain Pelecypoda. II.—The ancestry of the Gibbosæ. The ornament of the Trigoniæ, as shown by the ontogeny and phylogeny of modern species, develops from concentric to radial, with tuberculations developed on alternating radii. Fossil forms show the development of a third type of ornament, viz. diagonal by the junction of these alternating tubercles. Working from this basis, the Gibbosæ (part of the Glabræ, Lycett) can be traced back through the Undulata (Lycett) to the Triassic purely concentrically ornamented form *Myophoria curvirostris*.

DIARY OF SOCIETIES.

THURSDAY, MARCH 2.

ROYAL SOCIETY, at 4.30.—Reversal of the Reflex Effect of an Afferent Nerve by altering the Character of the Electrical Stimulus applied: Prof. C. S. Sherrington F.R.S., and Miss S. C. Sowton.—Carbon Dioxide Output during Decerebrate Rigidity (Preliminary Communication): Dr. H. E. Roaf.—The Alcoholic Ferment of Yeast Juice. Part VI. The Influence of Arsenates and Arsenites on the Fermentation of the Sugars by Yeast Juice: Dr. A. Harden, F.R.S., and W. J. Young.—Experiments to ascertain if certain Tabanidæ act as the Carriers of *Trypanosoma pecorum*: Col. Sir D. Bruce, F.R.S., and others.—Experimental Studies in Indian Cottons: H. M. Leake.

LINNEAN SOCIETY, at 8.—Dermaptera (Earwigs) preserved in Amber, from Prussia: Dr. Malcolm Burr.—Report on the Marine Polyzoa of the Collection made by Mr. J. Stanley Gardiner in the Indian Ocean in H.M.S. *Sealark*: Miss Laura Roscoe Thornely.—On the Mysidacea and Euphausiacea collected in the Indian Ocean during 1905: W. M. Tattersall.

RÖNTGEN SOCIETY, at 8.15.—Some Experiments with a 10,000 volt. Storage Battery: A. A. Campbell Swinton.

FRIDAY, MARCH 3.

ROYAL INSTITUTION, at 9.—Scents of Butterflies: Dr. F. A. Dixey, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Lagos Harbour Survey, 1909–1910: H. Ellis Hill.

SATURDAY, MARCH 4.

ROYAL INSTITUTION, at 3.—Radiant Energy and Matter: Sir J. J. Thomson, F.R.S.

ESSEX FIELD CLUB, at 6 (at the Essex Museum of Natural History).—Further Notes on Moorlog, a Peaty Deposit from the Dogger Bank: H. Whitehead and H. H. Goodchild, with Notes on the Plants by Clement Reid, F.R.S.—Note on some Ichneumonstung Larvæ: Rev. W. K. Wyley.—Notes on *Plusia moneta* in Britain: C. Nicholson.

MONDAY, MARCH 6.

SOCIETY OF ENGINEERS, at 7.30.—Petrol Air-gas: E. Scott-Snell.

ROYAL SOCIETY OF ARTS, at 8.—Applications of Electric Heating: Prof. J. A. Fleming, F.R.S.

ARISTOTELIAN SOCIETY, at 8.—Knowledge by Acquaintance and Knowledge by Description: Hon. Bertrand Russell.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Industry of Brewing: A. C. Chapman.

VICTORIA INSTITUTE, at 4.30.—Psychology: Rev. Canon I. Gregory Smith.

TUESDAY, MARCH 7.

ROYAL INSTITUTION, at 3.—Crystalline Structure: Mineral, Chemical, Liquid: Dr. A. E. H. Tutton, F.R.S.

ZOOLOGICAL SOCIETY, at 8.30.—Some New Siphonaptera from China: The Hon. N. Charles Rothschild.—(1) Contributions to the Anatomy of the Anura. I. Some Anatomical Notes upon the Frog *Megalophrys* (*Leptobrachium*) *feae*; (2) On the Spermatophores in Earthworms of the Genus Pheretima (=Perichæta): F. E. Beddard, F.R.S.—(1) A Rare Beaked Whale: (2) Age Phases of the Rorqual: R. Lydekker, F.R.S.—On Longevity and Relative Viability in Mammals and Birds; with a Note on the Theory of Longevity: Dr. P. Chalmers Mitchell, F.R.S.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Further discussion*: Modern Railway-signalling; some Developments upon the Great Western Railway: A. T. Blackall.

WEDNESDAY, MARCH 8.

GEOLOGICAL SOCIETY, at 8.—Contributions to the Geology of Cyrenaica: Prof. J. W. Gregory, F.R.S., R. B. Newton, F. Chapman, and D. P. Macdonald.—The Teeth of Ptychodus, and their Distribution in the English Chalk: G. E. Dibley.

ROYAL SOCIETY OF ARTS, at 8.—Plague and its Dissemination: James Cantlie.

THURSDAY, MARCH 9.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: (1) The Absorption Spectra of Lithium and Cæsium; (2) Dispersion in Vapours of the Alkali Metals: Prof. P. V. Bevan.—On the Ionic Solubility-product: J. Kendall.—Note on the Electrical Waves occurring in Nature: Dr. W. H. Eccles and H. M. Airey.

MATHEMATICAL SOCIETY, at 5.30.—On the Reduction and Classification of Binary Cubic Forms which have a Negative Determinant: G. B. Mathews.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Laying and Maintenance of Transmission Cables: C. Vernier.

FRIDAY, MARCH 10.

ROYAL INSTITUTION, at 9.—Recent Advances in Turbines: Hon. C. A. Parsons, F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 5.

MALACOLOGICAL SOCIETY, at 8.—On the Recent Species of Vulsella; on a New Species of Phasianella: E. A. Smith.—On the Value of the Gasteropod Apex in Classification: T. Iredale.—*Valvata Woodwardi*, n.sp., and *Spherium Bulleni*, n.sp., from the Forest Bed (Cromerian) of West Runton, Norfolk: A. S. Kennard.

PHYSICAL SOCIETY, at 8.—Demonstration of the Working of the Gyro Compass: G. K. B. Elphinstone.—Note on an Electrical Trevelyan Rocker: Dr. W. H. Eccles.—Notes on the Tilted Gold-leaf Electroscope: Dr. G. W. C. Kaye.

SATURDAY, MARCH 11.

ROYAL INSTITUTION, at 3.—Radiant Energy and Matter: Sir J. J. Thomson, F.R.S.

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