THURSDAY, DECEMBER 9, 1909.

PLANT RECORDS OF THE ROCKS.

Studies in Fossil Botany. By Dr. Dukinfield H. Scott, F.R.S. Second edition. Vol. I., Pteridophyta. Pp. xx+363. Price 6*s.* net. Vol. II., Spermophyta. Pp. xiii+(355–676). Price 5*s.* net. (London: A. and C. Black, vol. i., 1908; vol. ii., 1909.) Price, 2 vols., 10*s.* 6*d.* net.

IN the preface to the first edition the author expressed the hope that the palæontological record "will no longer be ignored by students of the evolution of plants." Since these words were written the study of the plant-records of the rocks has made steady progress, not only as regards results, but in the vigorous growth of interest shown in the relics of past floras. This remarkable activity is in large measure the direct result of the influence exerted by Dr. Scott, not only by his own researches and by the encouragement and generous assistance which he is always ready to give to younger workers, but in no small degree by his well-balanced and lucid treatment of that branch of botany to which he has devoted himself with conspicuous success.

The recent issue of the "Studies" is a new edition in more than name; two volumes replace the single volume in which the lectures were originally published, and, as the result of the rapid progress of palæobotanical work during the last eight years, many of the chapters have been largely re-written and others have been amplified. In the section devoted to the Equisetales the additions are few; reference is made to Mr. Hickling's recent account of the course of the vascular bundles in the sporangiophores of *Palaeostachya vera*, and to Halle's monograph of Mesozoic species of Equisetites. In the first edition a brief reference was made to the important discovery of Lepidocarpon, a seed-bearing lycopodiaceous strobilus: subsequent work by Dr. Scott and others has now rendered possible a more adequate treatment of this and similar types. A drawing of a transverse section of *Lepidodendron Wunschianum*, published in the first edition, is again reproduced with a broad band of tissue labelled "phloem," though it consists of extremely short parenchymatous cells, and a few immature xylem elements. It is a fact of considerable interest that in Lepidodendron stems which have formed a broad cylinder of secondary xylem, no true secondary phloem has been discovered. To the consideration of this question Dr. Scott hardly does justice. There are still many points to be cleared up in regard to the morphology of Palæozoic lycopods, and this can be done only by a detailed comparative treatment of all known species, founded on anatomical characters.

It is, however, especially in the account of the ferns that the results of recent investigations are most apparent. The student of Palæozoic ferns has now to face the difficulty of distinguishing between true members of the Filicineæ and fern-like plants which bore seeds. The account of the Botryopterideæ, a group of ferns which has gained considerably in importance since the removal of many genera of Palæozoic "ferns" to the new group Pteridospermeæ, is particularly welcome as coming from one who is exceptionally well qualified to deal with these still imperfectly known types. The excellent description, which is necessarily condensed, leads one to express the hope that Dr. Scott will soon publish a more comprehensive account of his researches into the structure and affinities of these generalised ferns. The account of the genus Lyginodendron has been modified as the result of Dr. Kidston's important contribution to our knowledge of the male reproductive organs, which had been previously referred to Zeiller's genus Crossotheca and regarded as fern sporangia. The chapter on the Medulloseæ contains interesting new matter, including some admirable drawings by Mr. Maslen of the seed Trigonocarpon and photomicrographs illustrating Prof. Oliver's recent work on the multicellular pollen-grains, and what are believed to be the remains of motile male gametes of Stephanospermum.

A word of praise is due to the publishers for the quality of the type and for the successful reproduction of the illustrations. Some new figures have been added, the most striking of which is, perhaps, a drawing of a transverse section of a young vascular bundle of *Botryopteris hirsuta*, showing the thin-walled immature xylem, with a few lignified protoxylem elements. It is no exaggeration to say that the volumes before us afford the most convincing demonstration so far presented in book-form of the possibilities of palæobotanical research. As we read the descriptions of many of the extinct types, and note the perfection of the preservation of their tissues, we forget that the material from which the data have been obtained has for countless ages been entombed in the older rocks of the earth's crust.

Though mainly concerned with Palæozoic plants, Dr. Scott adds a chapter on Mesozoic gymnosperms, in which special attention is directed to Mr. Wieland's able monograph of the remarkable silicified cycadean stems from America. In the clearly written account of these plants, emphasis is laid on the striking differences between their flowers and those of recent cycads, a difference which is necessarily somewhat obscured by the application of the term cycad to plants the reproductive organs of which differ *toto coelo* from those of the Cycadaceæ. The opinion held by several botanists that the results of Mr. Wieland's work afford a clue to the solution of the problem of the origin of the angiosperms receives due attention. Bearing in mind the scope of the "Studies," it would be unreasonable to find fault with the brevity of the section devoted to the past history of the Coniferales. In the admirable chapter devoted to general results, the author adopts a new grouping of the vascular plants, which he naturally speaks of as provisional. As knowledge increases, we conveniently record progress towards what we believe to be a closer approximation to a natural scheme of classification by means of changes in the arrangement of the subdivisions or by a redistribution of genera. Any change challenges criticism, but, whether accepted or not, it stimulates discussion and helps us to correlate our

ideas. Bacon's aphorism, "Truth more easily comes out of error than out of confusion," may be applied to any honest attempt to express progress in knowledge by a re-adjustment of existing classifications. These words may seem to imply a disinclination to accept the views embodied in Dr. Scott's classification; they are quoted rather as an expression of gratitude for a contribution the value of which is to be measured, not by considerations of finality, but by the stimulus which it gives to wholesome criticism and to a broader survey of the facts at our disposal.

By the expansion of the "Studies," Dr. Scott has given a further incentive to students of plant evolution, and has produced a book which, in clearness of exposition, in scientific accuracy, and in soundness of judgment, it would be difficult to surpass.

A. C. SEWARD.

PISCINE MORPHOLOGY.

A Treatise on Zoology. Edited by Sir Ray Lankester, K.C.B., F.R.S. Part IX., Vertebrata Craniata. First Fascicle, Cyclostomes and Fishes. By E. S. Goodrich, F.R.S. Pp. xvi+518. (London: A. and C. Black, 1909.) Price 20*s.* net.

BOTH the author of this book and the editor of the "Treatise on Zoology" are to be congratulated on this, the latest addition to the series. The author is dealing with a subject with which he is thoroughly familiar, and to which he has contributed a large amount of important research. The whole plan of the book is carefully conceived and carried out, and we can only regret that the necessity to keep the size of the book within certain limits has made great concentration inevitable in dealing with many parts of the subject. However, references to more than five hundred original papers afford a guide to the student who wishes to amplify Mr. Goodrich's text.

This book is less a mere compilation than are most text-books, and the personality of the author is constantly felt. One of the chief features is the great number of excellent new figures, largely semi-diagrammatic representations of dissections, showing the three dimensions of space. Readers will be deeply grateful for this, for we have all experienced the annoyance of turning up text-book after text-book in the attempt to clear up some doubtful point, and finding the same figure, taken from some time-honoured authority, reproduced in all. How little the book before us suffers from this common failing is evident when it is said that more than a hundred and fifty of the figures are of the author's own drawing.

The subject is considered from a purely morphological and evolutionary point of view, to the almost complete exclusion of the physiological side, and the references to function are extremely few. While it is necessary in a book of limited length to discriminate between what to put in and what to leave out, one feels, perhaps, that in this case the fact that organs are functional parts of living animals has been kept too much in the background.

It is natural, and also desirable, that an author should treat at most length those parts of his subject to which he himself has given most attention, even at the expense of other portions. Here, many of the "soft-parts," for example, the nervous system, and the digestive organs receive rather scant attention. On the other hand, the supporting tissues, especially the exoskeleton and the skeleton of the median and paired fins, are admirably treated, and at considerable length.

The classification adopted differs in many respects from that found in contemporary text-books. The Pisces are divided into three great groups, the Chondricthyes, Ostracodermi, and Osteichthyes. The Chondricthyes include the Elasmobranchii (Selachii and Holocephali) and the extinct groups usually associated with them. The Osteichthyes are divided into two groups, the first including the Dipnoi and Coccosteomorphi, the second the Teleostomi. Useful phylogenetic trees are given at the beginning of the larger groups. In dealing with the Teleostei, use is freely made of subdivisions represented only by letters or numerals, thus saving the coining of new words—a most desirable proceeding in dealing with a provisional classification, such as that of the Teleosteans must at present be.

A few special points of minor importance call for criticism. On p. 11 we read that

"Stöhr showed that, in the Urodela, the 'vertebral region' is developed from three distinct centres—the parachordal, the mesotic cartilage of the auditory capsule, and an occipital segment resembling a vertebra."

This is a very confusing use of the terms, neither in accordance with Stöhr's original usage nor with that commonly accepted at present. Stöhr divided the post-trabecular elements of the skull into three, the "Balkenplatte," mesotic cartilage, and occipital portion, and identified the *last* of these with Huxley's parachordals. The custom now is to use the word parachordal as including all these three sections. The student will have difficulty in reconciling Mr. Goodrich's use of the term with either of the other two meanings.

On p. 116 we read, as one of the *primitive* characters of the Pisces (which group here does not include the Cyclostomes), that the pericardium may communicate with the abdominal cœlome. In view of the fact that this communication in Elasmobranchs is formed secondarily in ontogeny after the two cavities have been completely separated from each other, it would have been better not to have included it in the list of characters "considered primitive" without a qualifying note.

"Occipital" (p. 239) hardly seems a happy name for the large dermal bone of the Dipnoi (Wiedersheim's fronto-parietal), which, indeed, roofs in the whole cranium in the Dipneumona.

Considering the book as a whole, we may say confidently that, in spite of the number of excellent text-books already available, Mr. Goodrich's work will be extremely welcome to the student of vertebrate morphology, as being both a trustworthy source of general information on the subject and in many points an epitome of recent research by one who has himself taken a most important part in it.

W. E. A.

FRENCH SYLVICULTURE.

Sylviculture. By Albert Fron. With an introduction by Dr. P. Regnard. Second edition. Pp. 496. (Paris: J. B. Baillière et Fils, 1909.)

MR. G. WERY, the sub-director of the Institut Agronomique, is the editor of the French "Agricultural Encyclopædia," which consists of sixty volumes, each containing 400—500 pages, copiously illustrated, and sold in paper covers at 5 francs each, or bound for 6 francs. The subjects dealt with are distributed under six headings, as follows:—

(1) *Cultivation and Improvement of the Soil.* General agriculture; manures.

(2) *Production of Plants.* Agricultural botany; cereals; fodder plants; garden vegetables, orchards, vines, diseases of cultivated plants. Fron's sylviculture comes under this heading.

(3) *Production of Animals.* Agricultural zoology; entomology and the study of animal parasites; farm stock; breeding and rearing horses; fish; bees; birds; game, &c.

(4) *Agricultural Technology.* Dairy farming; brewing; flour-mills; cider, wine; also agricultural chemistry in two volumes.

(5) *Rural Engineering.* Agricultural machines; motors; buildings; survey; drainage.

(6) *Rural Political Economy, and Law.* This comprises six volumes, including hygiene.

We have therefore a splendid series of cheap scientific books by professors and experts of agriculture and of the allied arts, and if the other subjects are treated as skilfully and thoroughly as Mr. Fron has dealt with sylviculture, the French landowners and farmers are thus endowed with an excellent, cheap, technical literature.

Mr. Fron is an inspector of the State forests, and professor of forestry at the National Forest School at Les Barres, where promising young forest guards are trained to become head-guards and forest officers in the State, communal, and private forests. The first edition of the book has been sold, and this new edition has extended the subject-matter, so as to form a concise, clearly-written book, suitable for the private landowner and his foresters. It is divided into three parts:—

(1) *The Forest and its Constituent Trees and Shrubs.* This gives an account of the life-history of a tree, and a description of its parts; a list of the native woody species of France, with their botanical characteristics, and the uses to which their timber may be put. Then come trees considered in groups, the effects of density of growth, or its absence, on their forms and on the soil. Different kinds of crops of trees, natural or artificial, indigenous or exotic, follow, and the effects of forests on the flow of water and on the soil of mountains are described.

(2) *Practical Sylviculture.* Methods of stocking the ground, artificial or natural. Human agency in its effects on forest soil and on tree-crops. Methods of felling. General ideas about working-plans (quite sufficient for the private owner). Cubage and combinations of woods. Daily work done by an average labourer in various operations. Protection of forests against man, animals (including insects), physical phenomena (fire, snow, gales, &c.); fungi, weeds, &c. Valuation of forests.

(3) Comprises a study of the types of forest that prevail in France and of their management.

The term *sylviculture* among French professional foresters means a limited part of forestry, dealing with the cultivations of forest trees, but not including valuation or working-plans. The author, being a professional forester, knows this well enough, but has extended the meaning of the term in the way it is understood by the French people, for, unfortunately, the latter have not adopted the old French term, "*foresterie*," which is more comprehensive than *sylviculture*, corresponding to our term *forestry*.

The book is well and logically written and up to date, and its forestry is quite sound, while the printing is well done, and though the plates are somewhat rough, owing to the smooth paper, they serve to illustrate the author's points, and he has performed his task in a masterly manner.

A book resembling Fron's sylviculture, dealing with British woodlands, is still a desideratum. Our works on forestry are either comparatively very expensive and above the heads of the estate forester, or are too sketchy and controversial to be real text-books. But it is doubtful whether any British author could afford to publish a book like Fron's at 5*s.* a copy, so as to place it within the reach of estate foresters. "Our Forests and Woodlands," by John Nisbet, costing 7*s.* 6*d.*, is still one of the best short accounts of British woodlands, and is beautifully though sparsely illustrated, but it does not possess the clear scientific arrangement, nor the completeness of Fron's book. "English Estate Forestry," by A. C. Forbes, as well illustrated as is Nisbet's book, costs 12*s.* 6*d.*, and though also an excellent book, is not sufficiently detailed to become an elementary text-book, nor does it give a satisfactory account of coppice-with-standards, which on the Continent is the only recognised method of producing large, broad-leaved timber other than beech that is within the range of private estate management. W. R. FISHER.

PRACTICAL CHEMISTRY.

(1) *Exercises in Physical Chemistry.* By Dr. W. A. Roth. Authorised Translation by A. T. Cameron. Pp. xii+196. (London: Constable and Co., Ltd., 1909.) Price 6*s.* net.

(2) *Laboratory Methods of Inorganic Chemistry.* By Heinrich Biltz and Wilhelm Biltz. Authorised Translation by W. T. Hall and A. A. Blanchard. Pp. xv+258. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1909.) Price 12*s.* 6*d.* net.

(1) ACCORDING to the experience of the author of this laboratory guide to physical chemistry, the existing German works on the subject contain either too much or too little for the beginner, and he has, therefore, attempted to cater for the

student who is commencing to study the subject. To a large extent the book is based on the "Kleine Praktikum," arranged by Prof. Nernst for students of physical chemistry at the universities of Göttingen and Berlin. As such it presents many features of merit, but at the same time a lack of discretion in regard to the relative amounts of space devoted to the various sections of the subject detracts very largely from its value as a work for general laboratory use. Only nine pages, for example, are devoted to the chapter on chemical statics and dynamics, whereas twenty-two are taken up by that on the determination of density. Again, thermochemistry is liberally treated, while spectroscopic and electrolytic work are not dealt with at all. Apart from this lack of proportion, the subject-matter is carefully handled, and the exercises are in general well chosen. Special stress is laid on the application of physico-chemical methods in connection with quantitative analysis and the determination of the constitution of organic compounds. The translator has added a chapter on the construction and use of the thermostat, and also an appendix on the use of the electroscope in radio-active work.

(2) In consideration of the fact that preparative work in inorganic chemistry forms an essential part of the training of the modern chemical student, an addition to the rather scanty literature of the subject is not unwelcome. In this book the authors outline a course of laboratory work which is essentially synthetic in nature, and is designed to aid in acquiring a more adequate knowledge of inorganic chemistry than is to be obtained by practice in chemical analysis alone. It is intended primarily for those who have passed beyond the more elementary stage in their study of chemistry. Although this is the case, the experimental part of the book is set out in relatively complete detail, and, to assist in the study of the theoretical relations involved, brief discussions of a general nature are interspersed throughout the book.

The experiments, which involve the preparation of more than 200 substances, have been carefully compiled, and the processes have been tested in the authors' own laboratories.

Having regard to the meritorious nature of the contents of the book, it is unfortunate that the authors should have departed from the usual practice in the arrangement of their material. Instead of treating the compounds according to the periodic groups, they have chosen to base the classification upon the different types of combination. It is claimed that this arrangement results in a better comprehension of analogous methods of preparation and analogous properties, and a more intimate amalgamation of experimental and theoretical chemistry. The justice of this claim appears doubtful. On the other hand, the general impression created by the arrangement is that the experiments have been written down in haphazard order, with the result that closely related compounds are often widely separated. In these circumstances a re-arrangement of the material on the lines of the periodic table would add to the value of the book.

SCIENTIFIC METHOD IN GEOGRAPHY.

Macmillan's Practical Modern Geographies. (1) *A Geography of the British Isles.* By Dr. A. Morley Davies. Pp. xiv+358. Price 3*s*.

(2) *Practical Exercises in Geography.* By B. C. Wallis. Pp. xxiii+184. (London: Macmillan and Co., Ltd., 1909.) Price 2*s*. 6*d*.

(1) IN the "Geography of the British Isles," Dr. Davies introduces each section by a number of exercises with maps and statistics, so that pupils may have inferences of their own gleaning to help them to appreciate the descriptive portions of the book. This is an interesting experiment, and is carried out with considerable success, though chances are missed in the descriptive paragraphs which might have been used to teach rather more by appeal to the imagination. In that way, too, the work would have been made more valuable as a book for the pupils themselves to handle.

The subject is introduced through a brief survey of the British region as a whole, and then its tides and climate are considered, after which districts are studied in a regular sequence. It is characteristic of the district-study in this book that no attempt is made to define the districts in any exclusive fashion; they are chosen as geographical units, and the occasional overlapping only enhances the thoroughness of the survey.

London is of such unique interest, and shows in so many ways the influence of the past on the present geographical conditions that it might have been considered in more detail, especially from this point of view. A fuller account might also have prompted teachers in other centres to study their own towns in similar fashion, and thence to introduce local and practical considerations into their teaching. A large number of district maps and some good photographs, mostly illustrating physical features, enrich this book, and an alphabetical index of the abbreviated names used on the maps is a useful addition.

(2) "Practical Exercises in Geography" is a reasoned attempt to work out a continuous series of practical exercises, some of the nature of experiments, some "in the field," and some in the class-room. The course begins with the simplest rudiments of surveying, and leads up very effectively to the understanding of contour lines and the relief of the country, the United Kingdom being, of course, the chief object of study.

Following this are exercises on the factors of climate, and from the basis of the study of relief and of climate we proceed to vegetation and human activities. A less satisfactory chapter on rocks and minerals is inserted mainly for the purpose of drawing in the consideration of coal, iron, and other mineral products. The definition of metamorphic rocks as "rocks which were once 'water' rocks and have since been changed, usually by the action of heat," is objectionable.

The course should give a reasonable knowledge of British geography in a somewhat unusual fashion, but it is to be feared that the knowledge of other

areas acquired here and there would not be satisfactory for any purpose unless woven into a more complete system by the teacher. An interesting experiment is the inclusion of additional exercises, which are based upon descriptions extracted from the volumes of the Highways and Byways Series. They are well chosen to illustrate the different types of English scenery, and should be a useful link between æsthetic appreciation and exact observation.

OUR BOOK SHELF.

Carburettors, Vaporisers, and Distributing Valves used in Internal Combustion Engines. By E. Butler. Pp. xi+176. (London: C. Griffin and Co., Ltd., 1909.) Price 6*s.* net.

MR. BUTLER has written an interesting book on a subject which hitherto has not had justice done to it; and he is to be congratulated upon his bold decision to devote a book exclusively to these matters of detail instead of compressing them into the small space that can be spared in books dealing with internal combustion engines in their complete form. It cannot, of course, replace the completer treatises, but it is an excellent adjunct to them and is evidently written by one who is thoroughly familiar with this side of the work.

The volume contains twelve short chapters, of which the first four are concerned with surface and spray carburettors for petrol and alcohol motors, carburettors capable of automatically adjusting the air and petrol supplies over a wide range of speed, and various types of vaporisers for use with the heavy oils forming the second distillate from petroleum. The remainder of the book includes descriptions of various forms of admission and exhaust valves used on all classes of internal-combustion engines, together with some discussion of methods of actuating, timing, and water-cooling them.

Mr. Butler is an inventor on these lines, and has made himself familiar with what others have done in the same field; thus there are illustrations of no fewer than fifty-two different kinds of carburettor and vaporiser. With so much study of these matters, we wonder to find that he is apparently unaware of the increasingly common practice with motor vehicles of using the heat of the exhaust gases to warm, not the mixture as a whole, but the air supply only. The warm air is then passed over the jet and all the other arrangements are as usual. At least equal economy is obtained in this way besides greater ease of fitting and a lowering of the prime cost. Even with so simplified a form of carburettor or vaporiser as this makes, it has been found that the cylinders do not require cleaning out at any more frequent intervals.

As regards the valve mechanisms, we are glad to find that the author has included a description of the Knight engine, and, further, that he has given a good deal of space to the discussion of sliding and rotary valves. We cannot but feel that the poppet type of valve is unlikely to be permanently used, and the author deserves our thanks for having taken us some steps along the road towards a better form of valve mechanism. Many motor manufacturers are working in the same direction, and there is no doubt that we shall soon be hearing of other suggested forms of valve. If the experience of extended use of the Knight engine is favourable, it will give great impetus to this development. With the largest forms of gas engine there are, of course, already many engines now running with complete success, using slide valve forms of control for either the admission or exhaust ports, or for both.

Cotton Spinning Calculations. By W. S. Taggart. Pp. xiv+335. (London: Macmillan and Co., Ltd., 1909.) Price 4*s.* net.

THE author of this excellent and beautifully printed text-book assumes that the reader has no special equipment beyond an elementary knowledge of arithmetic, and some acquaintance with the various processes of cotton manufacture and the technical nomenclature used in connection therewith. In the introductory chapter, he gives general calculations respecting the velocity ratio in wheel trains and belt gearing; the surface velocities of rollers and the stretching of fibres resulting from "draft"; the estimation of "hanks" and "counts"; and the force actions of levers. A set of exercises closes this part. In succeeding chapters the treatment is more direct and special. The various machines through which the material passes, from the Scutcher to the Ring Spinning Frame, are considered in detail. The author has had the assistance of the leading manufacturers of textile machinery in the cotton district, and is thus able to give diagrams, drawings, and tables of wheel teeth, showing very clearly with full details the mechanisms used in all the standard types of machines. The calculations are therefore based on numbers representing the best modern practice. A special chapter is devoted to the consideration of epicyclic or differential gears and the design of cone drums. Thus, by repetition, and by the wealth of illustration provided, no reader should fail to obtain a thorough insight into the action of the most complicated of the mechanisms. This kind of quantitative work is essential if a student is to have anything more than a superficial knowledge of the subject, and it will enable him readily to calculate the wheel changes, &c., necessary in order that a machine shall be able to cope with the varying demands made upon it.

The author concludes his very interesting volume with a number of useful tables and an index. Both author and printers are to be congratulated on the production of this admirable work, which should be in the hands of everyone, at home and abroad, who is interested in the practical working of textile machinery.

Proceedings of the Aristotelian Society. New series, Vol. ix. Pp. 259. (London: Williams and Norgate, 1909.) Price 10*s.* 6*d.* net.

OF the nine articles contained in this volume the most important are, perhaps, Prof. Alexander's essay on "Mental Activity in Willing and Acting," and Prof. Stout's rejoinder, "Are Presentations Mental or Physical?" The point at issue in these papers is one of fundamental importance for both psychology and the theory of knowledge, since Prof. Alexander's contention, to put it quite plainly, is that all mental activity consists solely of conation and feeling, or possibly, since it is conceivable that the feeling or affective side of mental life may be reducible to experience of successful and thwarted conation, of conations alone. Hence he refuses to admit the existence of such cognitive processes as have usually been supposed to be denoted by the names sensation, imagination, perception. On his view the *object* apprehended in all these processes is physical; the *process* involved is simply conation directed towards a specific physical object. It follows, of course, that if Prof. Alexander makes out his case, "presentations" must be deleted entirely from our account of the stuff out of which mind is made, and, in the theory of knowledge, any doctrine which assumes either that "we can only know our own sensations," or that, at any rate, we begin by knowing our sensations and

have to infer from them the character of the physical realities which are their stimuli, must be erroneous. Prof. Stout's criticism appears to show that Prof. Alexander's doctrine cannot be sustained as it stands, but the fact that it can be put forward by a writer of such philosophical eminence is an interesting sign of the influence which Avenarius is at last beginning to exercise on British philosophy.

Very similar tendencies are revealed by Mr. A. Wolf's interesting paper on "Natural Realism and Present Tendencies in Philosophy." The interest awakened by Bergson's striking book "L'Évolution Créatrice" is witnessed to by Mr. Carr's disquisition on Bergson's theory of knowledge, and Mr. G. T. R. Ross's treatment of the satisfaction of thinking. Pragmatism, as one would expect, does not go unrepresented. Dr. Schiller inflicts one of those castigations which are becoming periodical with him on rationalism in a paper on "The Rationalistic Conception of Truth," and the subject also figures prominently in a so-called symposium on pluralism, in which different points of view are represented by Dr. Schiller, Prof. Muirhead, and the writer of this notice. The volume further contains an essay on "The Mutual Symbolism of Intelligence and Activity," by Mr. Foston, and a discussion between Prof. Bosanquet, Dr. Sophie Bryant and Mr. G. T. R. Ross on "The Place of Experts in Democracy."

A. E. TAYLOR.

An Introduction to the Study of Biology. By J. W. Kirkaldy and I. M. Drummond. Pp. iv+259. (Oxford: Clarendon Press, 1909.) Price 6*s.* 6*d.*

THIS little book represents an attempt to deal, within the limits of some 250 pages, with the study of biology as exemplified primarily by the organisms prescribed in the syllabus of the Oxford and Cambridge Schools' Examination Board. The authors have, however, realised the deficiencies of the type system and endeavoured to "bridge over the gulfs" by brief accounts of, or references to, a considerable number of forms "allied" to the selected types. Thus Monocystis, Hæmamœba, Bacillus, Chromulina, Actinosphærium, Globigerina, Rhaphidococcus, Arcella, Euglena, Noctiluca, Stylonichia, Acineta, Desmids and Diatoms are all introduced as allies of the more familiar Protozoa, viz. Amœba, Saccharomyces, Sphærella, Vorticella and Paramœcium.

There is no doubt that a too rigid adherence to the type-system does produce a very disconnected idea of the animal kingdom, but we fear that the ordinary schoolboy will think that it is bad enough to have to make the acquaintance of the types without having to shake hands with so many of their relations. No fewer than sixteen types of animals and plants are dealt with in more or less detail, ranging from the Amœba to the dogfish, and from the yeast to the sunflower, besides chapters on the distinction between animals and plants, the life-history of the frog, and the physiology of the rabbit.

The book contains numerous illustrations, for the most part borrowed from very familiar sources; a few are original, but we cannot congratulate the authors very warmly upon these. The picture of a crayfish on p. 112 is extraordinarily crude. The book gives an enormous amount of information gathered from a very wide field, but it is far too concentrated to be inspiring, and the authors do not appear to have succeeded in putting the general principles dealt with in a very clear light. We hope it is intended to be read in connection with a course of practical work, but we have not been able to find any reference to the necessity for such a course.

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 End of the *Beagle*.

IT is well known that Charles Darwin began to advocate his famous doctrine of evolution after his voyage on board H.M.S. *Beagle* as naturalist, in the course of which he went to South America, Africa, and Oceania, and founded the theory of natural selection; but it has been a matter of regret among men of science throughout the world that the famous old ship had passed out of sight. As the result of careful inquiries, however, by Mr. Shigetaka Shiga, a renowned geographer in Japan, it has now been ascertained what was the ultimate fate of the *Beagle*.

Mr. S. Shiga has told the story to the editor of the *Yorodzu Chōhō*, the most popular newspaper in Tokyo, as follows:—"While I was attending the Sapporo Agricultural School some twenty years ago, I read in the *Living Age*, an American literary magazine, that the *Beagle* had been sold in Japan. After my inquiry it was found out that the warship had been bought by the Lord Shimadzu, who had changed its name to *Kenkō-maru*. Afterwards it was purchased by the Naval Department, and kept as a training ship of the Naval School in Tsukiji, Tokyo; but I had then no intention of preserving the famous ship, and so took no notice of the matter.

"This spring I heard Englishmen were sorry at having lost all trace of the *Beagle* at the hundredth anniversary of the great naturalist's birth. I then applied to a steward of Prince Shimadzu, as well as Viscount Captain Ogasawara, to get fuller particulars of the ship. According to the record of the Prince, the *Kenkō-maru* was certainly the *Beagle* that had been built of teak at Liverpool; it was bought for 75,000 dollars in Nagasaki on July 23 in the first year of Gwanji (1864 A.D.). Viscount Ogasawara informed me of the same fact, and added that the Naval Department ordered several officials, Kawamura (the late Count Sumiyoshi), Masuda, and Satō, to receive the same ship from the Shimadzu clan at Shinagawa on June 13 in the third year of Meiji (1870). It was in existence as a training-ship in the thirteenth year (1880), and was re-named *Yeiji-maru* at Yokosuga in the fifteenth year (1882). It was in May of the twenty-second year that the ship was sold by auction for 3276 *yen* to the late Kikusaburo Oaki, the proprietor of the Oaki Ship-building Yard.

"After some inquiries about the *Yeiji-maru* at Oaki's, I learned that the ship had been broken up at the old Shinagawa Fort, and that her cabin had been preserved for three years, when it was lost sight of; but Mr. Keizo Oaki, the present owner, who superintended the breaking up of the ship as the engineer-in-chief, has had the kindness to make inquiry of the workmen engaged in the work. The result is as follows. A part of the ship was at length discovered. It was being used as a stand for stones which have been piled up near the temple of Suitengu, in the premises of the dockyard. Having been taken out, it was found to be a part of the ribs of the *Beagle*, 3·5 feet in length, 1·5 feet in breadth, and of teak. Thus a portion of the fragments of the famous *Beagle* has at last been found."

TOYOZI NODA.

Ichinoseki, Iwate, Japan, October 27.

The Maintenance of Forced Oscillations of a New Type.

IN a paper "On a Class of Forced Oscillations" published in the *Quarterly Journal of Pure and Applied Mathematics* (No. 148, June, 1906), Mr. Andrew Stephenson discussed mathematically a proposition which may be stated in his own words thus: periodic non-generating force acting on a system in oscillation about a position of stable equilibrium exerts a cumulative action in intensifying or diminishing the amplitude, if its frequency is contained

within any one of a number of ranges lying in the vicinity of 2μ, $2\mu/2$, $2\mu/3$ . . ., where μ is the natural frequency of the system.

Further investigations upon this and other allied subjects appear in seven subsequent issues of the *Philosophical Magazine*. As regards the forced oscillations discussed in the *Quarterly*, the author gives, in the way of experimental verification of his mathematics, the following:—the influence of the disturbing motion becomes feebler as r increases, but it may easily be observed experimentally in a number of cases. For this purpose suspend a load by means of a spiral spring, and attach to it a pendulum light compared with the load, but of such density that the air resistance is negligible; the pendulum being of suitably chosen period, it will be found that when the load is carefully adjusted the relative equilibrium of the pendulum in the vertical motion is unstable.

I believe the beauty and interest of the results obtained by Mr. Andrew Stephenson have not been generally realised, otherwise it is nearly certain that something more satisfying in the way of experimental demonstration of these oscillations than mere observation of "instability of equilibrium" in certain cases would have been put in the field. I think an experimentalist would hardly be pleased with anything less than the actual permanent maintenance of oscillations of the type mentioned, *i.e.* something similar to the experiments of Faraday, Melde, and Lord Rayleigh for the case of double frequency, which, as Mr. Stephenson points out, is only one particular case of his general theorem.

During the course of certain acoustical work which I have been engaged in during the last two years, I observed certain types of stationary vibration which I find are undoubtedly of the kind contemplated in Mr. Stephenson's paper. These observations were made with an apparatus from which any new effects were apparently hardly to be expected. The arrangement was the well-known one of a string maintained in vibration by a tuning-fork oscillating in a direction parallel to the string. It is generally supposed that the oscillations permanently maintained have a frequency which is half that of the tuning-fork. I found this was *not* always the case. With an electrically maintained tuning-fork the amplitude of oscillation of which could be readily adjusted, the stationary oscillation of the string had a frequency of $\frac{1}{2}$ of, equal to, 3/2 times, twice, &c., that of the tuning-fork, each term in the harmonic series appearing separately by itself with a fairly large amplitude, or with one or more of the others conjointly, according to circumstances. The frequency- and phase-relations could be studied by several methods, most of which were very simple applications of the principle of Lissajous's figures.

The possibility of isolating the harmonics, and also certain serious discrepancies between theory and experiment as regards the phase of the oscillations in the case of double frequency, were traced to the existence of variations of tension in free oscillations of sensible amplitude. These variations of tension were experimentally demonstrated by a special form of monochord denominated the "Ectara" (*vide* the Journal of the Indian Mathematical Club for October, pp. 170–5), in which the sounding surface is a membrane perpendicular to the vibrating string, and emits a tone having *twice* its frequency.

Post-Box 59, Rangoon. C. V. RAMAN.

Absorption-bands in Colourless Liquids.

IN the obituary notice of the late Dr. W. J. Russell, F.R.S. (NATURE, November 25, p. 101), whose genial friendship I enjoyed and with whom, when occasionally in London, I had friendly intercourse, it is stated that he had published "papers conjointly with Mr. Lapraik on absorption spectra, and notably one on the absorption bands in the visible spectra of colourless liquids, which was the pioneer paper in a branch of inquiry that has been ably followed up by Prof. Noel Hartley, F.R.S., Mr. E. C. C. Baly, F.R.S., and others." It seems ungracious to call in question the accuracy of this reference, and I feel, indeed, a great inclination to let it pass without comment, although it is incompatible with authoritative statements made elsewhere; but, inasmuch as the passage is liable to be reprinted without question and repeated in other publications, I consider it would be better to invite the writer's attention to the Chemical Society's Transactions, xxxix., 153–68, 1881, "Researches on the Relation between the Molecular Structure of Carbon Compounds and their Absorption Spectra," and suggest that he should compare it with the paper which follows in the same volume, pp. 168–73, "On the Absorption-bands in the Visible Spectrum produced by Certain Colourless Liquids." Having done so, I think he will agree that not only is the latter not the pioneer paper, but also that there is very little in common between the two. In fact, the latter communication is more closely allied to the work of Abney and Festing in the infra-red region, a work to which the authors themselves make a special reference.

W. N. HARTLEY.

Royal College of Science, Dublin, November 30.

The Inheritance of Acquired Characters.

IN his review of Prof. Poulton's work, "Charles Darwin and the Origin of Species," Prof. Meldola says (NATURE, November 25, p. 92) that the Darwinian theory is absolutely dependent upon the truth of the belief "in the transmissibility by inheritance of individual differences or 'fluctuations.'" This is undoubtedly true. There is now available a vast amount of evidence tending to show that "fluctuations" seemingly the direct results of changes in the environment are inherited; but how is it possible to convince Weismann and his followers that such "fluctuations" have not been due, as they will say, to "spontaneous germinal variations"? Surely the *onus probandi* really rests with them!

We have here the question of the inheritance or not of acquired characters reduced to its simplest terms. There is much and very varied evidence to show the influence of changes in the environment in producing "fluctuations" which are heritable, but what evidence can those who disbelieve in the inheritance of acquired characters present to show that in all such cases there *must* be a primary germinal change? H. CHARLTON BASTIAN.

The Athenæum, November 26.

Luminous Night Clouds and Aurora Spectrum.

ON the evening of Friday, December 3, there occurred a very brilliant display of luminous night clouds in rather peculiar circumstances. During the earlier part of the evening the sky had been clear, and no indications of an aurora were observed. About 10.15 p.m. the sky became completely overcast quite suddenly, and it was noticed that this appeared to be by general formation of haze *in situ*, and not by the drifting of clouds. Almost immediately after this numerous patches of light cloud appeared, travelling with considerable velocity eastward. From numerous previous experiences it was at once apparent that these were not ordinary cloud forms, and the moon was not high enough to account for their extreme brilliancy. Careful examination with a hand spectroscope confirmed the surmise that they were luminous clouds, the green auroral line being very bright and sharply defined; on several of the brighter masses other lines were suspected, but not sufficiently well to assign any position. These observations were confirmed by Mr. W. Moss. At about 10.45 p.m. the clouds gradually became less frequent, and the sky became clear again almost as suddenly as it had been overcast.

It will be of interest to hear if any magnetic storm has been recorded for this epoch. The surface of the sun has been in continued disturbance during the past week, as evidenced by the rapidly changing forms of numerous spots. One of the largest groups would be passing round the north-west limb. CHARLES P. BUTLER.

Solar Physics Observatory, London, S.W.

Coloration of Birds' Eggs.

SOME time ago I wrote a short letter asking for information about the colours of birds' eggs, which appeared in NATURE of May 14, 1908. I read the answer to my letter in a subsequent number of NATURE, which, unfortunately, did not appear to me to throw much light on the subject.

I would like to suggest that this colouring of eggs was in some way originally analogous to the change of colour observable in the chameleon and certain lizards, though by no means at the same level of development. Although it is quite possible that the colouring in some cases is protective, or has become so, it does not seem that this is a fixed rule. Why should the egg of a starling, which generally builds on house-tops, be blue? The hedge-sparrow's, again, is blue, while the thrush's is blue spotted with black, and the blackbird's is green, though the position of their nests is vastly similar. Again, on examining the excellent "clutches" at the Natural History Museum which exhibit the additional cuckoo's egg, one is struck by the variation in shade, which, according to observers, is matched by the bird itself.

It seems to me that the elucidation of this problem would be of great value in such vexed questions as the inheritance of acquired characteristics, and might be really illustrative of the exact processes of evolution.

R. L. LESLIE.

13 Electric Mansions, Brixton, S.W., December 1.

The Terminal Velocity of Fall of Small Spheres in Air.

AT the recent Winnipeg meeting of the British Association we presented some results on the terminal velocity of fall of approximately spherical spores, which were not in agreement with Stokes's formula (see NATURE, October 14, p. 472). We have succeeded since in making minute spheres of paraffin wax, a certain black wax, and mercury, and have determined their terminal velocities over a wide range of sizes by the same method as in the preceding investigation. The velocities obtained for these spheres are in close agreement with Stokes's formula. The reason for the deviations in the former cases is not clear.

JOHN ZELENY.
L. W. MCKEEHAN.

University of Minnesota, November 23.

THE PROPHYLAXIS OF TROPICAL DISEASES.

THE history of tropical medicine, or what might be called its recent twentieth century renaissance, will go down to posterity as one of the most remarkable chapters in medicine. In a book entitled "Mosquito or Man? The Conquest of the Tropical World,"[1] Sir Rubert Boyce endeavours, in his own words, to epitomise this wonderful movement, a movement initiated in England by the then Secretary of State for the Colonies, Mr. Joseph Chamberlain, and by Sir Patrick Manson, a physician who had practised in the East, and had returned home imbued with the idea that the diseases of the tropics stood, so to speak, by themselves, and thus required special teaching in the medical schools of this country. The idea gained ground; two tropical schools, one in London, one in Liverpool, were founded, as Sir Rubert describes in his first chapter, and from that day onwards things have never looked back. Discovery after discovery have poured from these schools until now we stand on the threshold of a new world, a tropics as healthy as a temperate clime.

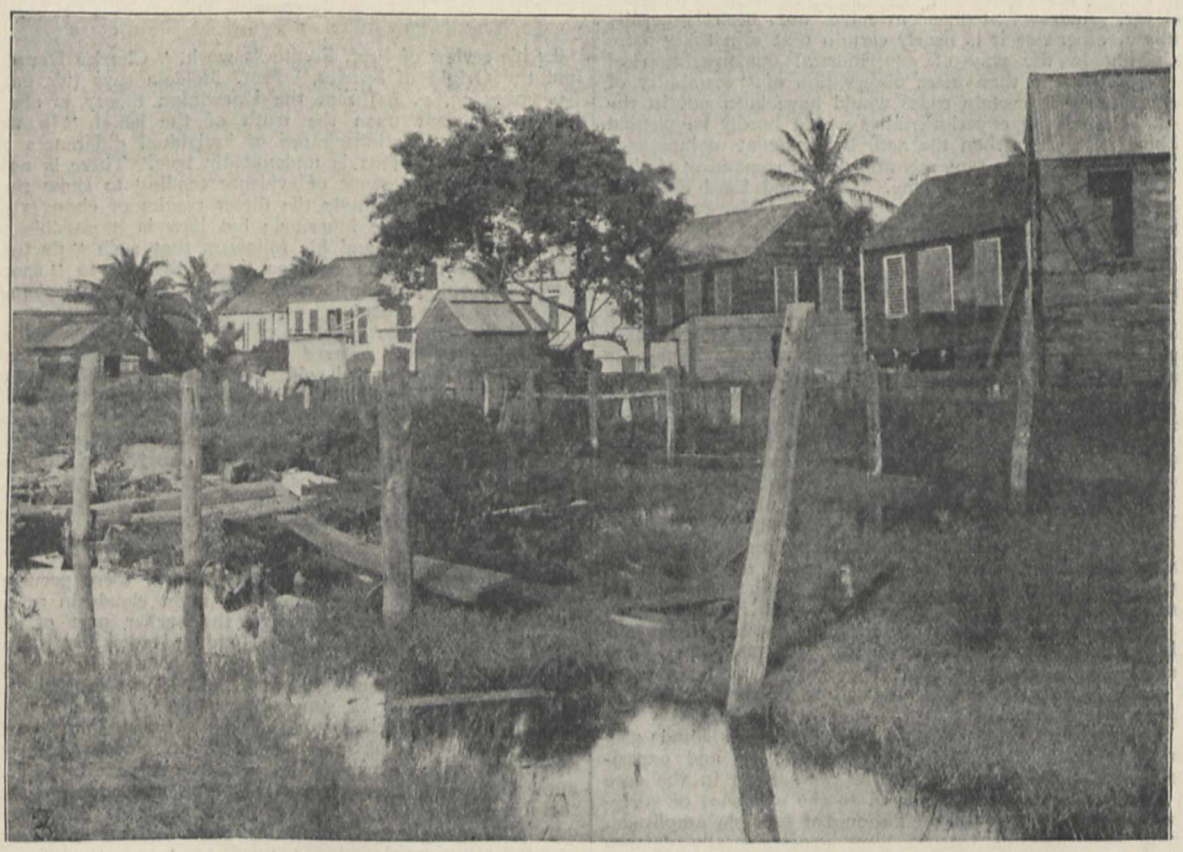


FIG. 1.—Water-logged Anopheline Breeding Land, Belize. From "Mosquito or Man?"

There apparently is nothing new under the sun, not even in medicine; the author describes in his fourth chapter how Sir Henry Blake, when Governor of Ceylon, had been shown a medical work written fourteen hundred years ago, in which the mosquito was stated to be a carrier of disease, and in which malaria was described as being transmitted by flies or mosquitoes—a truly prophetic utterance. More recently than this certainly, but yet, as things go now, of older

[1] "Mosquito or Man? The Conquest of the Tropical World. By Sir Rubert Boyce, F.R.S. Pp. xvi+267. (London: John Murray, 1909.) Price 10*s.* 6*d.* net.

times, Beauperthuy, in 1853, practically said the same thing, and had he but had a disciple of the worth of Ross the thing would have been settled long ago, and the gain to humanity have been the saving of millions of lives. Unfortunately, neither he nor King nor Finlay could prove the truth of their assertions, so it was left for Manson to revive the view once again, and this time at last a worker—Prof. Ross—came forward, and by a brilliant piece of research work solved the mystery once and for all. Long before this, Manson had also shown that the *Filaria bancrofti* underwent a metamorphosis or development in the tissues of a mosquito, and Low had subsequently proved—not Manson, as the author erroneously states on p. 36—that after this development was complete, the parasites found their way into the proboscis, and so got back to man when the insect bit again.

samples of what may be done. He has complained at times of the slowness with which this new sanitation has moved in some of the British Colonies, and certainly, as compared with American dependencies, it has been slow; but now, as chapters viii. and xiv. of "Mosquito or Man?" show, the movement is advancing, most of the West Indian islands, terrified by the fear of yellow fever, the scourge of these parts, having now got definite ordinances and regulations dealing with the question of breeding grounds of mosquitoes.

The historical survey of yellow fever contained in chapter xi. gives an idea of what these places were like in the old days, Fergusson telling how 1500 soldiers had perished in one epidemic, while in another instance the Secretary for War in England wanted to know from the Governor of British Guiana why in

FIG. 2.—Too much Bush. Georgetown, Demerara. The effect is to obscure Sunlight and Fresh Air. From "Mosquito or Man?"

The Americans in Havana, profiting by Ross's work on malaria in the mosquito, tried mosquitoes for yellow fever, and by a series of experiments proved that a mosquito, the *Stegomyia calopus*, is the sole agent in the transmission of this disease. Here, then, were three of the most important tropical diseases clearly proved to be carried by mosquitoes, and, the cause having been ascertained, there only remained the question of prevention. How difficult it is to break down old traditions, and the antagonism that was displayed to the men of science who were sent out to preach the new doctrines are well brought out in chapter iii.; even to the present day there are members of the medical profession who disbelieve in the mosquito, *vide* p. 118. Ross at once, after his researches on the development of the malarial parasite in the mosquito, advocated a war against these insects as being the rational method of cutting the cycle and stamping out the disease, and his original campaigns and subsequent ones—Ismailia, for example—are

a few months 69 per cent. of the white troops had perished. The churchyards of Barbados and the other islands are full of the bones of the victims, and it is said of the slopes of the Morne in St. Lucia that there is not a square yard without the remains of a soldier under it, more being there from the results of yellow fever than from the bullets of the enemy. Now what do we find? Let us refer to chapter xiv., which contains an account of the anti-yellow fever campaign in Havana, 1900. As Sir Rubert says, "This will always remain one of the first and one of the greatest examples of what has been done to stamp out a disease by concerted intelligent action, and using the latest and most modern weapons. When the American Government took over the administration of Cuba, one of the first things to be done was to make Havana a livable place. Hitherto it had been notoriously unhealthy, 35,952 persons perishing of yellow fever between the years 1853–1900, this being equivalent to 754 a year, 64 a month, or to 2 deaths a day;

and now, after General Woods, Colonel Gorgas, Guiteras, Finlay, and others took the situation firmly in hand, and organised a thoroughly efficient sanitary administration and a special raid upon the breeding places of the Stegomyia, the death-rate for Cuba has come down to between 11–17 pro mille. In 1907, only one case of yellow fever was reported in Havana."

Panama, New Orleans, and every other place treated in a like manner have given similar results, and certainly no sane individual will be found who, after reading "Mosquito or Man?" will deny that the mosquito is the only transmitter of yellow fever, and the remarkable results that follow its destruction.

Equally remarkable are the results that follow the extermination of anophelines for malaria. It was computed that Ismailia (p. 65), already mentioned, in 1886 had every inhabitant infected. Ross began his anti-malarial campaign there in 1901; by 1904 the cases were diminishing fast, until in 1905, 1906, 1907, and 1908, there were no new cases at all, indicating that the disease had been entirely stamped out. One would like to multiply further examples, but space forbids; those desiring more must read the book for themselves. There is little to criticise adversely in the work. Of omissions one might notice what was the first anti-malarial and yellow-fever campaign in the West Indies, namely, that conducted on the Morne and Vigie in St. Lucia in the year 1901, and also the pioneer work done on the destruction of mosquitoes for filariasis in Barbados.

Of errors, on p. 128, in the sentence "then after a latent period of three days the Stegomyia," &c.—should manifestly read "thirteen" days. On p. 133, "Man suffering from yellow fever after the fifth day is the reservoir" should read "Man suffering from yellow fever on the second or third day or before the fifth is the reservoir."

The book is clearly and ably written, is most interesting to read, is nicely illustrated by beautiful photographs, and we cannot do anything but praise the author for its production.

INDUSTRIAL EDUCATION.

TECHNICAL education may be regarded as falling naturally into two main divisions, (1) the education of the higher ranks of those engaged in industrial work, and (2) the education of the rank and file. From time to time one or other of these divisions occupies the more prominent place in the public interest. Recently, probably as a result of the discussions following the publication of the reports of the Poor Law Commission, special prominence has been given in the Press and elsewhere to the problem of the industrial education of those who will become in the near future the skilled workmen, artisans, and craftsmen of this country. Two recent attempts to influence public opinion in this matter may be here briefly recorded. Probably the more useful of the two is an attempt to organise a National Industrial Education League, the main object of which, in the language of its promoters, is "to make elementary education go hand in hand with industrial training, and to stop the criminal waste of the nation's best asset by giving our boys, before leaving school, a sound elementary industrial training." This proposal "has already received the approval of fifty-seven trades' councils, and of the representatives of 3,000,000 of industrial workers." In addition, promises of support have been received from many large employers of labour, distinguished educationists, and well known public men. Special stress is laid upon the fact that, "while the present system of technical education has benefitted many, it has left uncared for, and can never reach, the bulk of the children who are destined to become industrial workers."

The second recent noteworthy attempt to arrive at some definite agreement in the matter was a conference held on Friday, December 3, at the Mansion House, at the invitation of the Lord Mayor, to consider (1) the development of industrial training in both elementary and trade schools, and (2) the organisation of facilities for bringing boys and girls who are leaving the public elementary schools into better touch with the openings that exist in the industrial and commercial world. The conference was attended by a number of representatives of the London County Council Education Committee, many large employers of labour, and delegates from trades unions. It is probable that the London County Council, at whose suggestion the conference was called, will not profit much by the deliberations of the conference. As no definite resolutions were submitted for discussion, there was a tendency to neglect general principles and treat side-issues only. Running throughout most of the speeches, however, was a belief in the impossibility of reviving the old system of apprenticeship and the consequent necessity for some form of educational work to give the necessary industrial training formerly supplied by the apprenticeship system.

Interest in industrial education is now extending to the political parties. Thus the National Union of Conservative and Constitutional Associations, at its recent annual meeting in Manchester, passed a resolution urging

"that the Conservative leaders at once push forward a scheme of development of technical, scientific, and agricultural education for Great Britain and Ireland, and that this scheme must be linked with the system of primary education."

On the other side of the political platform, the Labour party has passed resolutions at recent conferences demanding a free national system of primary, secondary, university, and technical education. At the forthcoming annual conference of the Labour party to be held in January, 1910, the conference will be asked

"to observe the increasing tendency to make use of boy and girl labour in monotonous and uneducational industrial work as fatally destructive in its results upon the health, character, and subsequent industrial efficiency of the boys and girls themselves . . . and to urge upon the Government the desirability of so amending the Factory and Education Acts as to secure to every boy and girl between the ages of fourteen and eighteen efficient physical and technical training."

As the question of industrial education is one which affects the working classes more than any other section of the community, it is obvious that any future legislative action on the matter will be considerably influenced by expressions of opinion from bodies such as the Labour party and the trades unions. There is a danger that organisations of this type may be tempted to use their influence to give an unduly utilitarian bias to the education of boys and girls in the elementary and continuation schools. This danger is, however, more apparent than real, as is shown by (1) the vigorous support given by trades unions and similar bodies to the Workers' Educational Organisation, the object of which is to secure university education in literature, history, political economy, and the like for working men, and (2) the general undercurrent of opinion among workmen that the financial benefits of trade and technical education will ultimately fall to the employer and not to the workman.

At the present time much controversy is taking place respecting the question of apprenticeship. Is it desirable to revive the system of apprenticeship, and if

desirable, is it possible to do so? The general trend of opinion at the present time is that, except for certain isolated trades, a revival of the apprenticeship system is both undesirable and impossible. Apprenticeship gives manual dexterity, but not the general industrial knowledge and intelligence which will enable the boy to adapt himself to changing industrial conditions. Hence it is desirable to make the necessary provision for compulsory education in the principles of different trades. The chief suggestions for effecting this are as follows:—(*a*) that the "leaving age" should be raised to fifteen years, the later years of school life being given partly to continuing the general education of the boy or girl, and partly to manual, scientific, and industrial work; (*b*) the establishment of "trade schools" for boys of from thirteen to sixteen years, giving about fifteen hours per week to class-room work in science and English, and about fifteen hours per week in the workshops; (*c*) compulsory attendance, for about twelve or more hours per week, at day or evening continuation schools for all young persons engaged in industrial work.

The movement for the spread of industrial education among the mass of the population of this country merits the support of the scientific world because of its bearing upon the general intellectual development of the nation as a whole, if that industrial education be framed upon sufficiently broad and generous lines. National progress, whether industrial or scientific, depends upon two main agencies—the organiser or leader and the skilled subordinate. University and higher technical education will produce the first of these, but the second will only be forthcoming in sufficient quantities through the operation of a broad general scheme of industrial education.

J. WILSON.

NILOMETRY.[1]

IT is the common fate of the ancient gods of flood and field in these sternly practical days to find their empires gone, their sceptres dishonoured, and even their personal liberty endangered. The Nile is no exception to the rule. The old age of the river of Egypt finds his fitful temper curbed, his moods controlled,

"... all his faults observed,
Set in a note-book, learned and conned by rote."

Where he was master, he has become a slave. Where he ruled, he must now learn to obey.

Such are the reflections induced on turning over the pages of a report, recently issued by the Egyptian Survey Department, dealing with the measurement of the water discharged by the Nile. The patient, persistent efforts of a Governmental bureau are gradually transforming the excesses of a capricious river into quiet and orderly processes adapted in every way to the agricultural needs of the country through which it flows. The construction of the Aswan Dam constituted the first great epoch-making achievement in this direction, and it is being followed up by a series of systematic observations of the regimen of the river which will throw light upon many obscurities in its phenomena, and enable further steps to be taken for its improvement.

The Nile, as is now generally known, is fed almost exclusively by the rain which falls over two elevated areas, the equatorial plateau of Central Africa and the Abyssinian plateau. These two sources act in very different ways, the first affording a relatively small but continuous supply, and the latter, copious but intermittent increments, producing the regular flood effect upon which, until quite recently, the agricultural prosperity of the country depended.

The admeasurement of the variation in the volume of water which is thus discharged necessitated the establishment of a gauging station, and the report states that, on grounds of expediency, a site was chosen at Sarras Old Fort, a little above Wadi Halfa. Here the necessary plant and apparatus were installed. It would take too long, however, to recapitulate, even succinctly, the dispositions which were made and the manner in which various local obstacles were overcome. These were duly related in the report, and the results of the observations taken are tabulated in part ii. of the volume. They include the mean velocity and cross-sectional area of the stream on successive dates, also a chemical analysis of the water and the percentage of mud in suspension. A third section gives a brief mathematical account of various rating formulæ for current meters.

[1] "Measurement of the Volumes Discharged by the Nile during 1905 and 1906." By E. M. Dowson, with a Note on Rating Formulæ for Current-meters, by J. I. Craig. Egyptian Ministry of Finance. Survey Department Paper, No. 11. Pp. 82. (Cairo: National Printing Department.) Price 100 millièmes.

NOTES.

WE regret to see the announcement of the death, on December 5, of Prof. H. Bauerman, at seventy-five years of age. The funeral will take place at Brookwood Cemetery on Friday, ember 10.

PROF. A. C. SEWARD, F.R.S., professor of botany in the University of Cambridge, has accepted the invitation of the executive committee of the Yorkshire Naturalists' Union to be president of that society for the year 1910.

THE council of the University of Paris has, we learn from the *Revue scientifique*, passed a resolution to the effect that monuments intended to commemorate men who have brought distinction on the University of Paris since 1808 shall be erected in the church of the Sorbonne. This honour will be awarded on the decision of the council, by a majority of two-thirds, not earlier than ten years after the decease of the person concerned.

WE notice with regret the death of Dr. Jean Binot, on November 25, at the age of forty-two years. Dr. Binot had charge of one of the laboratories of the Pasteur Institute of Paris. Before taking up the study of bacteriology he was associated with astronomy. In 1901 he had charge of an expedition for the study of the transit of Venus, and in connection with this work he was awarded the Janssen prize of the Paris Academy.

AN appeal is being made to the Treasury for funds to complete the publication of the scientific reports of the voyage of the *Scotia*. It appears that the Scottish expedition is the only one of the recent Antarctic expeditions—British, Belgian, German, French, Swedish, and Argentine—that has not received Government help. The appeal is made by the committee of the Scottish National Antarctic Expedition through its honorary secretary, Mr. J. G. Ferrier. An additional grant is asked for beyond the funds for publication, to enable Dr. Bruce to reimburse those who have advanced money beyond their regular subscriptions to the expedition.

THE following are among the lecture arrangements at the Royal Institution before Easter:—Mr. W. Duddell, a Christmas course of six illustrated lectures on modern electricity, adapted to a juvenile auditory: (1) first principles; (2) electrical instruments; (3) Röntgen rays; (4) the generation of electricity; (5) electric oscillations; (6) electric lighting; Prof. W. A. Herdman, three lectures on the cultivation of the sea; Rev. C. H. W. Johns, two

lectures on Assyriology; Prof. F. W. Mott, six lectures on the emotions and their expression; Prof. Silvanus P. Thompson, three lectures on illumination, natural and artificial; Sir J. J. Thomson, six lectures on electric waves and the electromagnetic theory of light. The Friday evening meetings will commence on January 21, when Sir James Dewar will deliver a discourse on light reactions at low temperatures. Succeeding discourses will probably be given by the Rev. Canon Beeching, Prof. W. Bateson, Mr. C. E. S. Phillips, Prof. H. H. Turner, Lord Rayleigh, Dr. C. Chree, Dr. H. Brereton Baker, Sir J. J. Thomson, and other gentlemen.

THE death is announced of Dr. T. Nishikawa, of Tokyo, for a number of years an associate of Dr. Kishinouyé in the Imperial Fisheries Bureau in Tokyo, and later a special investigator of pearls. Writing in *Science*, Prof. Bashford Dean says that Dr. Nishikawa was distinguished as the discoverer of a process by which the pearl oyster may be caused to secrete spherical pearls. Before this only hemispherical pearls had been produced, in spite of centuries of experimentation, especially in the Orient. Dr. Nishikawa devoted nearly ten years to his studies on producing pearls, and achieved success only in the days of his final illness. In his memory, and in token of the importance of his discovery, a number of his living pearl oysters were taken to the University of Tokyo on the occasion of the late graduation ceremony; they were opened in the presence of the Emperor, and Prof. Iijima demonstrated that their mantles had secreted spherical pearls. The publications of Dr. Nishikawa include important contributions to our knowledge of Japanese fishes, structural, systematic, and embryological. Especially to be recalled is his pioneer paper on the development of the remarkable frilled shark, *Chlamydoselachus anguineus*.

THE Dick Institute, Kilmarnock, a gift to his native town from the late James Dick, of the Greenhead Gutta-percha Works, Glasgow, was destroyed by fire on the evening of November 26. The building, which cost about 15,000*l*., consisted of a public library and museum. The latter contained the very valuable collection of Carboniferous fossils which belonged to the late James Thomson, of Glasgow; a splendid collection of silurians, antiquities, &c., presented by the late Dr. Hunter-Selkirk, of Braidwood, Lanarkshire; and a very handsome collection of native birds presented by the Kilmarnock Glenfield Ramblers' Society, together with numerous other articles of great scientific value. Mr. H. Y. Simpson, librarian of the institute, informs us that the whole of these have been destroyed by the fire, and the loss is looked upon as irreparable, particularly so in the case of the Thomson collection of corals and reptiles, many of which were type-specimens, and therefore regarded by geologists as quite of incalculable value.

THE annual general meeting of the Royal Agricultural Society of England was held on December 8, when various reports, including that of the council, were considered. The council's report shows that the total number of governors and members on the register is 9920. The show of 1910 will take place in Liverpool on the Wavertree Playground from June 21–25. We notice that prizes to the value of 450*l*. are offered for the best managed farms in four classes, duly specified in the report, the competition being confined to tenant farmers resident in Lancashire and Cheshire. The society is also offering a gold medal for the best agricultural motor. A pleasing increase in the number of samples analysed in the society's laboratory is recorded, the number for the last twelve-months being 475, as against 410 in 1908. The work at the Woburn Experimental Farm and Pot-culture Station has progressed well. The field experiments have included an extensive series on the relative value of the new nitrogenous manures, calcium cyanamide and calcium nitrate, in comparison with ammonium sulphate and sodium nitrate; also a further trial has been given to "nitro-bacterine" and other methods for inoculating leguminous and other crops, and the experiments with magnesia on different field crops have been carried a stage further. Satisfactory work is reported also in the botanical and zoological departments.

AN article upon "The Danger of the Comet," contributed to the December number of *Pearson's Magazine* by Mr. E. C. Andrews, contains some interesting particulars—popularly expressed—relating to Halley's and other comets, and an imaginative description of the consequences of a collision between the earth and a comet. As nothing is definitely known about the size of the meteorites which probably form a comet's head, the result of the earth passing through the head is problematical. If the head is merely a condensed swarm of cosmic dust particles, there would be a fine shower of shooting-stars, but if the meteorites in it weigh tons instead of grains or ounces, the consequences of a collision with it would, of course, be serious. The tail of a comet is, however, so extremely attenuated in its nature that even if it consists of poisonous gases our atmosphere is not likely to be appreciably affected by it. To describe the tail, as Mr. Andrews does, as a "dense stream of fiery fragments" is, to say the least, misleading. No comet has a mass which is as much as the hundred-thousandth part of the earth's mass; in other words, the total mass of any comet is less than that of a ball of iron 150 miles in diameter. The fall of a comet into the sun would, therefore, not produce more heat than the sun radiates in eight or nine hours. As Prof. C. A. Young remarked, when referring to the possibility of this event, "there might, and very likely would, be a flash of some kind at the solar surface as the shower of cometary particles struck it, but probably nothing that the astronomers would not take delight in watching." It is desirable to remember facts like these when speculating upon the subject of danger from comets.

THE report of the committee of the Warrington Museum for the year ending at Midsummer last records the additions to the collection during the year. The curator ought to be aware that *Vespertilio auritus* is not the proper designation for the long-eared bat.

IN a paper published in the *Boletin de la Instrucción Pública*, Buenos Aires, Mr. R. Sinet gives an illustrated summary of Dr. Ameghino's views with regard to the pedigree of the human species, especially dwelling on the supposed evidence of the evolution having taken place from marsupial-like ancestors in South America itself.

IN vol. xl., part i., of the *Comptes rendus de la Société Impériale des Naturalistes de St. Pétersbourg*, Mr. G. Nilus describes two polyzoans, *Loxosoma murmanica* and *L. brumpti*, collected in Kola Fjord, on the Murman coast, where they occurred in great profusion, accompanied by other polyzoans and the gephyrean *Phasiolion spitzbergense*.

THE first two articles in the January-June issue of the *Sitzungsberichte und Abhandlungen* of the Dresden Institute are devoted to subjects connected with Darwinism and Darwin, Dr. E. Kalkowsky dealing in the former with the geological foundation of the doctrine of evolution, while

in the latter Prof. O. Drude discourses on the theory of the origin of species, and especially the publication of the famous volume bearing that title, as a land-mark in the life of Darwin.

ACCORDING to a paper by Mr. L. B. Taylor, published in the October number of the Journal of the South African Ornithologists' Union, Verreaux's eagle (*Aquila verreauxi*) constructs its nest in Cape Colony entirely of the green boughs of a rough bush, which must be very difficult to break off. The only other instance of the use of similar material for nest-making occurs in the case of the African *A. wahlbergi*, where it is used as lining. *A. verreauxi* preys, to a great extent, on hyraxes, numerous remains of which were found in the nest examined by Mr. Taylor, but also hunts and kills a certain number of klipspringers.

THE latest issue (vol. vi., anno 3) of *Rivista di Scienza* contains three articles on geological subjects, Prof. L. de Marchi dealing with mountain-formation, Prof. F. E. Mess contributing the second instalment of an interesting article on modern theories of volcanic action, and Messrs. P. Enriques and M. Gortani discussing the succession of geological periods. The last-named article is of a somewhat remarkable character, as the authors deny the existence of any such definite periods. They do not, however, propose to abolish the generally accepted geological classification, which they consider necessary for the convenience of study, but content themselves with pointing out its purely artificial character.

THE important subject of the working of teak forests comes in for discussion in the *Indian Forester* (October). Mr. J. F. Troup, the imperial superintendent of forest working-plans, recommends measures for improvement fellings in the Burma forests associated with burning of undergrowth to help natural reproduction and produce even-aged crops. With reference to the mixed teak forests in the Central Provinces, where the system is coppice with standard, Mr. C. M. McCrie points out that information is wanting as to the longevity of coppiced stools and coppice shoots, also as to the fertility of seed produced by the latter.

FOR many years coffee plantations in Central America have suffered from the attacks of a parasitic fungus which is said to be almost as dangerous as its better known eastern congener, *Hemileia vastatrix*. Little information has been available concerning the life-history of the fungus except the production of a conidial stage on diseased leaves, shoots, and fruits, to which Cooke gave the name *Stilbum flavidum*. Mr. G. Massee now records in the *Kew Bulletin* (No. 8) that he has obtained an ascus-forming (Nectria) stage, which transfers the fungus to the genus Sphærostilbe. Unlike the conidia, the ascospores readily produce infection in healthy leaves, leading to the formation of the customary white spots and conidiophores.

A STUDY of the phytoplankton gathered in the North Atlantic Ocean affords a great deal of variation, as will be realised from the results published by Mr. W. Stüwe in Engler's *Botanische Jahrbücher* (vol. xliii., part iv.). From Dover to Brest the plankton is coastal, and consists almost entirely of diatoms, with a preponderance of species of Coscinodiscus and Biddulphia. Thence to the Azores species of Ceratium abound in the deeper waters, but in the neighbourhood of the Canaries the increase of Bacillariaceæ betokens an influx of coastal forms. Around the Cape Verde Islands Trichodesmium is dominant in the equatorial currents. Another type of vegetation is met with in the Sargasso Sea, in which species of Ceratium, notably *Ceratium tripos protuberans*, are common. With regard to vertical distribution, in the colder waters the Bacillariaceæ predominate at the surface, while the Peridineæ occur in the next zone; in the warm seas the Peridineæ lie at the surface, and the diatoms are found below.

THE results of manurial experiments on the sugar-cane, carried out at the Experiment Station of the Hawaiian Sugar-planters' Association, have just been issued (Bulletin No. 29). The results could not be correlated with the chemical composition of the soil as determined by the ordinary methods of analysis or by the aspartic acid method first used in Hawaii, and the author concludes that the profit resulting from the application of manures will depend largely upon other factors than the chemical composition of the soil. The greatest loss from the use of improper mixtures of fertilisers was found to occur in acid soils.

WE learn from the *Journal of Agriculture of South Australia* that the Irish potato blight (caused by the fungus *Phytophthora infestans*) has made its appearance in several of the Australian States. It does not appear that the disease is yet very widespread, and by mapping out the affected areas and adopting suitable precautions within those areas it should be possible to prevent great damage being done. A well-illustrated account of the disease is given, so that the practical man may readily recognise it, and methods of treatment are fully described. Spraying with Bordeaux mixture is a well-recognised preventive measure, and is discussed at some length.

A SUMMARY has recently been issued from the New Jersey Agricultural Experiment Station of the investigations carried out by Messrs. Voorhees and Lipman on various nitrogenous manures. Out of a hundred parts of nitrogen supplied as nitrate of soda, sixty-two parts were recovered in the crop over a period of ten years, and in the case of ammonium sulphate forty-three parts were recovered; these results agree almost exactly with those obtained by Wagner at Darmstadt. The relative availability of the various fertilisers tested was:—

Sodium nitrate	100
Ammonium sulphate	69·7
Dried blood	64·4
Solid manure (fresh)	35·9
Solid and liquid manure (fresh)	53·0
Solid and liquid manure (leached)	43·1
Solid manure (leached)	38·9

THE fundamental importance of irrigation and of methods of dry-farming in South Africa is well brought out in a series of articles in recent issues of the *Agricultural Journal of the Cape of Good Hope*. Throughout considerable areas of South Africa the rainfall is either insufficient or is too irregularly distributed for the best crop returns to be obtained, and the chief problem in arable farming becomes the provision of proper water supply. Recourse may be had either to irrigation or to "dry farming," the former being more generally applicable than the latter. A delegate was sent to the National Irrigation Congress at Albuquerqu, New Mexico, U.S.A., and his report contains many suggestions likely to be of value in evolving methods suited to South Africa. There is also a report on the possibilities of irrigation in Bechuanaland. By way of encouraging dry farming, the De Beers Company is offering at the next Bloemfontein show a prize of 20*l.* for the best exhibit of maize grown on "dry lands" without irrigation.

IN *Man* for November Mr. W. G. Aston raises the question of the origin of sexual antipathy among near relations.

Contesting the views of Messrs. Ellis and Crawley, he regards it as mainly based on a recognition by even savage tribes of the physical dangers of interbreeding. He lays stress on the dogma of Dr. Tylor that "exogamy was an early method of political self-preservation" in widening the influence of the clan by foreign alliances. Nothing is more fatal to a clan than consanguineous marriage, "and few things are more vital to the welfare of a family, a tribe, or a nation than the right ordering of the sexual relations."

IN the September number of *Spolia Zeylanica*, issued by the Colombo Museum, Ceylon, Mr. P. Arunachalam describes the ancient bronzes in the collection, and Mr. D. Wickremasimghe contributes notes on the inscriptions attached to them. The antiquity of the specimens is not very great. King Sigiri Kasypa rendered, we are told, "a lasting service to the chronological history of Ceylon by murdering his father in the fifth century A.D.; but for this signal act of parricide Ceylon dates would be in a greater state of confusion than they are," the date of this event separating the Mahawansa from the so-called Sulawansa period, which terminated in 1815 A.D. All the ancient bronzes in Ceylon belong to the period corresponding to the Middle Ages of Europe. The catalogue is well illustrated with photographs of the more notable specimens, and is of interest as facilitating the comparison of Sinhalese with Hindu art.

THE monthly review of cartography in *Petermann's Mitteilungen* (p. 281) contains articles by Dr. Max Gasser and Herr Moedebeck, president of the International Commission for "Luftschifferkarten," on maps for use on balloons and flying machines. The arrangement recommended is a general map on a scale of 1/1,000,000, with a smaller 1/200,000-map for the details of routes. The requirements of aërial navigation are dealt with in considerable detail, and a system of conventional signs and colours is proposed. It is suggested that the larger scale map should show parallels at intervals of ten minutes and meridians at intervals of twenty minutes, in accordance with the methods for astronomical determination of position worked out by Dr. Marcuses. Specimen maps accompany the papers.

IN *Symons's Meteorological Magazine* for November Dr. H. R. Mill gives a preliminary account of the remarkable rainfall of October 26–28 in the south of England. On the morning of October 26 the centre of a deep barometric depression lay to the south of Ireland, and moved slowly to the south-eastward; on October 28 a change of direction took place, the centre moving north-easterly, the effect being to enclose the south of England between the S.E. and N.E. paths of the depression. A list of the records is given for places where more than 2·5 inches of rain fell in one day, and more than 4 inches in three consecutive days. Both these conditions obtained in parts of Kent, Sussex, and the Isle of Wight. Among the heaviest falls during the three days, we note 6 inches at Ramsgate and 5·27 inches at Brighton; so far as available records show, no previous daily fall of 3 inches had been observed within twenty miles of Brighton, where 3·60 inches fell on October 26, or within forty miles of Broadstairs, where 3·14 inches fell on October 28. The month over the country as a whole was by no means so wet as October, 1903.

THE *Journal de Physique* for November contains a description of an electromagnetic compass suitable for use on board ironclads, which was described before the Société française de Physique more than a year ago by the inventor, M. Louis Dunoyer, and has now been tested on board one of the French cruisers. The apparatus consists of a solenoid wound with two wires in parallel, which can be rotated at a constant speed about a vertical axis to which its own axis is perpendicular. The ends of each of the two wires are connected to a two-part commutator on the axis of rotation, and the two pairs of brushes bearing on the commutators are set at right angles to each other. From the brushes wires lead to the coils of two moving coil galvanometers. The coils move about horizontal axes at right angles to each other, and mirrors attached to them produce images of two lines of light on a horizontal ground-glass screen. As the solenoid rotates the mean currents through the galvanometer coils are proportional to the sine and cosine of the angle between the axis of the ship and the horizontal component of the earth's magnetic field, and the line joining the crossing point of the two images to the centre of the screen gives the direction and magnitude of that component. The apparatus allows of ready compensation for both permanent and temporary magnetism of the ship. As the ship is "swung" the crossing point of the lines of light describes on the glass screen an ellipse, the axis major of which will, in general, be inclined to the direction of motion of both the galvanometer coils. By rotating the solenoid with respect to the commutators, the axis may be made to coincide with one of these directions. It is then only necessary to add resistance to the circuit of the coil which gives the larger deflection to reduce the ellipse to a circle, which would be the figure obtained if the earth's magnetic field were undisturbed by the vessel. The method is evidently very flexible, and admits of the observations being taken in the cabin while the rotating solenoid is placed on deck.

A PAPER on concrete pile foundations was read by Mr. Alex. Melville on November 23 before the Institution of Engineers and Shipbuilders in Scotland. Special reference was made to the Simplex method, a system which has been specified by the Admiralty for the naval base at Rosyth. This system is the invention of Mr. Frank Shuman, of Philadelphia, who took out his first patents in 1903. The essential principle lies in the driving of a tube or forme constructed of lap-welded steel, the lower end of which is closed by a loose point or by a pair of hinged jaws. These jaws open when the tube is being pulled up and permit concrete to be passed through, filling up the space left by the tube simultaneously with its withdrawal. The jaws are, as it were, cut out of a cylinder of exactly the same section as the sleeve, and so lie close against the sides of the hole left by the sleeve as the forme is withdrawn, thus offering no obstruction to the free passage of the concrete. A driving cap is attached to the top of the forme when the pile-driver is at work. On completion of driving the cap is removed, and concrete is filled into the forme to a height of several feet above the level of the finished head of the pile in order to allow for sinking as the forme is withdrawn, an operation performed by means of tackle connected to the pile-driver. Such piles can be inserted to any depth, and can be put in as close as 3 feet from centre to centre; reinforced piles on this system may also be executed. The method has many advantages, and has been very successfully applied in this and other countries.

Engineering for November 26 has an interesting leading article on the encouragement of aviation. Although there are some small signs of our waking up, everybody must deplore our backwardness in taking a lively and efficient interest in the new movement. It cannot be said, in re-

gard to aviation, that public or national bodies have interfered with onerous legislation such as has retarded other budding industries. The movement has received but little encouragement in the way of State-aided experimental work; plenty of private pioneer work has been done—indeed, we were among the first to take seriously to aëronautics—yet we are woefully behind our neighbours. Extremely rapid progress has been made recently in other countries in heavier-than-air machines, and it seems clear that we should actively encourage the development of that branch of the science which appears of the greatest promise. Two methods have been adopted on the other side of the Atlantic which we might do worse than imitate. One is a national competition promoted by the United States War Department; the other is the method adopted by Dr. Graham Bell, who collected around him a number of ardent workers, who banded themselves together with the object of producing several successful machines. These men were all well acquainted with the principles underlying the art, and their collective wisdom has been well proven in the results achieved. Our own few earnest workers worry along independently, until financial stress often directs their attention to other matters. Continuing, our contemporary thinks that the movement of aviation is not in the right hands. Anyone who attends the meetings of the two best known societies connected with aëronautics must know that the discussions are not at all on a high level, and compare very unfavourably with those at, say, the Institution of Civil Engineers or the Institution of Mechanical Engineers. It is admitted that sport is quite a legitimate opening for aviation, as it has been for yachting and motoring; but, as has happened in these latter sports, the flying machines now built merely to win races will probably give place to machines of a more serviceable type when the movement has become leavened with the ideas of engineers and the results of scientific studies.

EVIDENCE of the interest that is taken in the isomeric change of optically active compounds is afforded by two papers by Mr. H. Wren in the October number of the Chemical Society's Journal. The substance selected for examination was *l*-benzoin, $C_6H_5.CHOH.CO.C_6H_5$, a compound which contains an asymmetric carbon atom, but would lose its optical activity if converted into the isomeric "enol," $C_6H_5.C(OH):C(OH).C_6H_5$, and might therefore be expected to racemise with great readiness, at least in presence of an alkaline catalyst. The experiments carried out by the author showed that *l*-benzoin retained its activity in the crystalline state during three months, and that its solution in acetone was unchanged at the end of eight days. The addition of a small quantity of sodium ethoxide to its alcoholic solution was, however, sufficient to destroy its optical activity in a single day. The methyl ether, $C_6H_5.CH(OCH_3).CO.C_6H_5$, lost its optical activity completely in five minutes when dissolved in alcoholic potash of N/9 strength, and a progressive racemisation by dilute sodium ethoxide was completed in the course of three hours. Complete racemisation took place on attempting to prepare the ethyl ether by means of alcohol and hydrogen chloride, and a partial loss of activity took place when silver oxide and ethyl iodide were used. The oxime $C_6H_5.CH(OH).C(:NOH).C_6H_5$, and carbanilide

$$C_6H_5.CH(O.CO.NH.C_6H_5).CO.C_6H_5,$$

were found to be optically active, but the former suffered a partial loss of activity on acetylation, and the latter was completely racemised by heating above its melting point during four hours at 140°, contact with the glass being shown to be an important factor in promoting the change. A racemic product was also obtained on condensing *l*-benzoin with aniline. The changes here recorded are very similar to those that have been observed amongst the derivatives of camphor, but differ from them in that the inversion of the one asymmetric carbon atom causes a total loss of optical activity.

DR. MAXIMILIAN TOCH, of New York City, in his address as chairman of the American Society of Chemical Industry, dealt with the influence of chemistry on civilisation. The address is published in the issue of *Science* for November 19. In the course of his remarks, Dr. Toch said:—Chemistry needs no sponsor, but its effect on civilisation has been more marked than that of any other science. True, it has reached out and taken electricity and physics as aids, but, withal, engineering made but little progress until steel and cement—two chemical products—were cheapened, simplified, and made universal. Medicine has claimed great honours, but the masterful work done in coal-tar chemistry, in the production and discovery of synthetic drugs, the discovery of anæsthetics, the marvellous work done in the metabolism of matter, the excellent analytical schemes for the waste matter of the tissues, are all due to the researches of chemistry, and their civilising influence is greatly felt. The engineer may boast of his skill, but he has done nothing greater than the pyramids, nor finer than the temples of Greece and Egypt. The monuments he has wrought in steel were given to him by the ability of the chemist to control carbon in iron, and the economic principle involved in the production of steel supplies work, puts money into circulation, and keeps the wheels turning. For a science so young its civilising influence is enormous, and there is no doubt that the rapid progress which chemistry made in the nineteenth century will be outstripped in the twentieth, for the control of our foodstuffs, the application of the raw materials in the earth, and the refining of metals, create positions, give progress to a country, and help largely in the establishment of chemistry as a profession.

THE Geological Society has published a catalogue of the geological literature added to the society's library during the year ended December 31, 1908. The catalogue has been compiled by the assistant-librarian and edited by the assistant-secretary, and its price is 2*s*.

MESSRS. FLATTERS AND GARNETT, LTD., 32 Dover Street, Manchester, have just issued a new classified catalogue of lantern-slides illustrating various subjects of biology, geology, astronomy, physiography, textile fibres, machinery, &c. The slides are from drawings, photographs of specimens, and photomicrographs, and most of them are not to be found in other catalogues. For the illustration of lectures or lessons in biological and other subjects many of the slides should prove very valuable.

OUR ASTRONOMICAL COLUMN.

DISCOVERY OF A NEW COMET, 1909*e*.—A telegram from the Kiel Centralstelle announces the discovery of a comet by Prof. Daniel, at Princeton, on December 6. Its position at 9h. 23·9m. (Princeton M.T.) was

R.A. = 6h. 16m. 32s., dec. = 33° 50′ N.,

and its magnitude was estimated as 11·0. This position lies at about the centre of the triangle formed by θ and κ Aurigæ and θ Geminorum. The comet is said to be moving slowly in a northerly direction.

HALLEY'S COMET.—According to the ephemeris, Halley's comet is now approaching the sun at a rate of about 1,230,000 miles per day, whilst its distance from the earth

as decreasing daily by some 460,000 miles; its distance from the earth on December 11, at 9 p.m., will be about 128·5 million miles.

Observations made at the Solar Physics Observatory, South Kensington, with the 36-inch reflector, show that the comet is a nebulous object, easily recognisable, and having no visible nucleus; exposures of five to ten minutes give a distinct image, and show how rapidly the object is moving in relation to the surrounding stars.

With a 3-inch Dallmeyer portrait lens, Mr. Longbottom, Chester, succeeded, on November 21, in photographing an excellent image of the comet, on an Ilford plate, in thirty minutes.

ABSORPTION OF LIGHT IN SPACE.—In this column for February 25 (vol. lxxix., p. 499) we directed attention to Prof. Kapteyn's researches on the absorption of light during its passage through interstellar space, in which he found a value corresponding to an absorption of 0·016 of a magnitude in a distance of thirty-three light-years.

Another paper dealing with this subject he now publishes in vol. xxx., No. 4, of the *Astrophysical Journal*, and as No. 42 of the "Contributions from the Mount Wilson Solar Observatory." The criterion he adopts is that such absorption would manifest itself, *ceteris paribus*, by the more distant stars being redder than the nearer ones. The subject is too complicated to discuss here, but, by comparing the photographic and visual magnitudes of stars of which the spectral types are known, from Misses Maury's and Cannon's classifications, and for which measures of distance are available, he succeeds in showing that such absorption probably does exist. The results indicate that for the photographic rays the loss per 32·6 light-years is 0·00945, while for the visual rays it is 0·00465, magnitude; the final value for d (increase in redness per 32·6 light-years) is $0·0066 \pm 0·0031$ magnitude. Apparently there is no reason for assuming the absorption to be different in galactic and extra-galactic stars.

Incidentally, Prof. Kapteyn finds that for stars of the same spectral class, the ratio between the brightness of the violet radiations and that of the visual rays changes largely with the apparent magnitude. This, however, is probably a photographic, and not a cosmical, phenomenon.

Prof. Kapteyn's result proves abundantly that such large values, for the absorption, as are implied by the results recently brought out by certain investigators must be illusory.

COPERNICUS ANTICIPATED.—No. 21 of the *Revue générale des Sciences* (November 15, p. 866) contains an interesting article, by M. Pierre Duhem, giving an account of the life and works of Nicole Oresme, who became Bishop of Lisieux in 1377, and died at that place in 1382. Oresme translated, with commentaries, the four books of Aristotle, but the translation was never printed, although there are several manuscript copies; it is on one of these that M. Duhem bases his note. In this work, Oresme, commenting on Aristotle's contentions for an unmovable, central earth, gives numerous reasons and arguments against such an hypothesis, and clearly shows that, in his opinion, it was entirely wrong. In concluding his note, M. Duhem suggests that, not only was Oresme the precursor of Copernicus, but he may have been, also, the inspirer.

STAR ALMANAC AND CALENDAR FOR 1910.—From Messrs. King, Sell and Olding we have received copies of "The Star Almanac for 1910," "The Star Calendar for 1910," and "The Stars from Year to Year." These works, for 1909, were reviewed in our columns for December 3, 1908, and maintain the favourable opinions then expressed concerning them. The prices are 3*d*., 1*s*., and 1*s*., respectively.

MAGNETIC EXPEDITIONS.

OF the many successfully conducted land expeditions sent out by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington since its establishment in 1904, news has just been received of the successful completion of two of the most important and interesting ones. Mr. D. C. Sowers headed an expedition which started out from Peking, China, on January 30 of this year, passing through China and Chinese Turkestan, reaching Kashgar on August 2, and then crossing the Himalayan range and arriving at Leh, India, at the end of September. Magnetic observations and other geographical data were obtained along the entire route traversed. Mr. Sowers's chief assistant was Prof. Fuson, formerly professor of history and geography at the Christian College, Fuson, China.

Mr. C. C. Stewart started out from Washington last July to take charge of a canoeing magnetic exploring expedition in British North America. After reaching Lake Abitibi the party next proceeded to Moose Factory, then crossed James Bay to Rupert House, then up the Rupert River, and coming out at Roberval, Lake St. John, the middle of October.

News has also been received of the successful progress of the land magnetic surveys in Africa under the charge of Profs. Beattie and Morrison, research associates of the Carnegie Institution, and of the magnetic work in charge of Mr. J. C. Pearson in Persia, Asia Minor, and southern Asiatic Russia.

With the resumption of the ocean magnetic work by the *Carnegie*, the director of the department, Dr. Bauer, estimates that at the present rate of progress it will be possible in another five years to construct accurate magnetic charts of declination, dip, and force, as based on freshly acquired data, for the region of the earth 60° N. to 60° S.

The department is also cooperating with polar expeditions so as to secure information in regions which cannot be entered by the *Carnegie*, this vessel not having been built for going into the ice. Thus instruments were loaned and instructions drawn up for Mr. Jackson, of the Canadian Meteorological Office, who was detailed for duty on the Canadian exploring steamer *Arctic* (formerly the *Gauss*), in command of Captain Bernier, the vessel having recently returned to Quebec. Mr. Jackson has informed Dr. Bauer that he has secured a series of magnetic, atmospheric electric, tidal and meteorological observations at various points in the Arctic regions.

So also Dr. C. C. Craft, magnetic observer of the department, was assigned to Commander Peary's auxiliary steamer, the *Eric*, a year ago, and obtained magnetic data at a number of points in Labrador, Baffin Land, and Greenland.

During the past summer Mr. E. Kidson, formerly assistant at the Christchurch Magnetic Observatory, completed a magnetic survey of the interior of Newfoundland, and in the early part of the year an expedition, in charge of Mr. C. Sligh, made magnetic observations along the coasts and in the interior of Central America.

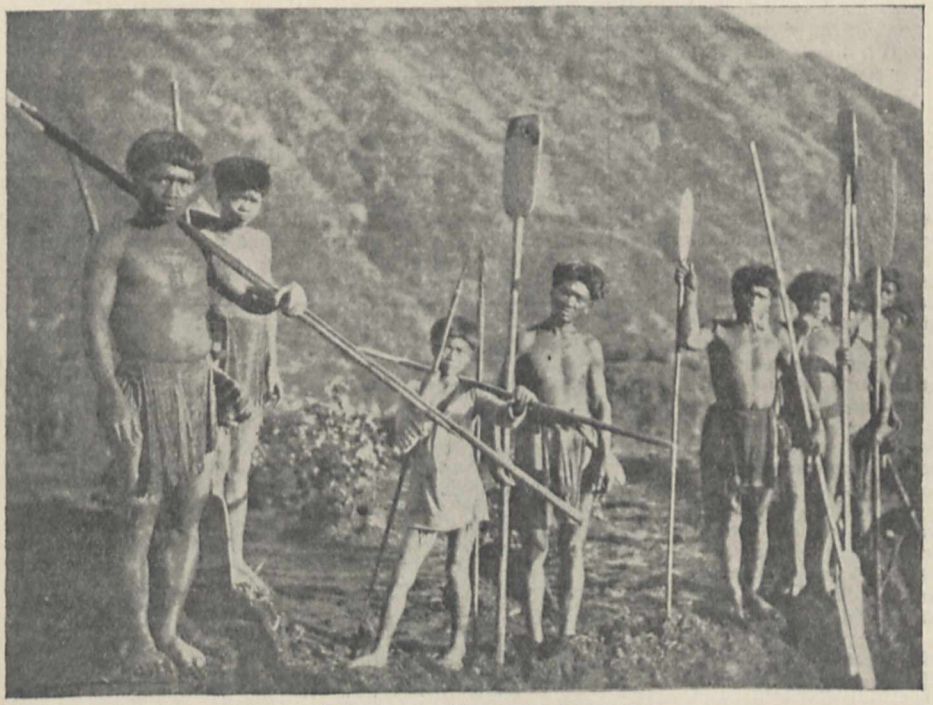
ETHNOGRAPHY IN THE PHILIPPINE ISLANDS.

THE Government Bureau of Science of the Philippine Islands is actively prosecuting inquiries into the physical anthropology and ethnography of the archipelago. The fourth part of the fourth volume of its Proceedings contains two papers of more than ordinary importance.

Mr. R. B. Bean contributes an elaborate article on the littoral population of Luzon and the adjacent islands, based on measurements of students at Manila. The view generally accepted is that of M. L. J. Montano ("Rapport a M. le Ministre de l'Instruction publique sur une Mission aux Îles Philippines et en Malaisie," Paris, 1879–81), who classes the inhabitants of the mountainous regions of the interior as Negritos; those of the fertile parts of the interior as Indonesian; those of the coast lands as Malay. In addition to these there is a considerable Spanish element, and, since the last conquest of the archipelago, American and negro mestizos or half-castes are springing up in every part of the islands, thus presenting in a very mixed population a series of most interesting problems for the physical anthropologist. Mr. Bean, from his recent inquiries, classifies the coast population into Modified Iberian, Australoid, and Primitive, with several intermediate types. The Modified Iberians correspond to the Mediterranean race of Sergi; the Australoids are below

the medium height, with narrow heads, broad noses and faces; the Primitives resemble the latter, but have a cephalic index ten in excess of the Iberian. The Australoid and Primitive types are probably the original elements in the population, the other types representing modifications caused by the introduction of Europeans and Chinese, recent and remote. The result is an improvement in all the physical measurements, which, with increasing European and Chinese immigration, will probably advance, and be accompanied by an increase of bodily and mental vigour, a process facilitated by improved nutrition and in hygiene by the reduction of noxious parasitic life.

The second paper devoted to pure ethnography is an account, by Fr. Juan Villaverde, of the Quiangan Ifugao tribes. They are of Negrito affinities, and present a remarkable combination of an advanced culture with savagery. They live by agriculture, cultivating rice in the hilly tracts by an elaborate system of terrace farming, by which they utilise the supplies of spring water which they consider necessary to the growth of this crop. They have neither king nor rulers, but are divided into two distinct grades, the nobles exercising considerable authority over the plebeians. A man can rise to the higher from the lower class by the exercise of profuse hospitality, which is provided by a series of elaborate feasts. They respect the aged, who act the part of priests in their idolatrous rites, and generally hold women in high estimation. They divorce their wives continually, each of the pair readily finding a fresh partner. Their worship is chiefly that of the moon and other heavenly bodies, and they practise divination to relieve the fears of the spirit world which always beset them. They lend and borrow on exorbitant interest, and sons are responsible for the debts of their parents. Combined with this fairly advanced culture they are grossly addicted to drunkenness, and the absence of any controlling authority leads to constant blood feuds, every murder being followed by inexorable vengeance extending, not only to the offender, but embracing his nearest relatives. This is accompanied by the custom of head-hunting, in which even women, though ordinarily respected, and children are not spared, the heads of the victims being brought home in triumph, and the fronts of the houses decorated with the captured heads.



Ifugaos with wooden shovels, Banaue.

THE DEVELOPMENT OF EVOLUTIONARY IDEAS.

THE annual Herbert Spencer lecture was delivered at Oxford on December 2 by the Linacre professor, Dr. G. C. Bourne. In the course of a brief historical sketch, the lecturer pointed out that evolutionary ideas were widely prevalent at the end of the eighteenth century, though, after being apparently routed by Cuvier, the doctrine remained for many years in abeyance. Herbert Spencer was a pioneer in the evolutionary revival. Not an original investigator in zoology or botany, he was yet a very earnest student of biological subjects. Evolution, in Spencer's view, was a cosmic process, consisting essentially in the passage of the homogeneous into the heterogeneous. Confronted with the difficulty of the transition from the non-living to the living, Spencer framed the theory of "physiological units" with their mutual interactions. This proved to be a fertile idea, and was adopted in one form or another by many subsequent investigators. In phylogeny there is a real advance from the homogeneous to the heterogeneous; in ontogeny, however, there are obvious difficulties in the way of this interpretation. These difficulties Herbert Spencer tried to meet by assuming for his units "polarities" of differing values, and a power of undergoing modification when subject to the influence of each other and of the environment. Hence a true epigenesis took place, and in this way he thought it possible to account for both inheritance and variation. Acquired characters, he held, *must* be inherited; and on this basis he reared the fabric of the "synthetic philosophy."

Against the system thus outlined, two crushing blows were delivered by Weismann. The first was his insistence on the fact that there is no clear evidence of the inheritance of acquired characters; the second was the demonstration that the germ-plasm in ontogeny is from the first a structure of very great complexity. The germ, it was found, must have historical properties, and the embryological history of the individual is really a genealogy.

The bearing of recent experiments in the "mechanics of development" upon the views of Spencer and Weismann respectively was very carefully and lucidly explained by Prof. Bourne, who showed that the pre-existence of certain materials in the germ, and their subsequent sorting out in the course of ontogeny, facts which could no longer be denied, were entirely adverse to the Spencerian conception. On the other hand, the view of Weismann, though in some particulars erroneous, received in the main a strong confirmation from experiments by the followers of Mendel. Prof. Bourne concluded his discourse by urging that biological studies were no mere plaything, but of the highest importance for dealing with human affairs. An essential link was now broken in the chain of the synthetic philosophy, and it behoved those concerned in such matters to inquire whether our sociological methods were right, and whether certain schemes of social improvement, founded on the biological principles of fifty years ago, should not be re-considered in the light of those of the present day.

RESEARCHES IN RADIO-TELEGRAPHY.[1]

II.

IN a previous discourse explanations were given of the property of a closed or partly closed antenna of radiating more in some directions than others, and the action of Marconi's bent antenna was described. Two other inventors, Messrs. Bellini and Tosi, have taken advantage of this fact to construct antennæ of a very interesting character. They erect an antenna consisting of two wires, each bent into a triangular form, the top ends nearly meeting, the planes of these triangles being at right angles to one another, and both of them vertical. The nearly closed antenna circuits are then inductively coupled with a condenser circuit, which is capable of being swivelled round in various directions. If the said condenser circuit is placed in such a position as to be coupled with one of the triangular antennæ it will cause the maximum radiation to take place in the plane of that antenna, but none at all at right angles to it. If it is coupled with the other antenna it will cause radiation to take place to a maximum degree in the plane of that second antenna. If, however, the oscillatory circuit is placed in an intermediate position, so as to act inductively upon both the nearly closed triangular antennæ, then it can be shown, both mathematically and experimentally, that the radiation of the combined system is a maximum in the direction of the plane of the oscillatory circuit which is coupled with the antenna. Hence, with such a combined antenna, we have it in our power to create radiation most strongly in one direction, although not entirely suppressed in all other directions. By combining together, however, a single vertical antenna with two nearly closed circuit antennæ at right angles to one another, Messrs. Bellini and Tosi have constructed a complex antenna which has the property of producing radiation almost entirely limited to one-half the circumjacent space (Fig. 13). It therefore corresponds to a certain extent in effect to the optical apparatus of a lighthouse, with catoptric or dioptric apparatus, which projects the light from the lamp largely in one direction. It is not yet possible to make with electric radiation of long wave-length that which corresponds precisely with a beam of light wholly concentrated along a certain cone or cylinder, but it is possible, by the use of a complex antenna as described, greatly to limit the diffusion of the radiation. Since radiating and absorbing power go hand in hand, it is obvious that such a directive antenna also enables the position of a sending station to be located. Messrs. Bellini and Tosi have accordingly applied their methods in the construction of a *radiogoniometer* and receiving antenna, by means of which they can locate the direction of the sending station without moving the antenna, but merely by turning round a secondary circuit into a position in which the maximum sound is heard in a telephone connected with the receiver. By the kindness of Captain Tosi I am able to exhibit to you their ingenious apparatus (Fig. 14).

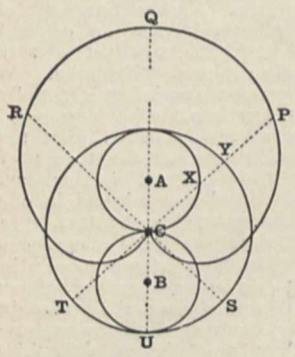


FIG. 13.

The space occupied by such closed antennæ has hitherto prevented their employment on ships. There is still, therefore, an opening for the invention of apparatus capable of being used on board ship which will enable one ship to locate, within narrow limits, the direction of another ship sending signals to it, and therefore of ascertaining immediately the direction from which some call for help is proceeding.

[1] From a discourse delivered at the Royal Institution, on Friday, June 4 By Prof. J. A. Fleming, F.R.S. Continued from p. 144.

We must pass on to notice, in the next place, some improvements in oscillation detectors and means of testing them. As already explained, the æther waves sent out by the transmitting antenna fall on the receiving antenna and create in it, or some other circuit connected to it, very feeble oscillations. These oscillations being very feeble, alternating currents of high frequency cannot directly affect either an ordinary telegraphic instrument or a telephone, but we have to interpose a device of some kind called an oscillation detector, which is affected by oscillations in such a manner that it undergoes some change, which in turn enables it to create, increase, or diminish a local current produced by a local battery, and so affect a telephone or telegraphic relay. One kind of change the oscillations can produce in certain devices is a change in their electric resistance, which in turn is caused to increase or diminish a current through a telephone or telegraphic relay generated by a local battery. To this type belong the well-known coherers of Branly, Lodge, and Marconi, which require tapping or rotating to bring them back continually to a condition of sensitiveness.

Coherers, however, have been devised which require no tapping. Thus it has been found by Mr. L. H. Walter that if a short length of very fine tantalum wire is dipped into mercury there is a very imperfect contact between the mercury and tantalum for low electromotive forces. This may perhaps arise from the fact that tantalum, like iron, is not wetted by mercury. If, however, feeble electric oscillations act between the mercury and tantalum, the contact is improved whilst they last. If, then, the terminals of a circuit containing a telephone in series with a shunted voltaic cell are connected to the mercury and tantalum respectively, and if damped or intermittent trains of electric waves fall on an antenna and excite oscillations which are allowed to act on the mercury-tantalum junction, then at each train the resistance of the contact falls, the local cell sends current through the telephone and produces a short sound, and if the trains come frequently enough this sound is repeated and will be heard as a continuous noise in the telephone (Fig. 15). This sound can be cut up into dot and dash signals by a key in the sending instrument. If the transmitter is sending persistent oscillations, then some form of interrupter has to

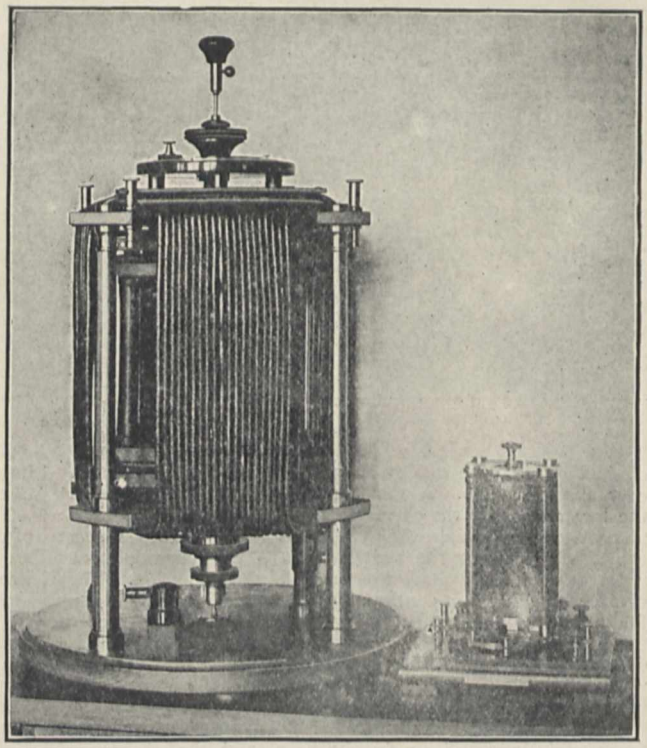


FIG. 14.—Bellini and Tosi's Radiogoniometers for Directive Radiotelegraphy.

be inserted in the receiving circuit to enable us to receive a continuous sound in the telephone, which can be resolved into Morse dot and dash signals by the key in the transmitter. The operator usually wears on his head a double telephone, and listens to these long and short sounds in the telephone, and writes down each letter or word as he hears it.

The reception of signals in modern radio-telegraphy is most usually effected by ear by means of some type of oscillation detector capable of actuating a telephone. It is important, then, to notice that, to obtain the highest sensitiveness when using the telephonic method of reception, the spark frequency or number of oscillation trains or the number of interruptions of the persistent train per second must take place at such a rate that it agrees with the natural time period of the diaphragm of the telephone used. An ordinary telephone receiver is most sensitive, according to the researches of Lord Rayleigh and M. Wien, for some frequency lying between 500 and 1000. Thus Lord Rayleigh (see *Phil. Mag.*, vol. xxxviii., 1894, p. 285) measured the alternating current in microamperes required to produce the least audible sound in a telephone receiver of 70 ohms resistance at various frequencies, and found values as follows :—

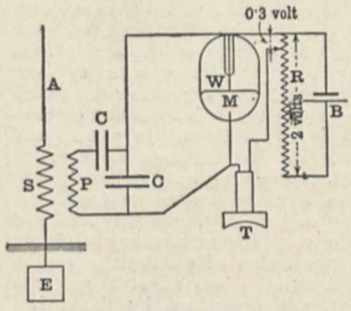


FIG. 15.—Walter's Tantalum Detector.

TABLE II.

Frequency...	128	192	256	307	320	384	512	640	768
Least audible current in microamperes ...	28	2·5	0·83	0·49	0·32	0·15	0·07	0·04	0·1

M. Wien found for a Siemens telephone somewhat different results, viz. :—

Frequency...	64	128	256	512	720	1927	1500
Least audible current in microamperes ...	12	1·5	0·13	0·027	0·008	0·013	0·024

Both, however, agree in showing a maximum sensitiveness for currents of a frequency between 600 and 700. This is due to the fact that the frequency of the actuating current then agrees with the natural frequency of the ordinary telephone diaphragm. Hence alternators for large-power radio-telegraphic stations are now designed to give currents with a frequency of about 300 or 600 alternations per second, so that, when producing discharges of a condenser, the number of sparks per second may be at least 600, and fulfil the conditions for giving maximum

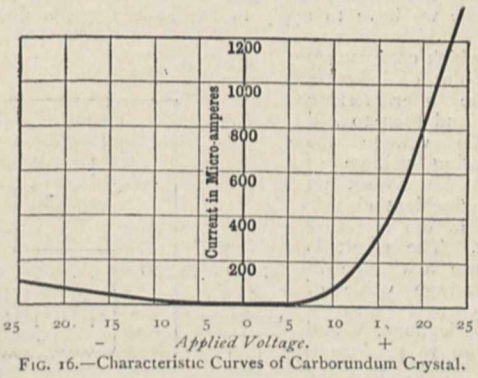


FIG. 16.—Characteristic Curves of Carborundum Crystal.

sound in the telephone of the receiver per microampere. Another class of oscillation detector recently discovered comprises the crystal detectors, which depend on the possession by certain crystals of the curious property of acting as an electrical valve, or having greater conductivity in one direction than the other, and also on not obeying Ohm's law as conductors. It was discovered by General Dunwoody, of the United States Army, in 1906, that a mass of carborundum, which is a crystalline carbide of silicon formed in electric furnaces, can act as a detector of electric oscillations if inserted in the circuit of an antenna, the crystal mass being held strongly pressed between two spring clips, which are also connected by a shunted voltaic cell in series with a telephone. When feeble oscillations are set up in the antenna, a sound is heard in the telephone.

This property of carborundum has been carefully investigated by Prof. G. W. Pierce, of Harvard, and he showed that a single crystal of carborundum has remarkable unilateral conductivity for certain voltages when held with a certain contact pressure between metallic clips. Thus for a crystal held with a pressure of 1 kilogram, and subjected to an electromotive force of 30 volts, the conductivity in one direction through the crystal was 4000 greater than in the opposite direction (Fig. 16). The result of these experiments was also to show that the current voltage curve or characteristic curve of a carborundum crystal is not linear—that is to say, the crystal, as a conductor, does not comply with Ohm's law, for the resistance of the crystal decreases as the current is increased. Hence the conductivity of the crystal is a function of the voltage acting on it (Fig. 17). Accordingly, if we pass a current from a local cell through a crystal under a voltage, say, of 2 volts, a telephone being inserted in series with the cell, and if we apply an oscillatory voltage also to the crystal, which varies, say, between +0·5 and −0·5 volt, then the crystal is alternately subjected to a voltage of 2·5 and 1·5 volts, but the corresponding currents would be, say, 8·4 and 1·8 microamperes, as shown by an experiment with one particular crystal employed by Prof. Pierce. The mean current would then be 5·1 microamperes, whereas

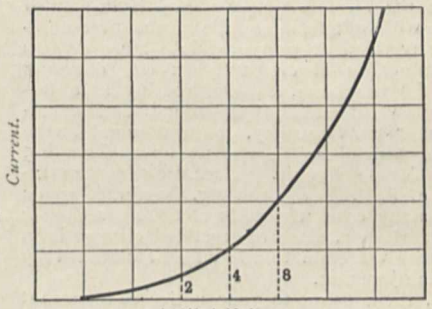


FIG. 17.

the steady voltage of 2 volts would only pass a current of 4 microamperes. Hence, apart from the unilateral conductivity, and merely in virtue of the fact that the characteristic curve is not a straight line, we find that such a crystal, or even a confused mass of crystals, can act as a radio-telegraphic detector.

There are, therefore, two ways in which a crystalline mass of carborundum can be used as a radio-telegraphic detector. It consists of a conglomeration of crystals arranged in a disorderly manner, or not so symmetrically as to neutralise one another's unilateral conductivity. Hence the mass of crystals, like the single crystal, possesses unilateral conductivity, and also a conductivity which is a function of the voltage applied to it. We may then use it without a local cell, and avail ourselves of its valve property to rectify the trains of oscillations in the antenna and convert them into short unidirectional trains which can affect a galvanometer or telephone; or, secondly, we may place the crystal between the ends of a circuit containing a telephone and a shunted voltaic cell, and then on passing oscillations through the crystal we hear sounds in the telephone, due to the fact that the conductivity is a function of the voltage, and is therefore increased more by the addition than it is diminished by the subtraction of the electromotive force of the oscillations to or from the steady voltage of the local cell. The telephone, therefore, detects this change in the average value of the current by a sound emitted by it. Prof. Pierce has discovered that several other crystals possess similar properties to carborundum—for example, hessite, which is a native crystalline telluride of silver or gold; an anatase, which is an oxide of titanium; and molybdenite, which is

a suiphide of molybdenum. As regards the origin of this curious unilateral conductivity, it seems clear that it is not thermoelectric, but at present no entirely satisfactory theory of the action has been suggested.

A number of forms of oscillation detector have recently been invented which depend on the curious fact that a

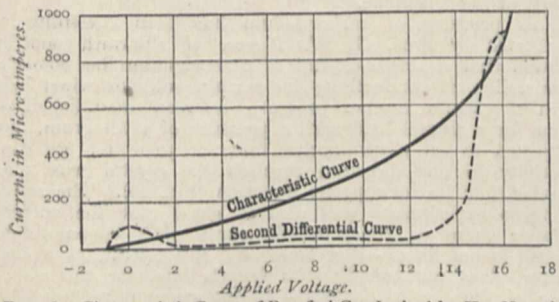


FIG. 18.—Characteristic Curve of Rarefied Gas Ionised by Hot Negative Electrode.

slight contact between certain classes of conductors possesses a unilateral conductivity, and can therefore rectify oscillations. One such detector, now much used in Germany, consists of a plumbago or graphite point pressed lightly against a surface of galena. It has been found by Otto von Bronk that a galena-tellurium contact is even more effective. To the same class belongs the silicon-steel detector of Pickard. If such a contact is inserted across the terminals of a condenser placed in the receiving circuit, and if it is also in series with a telephone, the trains of oscillations are rectified or converted into more or less prolonged gushes of electricity in one direction through the telephone. These, coming at a frequency of several hundred per second, corresponding to the spark frequency, create a sound in the telephone, which can be cut up by the sending key into Morse signals. According to the researches of Prof. Pierce and Mr. Austin, it seems clear in many cases that this rectifying action is not thermoelectric, since the rectified current is in the opposite direction to the current obtained by heating the junction.

I may, then, bring to your notice some recent work on another form of radio-telegraphic detector, which I first described to the Royal Society about five years ago under the name of oscillation valve. It consists of an electric glow-lamp, in the bulb of which is placed a cylinder of metal, which surrounds the filament but does not touch it. This cylinder is connected to a wire sealed through the glass. Instead of a cylinder, one or more metal plates are sometimes used. The filament may be carbon or a metallic filament, and I found some year or more ago that tungsten in various forms has special advantages. The bulb is exhausted to a high vacuum, but, of course, this means it includes highly rarefied gas of some kind. When the filament is rendered incandescent it emits electrons, and these electrons or negative ions give to the residual gas a unilateral conductivity, as shown by me in a Friday evening lecture given here nineteen years ago. Moreover, the ionised gas not only possesses unilateral conductivity, but its conductivity, like that of the crystals just mentioned, is a function of the voltage applied to it. Hence, if we apply an electromotive force between the hot filament and the cool metal plate, we find that negative electricity can pass from the filament to the plate through the ionised gas, and that the relation between the current and voltage is not linear, but is represented by a characteristic curve bending upwards, which has changes of curvature in it (Fig. 18). The sharp bend upwards at one place implies a large increase in the current corresponding to a certain voltage, which means that, corresponding to a certain potential gradient, and therefore velocity of the electrons, considerable ionisation of the residual gas is beginning to take place. The current, however, would not increase indefinitely with the voltage, but would before long become constant or saturated.

It will be seen, therefore, that at points on the curve where there is a bend or change of curvature, the second differential coefficient of the curve may have a large value. Hence, if we consider the current and voltage corresponding to this point, it will be seen that any small increase in the voltage increases the current more than an equal small decrease in voltage diminishes it. If, then, we superimpose on a steady voltage corresponding to a point of inflexion of the curve an alternating voltage, the average value of the current will be increased. This, then, points out two ways in which this oscillation valve or glow-lamp can be used as a radio-telegraphic detector. First, we may make use of the unilateral conductivity of the ionised gas in the bulb and employ the glow-lamp with cylinder around the incandescent filament, as a rectifier of trains of oscillations to make them effect a galvanometer or telephone. This method was described by me in papers and specifications in 1904 and 1905. In that case the valve is arranged in connection with a receiving antenna, as shown in Fig. 19, and used with a galvanometer or telephone. Mr. Marconi subsequently added an induction coil and condenser, and employed in 1907 the arrangements shown in Fig. 20. In this case the trains of oscillations set up in the antenna could not by themselves affect a galvanometer or a telephone, but, when rectified by the valve, they become equivalent to an intermittent unidirectional current, and can then affect the telephone or a galvanometer, or any instrument for detecting a direct current.

On the other hand, we may take advantage, as I have more recently shown, of the non-linear form of the characteristic curve. In other words, of the fact that the conductivity of the ionised gas is a function of the voltage applied to it, and in the second method the valve and receiving circuits are arranged as shown in Fig. 21. In this case we have to apply to the ionised gas a unidirectional electromotive force which corresponds to a point of inflexion on the characteristic curve, and then to add to this voltage the alternating voltage of the oscillations set up by the incident electric waves in the receiving circuit. The result is to cause a change in the average value of the current through the telephone, and therefore to produce a sound in it, long or short, according to the number of trains of waves falling on the antenna. This last method, then, requires the application in the telephone circuit of an accurately adjusted steady electromotive force, not any electromotive force, but just that value which corresponds to a point on the characteristic curve at which there is a sudden change of curvature.

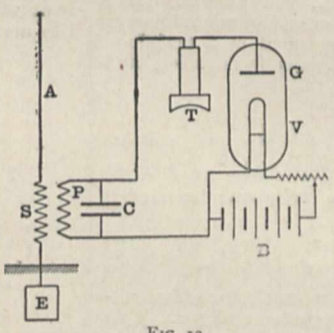


FIG. 19.

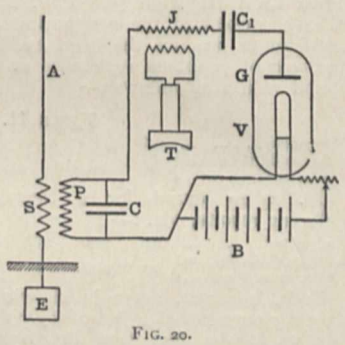


FIG. 20.

Connections for Oscillation Valve used as Radiotelegraphic Detector.

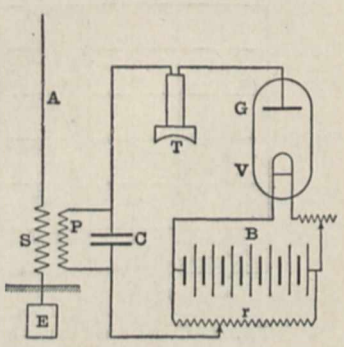


FIG. 21.—Connections for Oscillation Valve used as a Radiotelegraphic Detector.

At this point we may notice a broad generalisation which

has already been made by H. Brandes, viz. that any materials such as the crystals mentioned, or ionised gases, which do not obey Ohm's law as regards the independence of conductivity on impressed voltage can be used as radio-telegraphic receivers. It is necessary to be able to test the relative sensibility of detectors to know whether any new form is an improvement. It is not always possible for an inventor to get these tests made at real wireless telegraph stations. Moreover, it is no use to test over short distances, because then all detectors appear to be equally good. I have found, however, that we can make these comparative tests very easily within quite moderate distances by employing closed sending and receiving circuits which are poor radiators. All the devices called wave detectors are really only oscillation detectors, and we can therefore test their value simply by ascertaining how feeble an alternating current or alternating voltage they will detect. If we, then, set up in one place a square circuit of wire a few feet inside, and complete the circuit by a condenser and a spark-gap, we can set up oscillations in it by means of an induction coil. I find that it is necessary to enclose the spark-gap in a cast-iron box, and to blow upon the spark with a jet of air to secure silence, absence of emission of electromagnetic waves direct from the spark balls, and constancy in the oscillatory circuit. I then set up, a few score or few hundred feet away, a similar tuned closed oscillatory circuit, and I connect the oscillation detector to be tested either in this circuit or as a shunt across the condenser. The closed receiving circuit is so constructed that it may be rotated round either of three axes. It is then generally possible to find some position of the receiving circuit such that no sounds are heard in a telephone connected to a highly sensitive detector associated with the circuit. This position is called the zero position. If the receiving circuit is rotated round some axis, it begins at a certain displacement to receive signals, and the angle through which it has to be turned is a measure of the insensibility of the particular oscillation detector being used. I find, for instance, that it is quite easy to take one of my oscillation valves, a magnetic detector, an electrolytic detector, a crystal detector, or any other type, and arrange these in order of their sensibility by means of the device described.

Sensibility is not, however, the only virtue which a wave detector should possess. It is important that it should be simple, easily adjusted, and not injured by the chance passage through it of any unusually large oscillatory currents. Another quality which is desirable is that it should be quantitative in its action, and that any change in the amplitude of the wave received should be accompanied by an equal change in the current which the detector allows to pass through the telephone. A quantitative oscillation detector, then, enables not merely signals, but audible speech to be transmitted. In other words, it can effect wireless telephony. The difficulties, however, in connection with the achievement of wireless telephony are not so much in the receiver as in the transmitter. We have to obtain, first, the uniform production of persistent electromagnetic waves radiated from an antenna, and next we have to vary the amplitude of these electric waves proportionately to, and by means of, the aërial vibrations created by the voice speaking to some form of microphone. We cannot employ an intermittent spark generator, because each spark would give rise to a sound in the telephone, and these sounds, if occurring at regular intervals, would produce a musical note in the telephone. If, however, we make the sparks run together into what is practically a high-voltage arc taking a small current, then, in an oscillatory circuit shunted across this arc, we have set up persistent high-frequency oscillations, as first achieved by Mr. Duddell.

We can greatly increase the energy of the oscillations by immersing the arc in a strong transverse magnetic field and also in a hydrocarbon gas, as shown by Poulsen, or we may employ a number of arcs in series. E. Ruhmer has lately also employed a high-tension arc between aluminium electrodes (Fig. 22), shunted by a condenser and inductance as a means of generating persistent oscillations. As an alternative, it is possible to create them by a mechanical method, viz. by a high-frequency alternator, subject, however, to certain limitations as to frequency. Both these types of generator have their advantages and practical objections. There is good evidence that radio-telephony has been accomplished over distances of 100 miles or more by each of these methods in the hands of experts, but what is now required is the reduction of the apparatus to such simple manageable and practical form that it can be applied in regular work. The wave-generating apparatus must be capable of producing uniform persistent oscillations of high voltage and frequency, not less than 30,000 or 40,000 per second, or at least above the limits of audition, and the amplitude of these oscillations must be capable of being varied by some form of speaking microphone placed in the oscillation circuit or in the radiating antenna, or in a secondary circuit coupled to it. No ordinary simple carbon microphone will safely pass sufficient current for this purpose. A type of multiple microphone has been used successfully, and also a duplex microphone, the invention of Ernst Ruhmer.

It is not, however, possible to speak of radio-telephony at the present time as having reached the same level of practical perfection as radio-telegraphy; but the possibilities of it are of such a nature that it will continue to attract the serious attention of inventors. This is not the place to enter into a full discussion of the causes which limit submarine telephony through cables, but there are well-known reasons in the nature of submarine cables as at present made which impose very definite limits upon it, owing to what is called distortion of the wave form. Electric wave telephony is free at least from this disadvantage, and if (as has been asserted) arc generators can be made self-regulating and capable of being worked for hours automatically, or even for ten minutes without being touched, then the remaining difficulties with the microphone are not insuperable.

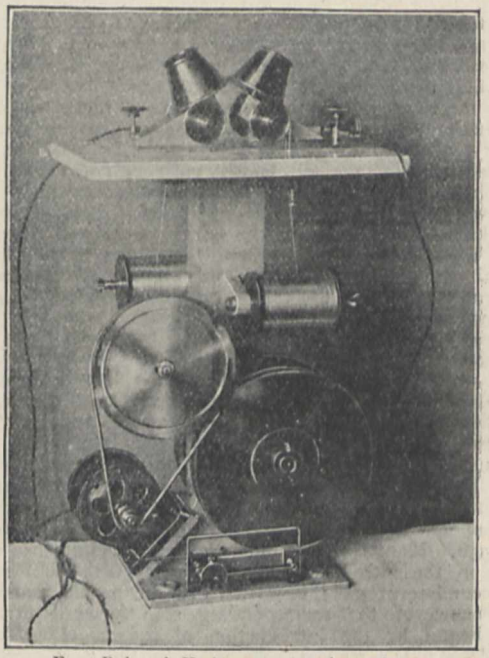


FIG. 22.—Ernst Ruhmer's High-tension Aluminium Arc for producing persistent Oscillations for Radiotelephony.

Time does not permit of the discussion of the many other points in connection with radio-telegraphy and telephony which have been the subject of recent work. Much attention has been paid lately to methods of cutting out atmospheric signals due to natural electrical discharges in the atmosphere, which are troublesome disturbers of the ætherial calm necessary for radio-telegraphy. Considerable thought and expenditure have been necessary to discover means for overcoming the difficulties of long-distance transmission by daylight, and also those arising from the cross-talk of other stations. Much also has been

done in training skilled wireless operators both in the Navy and for the mercantile marine work. Radio-telegraphy, like aviation, is an art as well as a science, hence personal skill is a factor of importance in turning the flank of the difficulties of the moment. Nevertheless, the art and the science of radio-telegraphy are both progressing, and the splendid services already rendered by it in saving life at sea are at once a proof of present perfection and an evidence that the arduous labours of investigators and inventors have borne fruit in yet larger powers to command the great forces of nature for the use and benefit of mankind.

ILLUMINATING ENGINEERING.[1]

THIS society has been founded to bring together all those who are interested in the problems, practical and theoretical, of the *art of directing and adapting light, that prime necessity of* civilised, as well as of uncivilised, *existence, to the use and convenience of man.* To advance the subject of illuminating engineering, to investigate through all its lengthened breadth the facts within its domain, to increase and diffuse knowledge respecting them, and to unite those who are devoting their energies to these things, is the object of the society. The ascertained facts are few—all too few; their significance is immense; their economic and social value is great; but the ignorance respecting them generally is colossal.

For practically a century only have there been any systematic means of illumination in use in any civilised country. Before the year 1800 there were as means of illumination daylight, oil lamps, rush lights, tallow dips, and wax candles. Monarch and peasant, merchant-prince and workman, had alike to depend on individual sources of light at night. Only in the larger towns and cities was there any organised attempt to light the streets by oil lamps. In 1819 the authorities of the day stoutly resisted the proposal to light the then House of Commons by gas—nothing but wax candles could be admitted; but gas lighting was coming in, and Argand and colza oil lamps were the sole competitors until after 1850. Everything else dates since then—practically during the last half-century. For paraffin lamps were not widely spread until the 'sixties. Arc lighting, though tried for spectacular and lighthouse purposes from the 'fifties, did not come into public question until about 1879. Glow-lamps followed three or four years later. Still later came incandescent gas mantles and acetylene gas lights, while the newest things in both gas lighting and electric lighting are affairs of only a year or two ago. Many persons now realise the immense stride made in the introduction of the Auer (Welsbach) mantle for incandescent gas; very many fewer people realise the significance of the corresponding step forward that has been begun by the introduction of the metallic filament glow-lamp. We are on both sides in the very middle of an immense evolution in the art of illumination.

But whilst the means of illumination have thus been developing with amazing strides during a single generation, and the organised systems of distribution by municipal and urban and rural authorities, and by private corporations, have ramified throughout the community and brought supplies of gas and of electricity—shall I also say of oil?—to our doors, there has been another and very different development going on. I refer to the growth of that branch of the science of optics which deals with the measurement of luminous values. Photometry has been growing into an exact science by the explanation of its laws and the improvement of the instruments of measurement. It was not until 1760 that the first real discussion of photometric principles was made known. In that year Lambert, in his "Photometria," laid down the fundamental laws, and likewise in the same year Bonguer gave to the world his "Traité d'Optique," wherein a primitive photometer was described. Rumford's shadow photometer was invented in 1794, and Ritchie's in 1824. Then comes a long gap. Save for Bunsen's over-rated grease-spot instrument, there was no important advance in photometry until the 'eighties, when there were produced many novel forms, some of them, including the now well-known forms of L. Weber, Lummer-Brodhun, and Rood, capable of yielding results of much higher precision in the comparison of different sources of light; also in the 'eighties we meet for the first time with special forms of photometer of the kind destined to play a very important part in the work of our society, many photometers measuring the values, not of the brilliancy of a source of light, but the illumination of a surface.

Our primary concern is the adequate and proper illumination of things; and as we have to reduce the present chaos to an exact science, our first business is to secure some common agreement as to the measurement of illumination and the establishment of reasonable rules as to the amounts of illumination required in different cases.

Foremost, then, in the programme of work for our society we put the question of the units of measurements and the promulgation of the proper definitions of them. We must secure agreement—national and, if possible, international—as to what shall be taken as the unit of light and what as the unit of illumination at a surface.

Happily, the long-standing controversy as to the former appears to be settling itself by at least a preliminary agreement between the standardising laboratories of the great nations. One "candle" is no longer to be a vague and indefinite thing. The new definition provisionally agreed upon is an ideal unit, in terms of which one can describe the several standards in use in different countries. If this provisional *entente* can but be ratified by a little international common sense, we shall have henceforward an international "candle" such that it is the same in England as in America, equal to the *bougie décimale* accepted in France, and related to the Hefner-candle of Germany in the precise proportion of ten to nine.

But we have still to find agreement on the standard of illumination. Here in England, and in the United States, we have already grown accustomed to describe amounts of illumination of surfaces in terms of a British unit—the "candle-foot"—not perhaps a very happy term—one that we would readily exchange for a better—meaning, thereby, the intensity of the illumination at a surface situated at the distance of one foot from a light of one "candle." The source being assumed here to be concentrated at a point, the law of inverse squares holds good.

Adopting the candle-foot as the unit of illumination, one may readily state certain facts with definiteness. All competent authorities are agreed that at night, for the purpose of reading, an illumination is required not less than one candle-foot, some authorities saying 1½ candle-foot. The facts appear to be that reading is impossible with an illumination of one-tenth candle-foot, difficult and fatiguing with one of one-fifth candle-foot, comfortable with from 1½ to 3 or 4 candle-foot, but that if the illumination exceeds 6 or 8 candle-foot, the glare of the page is again fatiguing and dazzling. The page should neither be under-illuminated nor over-illuminated. Something depends, it is true, on the size of the print. Under a feeble illumination of, say, ½ candle-foot, a type of pica size printed in a fount of bold face properly inked is legible when one of long-primer size, printed in a weak way, would be practically illegible. Something also depends on the state of the eye as affected by the general illumination of the surroundings. Very seldom does one find in any ordinary room an artificial illumination exceeding 3 candle-foot. By day, on a writing-table placed near a north window—or near any window not receiving direct sunlight—the illumination may exceed 3, and may even attain 4 or 5 candle-foot.

Until a unit of illumination was thus agreed upon, it was impossible to render any reasonable certainty to estimates of the amount of illumination in any case of dispute. What is the meaning of the term well-lit as applied to any room, building, factory, workshop, or school? Formerly the term was entirely vague. To-day the answer can be given in numerical terms. Formerly judgment had to be made by the unaided eye, and the eye is notoriously a bad judge. As between two different illuminations, the powers of discrimination of the eye are very limited. The eye can equate, but it cannot appraise. It can tell with fair accuracy whether two adjacent patches

[1] Abridged from the inaugural address delivered at the inaugural meeting of the Illuminating Engineering Society held on November 18, by Prof. Silvanus P. Thompson, F.R.S., president of the society.

are equally bright; if they are not equally bright it cannot say with any kind of proportionality what their relative brightnesses are. All photometry depends on the perception of an equality.

Photometers for the measurement of illumination have been mentioned earlier as coming first into notice in the 'eighties. One of the earliest in this country was that constructed by Sir William Preece, with the assistance of Mr. A. P. Trotter, for measurement of the illumination of side-walks and pavements of streets. It has been subsequently developed by Mr. Trotter, and as constructed by Mr. Edgcombe is a most useful and handy instrument, telling the amount of illumination directly in terms of the candle-foot. Another, by Mr. Haydn Harrison, measures the illumination, not on the horizontal, but at 45°. Almost equally early with the Preece-Trotter illumination photometer was the school photometer of Petruschewsky, apparently little known in this country. Most recent of this sort is the form due to Martens.

The principles and construction of photometers are matters that have interested me for nearly thirty years. About 1880 I brought out a form of wedge-photometer (modified from Ritchie's form), in conjunction with Mr. C. C. Starling, for electric light measurements. Later I gave to the Physical Society an investigation of the errors arising in photometry from the almost universal assumption that the law of inverse squares is fulfilled. In 1882, when lecturing at the Crystal Palace Exhibition, I gave diagrams to show the effect of the superposition of illumination from two or more lamps, and discussed the variations of illumination in a street between the places of maximum and the places of minimum illumination. Twelve years ago I described a tangent photometer, which has remained a mere optical curiosity.

No one can have worked at the photometry of modern lamps, or of the illumination of surfaces lit by lamps, without becoming conscious how much misunderstanding there is of the elementary laws of illumination. There is Lambert's cosine law, admirable and simple if only it were not in so many cases vitiated by the presence of organised—that is, specular—reflection. There is the law of inverse squares, itself a universal geometrical law of action radiating from a point, so fatally and absolutely misleading if applied to any other case than that of action from a point.

One subject on which more information is badly needed is the specific brightness of surfaces of different kinds when subjected to a standard illumination. For instance, how much light is reflected, per square inch, when illuminated with an intensity of 1 candle-foot, from such materials as oak panelling, whitewash, brown paper, or the surface of a red brick wall? Here in this theatre the walls are tinted of a dark Pompeian red or maroon, which reflects but little light. The extra annual expense on lighting that might be saved had a lighter tint been used is surely worth considering.

The subject of diffuse reflection which here comes into play has indeed been investigated partially by several persons. There are Dr. Sumpner's researches of 1894 and those of Mr. Trotter on white cardboard and other white matt surfaces, but how few others! Again, there is the subject of diffuse refraction, which occurs in ground-glass shades, ribbed and corrugated glass panes, and other devices for diffusing the concentrated light of lamps. Yet how little does any optical book tell us on the subject of diffuse refraction. Reflection and refraction as they occur at dull or irregular surfaces appear to be of no importance to the academic writer of text-books of optics, but they are of vital interest to the illuminating engineer. Again, there are a number of semi-physiological problems that demand investigation and settlement. We all know that our eyes have an automatic diaphragm which stops down the entering light to protect our eyes from glare, rendering us relatively insensitive to bright lights. Does anyone know whether the contraction of the pupil depends on the total amount of light entering the eye or on the intensity of the image on local patches of the retina?

Again, we all know how an unshaded arc-lamp, or even glow-lamp, "cuts" the eyes by the very concentration of its beams, even when it may be many feet away, while the same actual amount of light, if diffused over a greater apparent surface, as by a surrounding globe of ground glass, is quite readily endured, and does not produce the same painful sensation. Does anyone know how great is the specific brightness of surface that the eye will tolerate without experiencing this discomfort? We can look at a white cloud or at the blue sky without pain. Can we endure a specific brightness of so much as one-tenth of a candle per square inch?

Our eyes are provided by nature with a most exquisite and automatic iris diaphragm which opens in the dark and closes in the light, thereby shielding us partially against the evil effects of glare. Putting it in the language which the photographer uses to describe the stopping-down of a camera-lens, the automatic iris of our eye can close the pupil so that while in a comparative darkness the aperture opens to $f/2$ or $f/2{\cdot}5$, it closes, amid a brilliant surrounding illumination, to about $f/20$. Suppose we are looking out in relative darkness, and are confronted with a brilliant patch shining with a specific brightness of one-tenth of a candle per square inch, we shall feel a certain amount of discomfort from its glare, and if we regard it steadily for a second or two will, on closing our eyes or turning away, see those persistent coloured images that trouble us after looking at any very bright light; but now let the same brilliant patch be placed against a bright background. Far more light will enter the eye; the automatic iris of the eye will in a few moments have contracted, stopping down the lens of the eye so that it will be far less sensitive. In these circumstances, will the patch that has a specific brightness of one-tenth candle per square inch pain or dazzle the eye? I ask the question, but I do not know the answer. Does anyone know what the answer ought to be? It is a simple question, and a few experiments would soon settle it. Of course, one must admit that the automatic action of the iris diaphragm, important as it is, does not by any means account for the whole of the facts about the want of proportion between the intensity of a stimulation and the intensity of the resulting sensation. Fechner's logarithmic law of psychophysics gives a clue, but even this does not seem capable of expressing, much less of explaining, the facts about the observed want of proportionality. Why should a light of ten-fold brilliancy not produce a sensation ten times as intense? And why should a greater brightness of the general surroundings relieve us of the annoyance of those coloured after-images? After-images can be seen even under extremely feeble illumination, as I have again and again found. Has anyone discovered any exact law governing their occurrence?

All these queries show that there is plenty of work awaiting us, even in the mere collection and completion of such scattered information as is already available; but there are even more important questions before us, more important, not in science, but in their relation to the public welfare and the economics of the community.

Now that we have a standard of illumination and simple portable instruments that will measure it, there can be no excuse for inaction or ignorance in applying that knowledge to securing proper illumination for public and private buildings.

Let me begin with school buildings. They are the most important; for whatever bad results flow from bad lighting of churches, factories, or railway stations, those which result from the bad illumination of schools are far more to be deplored—they imperil the eyesight of the next generation.

All ophthalmic surgeons agree that the cause which forces the children into increasing shortsightedness is protracted poring over books under an insufficient illumination. Even in what an inspector might call a well-lit school the illumination at the surface of the desk may be quite insufficient if the desks are badly placed, or the windows insufficiently high, or the lamps badly distributed.

All educational authorities ought henceforth to insist on rational requirements as to lighting. Hitherto they have had nothing definite to specify; now that illumination photometers are available, they ought to require a minimum of 1½ candle-foot at the worst-lighted seat in the schoolroom, and not depend on purely architectural rules

about heights of windows or areas of window-space. In England the Board of Education, in its Building Regulation (1907), Rule 6, clause *c*, has laid down a foolish rule:—"Skylights are objectionable. They cannot be approved in school-rooms or class-rooms." That perfectly monstrous provision ought to be at once repealed. The universal experience of the textile industries, where adequate lighting of spinning and weaving machinery is a prime necessity, is that no method of lighting is so satisfactory as skylights in roofs specially constructed to receive light from the northern sky.

Hitherto little attention has been paid by either local or central authorities to conditions affecting the lighting of factories and workshops. It is true that the factory inspectors require periodic whitewashing of factories, but that is for sanitary reasons, not primarily to secure better illumination. The Home Office has its regulations as to temperature and degree of moisture required or permissible in the different classes of factories and workshops. Then why not also similar regulations as to the proper amount of illumination? Surely the eyesight of the workers is as well worth protecting from injury as their lungs and their limbs. So far as I am aware, Holland is the only country in which legislation has fixed a statutory amount of illumination in factories, the figure there being from 10 to 15 candle-metre, equivalent, therefore, broadly to the value of 0·9 to 1·35 candle-foot.

Architects are often blamed for deficiencies in the lighting of the buildings they design, perhaps more often for the deficiencies found at night by artificial lighting than for those of the lighting by day. For this the fault rests no doubt largely with the persons who have installed the lighting arrangements, and one must not blame the architect too severely for having been as ignorant as all the rest of the world about the principles of illumination; but henceforward, when once it is known how much illumination is required in the rooms of different kinds, the architect ought in his specification to set down, with appropriate numerical values, what degree of illumination is required in the various parts of his building.

I venture to suggest that it would be a good thing if, in the public interest, our society, or some committee appointed by it, could draw up a model specification, or model clauses for architects to insert in their specifications, in which the proper way of prescribing the requisite amounts of illumination in different classes of cases should be set forth.

Outside all these matters of more public interest, there are topics enough to occupy our society for many months to come. We shall have discussions on several interesting subjects during next spring, and there are many problems awaiting solution. When all else fails us, we can turn to the eternal question of the measurement of colour. We have also the long outstanding problem of the production of light without heat, accomplished in nature by the fire-fly, but unrealised by any artificial lamp. We might turn to discuss special cases, such as the flashing lights of lighthouses, or the special lights needed in the hospital for the detection of rashes or the treatment of disease. Amid such endless ramifications of our subject there is no fear of coming to a premature end of our programme. There is, indeed, abundance of work before us.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. Baker has been appointed chairman of the examiners for part ii. of the mathematical tripos; Mr. A. Hutchinson, chairman of the examiners for the natural sciences tripos; and Mr. H. W. V. Temperley, chairman of the examiners for the economics tripos, 1910.

Mr. A. E. Shipley has been appointed a manager of the Balfour fund.

Mr. J. E. Purvis has been appointed university lecturer in chemistry and physics in their application to hygiene and preventive medicine for five years.

The Walsingham medal for 1909 has been awarded to Mr. L. J. Wills, for his essay entitled "The Fossiliferous Lower Keuper Rocks of Worcestershire," and a second medal to Mr. H. H. Thomas, for his essay entitled "The Leaves of Calamites (Calamocladus section), with Special Reference to the Conditions under which they Grew."

It is proposed that a grant of 100*l.* be made from the Worts fund to Mr. J. Romanes towards defraying the expense of a journey to Costa Rica with the object of studying the geology and geography of that country.

THE Earl of Crewe, chairman of the governors of the Imperial College of Science and Technology, will distribute the diplomas, medals, and prizes to the successful students at the Royal College of Science on Thursday next, December 16. Prof. Adam Sedgwick, F.R.S., will deliver an address.

DR. H. A. MIERS, F.R.S., principal of London University, will distribute the prizes and certificates at the Sir John Cass Technical Institute, Aldgate, on Thursday, December 16. There will be an exhibition of students' work and apparatus in the laboratories, workshops, and other rooms of the institute.

A CONFERENCE to discuss the needs of technical education in Burma was held at Rangoon early in November. We learn from the *Pioneer Mail* that Mr. J. G. Covernton, Director of Public Instruction, in opening the discussion, presented a brief sketch of what had been done in the past in the way of technical education. He divided the work of technical instruction into two main groups:—(1) those connected with scientific professions, especially engineering; (2) those connected with ordinary country and home life. He proposed that a central technical school for industrial education in the vernacular should eventually be opened at Insein in connection with the engineering school, and related to all the selected vernacular schools for technical education which may hereafter be established, and that pupils who showed special aptitude for technical training should be drafted to this central school. The instruction should be in the vernacular, and its aim be to provide for a general technical training for hand and eye. For trained pupils who might hope to be skilled artisans in various crafts and industries there should, the director said, be local industrial schools in local industries.

THE report for 1908–9 on the work of the Department of Technology of the City and Guilds of London Institute has just been published. It abounds in interesting information concerning the useful work being accomplished by the department in the way of improving the technical education of the country. At the last examinations held by the department, 23,399 candidates were presented in technology from 404 centres in the United Kingdom, and of these 13,665 passed. By the aid of advisory committees the institute is enabled, the report points out, to promote useful relations between trade organisations and the schools in which artisans and others receive their technical instruction. The institute, too, has a system of inspection of trade classes by professional experts, and during the session under review 107 centres were visited by members of the institute's staff for the examination, inspection, or organisation of classes. The report also states that the independent criticisms from examiners in wholly distinct subjects show that many teachers, while undoubtedly using their best efforts to acquaint the students with the technical details of their trade, fail to obtain good results owing to their giving instruction on wrong lines, paying too much attention to description and too little to the theory of the subject and to the principles underlying the work in which they are engaged. This may be partially due to lack of experience in teaching and failure to realise the difficulties of their students, and in such cases a visit from an inspector, himself an experienced teacher in the same subject, would often do much to remedy the defects, more especially if the visit can be repeated so as to enable the instructor to avail himself of the inspector's experience from time to time in the difficulties that arise. The institute also concurs in a suggestion, made by its inspectors, that if the education authority could send a comparatively inexperienced teacher to visit some of the schools at which successful classes are conducted and see their methods of work, such a visit would amply repay its cost.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 25.—Sir Archibald Geikie, K.C.B., president, in the chair.—Sir W. de W. **Abney**: The change in hue of spectrum colours by dilution with white light. The author shows that by diluting the spectrum colours from the red to the green-blue with moderate percentages of white light, their hue travels towards the yellow, the change being dependent on the amount of red and green existing in the white added. At a point near λ 5780 the hue remains unaltered by the addition of white, and it is towards this point in the spectrum that the colours on each side of it travel. It is pointed out that this change in hue enables the relative amounts in green and red from λ 5000 to λ 6000 to be accurately determined.—Prof. G. E. **Hale** and F. **Ellerman**: The nature of the hydrogen flocculi and their structure at different levels in the solar atmosphere.—Prof. H. L. **Callendar** and H. **Moss**: The boiling point of sulphur corrected by reference to new observations on the absolute expansion of mercury.—C. **Cuthbertson** and Maude **Cuthbertson**: The refraction and dispersion of neon. The refractivities of neon (Ne_2) for different wave-lengths are found experimentally to be

$\lambda \times 10^8$	$\mu - 1 \times 10^6$
6438	134·02
5461	134·30
4800	134·63

These can be expressed by the formula

$$\mu - 1 = \frac{5{\cdot}133 \times 10^{27}}{38517 \times 10^{27} - n^2}$$

where n is the frequency V/λ. Owing to the feebleness of the dispersive power of neon, the accuracy of the value obtained for the dispersion is not to be relied on to less than 5 per cent. Revised formulæ for the refractive indices of helium, argon, krypton, and xenon are given, in the same form, which supersedes the use of Cauchy's formula.—C. **Cuthbertson** and Maude **Cuthbertson**: The refraction and dispersion of air, oxygen, nitrogen, and hydrogen, and their relations. The refractivities of these gases for different wave-lengths are found experimentally to be

$\lambda \times 10^8$	$(\mu - 1)10^6$			
	Air	Oxygen	Nitrogen	Hydrogen
6563	291·92	269·75	298·16	138·60
5790	292·98	270·99	—	139·33
5461	293·60	271·70	299·77	139·71
4861	295·11	273·45	301·21	140·64

Cauchy's formula of two terms is shown to be inadequate to express the dispersion of a gas, and a formula of Sellmeier's type is adopted,

$$\mu - 1 = \frac{C}{n_0^2 - n^2}.$$

In this form the refractivities of these gases are given by the constants shown in the table below. Revised values of the indices of sulphur, phosphorus, and mercury, expressed in the same form, are also given, and it is shown that, on the electronic theory of dispersion, the relative numbers of "dispersion electrons" in hydrogen, oxygen, and nitrogen are as 1, 2, and 3 almost exactly; in sulphur and phosphorus, to a less degree of accuracy, as 3 and 4½. In mercury the number is in the neighbourhood of 4½ to 5.

	$C \times 10^{-27}$	$n_0^2 \times 10^{-27}$	V	C/V
Air	4·6463	16125	—	—
Hydrogen.	1·692	12409	1	1·692
Oxygen ...	3·397	12804	2	1·699
Nitrogen...	5·0345	17095	3	1·678
Sulphur ...	4·808	4600	3	1·603
Phosphorus	7·61	6534	4½	1·691
Mercury ... to	7·82	4360	4½	1·74
	8·371	4740	5	1·68

—C. **Cuthbertson** and Maude **Cuthbertson**: The refraction and dispersion of sulphur dioxide and hydrogen sulphide, and their relation to those of their constituents. The refractivities of sulphur dioxide for different wave-lengths are found experimentally to be

$\lambda \times 10^8$	$(\mu - 1)10^6$
6700	656·40
6500	657·10
5800	661·26
5461	663·97
5000	668·63

These can be expressed in a formula of Sellmeier's type,

$$\mu - 1 = \frac{5{\cdot}728 \times 10^{27}}{8929 \times 10^{27} - n^2}.$$

The refractivities of hydrogen sulphide for different wave-lengths are found experimentally to be

$\lambda \times 10^8$	$(\mu - 1)10^6$
6563	636 22
5790	641·17
5461	644·03
4861	650·98

These can be expressed in the same form by

$$\mu - 1 = \frac{4{\cdot}834 \times 10^{27}}{7805 \times 10^{27} - n^2}.$$

The number of "dispersion electrons" in SO_2 is shown to be approximately equal to the sum of the numbers of "dispersion electrons" in S_1 and in O_2. The number of "dispersion electrons" in H_2S is, approximately, one more than the sum of the "dispersion electrons" in H_2 and in S_1.—Prof. M. F. **Fitzgerald**: Flapping flight.—Dr. W. **Rosenhain** and J. C. W. **Humfrey**: The crystalline structure of iron at high temperatures. The paper contains a preliminary account of observations on the effects of strain on iron at high temperatures. Polished strips of nearly pure iron were heated *in vacuo* and strained while hot, the central portions of the specimen attaining a temperature of about 1100° C., while the ends remained below visible redness. Heating alone produced a surface pattern caused by a volume change in the metal when passing through the $\alpha = \beta$ transformation, and occasionally where the temperature was highest a slight tarnish which revealed the γ crystals. Heating and straining *in vacuo* showed that at all temperatures attained deformation took place by means of slip on the gliding planes of the crystals; three distinct regions could, however, be distinguished, and temperature estimations by the method of Joly's meldometer agree with the identification of these regions with the α, β, and γ ranges of Roberts-Austen. This identification is supported by differential heating and cooling curves given in the paper. In the α range the number and intensity of slip-bands increases rapidly with increasing temperature; at the transition point—which is seen as a well-defined line across the specimen—the bands suddenly cease and remain minute during the β range; in the γ range the bands are again numerous, but differ from those observed in the α range by their straightness and regularity and by the frequent occurrence of twin crystals. These observations are illustrated by three photomicrographs. The authors consider that their observations strongly support the allotropic theory of Roberts-Austen, particularly since they show that β iron, although at a higher temperature, is markedly harder and stronger than α iron. So much is this the case that when such a specimen was broken while hot, the fracture took place in the region of hottest α iron, just before the transition point. The present observations also demonstrate the similarity of γ iron, as found in nearly pure iron when heated, with the well-known "γ iron" found in alloy steels.—Dr. A. E. H. **Tutton**: The relation of thallium to the alkali metals: a study of thallium-zinc sulphate and selenate. This communication contains the results of an investigation of the thallium salts of the zinc group of the monoclinic series $R_2M\left(\begin{matrix}S\\Se\end{matrix}O_4\right)_2.6H_2O$, analogous to the previous investigation of the simple rhombic salts of the series $R_2\begin{matrix}S\\Se\end{matrix}O_4$. The conclusions formed as the result of the latter research are fully confirmed and independently substantiated, as regards the relations of thallium to the alkali

metals and ammonium, and the nature of the isomorphism existing between the salts of these various bases. A large number of crystal measurements and determinations of physical constants are recorded in the paper. The main conclusion is that the morphological and physical properties of the crystals of these thallium double salts are such as quite entitle them to inclusion in the monoclinic isomorphous series of the general formula above given, but not to places in the more exclusive eutropic series within that isomorphous series. This eutropic inner series is confined to the salts the interchangeable metals of which belong to the same family group of the periodic classification, namely, to those of potassium, rubidium, and cæsium, the crystals of which exhibit the regular progression of angles and physical constants, according to the atomic weight of the metal, already pointed out by the author in previous communications. The crystals of the thallium salts resemble very closely those of the ammonium salts—which are also outside the eutropic series, but are included in the isomorphous series—except as regards one outstanding specific property, that of refraction; for the crystals of the thallium double salts, like those of the simple sulphate and selenate of thallium, exhibit transcendent refractive power, which proves to be a characteristic property of the crystals of all the thallium salts yet studied by the author.—P. F. **Everitt**: The nature of the diffraction figures due to the heliometer. This paper contains a discussion of the heliometer diffraction fringes. The matter is one of considerable importance, owing to its bearing on astronomical measurements taken with this instrument. A difficulty arose owing to the appearance of these fringes in heliometer work on an artificial double star. It was then found that, although the subject had been discussed by Bessel, Hansen, and Gauss, a good photograph of the actual fringes obtained by Scheiner and Hirayama, and a series given for the calculation of the fringes by Bruns, all attempts at their actual numerical determination had failed, owing to the extremely slow convergence of the series adopted, at a small distance from the centre of the system. By the adoption of a semi-graphic method, and the use of mechanical integrators, it has been found possible to carry out the calculations needful in order to obtain an accurate picture of the fringes. Photographs were taken of the fringes, and these, taken by the author, as well as the photograph taken by Scheiner and Hirayama, show a close agreement with the calculated contours, and enable one to obtain the proportions of the central (non-elliptic) oval, with which observers are chiefly concerned. The close agreement between the calculated and theoretical values of the different parts of the system is a further proof that the old undulatory theory suffices to determine in practice the true dimensions of such diffraction figures.—E. **Cunningham**: The motional effects of the Maxwell æther-stress. There is an outstanding gap in electromagnetic theory in respect to the attempt to reconcile the analysis of æthereal stress on the lines initiated by Maxwell with Newton's third law and with the law of the conservation of energy. In the present condition of theory there are assigned to the æther certain distributions of electromagnetic energy and momentum. The hypothetical distribution of energy is necessarily associated with the Poynting vector which measures its rate of transference. The distribution of momentum is so defined that the rate of increase of the total amount within any given volume supposed at rest in the æther is equivalent to the resultant of the Maxwell stresses on the bounding surface. There is, however, no connection established between the transference of energy across an area and the stress across that area. Such a connection would require that it should be possible to assign to the medium in which stress and energy reside a state of motion whereby the stresses might do the necessary amount of work; and this, again, would require the revision of the specification of stress, inasmuch as the ordinary expressions are computed for an element of surface which is at rest. In the first section of the present paper it is shown that, if g is the intensity of electromagnetic momentum $([EH]/4\pi c)$ and w the energy intensity $([E^2+H^2]/8\pi)$, and the velocity v is taken in the direction of g of magnitude, such that $(c^2+v^2)g=2vW$, the same stress system which would account for the transfer of momentum will account for the transfer of energy, provided the æther is assumed to be moving with velocity v. The stress system is not the ordinary Maxwell one, but reduces to it in the electrostatic case. In this case it is known that the Maxwell stress may be analysed into a tension along the lines of force, together with a uniform pressure at right angles to those lines. This property of the stress system, commonly given, is not true of the total stress (electric and magnetic) in the general field. It is shown, however, that the stress system obtained in the paper can always be reduced to this form. The direction of one of the principal stresses is always along the velocity v. It is shown, further, that at the surface of a perfect reflector, stationary or moving, the velocity v is equal to that of the reflector combined with a velocity tangential to it, that is to say, a perfect reflector is analogous to an impenetrable boundary. In the second part of the paper a similar analysis is applied to radiation such as would exist in the interior of a cavity the walls of which are moving, so that, although the electric and magnetic forces vary extremely rapidly and in an irregular manner, there is necessarily a transfer of energy. Taking ϵ and γ as the mean values of the energy and momentum over intervals of time, which are short as compared with those which are appreciable by mechanical means, but long as compared with the period of the irregular fluctuations which constitute natural radiation, it is found that the mechanical properties of the radiation may be represented as those of a continuous quasi-fluid, in which there is a definite pressure p at every point (the same in all directions) and a definite velocity v, the relations connecting the several quantities being

$$3p=\epsilon-v\gamma \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$
$$c^2\gamma=v(\epsilon+p) \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

If a small volume V is followed in its motion with the quasi-fluid, it is found that the quantity

$$pV^{4/3}(c^2-v^2)^{-2/3} \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

remains constant. If v^2 is neglected this becomes the known equation connecting the pressure and volume of steady radiation for adiabatic changes. Finally, it is shown that if a state of the radiation differing slightly from the actual is conceived, and dQ is the difference in the energy of the small volume V, after allowing for the change due to mechanical causes, such as increase of momentum and volume, the condition that the expression dQ/T should be a perfect differential is that

$$p(c^2-v^2)^2=kT^4 \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

This with (3) involves the equation

$$pV/T=\text{constant}.$$

—Dr. H. C. **Pocklington**: The aberrations of a symmetrical optical instrument. The doubly modified characteristic function is written down, and the singly modified function derived from it correct to terms of the fourth order of small quantities. This is transformed so as to take account of the existence of an exit pupil, and formulæ are found giving the aberrations for any position of the object and pupil in terms of the six coefficients of aberration of the system. Some relations are found between these aberrations, and connection is established with the methods of numerical calculation given in Whittaker's tract on "The Theory of Optical Instruments."—H. E. **Watson**: The spectrum of radium emanation.—Prof. E. G. **Hill** and Dr. A. P. **Sirkar**: The electric conductivity and density of solutions of hydrogen fluoride.—Sir David **Bruce**, Captains A. E. **Hamerton** and H. R. **Bateman**, and Captain F. P. **Mackie**: Sleeping sickness in Uganda. Duration of the infectivity of the *Glossina palpalis* after the removal of the lake-shore population.

Institution of Mining and Metallurgy, November 18.—Mr. Edgar Taylor, president, in the chair.—L. D. **Ricketts**: Experiments in reverberatory practice at Cananea, Mexico. A detailed description of the installation of a reverberatory furnace and McDougal calciners at the Cananea Consolidated Copper Co.'s Works, and of the difficulties that were encountered in connection with

the fuel available. The coal that was obtainable was of so unsuitable a quality that, after experiments with it whole and pulverised, none of which was attended with success, recourse was had to oil fuel. A feature of the smelting operation is the relatively large proportion of flue dust treated. Full details are given of the quantities of materials treated and of the costs of the various operations, and the author goes minutely into the circumstances attending the failure of the coal-firing and difficulties encountered during that and the subsequent oil-firing. The paper is principally composed of observed facts.

Physical Society, November 26.—Dr. C. Chree, F.R.S., president, in the chair.—Dr. J. W. **Nicholson**: The effective resistance and inductance of a helical coil. This paper deals with a determination of the effective resistance and inductance of a helical coil of great length, composed of thin wire, wound on a cylinder the radius of which is large in comparison with that of the wire. The pitch of the winding is not small, so that the problem cannot be treated by the method of Cohen. The method employed depends upon the use of a type of "helical coordinates" defining the position of any point, and of the general theorem relating to orthogonal systems of coordinates. A solution is obtained for the internal and external forces, corresponding to a given impressed electromotive force, in the form of a Fourier series of which only the initial terms require calculation. The value of the effective current across any section is obtained, and thence the inductance and resistance. For a high frequency it is found that the change of self-inductance due to twisting of the wire tends to vanish, and that the change of resistance tends towards a value independent of the frequency.—W. A. **Scoble**: Ductile materials under combined stress. The author further considers the results from some earlier tests made on mild steel bars, $\frac{3}{4}$-inch diameter and 30 inches effective length, under combined bending and torsion. It is pointed out that the yield-point is usually selected as the criterion of strength, because it is more easily determined than the elastic limit, it is less affected by special treatment of the material, and it is assumed that the failure of Hooke's law between the elastic limit and the yield-point is due to local yielding. The elastic limit is the correct point, and is used throughout, because the intermediate state mentioned above does not appear in bending. The results of tests on steel and copper tubes under combined bending and torsion are also given. All the results indicate that the maximum stress and maximum strain laws do not apply to ductile materials. The stress difference or shear stress law is approximately true, but there is, in each case, a deviation from the law which is opposed to the other theories mentioned. The shear stress law appears to state the average behaviour of ductile materials, but there are considerable deviations from the law, which are usually opposed to the other theories. Other tests by the author indicate that brittle materials obey the maximum stress law, and it is therefore suggested that the value of "m" depends chiefly on the degree of ductility of the material considered, and to a lesser extent on the system of loading.—Drs. W. **Makower** and S. **Russ**: The recoil of radium C from radium B. It has been shown in a previous paper that, during a radio-active transformation involving the expulsion of an α particle, the residue of the atom from which the α particle has been expelled recoils in an opposite direction to that in which the α particle is emitted, and can travel a considerable distance through a gas if the pressure is sufficiently low. A similar effect was also demonstrable in the case of the transformation of radium B into radium C, although this transformation is supposed to be accompanied by only β rays. The phenomena associated with this recoil are studied in this paper. In the first place, it was found that it was only in certain circumstances that pure radium C free from radium B was projected from a plate coated with radium B and radium C. Secondly, the active deposit on a plate appears to be concentrated into heaps, so that radium C, in breaking up, mechanically carries with it some radium B. If, however, sufficient time is allowed after removing a plate from the emanation for Radium A to decay completely, and if, further, sufficiently small quantities of deposit are used to avoid the formation of heaps, practically pure radium C is emitted. The law according to which the radiation fell off with distance was also studied, and it was found that radium C is not emitted from an active plate equally in all directions, a greater quantity being emitted normally to the plate than in directions making an angle with the normal. The absorption by air of radium C when it recoils from radium B was investigated. It was found that about half the radium C projected from a plate was stopped by 2·5 cm. of air at a pressure of 0·04 mm. mercury. Since radium B emits only β particles, the energy of recoil in this case should be less than one-millionth of the energy of recoil in a transformation in which an α particle is emitted. The fact that the penetration of radium C when it recoils is as much as one-fortieth of that previously found for radium A and radium B is therefore surprising.—Dr. C. V. **Burton**: The sun's motion with respect to the æther. Notwithstanding the well-known "principle of relativity," it is theoretically possible to determine the motion of the solar system with respect to the æther from observations of the eclipses of Jupiter's satellites, and the possibility was indicated by Maxwell some thirty years ago. For convenience, the motion of the æther with respect to the sun may be called a wind, and the method proposed is based on the consideration that the tidings of an eclipse will travel towards us more rapidly when the Jovian system is to windward of us than when it is to leeward. The residual discrepancies between the observed and calculated times of eclipses have to be analysed for systematic differences depending on the direction in space of the straight line drawn from the earth to Jupiter, and formulæ are given for finding by the method of least squares the most probable values of a, b_1, c_1, the components of the sun's velocity with respect to the æther. The material available is to be found in Prof. R. A. Sampson's discussion of the Harvard photometric eclipse observations, about 330 eclipses of Jupiter's satellite I. being included. In order to obtain a preliminary notion of the accuracy to be expected, a simplified system has been considered in which (for one thing) the eccentricity of the orbits was virtually neglected, and it appears that some advantage is to be gained by taking the plane of Jupiter's orbit, rather than the ecliptic, as one of the coordinate planes. The axis of x is drawn from the sun's centre through the node of Jupiter's orbit, the axis of y lying also in that orbit, and the axis of z being perpendicular thereto. Taking 4·5 seconds as the "probable" discrepancy between theory and observation for a single eclipse, the following preliminary estimates are obtained:—probable error in a= 43·6 km. per second; probable error in b_1=45·6 km. per second; probable error in c_1=10,000 km. per second.

Royal Anthropological Institute, November 30.—Dr. A. C. Haddon, F.R.S., in the chair.—Canon **Greenwell** and the Rev. R. A. **Gatty**: Pit-dwellings at Holderness. An interesting discovery of pit-dwellings has been made by Mr. William Morfitt, of Atwick, near Hornsea, in Holderness. Mr. Morfitt for the past twenty years has devoted his attention to these dwellings, which are excavated 5 feet deep in the Boulder-clay, and are covered by an unbroken surface soil to the depth of 18 inches. The pits are filled with black mud, which on being removed discloses the original floor of the dwelling, with its hearth and broken pottery, the remains of past feasts in the form of broken bones, and the rude flint tools of the dwellers, for no well-shaped implement has come to light. About thirty of these dwellings have been examined and the pottery restored. Their great antiquity is proved by the fact that long after the inhabitants had ceased to occupy the pits, and mud had filled them up, a surface soil had formed to the depth of 18 inches, upon which late Neolithic implements and bronze implements have been found. This shows the dwellers to have been earlier than the Bronze age. The pottery is of the rudest kind, with no decoration. The bones remaining from the feasts include those of red deer, horse, Celtic ox, goat, and pig. Although the pits are now close to the sea, no fish bones or shells have been found in them, which proves that when they were occupied their position was far inland. The rapid

demolition of the land by the sea in this part of Holderness accounts for this, but it also shows that a long period of time must have elapsed. In all probability these pit-dwellings are among the earliest habitations of Neolithic man which have been found in England. Prof. Boyd Dawkins was present when a fall of cliff had exposed one of these pits on the estate of Colonel Haworth Booth, and verified the fact that the surface soil covering the pit was unbroken, and must have been deposited after the pit had become filled with mud.

Faraday Society, November 30.—Mr. James Swinburne, F.R.S., president, in the chair.—Dr. H. J. H. **Sand**: The electroanalytical determination of lead as peroxide. This investigation was carried out with the object of elucidating the cause of the discrepancy between the statements of various experimenters regarding the behaviour of an electrolytic lead peroxide deposit on drying at 200°. All authors agree that the peroxide deposit retains water at this temperature, but whereas Hollard and Bertiaux give an analytical factor of 0·853, most other investigators find a factor of approximately 0·864, the theoretical factor being 0·866. Incidentally, the effect of varying conditions on the coherence of the deposit was also studied. It was found that at 200° a lead peroxide precipitate is capable of absorbing moisture from a damp atmosphere, and an increase of as much as 1·7 per cent. of the weight of the deposit has thus been obtained. On heating in a dry atmosphere at the same and higher temperatures the peroxide loses its water exceedingly slowly.—A. **Jaques**: The influence of dissolved gases on the electrode potential in the system of silver—silver acetate, aq. Variable values were found for the E.M.F. of the cell

$$Ag \mid AgC_2H_3O_2, xN \mid NH_4NO_3, \text{sat.} \mid 0{\cdot}1\ N.E.,$$

and the variations were traced to the presence of dissolved air in the silver acetate solution. Measurements were made with saturated and 0·5 N silver acetate solutions saturated with hydrogen, oxygen, nitrogen, and carbon dioxide respectively, and reproducible values were obtained for the solution saturated with hydrogen which agreed with those calculated from the determinations of the E.P. of silver by G. N. Lewis and by Brislee. The values for solutions saturated with carbon dioxide also approximated to this. On blowing hydrogen into the solution saturated with carbon dioxide the potential fell about 30 millivolts, then gradually rose to about the normal value. With oxygen and nitrogen equal values were obtained—about 20 millivolts below that found with hydrogen. In 0·01 N silver acetate saturated with hydrogen the values were not reproducible. Similar measurements with 0·1 N silver nitrate and 0·5 mol. N lead acetate and lead nitrate showed that in these solutions the electrode potential is practically unaffected by the presence of dissolved gases.—A. **Jaques**: Contributions to the study of ionisation in aqueous solutions of lead acetate and cadmium acetate. From measurements of electrode potentials in solutions of lead and cadmium acetates, and their freezing points, and the solubility of silver acetate in them, it appears that in dilute single solutions ionisation occurs chiefly, though not entirely, according to the scheme

$$M(C_2H_3O_2)_2 \rightleftharpoons MC_2H_3O_2 + C_2H_3O'_2$$
$$MC_2H_3O_2 \rightleftharpoons M\cdot\cdot + C_2H_3O'_2,$$

where M represents Pb or Cd. Approximate values for the corresponding dissociation constants are calculated.—Prof. F. G. **Donnan** and Dr. G. D. **Hope**: The calorimetrical analysis of hydrated salts. The authors point out that the interpretation of the heats of solution of hydrated and partially dehydrated salt given by Thomsen in his "Thermochemische Untersuchungen" is in various cases either erroneous or unsatisfactory. It is shown that Thomsen's data for sodium carbonate indicate, when correctly interpreted, the existence of only the hydrates with 1, 7, and 10 mols. water per mol. anhydrous salt. The authors' experiments confirm this result. In the case of copper sulphate, neither the experiments of Thomsen nor those of the authors indicate more than the existence of the hydrates $CuSO_4{\cdot}5H_2O$ and $CuSO_4{\cdot}H_2O$, though the hydrate $CuSO_4{\cdot}3H_2O$ is known to exist.

Linnean Society, December 2.—Dr. D. H. Scott, F.R.S., president, in the chair.—Sir Charles **Eliot**: Nudibranchs from the Indian Ocean.—Dr. Georg **Ulmer**: Trichoptera von Mr. Hugh Scott auf den Seychellen gesammelt.—Dr. W. H. **Dall**: Report on the Brachiopoda obtained from the Indian Ocean by the *Sealark* Expedition, 1905.—Prof. J. S. **Gardiner** and others: Narrative of the *Sealark* Expedition, part iii.

PARIS.

Academy of Sciences, November 29.—M. Bouchard in the chair.—L. **Maquenne** and M. **Demoussy**: The blackening of green leaves. The blackening of leaves by the ultra-violet rays is not due to a specific action of this radiation; it takes place equally under all influences which determine the death of the protoplasm, such as heat, chloroform, or mechanical rubbing. This phenomenon is a consequence of diastatic action, and falls into the same category as the facts observed for the first time by M. Guignard in his researches on the localisation of plant principles.—A. **Witz**: The regeneration of the exhaust gases from internal-combustion motors. The author suggests that the exhaust gases, taken from the cylinder without cooling, should be passed over a column of incandescent coke. The gas thus produced, containing carbon monoxide, is washed and re-admitted with pure oxygen to the gas-engine cylinder. It is assumed that the price of the oxygen, prepared from liquid air, is now sufficiently low for use in this manner commercially. The utilisation of the heat in the exhaust gases is calculated to give an economy of about 30 per cent.—S. **Arloing**: Antituberculous vaccination in the ox. An account of the practical results which have been obtained in the direction of obtaining immunity against tuberculosis in cattle in experiments which have been carried on for more than twenty-five years.—M. **Jarry-Desloges**: The period of rotation of Mercury. The surface of Mercury presents a certain number of dark spots, often well defined. The chief difficulty in perceiving these is the bad quality of the telescopic images. The rotation of Mercury from these observations would appear to occupy a long period, and is probably equal to the time of revolution.—Robert **Jonckheere**: Study of the planet Mars at the Observatory of Hem. Details are given of observations taken between July 16 and November 1 of this year.—Jean **Merlin**: Algebraical equations.—M. and Mme. Paul **Dienes**: Algebraico-logarithmic singularities.—Frédéric **Riesz**: Linear functional operations.—L. **Lichtenstein**: The determination of the integrals of the equation

$$\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}+a\frac{\partial u}{\partial x}+b\frac{\partial u}{\partial y}+cu=f.$$

—H. **Pellat**: The bifilar pendulum. A supplementary note to a recent paper on this subject dealing with the error introduced by the defective flexibility of the suspending metallic ribbons.—H. **Merczyng**: Studies on very short electromagnetic waves. Reflection and anomalous dispersion of liquids. These measurements necessitated the exact determination of the wave-length of the electromagnetic waves, and the method based on the dimensions of the vibrators not being sufficiently accurate, an interference method was worked out. The dielectric constants with these short waves (4·5 cm.) and the optical refractive indices were compared for several liquids, including glycerin, methyl and amyl alcohols, acetic acid, aniline, and ethyl ether.—Edm. **van Aubel**: The production of ozone under the influence of ultra-violet light. Experiments are described proving that ozone is formed by the rays from a quartz mercury lamp.—Laurent **Raybaud**: The destructive effect of the solar radiation. An account of the action of various radiations on cultures of *Phycomyces nitens*.—Georges **Meslin**: Magnetic dichroïsm and the orientation of crystals of siderose in the field.—Edmond **Bauer** and Marcel **Moulin**: The constant in Stefan's law. A possible source of error in the determination of this constant by M. Féry is pointed out, and the constant re-determined. The value $6{\cdot}0\times10^{-12}$ is considered to be correct within 1 per cent.—E. **Rengade**: The theoretical form of the cooling curves of binary mixtures: the case of mixed crystals.—Paul **Sacerdote**: Changes in the colour of the diamond under the action of various physical agents. The

X-rays do not sensibly modify the colour of the diamond, but considerable change is brought about by the action of the kathode rays, the diamond developing a yellow tint. This tint is permanent at the ordinary temperature, but an exposure to a temperature of 300° to 400° C. rapidly restores the original tint.—André **Meyère**: The influence of radium, the X-rays, and the kathode rays on various precious stones. The stones examined in these experiments were the diamond, and white, blue, and rose corundums. One effect only was produced by all three radiations—the stone became more or less tinted yellow.—J. B. **Senderens**: The catalytic preparation of unsymmetrical fatty ketones. Thoria is the most suitable catalyser for the purpose of these experiments, and is employed at a temperature of 400° to 430° C. A mixture of fatty acids passed over this reagent gives the ketone according to the equation

$$R.CO.OH + R'.CO.OH = R.CO.R' + CO_2 + H_2O.$$

Small quantities of the two symmetrical ketones are formed simultaneously, but the three ketones are readily separated by fractional distillation.—G. **Vavon**: Hydrogenations in the terpene series. Pinene rapidly absorbs hydrogen in the presence of platinum black, giving a nearly quantitative yield of the hydrocarbon $C_{10}H_{18}$. Camphene and limonene behave similarly. In alcoholic solution hydrogen can be added in this way to maleic, fumaric, and cinnamic acids, and to erucic acid in ethereal solution.—T. **Klobb**: The phytosterols from the flowers of *Tussilago farfara*. Two new alcohols are described, one being a monovalent phytosterol, the other divalent and resembling arnidiol in its behaviour.—Georges **Darzens**: The catalytic hydrogenation of the quinoline and aromatic bases. The exact temperature at which the nickel oxide is reduced, and the temperature at which the catalysis is carried out, are the two essential factors in the successful reduction of quinoline and aromatic bases. The preparation of tetrahydroquinoline is described.—Paul **Gaubert**: The polychroism of artificially coloured crystals.—H. A. **Brouwer**: Certain lujaurites from Pilandsberg, Transvaal.—Lucien **Daniel**: A new graft hybrid.—F. **Bordas** and M. **Touplain**: An anaëroxydase and a catalase in milk. Repeating some work of M. Sarthou, the authors come to the conclusion that the existence of an anaëroxydase and a catalase in cow's milk has not been demonstrated; the colour reactions produced in milk on treatment with hydrogen peroxide are due to casein or its compound with lime.—L. **Cuénot** and L. **Mercier**: Studies on the cancer of mice. Relation between the grafting of the tumour, gestation, and lactation.—C. **Levaditi** and K. **Landsteiner**: The transmission of infantile paralysis to the chimpanzee.—Jacques **Pellegrin**: A new parasitic fish of the genus Vandellia.—A. **Gruvel**: The dispersion of some species belonging to the marine fauna of the coasts of Mauritania.—Paul **Lemoine**: The subterranean folds of the Gault in the Paris basin.—André **Delebecque**: The origin of the plain of Rocailles (Haute Savoie).—M. **Répelin**: The *rôle* of the most recent dislocations (post-Miocene) in the earthquake of June 11, 1909.

DUBLIN.

Royal Irish Academy, November 8.—Dr. F. A. Tarleton, president, in the chair.—Dr. R. F. **Scharff**: The evidences of a former land-bridge between northern Europe and North America. The author explained that he was only dealing with the most recent land-bridge of which we had any evidence between the two continents. The testimony in favour of this theory is of a two-fold character. It is based on an investigation of the sea-floor and on a study of the plants and animals of the countries supposed to have been joined to one another by land. The author alluded principally to the continental shelves and to the researches of Prof. Hull, Dr. Spencer, and Dr. Nansen. He also brought forward botanical and zoological evidence pointing to the existence of a former continuous land surface between north-western Europe and eastern North America. The theory of accidental transport of species across the ocean was especially commented upon and discussed, but the author was inclined to adopt the view that the similarity between the fauna and flora of the two continents was mainly due to a pre-Glacial land-bridge connecting Scotland with the Færöes, Iceland, Greenland, and Labrador.

NEW SOUTH WALES.

Linnean Society, September 29.—Mr. C. Hedley, president, in the chair.—E. W. **Ferguson**: Revision of the Amycteridæ (Coleoptera), part i., the genus Psalidura. The family Amycteridæ comprises several groups of hard-shelled, apterous, and solely terrestrial weevils. The genus Psalidura comprises the group the distinguishing character of which is that the males possess anal forceps. The previously described species, numbering 37 in Masters's Catalogue, have been revised, and reduced to 24, to which number 22 new species are added, making a total of 46 species. Of these, it has not been possible to examine any specimens of four species, of which three—*P. D'urvillei*, *P. mirabunda*, and *P. squalida*—were described originally from female specimens only (and the descriptions are, therefore, almost valueless).—T. H. **Johnston**: The Entozoa of monotremes and Australian marsupials.—T. H. **Johnston** and Dr. J. B. **Cleland**: Notes on some parasitic Protozoa.—J. H. **Maiden** and E. **Betche**: Notes from the Botanic Gardens, No. 15, on a plant, in fruit, doubtfully referred to Cymodocea.

October 27.—Mr. C. Hedley, president, in the chair.—A. M. **Lea**: Revision of Australian Curculionidæ, subfam. Cryptorhynchides, part x. The tenth instalment of the revision continues the consideration of the genera allied to Chætectetorus, all of them belonging to the "Cryptorhynchides vrais" of Lacordaire. Twelve genera, and thirty-eight species, including fifteen proposed as new, are described.—A. F. B. **Hull**: The birds of Norfolk and Lord Howe Islands. The number of species actually known to breed at the present time amounts to twenty-nine for Norfolk and twenty-one for Lord Howe Island.—R. J. **Tillyard**: Studies in the life-histories of Odonata. No. 3. Notes on a new species of Phyllopetalia, with descriptions of nymph and imago. The species here named *Phyllopetalia patricia*, n.sp., was described by the author in 1906 under the name of *P. apollo*, Selys. Further investigation has shown it to be possessed of a number of important peculiarities, marking it out as a distinct species. The discovery of the nymph by Mr. Keith Brown at Leura, Blue Mountains, is of the greatest importance to ontogenists, as the specimen is the only known form of the Petalia group of dragon-flies. Evidence is brought forward, mainly on the form of the labium, strongly supporting the view advocated by Dr. F. Ris, that the Petalia group is not referable to the Cordulegasterinæ at all (though at present placed in that subfamily), but is an archaic remnant of the true Æschninæ.—Dr. H. I. **Jensen**: Notes on some recent work on the rocks of Samoa. Prof. M. Weber, of Munich, recently published an exhaustive report on the petrography of the Samoan Islands, based upon the examination of a very complete series of rocks collected by Herr J. Friedländer in 1907. Additional light is thrown upon two problems discussed in the author's two papers on the geology of Samoa, &c., in the Proceedings for 1906 (p. 164) and 1907 (p. 706), namely, the significance of the case of a recently erupted basalt which, on analysis, showed a higher soda content than was to be expected from the results of the petrological examination; and the bearing of the sub-alkaline composition of the Samoan lavas now established by Weber, upon the hypothesis that the eruptions along the Samoa-Tonga-Taupo line depend upon an earth-folding movement (*loc. cit.*, 1906, pp. 661–2).

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 9.

ROYAL SOCIETY, at 4.30.—The Hexosephosphate formed by Yeast-juice from Hexose and Phosphate: W. J. Young.—On the Presence of Hæm-agglutinins, Hæm-opsonins, and Hæmolysins in the Blood obtained from Infectious and Non-infectious Diseases in Man (Third Report): L. S. Dudgeon and H. A. F. Wilson.—Gametogenesis of the Gall-fly *Neuroterus lenticularis* (*Spathegaster baccarum*). Part I.: L. Doncaster.—Preliminary Note upon the Cell Lamination of the Cerebral Cortex of

Echidna, with an Enumeration of the Fibres in the Cranial Nerves: Dr. E. Schuster.—Cortical Lamination and Localisation in the Brain of the Marmoset: Dr. F. W. Mott, F.R.S., Dr. E. Schuster, and Prof. W. D. Halliburton, F.R.S.—The Caudal Fin of Fishes (Preliminary Paper): R. H. Whitehouse.—Some Experiments with the Venom of *Causus rhombeatus*: H. E. Arbuckle.—On the Comparative Action of Stovaine and Cocaine as measured by their Direct Effects upon the Contractivity of Isolated Muscle: Dr. V. H. Veley, F.R.S., and Dr. A. D. Waller, F.R.S.—*Glossina palpalis* as a Carrier of *Trypanosoma vivax* in Uganda: Colonel Sir David Bruce, C.B., F.R.S., Captains A. E. Hamerton and H. R. Bateman, R.A.M.C., and Captain F. P. Mackie, I.M.S.—A Critical Study of Spectral Series. Part I., The Alkalies, H and He: Prof. W. M. Hicks, F.R.S.—On the Distribution of the Röntgen Rays from a Focus Bulb: G. W. C. Kaye.—On the Nature of the Ionisation of a Molecule by an α Particle: R. D. Kleeman.—Conduction of Heat through Rarefied Gases: F. Soddy and A. J. Berry.—Harmonic Tidal Constants for Certain Chinese and New Zealand Ports: T. Wright.—The Photographic Action of the α Particles emitted from Radio-active Substances: S. Kinoshita.

MATHEMATICAL SOCIETY, at 5.30.—Exhibition of an Instrument for Solving Cubic Equations: T. H. Blakesley.—The Connection between the Theories of the Singularities of Surfaces and Double Refraction: A. B. Basset.—On the Representation of a Group of Finite Order as a Group of Linear Substitutions with Rational Coefficients: Prof. W. Burnside.—The Eliminant of the Equations of Four Quadric Surfaces: A. L. Dixon.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Notes on Methods and Practice in the German Electrical Industry: L. J. Lepine and A. R. Stelling.

ROYAL SOCIETY OF ARTS, at 4.30.—The Punjab: Sir James Wilson, K.C.S.I.

FRIDAY, DECEMBER 10.

ROYAL ASTRONOMICAL SOCIETY, at 5.—On certain Families of Periodic Orbits: Sir G. H. Darwin.—Description of a Field Method for the Determination of Latitude with a Theodolite: N. S. Bartlett.—Southern Double Star Measures: G. D. Hirst.—Note on certain Coefficients appearing in the Algebraical Development of the Perturbative Function, Second Paper: R. T. A. Innes.—On the Modern Theory of Aberration: H. C. Plummer.—*Probable Paper*: On the Diagrammatic Representation of Proper Motions: H. H. Turner.

MALACOLOGICAL SOCIETY, at 8.—Note on the very young Stage of the Genus Humphreyia: G. A. Smith.—A Further Note on the Anatomical Differences between the Genera Cypræa and Trivia: H. O. N. Shaw.—A New Mexican Genus of Pleuroceratidæ: Prof. H. A. Pilsbry.—Notes on a Collection of Terrestrial Land Shells from Angola, with Description of New Species: H. B. Preston.—Notes on the Genus Libera: J. H. Ponsonby.

MONDAY, DECEMBER 13.

ROYAL SOCIETY OF ARTS, at 8.—Aëronautics: C. C. Turner.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Exploring Journeys in Turkey-in-Asia: Capt. Bertram Dickson.

TUESDAY, DECEMBER 14.

ZOOLOGICAL SOCIETY, at 8.30.—(1) On Change of Colour in a Specimen of *Mellivora ratel* living in the Society's Gardens; (2) A Comparative Examination of Three Living Specimens of *Felis tigris sondaica*, with Notes on an old Javan Male: Dr. F. D. Welch.—The Nesting-habits of *Phyllomedusa sauvagii*: Dr. W. E. Agar.—(1) Marine Fauna from the Mergui Archipelago, Lower Burma, collected by Jas. J. Simpson and R. N. Rudmose-Brown: Madreporaria; (2) Marine Fauna from the Kerimba Archipelago, Portuguese East Africa, collected by Jas. J. Simpson and R. N. Rudmose-Brown: Madreporaria: Ruth M. Harrison and Margaret Poole.—(1) Some Notes upon *Boa occidentalis* and *Boa (Pelophilus) madagascariensis*; (2) Notes upon the Anatomy of Monkeys of the Genus Pithecia: F. E. Beddard, F.R.S.—On the Ophidian Genus Grayia: G. A. Boulenger, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Railway Signalling in India: C. W. Hodson.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Notes on a Recent Ethnographical Expedition to the Congo: E. Torday.

WEDNESDAY, DECEMBER 15.

ROYAL SOCIETY OF ARTS, at 8.—The Diamond Fields of Brazil: H. Pearson.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—The Variations of Currents of Air indicated by Simultaneous Records of the Direction and Velocity of the Wind: Dr. W. N. Shaw.—(1) South American Rainfall Types; (2) The Study of Phenomenal Climatology: W. G. Reed.

GEOLOGICAL SOCIETY, at 8.—The Metallogeny of the British Isles: A. Moncrieff Finlayson.—The Skiddaw Granite and its Metamorphism: R. H. Rastall.—The Geological Structure of Southern Rhodesia: F. P. Mennell.

ROYAL MICROSCOPICAL SOCIETY, at 8.—On the Measurement of Grayson's Ten Band Plate: A. A. C. E. Merlin.—Convenient Form of Stand for Use as a Micro-colorimeter and with Micro-spectroscope: Dr. D. Marshall Ewell.—On the Life-history of the Hessian Fly, with Notes on the Tenby Wheat Midge: F. Enock.

THURSDAY, DECEMBER 16.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Some Quantitative Measurements in Connection with Radio-telegraphy: Dr. J. A. Fleming, F.R.S.—Efficiency of Short Spark Methods of Generating Electrical Oscillations: Dr. W. H. Eccles and A. J. Makower.

LINNEAN SOCIETY, at 8.—Report on the Crustacea Isopoda and Tanaidacea collected by Mr. C. Crossland in the Sudanese Red Sea: Rev. T. R. R. Stebbing, F.R.S.—Pycnogonida from the Red Sea and Indian Ocean collected by Mr. C. Crossland: Prof. G. H. Carpenter.—On a Collection of Blattidæ preserved in Amber from Prussia: R. Shelford.—Isopoda from the Indian Ocean and British East Africa: Rev. T. R. R. Stebbing, F.R.S.—The Bryozoa from Collections made by Mr. C. Crossland, Part II., Cyclostomata, Ctenostomata, Endoprocta: A. W. Waters.

INSTITUTION OF MINING AND METALLURGY, at 8.

FRIDAY, DECEMBER 17.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Mild-steel Tubes in Compression and under Combined Stress: W. Mason.—Compound Stress Experiments: C. A. M. Smith.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Foundation and Construction of Dock Walls: H. T. Tudsbery.

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