THURSDAY, FEBRUARY 9, 1911.

STUDIES IN PHYSIOLOGY.

Physiology the Servant of Medicine, being the Hitchcock Lectures for 1909, *delivered at the University of California, Berkeley, Cal.* By Dr. Augustus D. Waller, F.R.S. Pp. viii+143. (London: University of London Press and Hodder and Stoughton, 1910.) Price 5*s*.

WHATEVER may be the place of lectures in the education of youth, the endowments of lectureships for occasional addresses by distinguished men have proved of eminent service. And this not in science only, as the Gifford, Bampton, and other lectures bear witness. Of such happy advantage this bright little book is one more instance. Such an invitation serves both as a stimulant and a purpose to a man of science or learning, in the phrase of Prof. Waller (p. 66), to bring to "a kind of nodal point, or focus, several lines of thought"; and, moreover, to set forth for the intelligent world some summary of a life's impressions, which otherwise he might never have been led to do; and, as should be in such a work, this set of lectures contains matter of both practical and of theoretical value—matter, that is of both immediate and of future service to mankind.

Many of us in times past have wasted some little sympathy—quite uncalled for—with ardent physiologists, such as the late Burdon-Sanderson and our present author, who, in spite of laborious work in the field of electric biology, did not for a time seem to be engaged on a very remunerative task. In the field of therapeutics, for example, electric work seemed—apart from certain points or diagnosis—not to come to very much. But no one can read these lectures without being reinforced in the better judgment that if the harvest seemed long in coming it is now full of reward; and this little book, by a master of the subject, shows us lucidly and in perspective the useful and interesting results which are being attained. In the first lecture we read, from the starting point of the isolated muscle, the effects of ether, alcohol, and chloroform, in the electrical language of the cardiac muscle, as illustrated in part by the "torture" of "Jemmy." The point of view of this chapter is to illustrate how chemical changes in living tissues are signified and can be measured by the electrical. Lecture ii., starting from the isolated nerve, reads the language of nervous matter in the same manifestation. Lecture iii. is pharmaceutical, with a notable discussion of anæsthetics. Lecture iv. is full of facts and arguments on the photo-electrical response, not of the retina only, but also of green leaves and animal and vegetable tissues generally. The breadth of view, and this evocation of answers from all sides of nature, speak eloquently of the various and comprehensive talents of the author. Lecture v. may be for him the acme of his treatise, for in it he develops and emphasises his well-known contrast of the precious uses of general anæsthetics, with the intimate perils of their ordinary application; but in no pessimist spirit, in the assurance rather that under scientific guidance these uses can be had without the perils. How great under rule of thumb these perils have been, and still may be he does not hesitate to declare with the authority which belongs to one in whom to the talent of scientific discovery are added the practical dexterity of the mechanic and the enthusiasm of humanity. Prof. Waller believes that he has eliminated "idiosyncrasy"; and he anticipates a like dismissal for the "status lymphaticus." The last chapter—an appendix—is reserved for some notes and general reflections arising out of what has gone before, reflections full both of insight and accomplishment.

I had marked many passages for especial notice, but I see that in such a quest I should soon trespass beyond my limits. I will rather engage the reader of this notice to procure the little book for himself, advice which I offer, not only to medical, but to all readers of NATURE; for it is the note of a master of his subject that in addressing a larger public he can make it intelligible to every trained mind whatever its pursuits. And the paragraphs are full of happy and illuminating sidelights; for instance, on the "line of beauty" (p. 65), I have heard Watts say more than once that for the painter the line of beauty is one which cannot return into itself. From the time of Haller, or indeed from Harvey, physiology has been very fortunate in its exponents, a good fortune which it still enjoys.

CLIFFORD ALLBUTT.

THE PINES OF AUSTRALIA.

A Research on the Pines of Australia. By R. T. Baker and H. G. Smith. (Technological Museum, N.S.W., Technical Education Series, No. 16.) Pp. xiv+460. (Sydney: William A. Gullick, Government Printer, 1910.)

THE joint authors of this book are both officers of the Technological Museum of New South Wales, acting in the botanical and chemical departments respectively, and also joint authors of a similar "research" on the genus Eucalyptus, published some years ago. Beginning with the title of the present work, we question its appropriateness, though there may be local considerations which justify its adoption. To what extent the names "Moreton Bay Pine," "Cypress Pine," &c., are used, outside of books, is uncertain. Here, in the northern hemisphere, the term pine is by no means applied uniformly, but its use is restricted to the Abietaceæ, no member of which is a native of Australia. A criticism of this kind is easily put forward, but it is difficult to find a more suitable and popular name, as the family designation, Coniferæ, is equally open to objection, in view of a classification based on relatively recent researches. Mr. Baker, however, might have consistently used the term Coniferæ, inasmuch as he accepts and employs the classification and terminology of Bentham and Hooker's "Genera Plantarum," in which the six groups, Cupressineæ, Taxodieæ, Taxeæ, Podocarpeæ, Araucarieæ, and Abietineæ are regarded as tribes of one family or natural order—the Coniferæ. All these groups, except the last, are represented in the indigenous vegetation of Australia, and eleven of the thirty-two genera described by Bentham and Hooker are in part, or wholly, Australian, with a total of thirty-seven species. Of these Araucaria and Agathis (Dammara) are the only genuine cone-bearing genera; the former being also represented by recent species in Brazil and Chili, and the latter is spread over the Malayan Archipelago and extends to New Zealand and some of the Pacific Islands.

Coming to the plan of the book and the treatment of the subject, it should be explained that the main object of the investigations was to ascertain, describe, and illustrate the "commercial possibilities" of the various species of the Australian Coniferæ. The genus Callitris (otherwise Frenela)—to which Mr. Baker applies the popular name Cypress generically, in spite of his title—as now generally circumscribed, is almost restricted to Australasia (Australia and Tasmania). Two species, however, occur in New Caledonia, a fact overlooked apparently by Mr. Baker. There are eighteen Australian species, and they are spread over the whole country. Its nearest allies are African, and they have sometimes been referred to the same genus; but Mr. Baker, following other authorities, retains the North African Tetraclinis, and the South African Widdringtonia, which he diagnoses anew. Callitris is the only genus of Coniferæ of general dispersion in Australia, and the vast areas covered by some of the species will come as a surprise to most botanists. Mr. Baker gives very full details of the distribution of the Australian Coniferæ, but more especially within the State of New South Wales. *Callitris glauca* is found in all the States, "but nearly always away from the coast." Ten pages are devoted to its distribution in New South Wales, where it is known to occur in eighty-seven counties, covering hundreds of thousands of acres. *C. glauca* is perhaps the most important of all the small trees of Australia, as its timber (as well as that of other species of Callitris) is impervious to the white ant.

This species is illustrated by about thirty figures, from the habit of growth of the individual to the anatomy of the various parts. Altogether the work contains 296 figures of anatomical structure and chemical secretions, all photographic reproductions, some in colour and mostly of excellent quality. In addition there are about seventy unnumbered plates or full-page illustrations, some of which are scenic, others individual trees, while others represent herbarium specimens of the natural size. Unfortunately an index to the figures and plates is wanting. There are also three maps, one of which illustrates the distribution of the Coniferæ of New South Wales so far as at present known. In the compilation of this map the authors had the assistance of about 130 persons, mostly schoolmasters and mistresses. Assuming that they afforded trustworthy information, it is evidence of an interest in natural history not easily paralleled. As already mentioned, the chemical composition of the various products, the results of very protracted investigations, is given in considerable detail. In addition there is much practical information. Comparing the number of species cited, it will be seen that an average of twelve pages is devoted to each; more or less, according to their importance. Much space is devoted to anatomy and chemistry, and more might have been profitably given to morphology and a discussion of the theoretical structure of the female cone and the male catkin of the earlier writers. The term gymnosperm is mentioned, but no definition follows, and for a description of the family the reader is referred to Bentham and Hooker's "Genera Plantarum," as Mr. Baker considers it "would be superfluous to repeat it," losing sight of the fact that this classical work is expensive and accessible to comparatively few persons, besides not being up-to-date in many details.

W. B. H.

PRACTICAL INORGANIC CHEMISTRY.

A Manual of Practical Inorganic Chemistry, including Preparations and Qualitative and Quantitative Analysis, with the Rudiments of Gas Analysis, specially adapted to cover Preliminary and Intermediate University Courses and the First Three Stages of the Syllabus of the Board of Education. By Dr. A. M. Kellas. Pp. viii+347. (London: H. Frowde and Hodder and Stoughton, 1910.) Price 5s. net.

THIS volume belongs to the series of Oxford medical publications, in which an "Introduction to Practical Chemistry" was published by the same author in 1909. A comparison of the two volumes shows that nearly two hundred pages of the texts are identical, and there can be little doubt that the type set up for the earlier publication has been used in the production of the major portion of the present volume.

Amongst the new matter may be noted a section dealing with preparative work of a more advanced character. The preparations described include the chlorides and oxides of sulphur, phosphorus, and silicon, the chlorides of iron, aluminium, and tin, bleaching powder, potassium chlorate, chromate, bichromate and permanganate, sodium nitrite, calcium hypophosphite, and sodium thiosulphate. The list of metallic compounds, of which the mode of preparation is described, has, moreover, been extended so as to include practically all the inorganic compounds in the British Pharmacopœia. A summary of these compounds is given, in which the impurities to be looked for are in each case indicated. This extension is evidently designed for the special purposes of pharmaceutical students, and can scarcely be regarded as an enlargement in the scope of the work from a chemical or an educational point of view.

In the section dealing with the identification of acid radicles, the reactions of some thirty-three acids are given in the *Manual* as compared with sixteen in the *Introduction*. The short section devoted to quantitative analysis in the latter has been expanded from about twenty-five to seventy-five pages in the new volume, and in addition to several new gravimetric estimations, the commoner volumetric methods are described. This and the last section, in which the author gives an account of the apparatus and methods used in quantitative gas analysis, represent the greater part of what is not to be found in the previous volume.

The new matter is presented in a very lucid form, and from the instructions and detailed explanations, which are intended to lighten the work of the teacher, the average student should find little difficulty in working intelligently in the laboratory without much supervision.

In connection with the formulation of chemical changes, a brief reference is made to the theory of electrolytic dissociation, and the reader is informed that the reactions involved in analysis are, as a rule, ion reactions. If this is really the case, it is difficult to justify the author's use of ordinary chemical equations in preference to ionic equations, even if it be admitted, that, in some cases, the representation of oxidation and reduction changes is not quite so simple when the ions are taken into consideration.

In view of the undoubted merits which the book possesses, it is distinctly unfortunate that nearly two-thirds of the contents should be a mere copy of a previous and very recent publication. There is nothing in the titles of the two books to suggest such a large measure of identity in respect of text and diagrams to prospective purchasers, and it is to be regretted that the publishers should have seen fit to proceed to publication in this particular way. H. M. D.

MATHEMATICS AND OPHTHALMOLOGY.

The Prescribing of Spectacles. By A. S. Percival. Pp. vi+159. (Bristol: John Wright and Sons, Ltd.; London: Simpkin, Marshall, Hamilton, Kent and Co., Ltd., 1910.) Price 5*s.* 6*d.* net.

DR. A. S. PERCIVAL is one of the most eminent of the comparatively few English ophthalmologists who have shown the requisite knowledge to treat mathematically in an exhaustive manner optical problems connected with the eye. The ordinary student of ophthalmology is content to accept on authority the results obtained by others, or at most to study such geometrical expositions as may be readily understood. Indeed, he is generally wholly incapable of comprehending an analytical proof, and nothing is so abhorrent to his mind as an algebraical formula. It is greatly to be deplored that more emphasis is not laid upon the acquirement of a good knowledge of physiological optics, a subject which necessarily forms the very foundation of ophthalmology. Moreover, by far the greater part of every ophthalmic surgeon's work consists in the correction of errors of refraction, of defects in muscle balance, and other problems of an essentially optical nature. Only those who have given assiduous attention to the mathematical conditions presented by these problems can appreciate the help which this arduously acquired knowledge gives them. It is a humiliating fact that many practising opticians are far better equipped in this respect than most ophthalmic surgeons, and if the latter seriously expect to hold their own against the encroachments of the former they must outrival them on their own ground.

Dr. Percival's little book will prove of valuable service in the task. All the common problems which daily confront the surgeon in ordering spectacles for errors of refraction and defects of muscle balance are discussed, and the underlying principles lucidly explained. In most cases mathematical proofs, culled from the author's work on optics and other original papers, are set forth. Dr. Percival's name is specially associated with the formulæ for periscopic glasses, and the inquiring student will here be enabled to find out how the formulæ were arrived at, and why such lenses are to be preferred. A few paragraphs, such as the pinhole test of ametropia, might have been omitted as of little practical value, and the student would do well to read Maddox's book on the "Ocular Muscles" in conjunction with the chapter devoted to the subject in this work. The author's advice is always founded on a secure scientific basis, and such paragraphs as the following show that he is not carried away by purely theoretical conceptions. In speaking of the association between accommodation and convergence he says:—

"Clearly, if the relation between the two functions is unfitted for present requirements, and if there is no sufficient faculty of adaptation that can be brought into play by training, we should make the glasses suit the patient, instead of vainly attempting to make the patient suit the glasses."

And again:—

"In conclusion, I would say that although few patients will require such a complete examination as is here suggested, yet it is well to investigate the relationship of these functions of convergence and accommodation whenever symptoms still persist after the correction of any refractive errors and hyperphoria that may exist."

We can cordially recommend the book, and we hope that it may stimulate many ophthalmic surgeons to acquire a more profound knowledge of this branch of their subject.

THE BEETLES OF INDIA.

The Fauna of British India, including Ceylon and Burma: Coleoptera Lamellicornia (Cetoniinae and Dynastinae). By G. J. Arrow. Pp. xiv+322+ii coloured plates, and 76 illustrations in the text. (London: Taylor and Francis, 1910.)

THE beetles of India are an enormous subject, and the volume before us only deals with two subfamilies of the great group Lamellicornia, the first of which, though comprising the well-known and extremely interesting rose-chafers, is only represented by a few species in Britain, while the Dynastinæ, though a few species are found in southern Europe, is not represented in the British fauna at all. Two hundred and eighty-seven species of these two subfamilies are here described as belonging to the Indian fauna, but the editor's estimate of these being "perhaps less than one-sixth of the great 'series' of Lamellicornia," is perhaps somewhat too high, when we consider that the Lamellicornia include the whole of the chafers, the sacred beetles, and the stag-beetles.

Mr. Arrow has been fortunate in receiving the cooperation of the curators of most of the principal entomological collections in Europe and India, and of many enthusiastic and experienced collectors in India and Ceylon, and his work may therefore be taken as a trustworthy epitome of what is at present known relating to his subject. The glossary of technical terms which follows the preface will be useful, and there is also a comprehensive introduction of upwards of thirty pages in which the structure is fully described, and clearly illustrated by diagrams. These are points which are frequently too much neglected by entomological authors, but which are of real practical importance. Besides general remarks and a section on structure, the introduction deals with larvæ, vocal organs, sexual dimorphism, food and habits, and classification. The Lamellicornia beetles are mostly vegetable feeders, or dung or carrion beetles, and some of them, like our own cockchafers, are very destructive to grass in the larval stage, and to leaves of trees when mature. Some, chiefly belonging to the groups described in the present volume, inhabit the nests of ants and termites in the larval stage, and are tended by these insects for the sake of their secretions, while the dung and carrion beetles are general scavengers.

The Lamellicornia, as their name implies, are distinguished by their short lamellated antennæ, which may be observed in a well-developed and characteristic form in our common cockchafers. Mr. Arrow recognises three main families, the Scarabæidæ, Passalidæ, and Lucanidæ. The Passalidæ are not European; the Lucanidæ are the stag-beetles. The Scarabæidæ are divided into two smaller divisions, the Pleurosticti, with four subfamilies represented in the Indian fauna, and the Laparosticti, with eight.

The general arrangement of the volume is similar to that adopted in previous volumes of the "Fauna of India," and need not be further commented on here. Eight species are represented on each of the coloured plates.

We congratulate Mr. Arrow on the completion of an excellent piece of work, and hope that entomologists may have reason to be grateful to him for a long series of equally excellent volumes.

W. F. K.

ELECTRIC MOTORS.

Electric Motors. Continuous, Polyphase, and Single-phase Motors: Their Theory and Construction. By Henry M. Hobart. Second edition, entirely re-written, revised, and enlarged. Pp. xxiv+748. (London: Whittaker and Co., 1910.) Price 18*s.* net.

THE first edition of this work appeared in 1904. Since then remarkable advances have been made in electrical engineering. A foremost place in this progress must be given to electric motors, and more especially to that class employing commutators, in connection with both single- and poly-phase alternating currents. Indeed, the electrification of railways has made the variable-speed single-phase motor with a good starting torque indispensable, for at present the single-phase system alone seems to fulfil the requirements of main line electric traction. Also the polyphase induction motor is no longer to retain the great disadvantage in the matter of speed regulation, which makes it inferior to the continuous-current shunt motor, for successful means are now known whereby the speed may be varied economically over a wide range.

Both these problems are discussed in the present edition, and form part of the new material contained therein, but we find the treatment is mainly descriptive and too general to be of much use to anyone seriously engaged in the design or manufacture of these machines. Admittedly the subject is a difficult one, at any rate, more difficult than the design of ordinary continuous-current and induction motors. Nevertheless, in a book on the theory and construction of electric motors room ought to be made for a proper scientific study of these recent developments.

Coming to the other and major part of the book dealing with more or less *standard* motors, we do not find much improvement on the first edition. To a scientific engineer the author's style is too roundabout, illogical, and non-mathematical. A German engineer would probably call it "unpedägogisch." For instance, the author treats the principles of design by means of examples. Surely the classical way of developing formulæ from the theory, followed by practical details, and illustrated by examples, is far better. Nor—to judge from his examples—does the author appear to have kept pace with the times. We can only think that many of the designs, both of continuous- and alternating-current motors, have long since been repudiated by their respective firms.

The methods of calculation advocated by the author are often open to objection, but to cite instances would take us too far, as the list before us is really too long to choose from. We think enough has been said, however, to show that, while appreciating the immense amount of information the writer has collected, we cannot agree he has produced a book which can be regarded as a standard treatise on the theory and construction of electric motors for the use of students or scientifically-trained engineers.

STANLEY P. SMITH.

THE GEOLOGY OF GERMANY.

(1) *Lehrbuch der Geologie von Deutschland. Eine Einführung in die erklärende Landschaftskunde für Lehrende und Lernende.* By Prof. J. Walther. Pp. xv+358. (Leipzig: Quelle and Meyer, 1910.) Price 7.60 marks.

(2) *Geologie von Deutschland und den angrenzenden Gebieten.* By Prof. R. Lepsius. Zweiter Teil, Lief. ii., Das nördliche und östliche Deutschland. Pp. vi+247–548. (Leipzig: W. Engelmann, 1910.) Price 10 marks.

(3) *Geologie von Ostpreussen.* By Prof. A. Tornquist. Pp. vii+231. (Berlin: Gebrüder Borntraeger, 1910.) Price 10 marks.

(1) PROF. WALTHER has been fortunately compelled to write an account of the geology of Germany, in furtherance of the scheme to which he stands committed. He is one of those educational leaders who believe that knowledge of literature and of cosmopolitan science is insufficient for the citizen. The Fatherland itself, *solum patriae*, must be understood in order to be loved. We must not begin and end with arranging minerals in cabinets and pointing

out their technical applications. Let us appeal rather to the country round the pupil's home. We want, says Prof. Walther, a wider opening of doors and windows. He would play, like the famous piper of Hameln, a tune full of the magic of the world. The school must follow him, when the sun reveals the peaks of far-off ranges, and when the wind swirls the dust in clouds across the slopes. It must follow, when the rain furrows the farmlands, and the roaring stream undercuts its trembling banks. Nature is ready to reveal its beauties, small and great, and comparison with other lands will yet increase a love of home.

With such stirring words this vigorous work sets out. The illustrations are almost all from places that the author knows. They have been drawn with brush or pencil by Herr Weszner from photographs and other trivial sources, with an art that seems coarse at first sight, but which grows very quickly on the reader. The painter has understood his author—note the simple desolation of the "Baumfriedhof" among the dunes (p. 5), the cemetery of trees; the renowned quarry of Solenhofen (p. 94), on a plateau above the village, where the level strata appeal so temptingly beyond the woods; or the vivid little sketch (p. 256) of Karlsbad crowded in its ravine; and compare this last with the glimpse of Regensburg (p. 293), seated like an island in the alluvium, as one sees it for the first time in descending from the hills. The essentials are all there, just as in the text, which is pure literature. The geological map, however, is far too severe and uncommunicative. Even the German schoolboy might hesitate before a group of towns named Mü., La., Er., and Rud., in the country east of Eis., which we conclude is Eisenach. The Porta Westfalica is figured, and might well be named; we seek it on the Weser between Ha., the city of the piper, and Mi., probably the place of the "men who fought." We have some acquaintance with the Vistula, and can look with interest on Th., Mbg. (recalling a watergate on the Nogat), and even Di., a railway junction; but we cannot recover Cu. We are writing far away from atlases, and there is no need for so many puzzles in a work that connects geography and geology. But this shall be our only grumble, though we believe that another map on p. 125, full of attractive river courses, is on only one-tenth of the scale ascribed to it. Theoretical questions are not overlooked by the author, when once he has aroused interest in the origins of things. We are brought to contemplate the yielding but sustaining *Untergrund* on p. 28; we gaze on a north pole in the middle of Greenland during the Ice age (p. 113); and we picture intelligent apes using eoliths in the Miocene period (p. 128). Throughout its first two sections the book stands successfully apart from most of our attempts at "nature-study." While we are apt to insist on the beauty of things, Prof. Walther makes us know that they are beautiful by his telling of them. In the third section, he leads us to a closely written description of the origins of German landscape; but we still come across vivid touches that enable us to realise the past. We should like to quote the description (p. 171) of the volcanic cloud caught by westerly winds above the crater of the Laacher See, or the passages that trace the history of the granite tors which rise on the Fichtelgebirge through the woods (pp. 242–3). Teachers will select and enlarge the descriptions of their special areas; but they will learn to adopt a comprehensive view of natural phenomena that will fit them, in Walther's opinion, to live upon this living world.

(2) Prof. Lepsius has carried his great work on the geology of Germany to the end of its second volume, and it remains a storehouse of well-chosen references to original research. Some of these must have found their way into the book almost during its passage through the press. The author was never a mere compiler, and in the present part he adds greatly to the interest of his subject by a full discussion of recent views on the deposits of the north German plain. He holds that there is no doubt as to the advance of ice from Scandinavia over this vast area; but he will not countenance the suggestion of inter-glacial epochs. The evidence for these he regards as local, and as supporting his belief in prolonged Scandinavian glaciers, rather than in a continuous ice-sheet (p. 477, *et seq.*). He does not accept Greenland as an existing parallel for what occurred in northern Europe, and quotes Schwarz with approval as to the maximum thickness of an ice-flow (p. 475). He sees the cause of the Ice age in geographical conditions, and attributes the Dwyka Conglomerate of South Africa (p. 514) merely to the elevation of a mountain chain. He allows of great movement of blocks of chalk by advancing ice, but does not accept the evidence for plucking action. All this shows that the author's spirit aims far beyond mere description, and that he is quite prepared to champion views which others have set aside. We have dwelt on this part of the book rather than on the fine and detailed description of the Harz area (pp. 286–410), where Prof. Lepsius critically reviews the work of Lossen, on the basis of personal observations. His readiness to adopt new views where he holds them to be justified is never left in doubt, a good example being his treatment of the mingled types of igneous rocks on the margin of the granite of the Harz (p. 350). Nor does he shrink from controversy, when he claims to have converted an eminent colleague (p. 443) to his undoubtedly sound opinions on the famous Saxon granulites. Prof. Lepsius has now furnished us with one of the most serviceable reference books on the geology of Central Europe.

(3) Truly the geologist is happy anywhere. Prof. Tornquist writes on the geology of Ostpreussen with enthusiasm. This remote province, as he justly remarks, is known to few besides those that dwell in it, but to them its very expanse is beautiful. In his handsome volume we learn much stratigraphy from the fossiliferous pebbles that are embedded in the covering of glacial drift. We hear of interesting formations that are reached by borings, and the mantle of clays and sands seems to the student to cover fascinating mysteries. The derived fossils are beautifully illustrated, and the amber, with its included insects, is ascribed mainly to the Lower Oligocene of Samland (p. 98). The discussion of the drift leads

to an account of the oscillations of the margin of the Scandinavian ice, and the formation during a resting epoch of massive terminal moraines. A block of Miocene sediments with undisturbed bedding, including brown coal, and 30 metres thick, has been found at Georgenswalde, as a transported inclusion in the boulder-clay (p. 150). Marine clays with Yoldia and many other molluscs are regarded, in opposition to recent views in Sweden, as older than the maximum extension of the ice. These beds seem, indeed (p. 156), to have been deformed by the pressure of the ice. One great forward movement of the glacier-front, and one retreat, broken by pauses and small oscillations, are held (p. 159) to explain the phenomena in Ostpreussen. During a pause, which Prof. Tornquist explains by the sinking of the ice into yielding glacial deposits in a great depression in the south-east of the province (p. 175), the pre-Glacial marine sands and the earlier ground-moraines are said to have been pressed up as a ridge, just as the growth of the dunes along the northern coast has pressed up modern marine beds out of the sea (*cf.* p. 209). The photographs give vitality and interest to a strange monotonous country, which we well remember, as we crossed it under grey September clouds. The view of Neidenburg (p. 167) reminds us of the gravels washed from the retreating ice, and of the last villages of Prussian Poland, joined by tracks of trampled sand. On this broad outwash plain, the white-capped Cossack riders, night and day, keep the boundary between east and west along the fenceless fields.

GRENVILLE A. J. COLE.

OUR BOOK SHELF.

Orchids. By James O'Brien. Pp. xii+114. (London and Edinburgh: T. C. and E. C. Jack, n.d.) Price 1*s.* 6*d.* net.

IN the preface to this little book it is observed that householders in suburban districts who have but one conservatory may, if they choose, keep it furnished with orchids at a less expenditure of time and money than is needed for the usual occupants of such structures. Frankly, we doubt it. The same thing has been written many a time before and doubtless many a confiding householder has tried to do it, but so far as we can judge the successes are few and far between. The author of this work has devoted his life mainly to the study and cultivation of orchids, and, like most experts, is apt to take for granted a knowledge of certain fundamental principles which for himself require as little consideration as breathing, but which are nevertheless absolutely essential to success. It is over these that the average suburban householder with no special training comes to grief. No doubt it can be done, especially by persons with abundant time on hand, and plenty of enthusiasm; but not by the ordinary City man who has to leave his orchids—their shading and ventilation—to the tender mercies of the jobbing gardener or the occasional attentions of a distracted housemaid from ten to six, the most important part of the day in orchid culture.

But whilst we cannot support the optimistic views as thus expressed by the author, we can strongly recommend his book. It gives a condensed, but wholly admirable, account of the history of orchid cultivation, of the structure of orchid flowers, of the principles of building orchid houses, and the best short account we have yet seen of how to cultivate these plants. Many who have themselves spent years amongst orchids will read the book with profit and pleasure. It is well printed, and is illustrated by eight coloured pictures made from plants grown in the famous collection of Sir G. L. Holford, at Westonbirt. They represent the acme of the orchid cultivator's art.

Practical Mathematics and Geometry. By E. L. Bates and F. Charlesworth. Pp. viii+446. (London: B. T. Batsford, 1910.) Price 3*s.* net.

THIS book has been written with the view of meeting the recent addition to the Board of Education examination syllabus, which unites arithmetic, algebra, and practical drawing under the heading of "Preliminary Practical Mathematics." In deciding the question as to the best teacher for the combined course the following points cannot be ignored. The mathematical teacher as a rule cannot be entrusted to teach draughtsmanship—one of the most important lessons a young technical student has to learn, and one which, if spoiled at the start, is rarely remedied later. On the other hand, the engineering teacher is apt to attempt to specialise in mathematics too early; again, his time is generally fully occupied with his own special work.

The book before us contains 446 pages crowded full of matter presumably considered essential for a first year's evening course. It includes mathematical work up to quadratic and other equations, logarithms and variation, and plane and solid geometry up to the projections of simple solids and their sections. There is little attempt to coordinate the mathematical and drawing work.

Introduction à la Métallographie Microscopique. By Prof. P. Goerens. Edition Française traduite par Prof. A. Corvisy. Pp. 227. (Paris: A. Hermann et Fils, 1911.) Price 10 francs.

THE English translation from the German edition of this work appeared more than two years ago, and was reviewed in NATURE, vol. lxxviii (1908), p. 387. The present book, however, is not identical with any previous issue. It is a careful revision by F. Robin, and is in advance of its predecessors in several respects. The arrangement is somewhat more logical, the description of the measurement of temperature by thermocouples being followed at once by a section devoted to the methods employed in studying the microscopic structure of metals, and the remainder of the book is occupied by an account of the constitution of alloys, illustrated by a very large number of examples. The iron-carbon alloys are dealt with in detail in a separate section. The most important additions of new matter are descriptions of many series of binary alloys, which have been studied during the last three or four years, and a large number of beautiful reproductions of photomicrographs of the structure of metals.

Das Radium und die Farben. By Prof. Dr. C. Doelter. Pp. viii+133. (Dresden: Theodor Steinkopff, 1910.) Price 4 marks.

THIS is a useful summary of the very numerous observations which have been made on the colour phenomena produced in minerals by the neighbourhood of radio-active bodies. Although the facility with which experiments can be made with radium (at least by the fortunate possessor of an adequate specimen of that substance) have given a special prominence to observation made with it, it is well known that analogous colorations are produced by kathode and Röntgen rays, and by ultra-violet light. These subjects are included in the book, which contains a full bibliography.

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.*]

Drainage and Malaria.

THE writer of the paragraph upon Drainage and Malaria in the "Notes" of NATURE for September 15, 1910, is evidently unaware that the facts as they relate to Klang and Port Swettenham, the two stations mentioned, lend themselves to a quite different interpretation from that put forward. The idea conveyed by the paragraph referred to is that two intensely malarious places have been freed from malaria by drainage alone, with a saving of more than 400 lives per annum.

A study of the reports that have been published from time to time by Drs. Travers and Watson, the medical officers who claim to be responsible for this remarkable achievement, reveals the following facts.

Klang is the principal town in a district of that name in the Federated Malay States. Port Swettenham is a new port situated five miles from Klang. It was opened in 1901. The total population of Klang district for 1901 was 18,110, of which 3576 belonged to Klang town. In 1903 the population of Klang and Port Swettenham together was estimated at about 4000.

From 1898 to 1904 the total deaths registered in the town and district together were as follows:—

	1898	1899	1900	1901	1902	1903	1904
Total deaths ...	475	5:8	780	998	547	543	612
Rate per 1000 ...	26·3	31·0	43·0	55·4	30·3	30·1	34·0

It will be seen from this table that the mortality rose very markedly in 1900 and 1901, and fell sharply in 1902.

An analysis of the returns shows this to have been due to an extraordinary temporary increase in the mortality of Klang town during these two years. The following table gives the mortality in the towns from 1900 to 1904 compared with that of the rest of the district:—

		1900	1901	1902	1903	1904
Towns	Total	474	582	144	115	122
	Per 1000 ...	132·5	162·7	36·4	28·7	30·5
District	Total	306	416	402	428	490
	Per 1000 ...	21·8	29·7	28·7	30·5	35·0

A consideration of these figures indicates that some special influence must have been at work in Klang town to cause the appalling mortality of 1900–1, and the history of local events gives the clue to this.

At one time Klang was both port and railway terminus of the district, but in 1897 it was decided to construct a new port five miles beyond Klang. The site chosen was a mangrove swamp partially submerged by every high tide; and for the reclamation of this, the making of railway embankments and the construction of approaches to the wharves and building sites, earth had to be brought from a distance. While the work was in progress, the coolie labourers employed suffered severely from malaria, which increased in severity as the work approached completion. The health of the town was also affected, and when at last the new port and railway were opened on September 15, 1901, and a large number of Government servants and others connected with the shipping were transferred from Klang to quarters at Port Swettenham, many of them contracted malaria.

This appears to have seriously alarmed the authorities, who had remained unmoved at the fearful mortality that had taken place before the opening of the new port, and, as a result, steps were taken to draw up a scheme for the drainage of both stations. Meanwhile, quinine was freely administered as a prophylactic with such good effect that a marked improvement was recorded even before the drainage schemes could be executed. The epidemic which had raised the mortality to such a frightful figure in 1900 and 1901 declined very rapidly after the opening of the port and railway, and the total number of deaths during 1902 was less than one-quarter of those in 1901.

To those acquainted with conditions in the tropics, the occurrence of an epidemic of malaria during the construction of a new port and railway, and its disappearance after the completion of the work, occasions no surprise, for it is just what has happened hundreds of times in the past.

In the East, the coolie labourers employed on such works are drawn almost entirely from the poorest and most ignorant classes of the population; they are often brought long distances and set down in a country in which the climate, and even the food obtainable, differs greatly from that to which they are accustomed; if housed at all, they are generally crowded into temporary huts, but frequently they are left to find what shelter they can; they have often no one to look after them when sick, and no means of obtaining food if for any reason they are unable to work. Their work is arduous and their pay small, and owing to the fact that they generally try to save money for the support of dependants at home, it is no uncommon thing to find them attempting to exist upon a miserably insufficient diet. Camped as they usually are upon the site of the work, their surroundings are almost always highly insanitary, for there is rarely any pretence at a conservancy system, and sometimes no proper water supply; and if much earth-work is going on, the numerous pools of water formed during the rainy season speedily become the breeding places of countless swarms of mosquitoes. In these circumstances it is not surprising that coolie labourers on large public works should be decimated by outbreaks of epidemic disease. But whatever happens to the coolies, the work has still to go forward, so that as long as it is in progress there is continual immigration of new labourers to fill the gaps caused in the labour force by sickness, desertion, and death. This continual immigration is a further source of mischief, for the constant introduction of gangs of susceptible newcomers into camps which have already become hotbeds of disease increases the trouble, just as the addition of fuel to a glowing fire increases the blaze.

Those who, like the writer of this letter, have watched the course of epidemics of this kind among Indian coolies, cannot fail to trace in the history of events at Klang and Port Swettenham a similar occurrence. It may be remarked that the epidemic at these places began among the labourers on the work, and increased in severity as that work progressed; it occasioned a fearful mortality, such as is never seen except in conditions similar to those described above; and just as its origin can be traced to the construction of the new port and railway, so also can its decline be traced to the completion of this work. Once a big project of this kind is finished, the labour force rapidly disperses, immigration of the class of labour employed ceases, a settled population takes its place, and conditions as regards health rapidly approach the normal once more.

In these circumstances it becomes difficult, if not impossible, to estimate the value of the drainage projects that were carried out at Klang and Port Swettenham after the decline of the epidemic, for it is certain that in any case there was bound to be a great improvement after the completion of the work on the new port and railway, and the dispersal of the labour force engaged on their construction. The only legitimate method of testing the results of the drainage of the two stations is the comparison of the mortality rates of Klang prior to the commencement of construction work for the new port and railway with those recorded after the introduction of the drainage schemes, and until this has been done it is misleading to claim these places as demonstrating the value of drainage in combating malaria.

As for the statement that more than 400 lives per annum have been saved by the drainage of Klang and Swettenham, it is an absurd fiction based on the ridiculous assumption that but for the drainage schemes the enormous rate of mortality recorded in 1901 would have continued unchecked. CHAS. A. BENTLEY.

Bombay, October 22, 1910.

I HAVE read with interest Dr. Bentley's interpretation of the figures relating to the anti-malarial works at Klang and Port Swettenham published by Dr. Travers and myself, and I am familiar with Dr. Bentley's valuable paper on the human factor in malaria. This factor is undoubtedly of profound importance in certain outbreaks; but at Klang and Port Swettenham the sequence of events was not to be explained by Dr. Bentley's theory, and he has, I think, overlooked two points in my published reports which at once set aside his explanation of the figures.

The suggestion is that the origin and sustaining factor in the outbreak was a camp at Port Swettenham densely populated with coolie labour, the coolies of which not only suffered severely from malaria, but also infected the other inhabitants of the port and of Klang, and that when the construction works at the port were finished at the end of 1901, the camp was broken up, the coolies dispersed, and the epidemic subsided.

If this theory be correct, we should naturally expect to find evidence of a severe outbreak among construction coolies at Port Swettenham during 1901.

As a matter of fact, not only was there no outbreak of malaria among coolie labourers at Port Swettenham, but there were actually no camp coolies. There is abundant evidence that this was the state of affairs, although, as the port was not opened until the end of the year, it was not unnatural for Dr. Bentley to suppose such a camp existed.

To explain, I may say that most of the earth construction was finished at the end of 1895 (Dr. Travers gives the date of beginning work as 1897, but this is a slip; see *Journal of Tropical Medicine*, 1903). The wharves were finished at the end of 1900. The only works then remaining to complete the port were three iron goods-sheds and the passenger railway station, for which skilled labour was required. This was not forthcoming, and these few buildings were not finished until September 15, 1901, when the port was opened. Through trains were, however, running from June, 1901.

On my first visit to Port Swettenham, in January, 1901, instead of finding a great camp of coolies as suggested by Dr. Bentley, I found only some twenty or thirty persons. Instead of poorly paid coolie labourers, there were high-paid Chinese artisans. Except for these few Chinese, occupying one of a series of empty huts formerly occupied by the construction coolies, the place was deserted. The Government quarters on each side of the main road also stood empty, and were not to be occupied until some nine months after my first visit to the port.

This is a condition of affairs so completely different from what is demanded by Dr. Bentley's theory, that the theory obviously becomes untenable; and to show that such was actually the state of affairs in 1901, I now give some extracts from published reports.

A.—*Evidence of date of beginning works.*

"The extension of the Klang line from Klang to Kuala Klang (former name of the Port) was commenced on January 1, 1895, and at the date of writing (April, 1896) is nearing completion. It is not proposed to open this line until the wharves at the mouth of the river have been completed" (see Report of Resident Engineer, Railways for 1895, Selangor Government Gazette, 1896).

B.—*Evidence that wharves were completed at the end of* 1900, *and that remaining work was for artisans, who were difficult to obtain and keep at Port Swettenham.*

"The works remaining on hand are the passenger station and goods-sheds, which are being pushed on as fast as the difficulty of keeping skilled labour at this unpopular spot will permit. It is anticipated that the whole of the work will be completed by the middle of the present year" (see Administration Report for 1900, Selangor Government Gazette, 1901).

C.—*Evidence that artisans were not poorly paid and were scarce.*

Under the head of "Labour" in the Administration Report on Selangor for the year 1900 (Selangor Government Gazette, 1901), the British Resident wrote:—"More serious difficulty is caused by the great dearth of artisan and mechanical labour, the available number of skilled workmen having declined rather than advanced. . . . The mechanic of this country is almost always a Chinaman. He can do good work, and is well paid for it, and is consequently very independent. Latterly employers even of their own nationality have been quite unable to get the men they require, and works of all description have suffered in consequence."

D.—*Evidence that there was no great coolie population at Port Swettenham in* 1901.

"I was not surprised that the construction coolies had suffered severely from malaria, and although at the beginning of 1901 few coolies were actually living in Port Swettenham, I formed a very unfavourable opinion of it owing to the short residence necessary to infect new-comers." This is an extract from my Official Report to Government on the anti-malarial works at Klang and Port Swettenham. It was published in the Selangor Government Gazette, April, 1905, and reprinted in the Indian Medical Gazette of September, 1905. Dr. Bentley has, I think, overlooked this report.

E.—*Evidence that there was no great epidemic of malaria at Port Swettenham in the early half of* 1901.

If there was a great epidemic of malaria at Port Swettenham among coolies in 1901, one would expect to find evidence of it in the admissions to hospital. Now, in my articles in the *Journal of Tropical Medicine* in November and December, 1903, and April, 1905, a table appears giving the monthly admissions to Klang Hospital of cases of malaria from the port. The numbers were as follows:—January, 3; February, 0; March, 3; April, 4; May, 0; June, 5. During the six months, consequently, which Dr. Bentley supposes to have seen the culmination of a malaria outburst which almost annihilated Klang and Port Swettenham, the cases of malaria admitted to the hospital from the vortex of the storm numbered no more than 15. Dr. Bentley can scarcely have noticed these figures.

So far from Dr. Bentley's suggestion being correct, the figures show that the construction coolies had left Port Swettenham long before the great outbreak arose among the Government population, and those connected with the shipping who went to reside there after the port was opened. The epidemic at Port Swettenham, which arose in 1901 after the port was opened, was not among, or in any way connected with, poorly paid construction coolies, but among Government servants and their families, the shopkeepers, and the well-paid loading labourers (180 in number) who were transferred from Klang. Beyond these there was no population at the port. The outbreak began nine months at least, to my personal knowledge, after the construction coolies had left, and consequently it is impossible to attribute the subsidence of the outbreak to their departure.

With regard to Klang town, I cannot quite gather whether Dr. Bentley means it to be understood (*a*) that construction works and a coolie camp existed at Klang as well as at Port Swettenham, or (*b*) that the coolies from Port Swettenham infected Klang town.

If the former, I may say at once that no such works or such a coolie camp existed at Klang.

If the latter, why should Klang, formerly so susceptible of infection, be now immune? In the nine years which have passed since the outbreak in Klang, there has been an enormous increase in the populations of the towns and of the district. Places with much larger populations than that of Port Swettenham in 1901, or even to-day, and places much nearer than Port Swettenham to Klang, have been devastated with epidemics of malaria. Malarial subjects from these surrounding neighbourhoods now enter Klang in far greater numbers than nine years ago from Port Swettenham. Yet the residents of Klang do not suffer from malaria, and statistics show that malaria is hardly ever contracted in Klang to-day. Of 455 Klang children examined in 1909, thirteen only showed evidence of malaria. Of these thirteen, not one but had recently come to Klang, and had a history of malaria before arrival in the town.

I may remark, in passing, that when he asserts that the authorities remained inactive until "alarmed by the fearful mortality" at the new port, Dr. Bentley does less than justice to Dr. Travers and the administration, since the Klang scheme, which was to prove so dramatic a success, had already been approved before the occurrence of the Port Swettenham outbreak.

Dr. Bentley also suggests that the credit for the improvement of the health of Klang may be ascribed to quinine. Quinine, as a matter of fact, was freely administered at Port Swettenham in 1901, but no public distribution of quinine as a prophylactic was undertaken at Klang.

Not a single grain during all these years was given except to my hospital and private patients actually suffering from malaria.

Dr. Bentley thinks it a "ridiculous assumption" that the high death rates of 1900 and 1901 would have remained unchecked but for the measures recorded. If he will do me the honour of reading my forthcoming book, he will find it proved (as I venture to claim beyond dispute) that in many places in the neighbourhood of Klang, so long as the Anopheline factor remains undisturbed, these high death-rates do, alas! without any "absurd fiction," continue. In view of the large increase of population, we are justified in assuming that, but for the measures taken, malaria would have claimed many more than four hundred victims during each of the years under review; and Dr. Bentley will find that the two cases of anti-malarial works, the reports of which have incurred his criticism, have been paralleled strikingly in numerous instances.

It is commonly assumed that to rid even small tropical towns of malaria by anti-malarial operations presents insurmountable difficulties, and that to attempt such a campaign over extensive rural areas would be tilting at windmills. It can be shown, however, that in the Federated Malay States planters have, quite unconsciously, been carrying out great anti-malarial works over far greater areas than Klang and Port Swettenham, for the benefit of much larger populations, at only a small fraction of the expense, and with complete success. Indeed, one cannot help suspecting that great anti-malarial works are constantly being carried to a successful conclusion by those whose last idea would be that they were carrying out great sanitary works; and in view of what has already been achieved it would be rash to deny that the future may have in store for us the final expulsion of malaria from the whole of what is, even to-day, one of the most malarious portions of the tropics.

MALCOLM WATSON.

Klang, Federated Malay States, December 27, 1910.

Studies of Magnetic Disturbances.

IN the number of NATURE for August 11, 1910, Dr. L. A. Bauer published some results of investigations of magnetic disturbances, forming an abstract of papers published in *Terrestrial Magnetism*, xv., Nos. 1 and 2.

In these papers Dr. Bauer treats a number of problems of the greatest interest for the study of terrestrial magnetism; but in my opinion there are certain points of a fundamental nature which it would be well to take up for discussion, partly because certain of his results differ considerably from those of other investigators in this field.

Dr. Bauer treats the "positive equatorial storms" of May 8, 1902, and January 26, 1903, and concludes from a mathematical analysis "that for both disturbances the systems of disturbance forces which it would be necessary to superpose upon the earth's own magnetic field were precisely of the same character as the earth's. In other words, were we to assume electric currents as constituting the disturbance systems, then, as in the case of the earth's field, the currents would have to circulate from east to west if they are positive ones and in the contrary direction—from west to east—if they are negative or such as would be produced by moving negative charges. Furthermore, for both disturbances the electric currents would have to circulate chiefly in the regions above the earth" (NATURE, *loc. cit.*, p. 192).

I am not quite sure of what is meant by the expression, that the disturbance field is precisely of the same *character* as the earth's own field. For a real similarity, which would allow conclusions to a similarity in origin of the two phenomena, we should have provided the following relation

$$\mathbf{P} = k\mathbf{T} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where $\mathbf{P}$ is a vector representing the perturbing force at a certain place, $\mathbf{T}$ is the total force of the earth's permanent magnetic field at the same place, and k is a constant. The relation (1), however, is not even approximately fulfilled for any of the principal groups of disturbances treated by Birkeland in his work, "The Norwegian Aurora Polaris Expedition, 1902–1903," not even for the equatorial storms considered in Dr. Bauer's paper, so that the similarity assumed by Dr. Bauer cannot mean that relation (1) is fulfilled.

Then when Dr. Bauer, from the similarity between the earth's own field and the field of the positive polar storms, concludes that the disturbance current systems must circulate round the earth in the same direction as that which may be supposed to produce the permanent field of the earth, this conclusion is not justified without further proof, for the two similar fields show great differences. While the forces $\mathbf{P}$ and $\mathbf{T}$ have the same direction near the equator, this is no longer the case nearer the poles, where their vertical components have opposite directions.

It seems also difficult to understand how the direction found by Dr. Bauer can be brought into harmony with his statement that the greatest part of the current is to be found above the surface of the earth. For suppose that an electric current—circulating around the earth and *above its surface*—shall produce the observed perturbing force directed towards the north, it follows from Ampere's rule that the current must pass from *west* to *east*, or in the direction opposite to that found by Dr. Bauer. So long as we regard external systems as forming the primary cause of disturbances, this result must hold even if we take into account the magnetic permeability of the earth and the effect of induced currents.

Dr. Bauer states that the disturbance systems probably always can be supposed to originate from one internal and one external current system, and for the equatorial storms he has given the mathematical method for separating the two systems.

The separation was carried out for the perturbation of May 8, 1902, and "the surprising result revealed itself that the internal currents went in the same direction as the external ones, the latter being about three times the strength of the former."

Now two systems of this kind, keeping on simultaneously, must in some way be physically connected; but it seems rather difficult to see how this connection could be produced, for, as Dr. Bauer himself rightly remarks, the internal currents cannot be induced currents. Thus it seems that merely simple physical considerations will make the result very improbable, and besides, I think that objections can be made to the way in which it is deduced.

I am not going into details regarding the validity of the mathematical method, but I am merely going to show by an example that the method used by Dr. Bauer cannot be trustworthy.

The equations for the internal systems (see *Terr. Mag.*, xv., No. 1, p. 26) are simply expressing the forces on the surface of a sphere uniformly magnetised along a certain diameter. Suppose, now, that in a plane, perpendicular to this diameter and passing through the centre of the sphere, there was a circular current concentric with the sphere and with a radius large compared with that of the sphere. The magnetic field of the current in the space occupied by the sphere would be nearly uniform, and if the sphere was made of a homogeneous material it would be *uniformly magnetised*. In other words, the equations which should express a field due to an *internal* system will in this case express a field actually caused by an *external* one. The system of equations, however, which according to Dr. Bauer should express the field due to an external system, will not even approximately be able to express an external system of the kind here supposed. I think this will be sufficient to show that the result of the separation will require further proof.

I should also like to say a few words regarding the direction of the circular current of negative corpuscles which may be formed round the earth in the plane of the magnetic equator. These currents play an important part in the kathode ray theory of Prof. Birkeland, and it is of importance that no misunderstanding should exist on this point.

Dr. Bauer arrives at the conclusion that the direction of motion of the negative corpuscles of such a current is from *east* to *west*. I have not from his short note been able to follow his argument, but a simple consideration will show that the corpuscles will encircle the earth in a direction opposite to that found by Dr. Bauer.

Suppose a negative corpuscle is moving in the plane of the magnetic equator and describing a circular orbit concentric with the earth. The magnetic force due to the earth's magnetic field is directed towards the north, and the deflecting force must be directed towards the centre to keep the corpuscle in its orbit. Applying the well-known rule for electromagnetic deflection, we find that the corpuscle, if negative, must move from *west* to *east*.

The question regarding the simultaneity of the occurrence of the positive equatorial storms is a very important one for their physical explanation, for if it takes a time of several minutes for the pulse to travel round the earth, we must suppose that the currents producing the effects are near the earth compared with its diameter, while simultaneity of beginning would indicate very distant systems. The question of simultaneity can only have a definite meaning in the case of the abruptly beginning storms, *e.g.* the positive equatorial storms ("S" storms), and perhaps the cyclo-median storms. The polar storms, on the other hand, usually set in gradually, and near the auroral zone, where they are strongest, they are of a very local character; sudden changes at one station may have no corresponding sudden change at another; but in the case of these polar storms (cf. Birkeland's work) it is often found that the centres of disturbance fields move slowly, usually along the auroral zone.

It has usually been assumed that the positive equatorial storms set in simultaneously all round the world. The question is very carefully examined in the work of Birkeland, referred to above, for the storm of January 26, 1903. Looking at his figures, we notice that corresponding serrations show small differences in time at different stations, amounting to two or three minutes; but these *differences are equally great for neighbouring stations as for more distant ones.* The differences for neighbouring stations, which must be due to some error, are not so much caused by faults in the measurements on the time axis and the identification of corresponding points on the curves; they are rather to be considered as faults sticking to the magnetogram itself, for if we take out the time of several points of the disturbance, the time differences for corresponding points for two stations come out nearly constant.

Dr. R. L. Faris and Dr. Bauer, who have made a great amount of valuable work on the subject, have tried to eliminate the error by collecting neighbouring stations into groups, and then taking the difference between the average time of each group, and they arrive at the conclusion that the occurrence is not simultaneous. But so long as the differences between the groups are of the same order as the actual possible error of determination, it seems very dangerous to conclude to a non-simultaneity. Moreover, Mr. Krogness, by comparing the times of beginning of a number of storms at Potsdam with the corresponding times given by Dr. Faris for a group of stations on the western hemisphere, has found almost perfect simultaneity.

I think, then, that the present position of the question cannot be expressed in a better way than by the following statement taken from Prof. Birkeland's work:—

"We may conclude from this that the serrations appear simultaneously, or rather, the differences in time is less than the amount that can be detected by these registerings." L. VEGARD.

University of Christiania, January 14.

Sir F. Galton and Composite Photography.

MAY I be permitted, as an intimate friend of many years and under deep obligations to the late Sir Francis Galton, to say a word upon a matter which is perhaps not sufficiently emphasised? I refer to his very deep and lasting interest in composite photography, and his conviction of its scientific value. He considered it capable of and well worth systematic development. This was a frequent subject of conversation between us; and he told me many times (sometimes with reference to the original contributions to photography of my brother, Colonel Stuart-Wortley) that he felt the method ought to be developed, not as a newspaper curiosity, but as a serious aid to sociology, and especially to the study of heredity.

Prof. Bowditch, of Harvard, told me that he found an unaccountable indifference on the subject in America, while he entirely shared Galton's view of its possibilities.

If anyone could be found to take up the matter seriously there can be no doubt that the pioneer would be richly rewarded. In our last talk, a few weeks before his death, Sir Francis himself told me of really sensational results from the few experiments he was able to make with a comparatively primitive instrument. For instance, he told me he had collected photographs of Queen Victoria and Prince Albert and all their children. To his great surprise, the composite gave the likeness of Princess Alice and no one else. But this was only one of many equally suggestive results. VICTORIA WELBY.

Duneaves, Harrow, February 3.

Darwin and the Transmission of Acquired Characters.

IT is difficult to understand how anyone well acquainted with Darwin's works can come to any other conclusion than that he firmly believed in Lamarck's principle of the transmission of characters acquired by use.

Two clear examples may be cited from "The Descent of Man" (second edition):—

(1) "As the voice was used more and more the vocal organs would have been strengthened and perfected through the principle of the *inherited effect of use*" (p. 87).

(2) "There is no more improbability in the continued use of the mental and vocal organs leading to inherited changes in their structure and function, than in the case of handwriting, which depends partly on the form of the hand and partly on the disposition of the mind; and *handwriting is certainly inherited*" (p. 88).

In this matter Darwin was a true disciple of the great French naturalist to whom Prof. Judd refers with such scant respect. E. A. PARKYN.

January 30.

I REGRET that your correspondent should imagine that, in writing the words "poor old Lamarck," I showed "scant respect" for the great French naturalist. On the contrary, I desired to express the deep sympathy I felt for this grand pioneer in evolution, who, in old age and blindness, found his splendid achievements, for the time being, discredited by the work and arguments of his successful rival, Cuvier. In the little book which has given rise to this correspondence, I have insisted upon the splendid contributions of Lamarck, not only to botany and zoology, but also to geology, and have shown how the hostility towards his work, felt at first by Lyell and Darwin, was in the end modified, and his great merits acknowledged by both of them.

I quite agree with your correspondent that the passages he quotes—and many similar ones may be cited—show that Darwin accepted the Lamarckian views as to the transmission of acquired characters to a certain extent. Darwin's tendency was, however, to insist that individual variations were always "slight" or "exceedingly little," to use his own words In the passage to which reference has been made in the "Origin of Species," it would almost seem that he suggests that "variation" had been used in two different senses by authors—variations that could be transmitted and variations that could not be transmitted—and that he demurs to the distinction. I agree with Prof. Meldola, however, in thinking that, in all probability, the view put forward by Prof. Weismann in 1885, that *no* acquired character is *directly* inherited, never fairly came under Darwin's consideration.

In discussing questions of this kind, it is important to realise, so far as is possible, what was the current opinion at the time Darwin wrote. Now Baron Cuvier, his brother Frederick, and their followers—whose writings so greatly influenced naturalists in the early years of the nineteenth century—all freely admitted the transmission, by inheritance, of acquired characters, habits, and instincts in domestic animals like dogs; what they denied was that any of the variations so transmitted, so far as the experience of 2000 years showed, were of a *fundamental* character.

That Darwin not only accepted the idea of the transmission of acquired characters, but even speculated on the mechanism by which it might be accomplished, is shown by his invention of the "provisional hypothesis" of pangenesis, has been justly pointed out by Sir William Thiselton-Dyer. In introducing this hypothesis Darwin wrote:—

"A multitude of newly acquired characters, whether injurious or beneficial, whether of the lowest or highest vital importance, are often faithfully transmitted . . . and we may on the whole conclude that inheritance is the rule, and non-inheritance the anomaly" ("Variation of Plants and Animals," popular edition, p. 454)

No mistake can be greater, as it appears to me, than one prevalent at the present day—namely, that by the newer developments of evolutionary theory in Weismannism, Mendelism, &c., Darwin's results are in any way superseded. On the contrary, I firmly believe that had Charles Darwin lived, no one would have more gladly welcomed these new developments than would he; for he would have rejoiced to follow the investigations of the particular *methods* by which variations are transmitted, the possible *limits* of individual variation, and the *laws* which govern their appearance.

Kew, February 1. JOHN W. JUDD.

Glacial Erosion.

THE reviewer of "Geographical Essays," by Prof. W. M. Davis, writes in NATURE of January 19:—"Prof. Bonney's presidential address to the British Association has brought the controversy on glacial erosion to a head. It may be hoped that the authoritative and masterly statements on both sides will lead to an agreement as to the main facts, but no settlement can be expected until the arguments of those who limit the efficacy of glaciers as eroding agents have been directly answered."

I do not think that those who, like myself, hold that glaciers are powerful eroding agents would shrink for a moment from directly answering their opponents' criticisms. The most direct answer is that the deposits formed by glaciers are a direct measure of glacial erosion. I distrust all theoretical opinions based upon the study of ice as a "rock." In the early days of geological science it was difficult to convince the many that the "purling brook" and the "babbling river" had frequently excavated the deep valleys and gorges through which they run.

Do the opponents of glacial erosion really contend that the enormous deposits of boulder clay which cover such extensive portions of England, Scotland, and Ireland are not the results of glacial erosion? I say boulder clay advisedly; for there are immense deposits of laminated clay with or without boulders, sands, and gravels, which some may argue have no connection with glaciation. Here, however, I should again differ, for many years of careful study in the field have convinced me that nearly all these superficial or "drift" deposits are the result of glacial erosion.

Taking the "glacial" deposits themselves as a measure of glacial erosion, and concluding that we must look for marked effects in the areas from which the material was eroded, what do we find? We find surface lowland features, valley gradients, valley forms, and entire valleys and gorges, which are not such as are produced by the erosive action of water, rain, and frost.

The opponents of glacial erosion have been too much guided by glacial action, as now seen in such mountainous areas as Switzerland. The puny glaciers now found there cannot be compared, so far as the effects they produce are concerned, with the great confluent glaciers which once occupied the valleys.

It is a pity that in this country the conviction which so many hold concerning glacial erosion and climatal changes should have resulted in the stagnation of glacial geology as a science, for it cannot be denied that if glaciers have done very little as agents of change, there must be very little to study.

Glacialists of the active school cannot but feel grateful to such workers as Prof. James Geikie, Prof. W. M. Davies, Prof. R. S. Tarr and others, for keeping the lamp burning. R. M. DEELEY.

Inglewood, Longcroft Avenue, Harpenden, January 18.

HARDLY anyone disputes that the passage of ice over the British Uplands swept away all the loose rock materials and redeposited them in the Lowlands as glacial drifts. The controversy is not as to the removal of the loose débris, but of the excavation of basins in fresh hard rocks. As Mr. Deeley states, the opponents of glacial erosion have written extensively; but certain serious difficulties that have been advanced by Prof. Bonney, Prof. Garwood, and others, do not seem to me to have been directly answered. I share Mr. Deeley's gratitude to the three geologists whom he names for their important contributions to glacial geology. J. W. G.

An Unconscious Forecast by Joule.

THE following remarks by Joule in his paper on the changes in temperature produced by the rarefaction and condensation of air (*Phil. Mag.*, May, 1845) are worthy of notice:—

"The beautiful idea of Davy, that the heat of elastic fluids depends partly upon a motion of particles round their axes, has not, I think, hitherto received the attention it deserves. I believe that most phenomena may be explained by adapting it to the great electrochemical discovery of Faraday by which we know that each atomic element is associated with the same absolute quantity of electricity. Let us suppose that these atmospheres of electricity, endowed to a certain extent with the ordinary properties of matter, revolve with great velocity round their respective atoms. . . ."

"The phenomena described in this paper, as well as most of the facts of thermochemistry, agree with this theory; and in order to apply it to radiation we have only to admit that the revolving atmospheres of electricity possess, in a greater or less degree, according to circumstances, the power of exciting isochronal undulations in the ether which is supposed to pervade space."

In the idea of the "atmosphere of electricity" revolving round the atom, we have the substance of J. J. Thomson's corpuscular theory, while the electromagnetic mass of the revolving "atmospheres of electricity" would certainly cause them to be "endowed to a certain extent with the ordinary properties of matter." Again, the last phrase of the extract is simply the modern idea of electromagnetic waves in the æther.

The premature birth, in this short quotation, of three of the most startling advances of modern physics is not a little remarkable. B. A. KEEN.

University College, London, January 25.

The Sailing-Flight of Birds.

IN a letter to NATURE in February, 1876, I suggested that the sailing-flight of birds and the flight of flying-fishes could be explained as tobogganing under almost perfect conditions, and in 1889 the late Duke of Argyll accepted this, in a letter to the *Spectator*, as a correct and sufficient explanation. My old friend the late Prof. H. N. Moseley, a member of the *Challenger* staff, held the view that a quivering, imperceptible to the eye, of the wings and fins was the true explanation. I do not know which explanation has been generally accepted, but I would suggest that a kinematographic picture of the flying-fish ought to settle the question finally, if it is not already settled.

I said in my letter:—"By means of a suitable mechanism for changing the inclination of the wing-planes every few seconds the sailing-flight of the albatross, I believe, might be simulated without much difficulty." Has not the aëroplane done this? R. ABBAY.

Earl Soham Rectory, February 1.

A Morning Meteor.

A METEOR equal in brightness to the Pole Star, and of much the same colour, was seen by me to fall from the southern sky at 6.25 on the morning of Friday, February 3. Its path was one of ten degrees, extended along a line midway between α Coronæ Borealis and the planet Jupiter, which at that time was shining lustrously some thirty-four degrees south, and slightly east, of Arcturus. The meteor left a steel-blue train which remained visible for six seconds. JOSEPH H. ELGIE.

72 Grange Avenue, Leeds.

INVESTIGATIONS OF PLAGUE.

THE terrible intensity of the outbreak of pneumonic plague now raging in Manchuria, and the presence of plague-infected animals within our own borders, have called forth recently a number of communications on plague in the daily press. A special correspondent in *The Times*, in two well-informed articles (December 22, 1910, and February 6, 1911), summarises the situation, and gives an admirable sketch of the principal facts concerning the modes of spread of plague. Dr. L. W. Sambon has also contributed two letters on the subject to our contemporary. He cites some interesting historical references to the preventive methods adopted during epidemics of plague, but it is a pity that he has allowed himself to fall into error on some essential points in the epidemiology of the disease. He remarks, for example, that in his belief transmission from man to man is probably more frequent than from rat to man. If Dr. Sambon bases this statement upon personal experience of epidemics of bubonic plague, it must be said that his observations are directly opposed to the experience of many competent plague workers. Dr. Ashburton Thompson, an accepted authority, has stated that in Sydney plague owes nothing of its epidemic form to contagion from the sick. The view that bubonic plague is not directly infectious is held unanimously by authorities in India.

The Advisory Committee, appointed by the Secretary of State for India, the Royal Society, and the Lister Institute, has recently issued a further volume of Reports on Plague Investigations in India (*Journal of Hygiene*, vol. x., No. 3). The volume contains a number of articles which cannot fail to interest all those concerned with plague administration. Briefly stated, it may be said that these investigations confirm and amplify the conclusions already recorded.

The first article deals with the experimental production of plague epidemics among animals. In earlier experiments guinea-pigs were used, and it was conclusively shown that epidemics could not be produced amongst these animals except when rat-fleas (*X. cheopis*) were present in the godowns or small huts in which the experiments were carried out. Gotschlich criticised these experiments on the ground that guinea-pigs, unlike rats, do not feed on the carcases of their dead companions. He believes that among rats, plague is chiefly spread by the healthy animals feeding on the carcases of those infected with plague. In order to test the validity of Gotschlich's criticism, wild Bombay rats, previously freed as far as possible from fleas, were used in the present series of experiments. The results show clearly that epidemics occur among these animals only in the presence of fleas. The Commission found no reason for thinking that alimentary infection played any part in the production of these experimental epidemics. This conclusion completely agrees with their observations on the mode of infection in naturally infected rats.

The discovery by the Commission, in the early years of their work, of chronic plague in naturally infected rats, at first sight appeared to offer a plausible explanation for the persistence of infection amongst the rat population during the off-season, and for the recrudescence of the infection when the conditions again became favourable for the epidemic spread of infection amongst rats and human beings. From the evidence available, the Commission showed considerable hesitation in ascribing to these chronic plague lesions any important part in the continuance and revival of the rat epizootic. It leaned rather to the view that the quiescent season is bridged over by sporadic cases of acute rat plague. A great deal of fresh light has been thrown upon this question in the volume under review. A much more extensive experience of chronic plague in rats in Belgaum, Poona, and Bombay has fully convinced the Commission that the pathological appearances described as chronic plague are stages in the process of recovery from the acute disease. For this reason, and because the term has been associated with theories regarding the reappearance of the rat epizootic, they regard the name "resolving plague" as more appropriate. It is evident that the epidemiological importance of chronic rat plague is on this view considerably limited, if not, indeed, abolished.

An interesting contribution to the problem of the spread of plague through districts with numerous scattered villages, will be found in this volume. The collection and arrangement of the extensive data dealing with the recent history of human plague in three districts in the Punjaub and the United Provinces were undertaken by Major Lamb, I.M.S., and a statistical analysis of the results has been made by Dr. Greenwood. While the conclusions drawn from this survey are necessarily tentative, they are of value in suggesting a rational basis for effective plague administration in the thickly populated districts in India. It would appear that reimportation of the infective agent is more likely to be the cause of outbreaks in the villages than recrudescence. Again, a study of the distribution of infected villages in maps showing the position of affairs month by month, suggests a dissemination of the infection from various centres. The statistical evidence does not point to the conclusion that the infection of a village renders it more liable to be infected during the next following epidemic.

The Commission has recorded its observations of plague during the years 1908–9 in Belgaum and Poona. The special reason for selecting these towns was that, although not far distant from Bombay, the seasonal prevalence of the human epidemics is different. It had been already shown that in Bombay the rat-flea prevalence varied at different seasons of the year, and that the season of maximum rat-flea prevalence coincided with the height of the epizootic. The intimate relation between rat-flea prevalence and the spread of rat and human plague is well illustrated in the present observations. Moreover, the interesting fact is elicited that a close connection appears to exist between the flea prevalence and the hygrometric condition of the atmosphere.

The results at Poona show that the adverse factors which combine to bring an epidemic to an end are (1) a decrease in the number of fleas, (2) a decrease in the number of rats, and (3) an increase in the proportion of immune to susceptible rats.

Mr. Sydney Rowland gives an account of his work upon plague vaccines. This contribution, which is of too technical a character to admit of a summary of its contents, describes the results of an inquiry into the immunising constituents of the *B. pestis*. The results obtained are interesting, and suggest important improvements in the method of preparation of plague vaccines.

The volume concludes with a brief statement of the provisional conclusions reached by the Advisory Committee as the result of the investigations made under their direction from 1905–9 into the mode of spread of plague in India. The Committee concludes, that in nature plague is spread among rats by the agency of rat fleas, and that, in the great majority of cases during an epidemic of plague, man contracts the disease from plague-infected rats through the agency of plague-infected rat fleas.

A perusal of this volume of reports must impress the reader with the enormous amount of work entailed in order to collect the evidence leading to these conclusions. In this country it is still little under stood, amongst even the intelligent public, that the scientific study of disease can be effectively accomplished only at the outlay of much time and money. It is gratifying, therefore, to find that in the ably written article on the outbreak of rat plague in Suffolk, which appeared in *The Times* of December 22, 1910, the writer emphasises this point with refreshing candour. He insists that in a crisis of this kind, the effort to cope with the situation must be a national one, and that the Government must authorise the expenditure of ample funds to provide for the establishment of a staff of experienced investigators and administrators to deal with the problem. The history of the organisation of plague measures gives ample proof of the futility of adopting plans, however vigorous, that are not based on clear conceptions of the disease gained by scientific research.

WHAT SCIENCE HAS DONE FOR THE WEST INDIES.

A LITTLE more than a year ago I told in these pages, with a very sore heart, the story of what the late Sir Alfred Jones had accomplished for the West Indies by enlightened commercial methods. That chapter is unhappily closed, for no one has succeeded him. It is a more hopeful task which is now imposed upon me—to give some account of what science has done, and will continue to do. It is worth the telling, and it is more than a mere record of success, but carries a moral of far-reaching extent.

This journal, from its first number, has never ceased to preach the necessity of applying knowledge to the right conduct of human affairs. It continues to preach, and in face of the stolid conservatism of our methods, one might in a despondent mood think with little effect. But if one looks back over long periods it is not so, and the change in public opinion as represented by governmental action is little short of astonishing.

When I first became engaged in colonial work some forty years ago, the doctrine of *laissez faire* was in full swing. It was held that self-interest would determine whether an industry would succeed or fail; if it failed it deserved to do so, and another would take its place. In either case it was best to leave it severely alone. This is not the place to discuss how far such a doctrine is sound. But practically it is continually being abandoned. No industry is now free from governmental interference, and such interference is only tolerable if directed bv adequate technical knowledge. Interference must always be of the nature of restraint, and at any rate theoretically one mav ask whether some compensation is not justified. It can hardly be doubted that the community will have more and more to provide knowledge for industry of the kind that self-interest is powerless to provide for itself.

Mill, however, and other economists clearly saw that academic economic principles were not universally applicable to agriculture. The reason is obvious: the soil is not removable, but has to be utilised as best it can, and where it is. If it went generally out of cultivation food would fail. It was still, however, left to *laissez faire*, except in some measure in India, where the Government undertook the pioneering work in regard to tea, cinchona, rubber, and some other staples, and then left their commercial development to private individuals. In any other country but our own the work of Rothamsted would have been promoted by the State. There are undoubtedly advantages in scientific research being left unfettered to individual effort, but it is only the richest landowners, such as Coke of Holkham, and the Dukes of Bedford, who can afford to add to agricultural knowledge by experiment. The average cultivator is powerless to follow other than traditional methods. Yet it is in the interest of the community that he should do better in order that the maximum return may be obtained from the land.

When this country began to acquire tropical possessions, it was seen, however, that something more than *laissez faire* was required for their economic development. It was the Royal Society, at the hands of its president, Sir Joseph Banks, who first took the work in hand. Having the ear of the King, he was able to use Kew, which was then the private property of the Royal Family, for the purpose. The mutiny of the *Bounty* was an incident in an attempt to add to the cultural resources of the West Indies. An indirect result was the foundation of the great Dutch colonial botanical establishment at Buitenzorg. When it was decided that Kew should be maintained as a national establishment, its colonial utility was apparently one of the main reasons for the decision. In a scheme which received the sanction of Parliament the interests of "commerce" and "agriculture" were recognised, as well as the supply "of authentic and official information on points connected with the foundation of new colonies." Its functions in this respect were steadily fostered by the Hookers, father and son. The history of Kew thus affords one of the earliest instances in this country of the recognition of the duty of the State to promote scientific knowledge in the public interest. And the historic meaning of the controversies which have occasionally brought Kew prominently into public notice is simply the attempt of a policy of *laissez faire* to arrest its work.

But anything which is rooted in sound principles cannot be checked, because their necessity insists on asserting itself; and the West Indies again supply the illustration. Obviously their chief asset is solar energy. Our channel islands supply us with early vegetables. In a rule-of-three sum the West Indies stand for the channel islands of the North Atlantic shores. Alfred Jones saw this, and started a line of steamers to flood us with West Indian fruit. But this is anticipating. In the 'nineties their condition was the reverse of prosperous. And, if it is a paradox that science was indirectly the cause of the mischief, it happily was able to supply the remedy.

The Napoleonic empire left behind it two permanent legacies—the French code and beetroot sugar. When Napoleon's continental system closed the ports of Europe to British colonial produce, the import of tropical sugar was cut off. As sugar is a necessity of modern food there was the strongest impulse to find a new supply. I need not repeat a well-worn story. The chemist and the cultivator lavished all their resources on the unpromising beet, and ultimately dethroned the sugar-cane. Then came the bounties which flooded this country with sugar at scarcely more than cost price, and drove cane-sugar out of consumption.

There is a fundamental principle in agriculture: never to trust to a single crop. Ireland trusted to the potato and Ceylon to coffee, and both failed them; this was from disease. The West Indies trusted to sugar, and in their case the ruin was economic. The balance of solar energy being in its favour, on equal terms the cane should at least hold its own with the beet. But now comes the mistake and its moral. The sugar content of the cane was held to be incapable of increase; the methods of manufacture were often archaic and wasteful. Beetroot-sugar was the product of the most refined scientific skill in both directions. It was the fable of the hare and the tortoise.

In the 'nineties then the West Indies had sunk from prosperity to poverty. I heard it publicly stated at a meeting in the City of London that annexation to the United States was the only remedy. On some of the islands the peasantry were clamouring for food. And so things might have remained but for Mr. Chamberlain, who has never hesitated to cut himself adrift from hide-bound prejudices, and, regardless of them, to apply a practical remedy to an evil.

In 1897, after obtaining from Parliament some temporary relief, he sent out a commission of inquiry, of which Sir Edward Grey was a member, and to which Sir Daniel Morris, then assistant director of Kew, was attached as secretary. The Imperial Department of Agriculture was established the following year, and Sir Daniel Morris left Kew to take up the duties of commissioner. In a recent paper before the Royal Colonial Institute (see NATURE, January 26) he has given a full, and I think extremely modest, account of what he was able to achieve. That paper will speak for itself. My purpose is to show how success flowed from the patient and persistent application of scientific method.

The first thing was to see if the sugar-content of the cane could be improved. Like many other plants subjected to long cultivation, it was believed to have lost the power of producing seeds. The Pacific Islands had been ransacked without much success to find more productive kinds which might have arisen possibly by bud-variation. The White Transparent cane, which is regarded as a standard in the West Indies, yields 2¼ tons of sugar to the acre. As sugar-content varies, like everything else, in individual plants, it was suggested from Kew that an improved race might be obtained by the process of chemical selection by which the Vilmorins worked up the beet to a high standard and maintain it at it. Some success was obtained, but it was evident that it would be extremely slow. By a stroke of good fortune a more rapid method was discovered. About 1888, Mr. Bovell and Prof. Harrison noticed the spontaneous occurrence of seedling sugar-canes in Barbados. It was found that the sugar-cane did actually produce seed, though in so small a quantity that it had been overlooked. As this at once opened the door to seminal variation and selection, the attention of the Colonial Office was at once directed by Kew to the importance of the discovery. The work was vigorously taken up by Sir Daniel Morris, and from 1908 onwards seedlings have been raised on a large scale by Mr. Bovell, and continuously selected from, as well as hybridised.

The result has surpassed expectation. One seedling cane, for example, B. 3405, gave an increase more than the standard of one ton an acre, representing a net profit of £8. Dr. Watts, the present commissioner, estimates that the benefit to Antigua and St. Kitts alone would more than cover the expense of the department. Much light has been thrown on the food requirements of the cane by carefully controlled experiment. As might be expected, potash is found to be favourable, but phosphatic manures to have involved monetary loss. Dr. Watts, who has been the pioneer in the promotion of central factories, has obtained an increased production of 40 per cent. more than the "Muscovado system." Nor is this all. The pests and diseases by which the sugar-cane, like all other cultivated plants, is attacked had to be combated. The Cambridge School was drawn upon for mycologists and entomologists. Mr. Maxwell-Lefroy achieved a notable success in discovering the means of controlling the destructive moth-borer.

The upshot is that a moribund industry has been given a new lease of life by bringing scientific method to bear upon it. *Laissez faire* would say that the planters might have done it for themselves. But they did not, and, in fact, could not; a scientific campaign can no more be conducted by amateurs than a military one; the planters would not have known what positions to attack, nor could they have found the necessary men to do it nor directed them if they had.

Other industries had to be revived or created. Perhaps the most important of these was the production of Sea Island cotton with the generous help of the United States.

Lastly, but by no means least, an efficient system of rural education has been organised for the negro peasantry. I have no hesitation in saying that it is far in advance of anything which exists in the county where I am writing.

And thus Sir Charles Lucas, speaking from the perspective of the Colonial Office, is able to say that "while the eighteenth century saw the greatness of the West Indies, the nineteenth their distress, the twentieth century, he hoped, would witness their regeneration."

But this is not the end of the story. What has been accomplished in the West Indies has not been without its effect as an object-lesson elsewhere. It is to the credit of the Government of India that it has been, as already remarked, in advance of its time in pioneering work. It deprived China of the monopoly of tea, and, with the help of Kew, it has created the rubber industry of the East. But except as regards forestry it has effected little in intensive cultivation.

Canning claimed that he brought the New World to redress the balance of the Old. The Department of Agriculture for the West Indies has stimulated a new activity in the East, where some of its trained officers have found a larger scope for work. The recently published "Report of the Board of Scientific Advice for India" shows an awakeness and initiative which would have been looked for in vain a dozen years ago. W. T. THISELTON-DYER.

PICTORIAL NATURAL HISTORY.[1]

IN this little book the experience of the expert photographer has been combined with that of the keen naturalist; the result is a volume full of interest to all lovers of the countryside. The publisher, in a special preface, directs attention to the unusually large number of illustrations, which are exclusively reproductions of photographs taken by the author. Mr. Douglas English's success with his camera has been demonstrated on many previous occasions, and in "A Book of Nimble Beasts" he certainly gives us of his best. There are a number of pictures in this volume which are probably unique, and the reader's special attention is directed to the remarkable series of photographs illustrating the life-history of the sand-wasp (*Odynerus spinipes*).

The somewhat clumsy title is apt to give the impression that Mr. English's book deals in the main with the higher animals; this is by no means the case, and, indeed, some of the best pictures and chapters deal with the lower forms of life.

The value of the illustrations is increased by the fact that all are brought closely into connection with the chapters which they illustrate, a somewhat rare quality for a book of this type.

As in many recent books dealing with nature-study, Mr. English's text consists of a series of short stories, in the course of which the characteristic habits of different animals are brought out with the utmost faithfulness, and it is a pleasure for the reviewer to record the absence of any irritating zoological errors such as

[1] "A Book of Nimble Beasts." Bunny Rabbit, Squirrel, Toad and "those sort of people." By D. English. Pp. 319. (London: Eveleigh Nash, 1910.) Price 6s. net.

are so commonly met with in natural history books for the young. For the "Book of Nimble Beasts" addresses itself to children in particular, although it will undoubtedly appeal to their elders as well.

Mr. English's style is peculiar, and, although the majority of his stories are clearly narrated and read well, he occasionally gets carried away by his enthusiasm for odd words and still more odd constructions, so as to become almost unintelligible at times, as in the following passage from the last chapter on the pygmy shrew:—"He missed both shrews, who, dashing right and left of him, entangled him in double-minded purpose. Rested the pygmy, shrunk to a rigid wisp of apprehension, ear straining, muscle-tautened, behind a flimsy screen of bark." Such passages are fortunately rare, and the greater part of his text is marked by great lucidity. It is difficult to single out any particular story, among the best are "Bunny Rabbit" and "Spinipes the Sand-Wasp."

Fox Cub. From "A Book of Nimble Beasts."

The volume is tastefully bound, and both print and paper good. The "Book of Nimble Beasts" will prove a welcome gift for many a young naturalist.

ALCOHOL AND EUGENICS.[1]

DURING the course of the year 1910 there issued from the Eugenics Laboratory of London University a memoir, entitled "A First Study of the Influence of Parental Alcoholism on the Physique and Ability of the Offspring." The conclusion arrived at by the authors (Prof. Karl Pearson and Miss Elderton) was, broadly speaking, that parental alcoholism has no such influence. A result so sensational and so opposed to the opinions of many social workers was bound to arouse a storm of hostile criticism. It weakened one of the arguments against the excessive use of alcohol, and was interpreted as being a direct encouragement of vice.

(1) Prof. Pearson divides his critics into three classes:—(1) Paid officials and platform orators of various temperance organisations; (2) economists (already answered in a supplement to the original memoir); (3) men with medical training who have written on the subject of alcohol. It is the last class who are dealt with in the first of the two papers now under consideration. Their attacks—for one can hardly apply the term criticism to much that they have written—are repulsed with considerable losses. It is shown that many of the errors attributed by them to Prof. Pearson and his fellow-author may be found in an aggravated form in the investigations quoted as evidence rebutting their conclusions. A sample of this evidence is itself examined and its complete worthlessness exposed. It consists of data obtained by Dr. MacNicholl in America, by Prof. Laitinen in Helsingfors, by Demme in Berne, also a curious piece of statistical work by Bezzola. The defence and counter-attack are admirably conducted, the writing is clear, so concise as to make a summary impossible, and as entertaining as some of the controversial essays of Huxley. Yet while according this high praise to the memoir, we regret the necessity which compelled its production and thus diverted from its proper channel of original investigation any part of the energies of the Eugenics Laboratory staff.

It is with the greater satisfaction that we turn to (2), in which the relations between extreme alcoholism, mental capacity, education, occupation, and religious profession are discussed. The material on which the discussion is based consists of the published reports of the Langho, or Lancashire Reformatory, for the years 1905–10, supplemented by special information from Dr. F. A. Gill. Particulars as to the age, number of convictions, religion, and education of 333 female inebriates were obtained this way, and of the mental condition, physical state, and conduct of 207 among them. As the authors point out, results based on numbers so small are not in any way final; they may, however, suggest a solution of the problems, or at any rate indicate methods by which they can be profitably attacked. They certainly emphasise the need for the publication of good records of individual cases.

Perhaps the most pressing of the problems referred to is the relation of alcoholism to mental defect. The closeness of the association between the two is shown very clearly in the memoir. In table x. 223 female inebriates are classified with regard to their mental state. Of these only 37 per cent. were of normal intelligence; 53 per cent. were defective mentally; 6 per cent. very defective; and 3 per cent. actually insane. It is of the utmost importance therefore to determine whether it is the intellectual deficiency which leads to the alcoholism or the alcoholism which causes the deficiency. Light can be thrown on this point by measuring the correlations between education age and mental capacity, among the alcoholists. If it is the abuse of alcohol which causes a progressive degeneration of the intellect one would expect to find a sensible negative correlation between mental capacity and age—mental capacity diminishing as age increases. No such relation has been found. Allowing for differences of education the correlation between mental capacity and age is found to be $0 \cdot 006 \pm 0 \cdot 047$, or quite negligible.

[1] (1) "A Second Study of the Influence of Parental Alcoholism on the Physique and Ability of the Offspring." By Karl Pearson, F.R.S., and Ethel M. Elderton. Eugenics Laboratory Memoirs, XIII. Pp. 35. (London: Dulau and Co., Ltd., 1910). Price 4*s.*
(2) "A Preliminary Study of Extreme Alcoholism in Adults." By Amy Banington and Karl Pearson, F.R.S., with the assistance of Dr. David Heron. Eugenics Laboratory Memoirs, XIV. Pp. 55. (London: Dulau and Co., Ltd., 1910). Price 4*s.*

Questions of great interest are also raised in the dicussion of the relation between alcoholism and religion. Of the female inebriates in Langho Asylum quite one-half are Roman Catholics, while of the populations from which they are drawn not more than one-third are of this denomination in Liverpool or one-sixth in Manchester. These facts indicate that the Roman Catholics in Manchester and Liverpool are more given to alcoholic excess than the Protestants, and it is suggested that a reason for this may be found in a racial difference. The Roman Catholics are largely Irish immigrants, and the Irish immigrants in the industrial towns of England are not the most desirable specimens of their race. In this connection it is noted that "the Irish district of Liverpool . . . is one of the few instances in which during the last twenty years there has not been a fall in the birth-rate." Thus if alcoholism is due to an hereditary deficiency the differential birth-rate in Liverpool (and Liverpool is probably not exceptional in this respect), must lead to its propagation to a disproportionate extent.

That prostitution is in intimate association with alcoholism and mental defect is shown also in the tables of this paper. More than one-third of the whole number of women dealt with were prostitutes, but among these no greater proportion of mental defectives was found than among the remaining women. The Roman Catholic inmates of the asylum included a relatively smaller proportion of prostitutes than the Protestants, but this is due to the fact that the total proportion of alcoholists among the Roman Catholic community is greater, and not that the proportion of inebriate prostitutes is less.

Since the publication of the memoirs here described a further attack by Dr. Mary Sturge and Sir Victor Horsley, in the "First Study of the Influence of Parental Alcoholism on the Physique and Ability of the Offspring," has appeared in *The British Medical Journal* of January 14, and this has in turn given rise to letters in *The Times* from both sides. Six main errors are attributed by these critics to Prof. Pearson and Miss Elderton. Firstly, they are accused of having "committed the fundamental error of providing no adequate control of their investigations into the condition of the offspring of drinking parents." Secondly, of the unscientific use of terms, particularly of the term sober. These two criticisms cannot be considered independently. The memoir only claims to be a comparison between the offspring of sober and of alcoholic parents, therefore, if the term sober is used in a definite sense differing from alcoholic, the control provided is adequate for its purpose. A reference to it will show that the word has been carefully defined, and that the definition would be accepted by most people. The second alleged instance of the unscientific use of terms is that of the word "offspring" in the title. As the critics rightly remark, offspring might include persons of all ages, whereas only children of school age are dealt with. This would hardly, however, appear to be a justifiable ground for making such a charge, since a "first study" of a subject does not claim to deal exhaustively with the whole of it.

The third accusation is "selection by the authors of a non-representative population." It is stated that a slum population is dealt with in which 62·5 per cent. of the families were tainted with drink or in receipt of charitable aid, and that by selecting this population the authors cut themselves off from the possibility of making a comparison between the children of alcoholic and non-alcoholic parents respectively. It is a little difficult to see how the percentage to be placed in either group affects the possibility of making a valid comparison, nor is it explained how the receipt of charitable aid affects the question. With regard to the implied accusation that the data used were selected in order to give results of a particular kind, it may perhaps be remarked that as the chief difficulty in the systematic study of biological questions affecting mankind is to obtain trustworthy data on which to work, the possibility of *selecting* data on any other grounds than that of their trustworthiness does not exist, and it may be conjectured that Prof. Pearson and his colleague used all the evidence before them at the time of writing the paper.

The fourth charge is "absence of any proof of alcoholism beginning before the birth of the child." In so far as there is reason in this charge it is due to the deficiency of the data. The authors have had to make an assumption concerning the state of the parents before the birth of the children, namely, that people who use alcohol excessively after the birth of their children are very much more likely to have been similarly addicted before and at the time of the birth than those who do not. If this assumption is correct, and few people would dispute it, it follows that a classification according to the later habits would be reasonably correct also with regard to the earlier. A few parents would, no doubt, be placed in the wrong groups, and although this would tend to lessen any contrast between the offspring of the two divisions, it could not eliminate it, nor, indeed, reduce it seriously.

The fifth alleged error is "contradictory statements by Miss Elderton and Prof. Pearson concerning the children of alcoholic parents—for example, their physique, health, and higher death-rate." The contradictory statements appear to be (1) that the death-rate among the children of alcoholic parents is higher, (2) that the health of the surviving children of this class of parents seems on the whole to be slightly better than of those of the sober class. It is difficult to see in what respect the two statements are contradictory, though it may be contrary to expectation that the children among whom a larger proportion of deaths occur should be slightly healthier than the others. Prof. Pearson and Miss Elderton attribute this partly to accident, overlaying, burns, and other causes arising from carelessness, partly to want of home care, to food defects, and to other factors possibly toxic.

The sixth charge is "erroneous conclusion that the efficiency, as measured by wage-earning capacity, of an alcoholic male parent is at least equal to that of a less alcoholic male parent," which the critics describe as the chief generalisation raised by Miss Elderton and Prof. Pearson. With regard to this, we will quote the letter to *The Times* of January 16 by the latter: "Will it be believed that in a memoir of forty-six pages scarcely more than half a page is given up to the wage problem, and we distinctly state the purpose of that inquiry—namely, as a rough test, that the alcohol users were not initially, physically, or mentally, inferior to the sober." No conclusion such as that attributed to them was arrived at by them. Incidentally, the charge is made of "imagining and publishing statistical data where none exist in reality"; as an example of this we are told that Prof. Pearson has included in his tables seventeen porters, whereas only thirteen exist in reality. "He therefore has invented for this trade four imaginary individuals, though asserting throughout that he is quoting the Edinburgh figures." This is what Prof. Pearson is accused of: what he has actually done is to group as porters all those men in the class defined by the Registrar-General as engaged "in storage, porterage, and messages."

E. H. J. S.

NOTES.

FOR the meeting of the British Association for the Advancement of Science, which is to be held this year at Portsmouth on August 30 and following days, under the presidency of Sir William Ramsay, K.C.B., F.R.S., the following presidents have been appointed to the various sections:—Mathematical and Physical Science, Prof. H. H. Turner, F.R.S.; Chemistry, Prof. J. Walker, F.R.S.; Geology, A. Harker, F.R.S.; Zoology, Prof. D'Arcy W. Thompson, C.B.; Geography, Colonel C. F. Close, R.E., C.M.G.; Economic Science and Statistics, Hon. W. Pember Reeves; Engineering, Prof. J. H. Biles; Anthropology, Dr. W. H. R. Rivers, F.R.S.; Physiology, Prof. J. S. Macdonald; Botany, Prof. F. E. Weiss, with W. Bateson, F.R.S., as chairman of the Sub-section of Agriculture; Educational Science, Rt. Rev. J. E. C. Welldon, formerly headmaster of Harrow School.

IN December, 1910, a circular, signed by Profs. R. Meldola and W. J. Pope, was sent to a certain number of the Fellows of the Royal Society inviting subscriptions to a fund for the purchase of a portrait of Sir William Crookes, by Mr. E. A. Walton, of the Royal Scottish Academy. We learn that the necessary fund, of which Lord Avebury is treasurer, has now been raised, and that the portrait will be presented to the Royal Society at a meeting of the subscribers to be held at Burlington House on February 16.

AT the annual general meeting of the Royal Astronomical Society, to be held to-morrow, February 10, the gold medal of the society will be presented to Dr. P. H. Cowell, for his contributions to the lunar theory and gravitational astronomy.

As Prof. Karl Pearson is unable to lecture at the Royal Institution on March 3, the Friday evening discourse on that date will be delivered by Dr. F. A. Dixey, his subject being "Scents of Butterflies."

THE Reale Accademia dei Lincei has unanimously elected King Victor Emmanuel honorary president, in recognition of his work on Italian coins, the "Corpus Nummorum Italicorum."

To the list of names of honorary foreign members of the French Chemical Society, published in our last week's issue (p. 448), should be added Profs. S'vante Arrhenius, of Stockholm, and G. Ciamician, of Bologna. In the same paragraph, for "Cannizaro" read "Cannizzaro."

THE death is announced from Paris, in his seventy-first year, of Dr. Achille Kelsch, member of the French Academy of Medicine, and known by his work in epidemiology and diseases peculiar to warm climates.

THE Association of Economic Biologists will hold its tenth general meeting at Birmingham, in the University buildings, Edmund Street, under the presidency of Prof. Geo. H. Carpenter, on April 6 and 7. Non-members wishing to attend may obtain particulars from the joint honorary secretary, Mr. Walter E. Collinge, 59 Newhall Street, Birmingham.

MR. HUGH CHISHOLM, editor of the new edition of the "Encyclopædia Britannica"; Mr. F. W. Dyson, F.R.S., Astronomer Royal; and Surgeon-General Sir Alfred Keogh, K.C.B., Rector of the Imperial College of Science and Technology, have been elected members of the Athenæum Club under the provisions of the rule which empowers the annual election by the committee of a certain number of persons "of distinguished eminence in science, literature, the arts, or for public services."

THE systematic study of the megalithic and other remains in a district is a promising field of work for members of local scientific societies. We are glad, therefore, to see that in one of the papers to be read before the Cotteswold Field Naturalists' Club on February 14 at the Technical Schools, Gloucester, Dr. A. M. McAldowie will deal with "An Astronomical Study of the Long Barrows on the Cotteswolds, with Special Reference to the Meridian."

AT a general monthly meeting of the members of the Royal Institution on January 6, the treasurer reported that he had received 1200*l*., part of the legacy to the Royal Institution of the late Miss Wolfe, and 62*l*. 10*s*., a portion of the legacy of the late Mr. C. E. Layton. The special thanks of the members were returned to Dr. J. Y. Buchanan for his donation of 100*l*. to the fund for the promotion of experimental research at low temperatures. The institution has recently received a gift of 1000*l*. from Dr. Hugo Müller.

THE services rendered to forestry in the State of Vermont by Dr. Lewis Ralph Jones have been recognised in an exceptional way by the decision that the new forest reserve shall be called the "L. R. Jones State Forest." Dr. Jones was professor of botany at the University of Vermont from 1889 until he resigned the post last year to accept the chair of plant pathology at the University of Wisconsin. During this period he secured the establishment of the State forest nursery and the creation of the position of State forester, besides promoting in other ways the movement for better forest management.

THE Manchester Museum has recently received, through the generosity of Mrs. Leo Grindon, the important and extensive private herbarium formed by the late Mr. Leo Grindon, who was well known in Manchester as an enthusiastic botanist and teacher, as president of the Field Naturalists and Archæological Society, and as lecturer in botany in the Medical School until its incorporation with the Owens College. The herbarium is arranged on somewhat unique lines, for each plant is accompanied by numerous coloured and other illustrations, together with much valuable printed matter in the form of cuttings from various botanical books and periodicals. The herbarium is rich in specimens of garden plants, and affords valuable evidence of the effects of cultivation on various species. The gift is greatly valued by the committee and the University authorities, not only as a specially valuable instrument in botanical teaching, but also as a memorial of a Manchester citizen who was a distinguished teacher, and inspired much affection in the wide circle of his acquaintance.

GREAT interest attaches to an account, by Dr. E. Trouessart, in *La Nature* of January 14, of the reported discovery in the Congo of a new mammal, which appears to be known to the natives as the "water-elephant." A herd of five of these animals was seen by Mr. Le Petit, one of two explorers sent by the Paris Museum of Natural History, on the northern shore of Lake Leopold II. Before the animals plunged into the lake, Mr. Le Petit had the opportunity of seeing that they were smaller than elephants—their height being estimated at 6 feet—with much shorter trunks, smaller ears, relatively longer necks, and apparently no tusks. Their footprints are also different from those of elephants. In an interview accorded to a reporter of *The Daily Express*, recorded in that journal of February 6, Dr. Chalmers Mitchell expressed his belief in the authenticity of the discovery, and suggested that the apparently new animal might represent a primitive type of elephant. In this connection, it may be pointed out that Mr. Le Petit's description of the animal accords almost exactly with the restoration of Palæomastodon, of the Lower Tertiary of the Fayum, given by Dr. C. W. Andrews on p. 22 of the "Guide to the Elephants in the British Museum, Natural History." The members of that genus are there stated to range in height from 4 to 6 feet.

MR. GEORGE GREY, whose death at the Nairobi Hospital on February 3, as the result of wounds received from a lion, will be widely lamented in geographical and mining circles, as well as by his many personal friends. His exploratory work as a mining engineer is of scientific as well as commercial value, the discovery and location of the great mineral belts in North-western Rhodesia and the Katanga district of the Belgian Congo being due to him. Eleven years ago Mr. Grey mapped out a hundred copper mines from Kasanschi to the Kambone, as well as the alluvial goldfields of Rüwe, rich tin areas, and other valuable minerals, controlled by the Tanganyika Concessions Company. His work added to geographical knowledge and opened up a vast region to mining, commercial, and pastoral enterprises.

PROF. D. OLIVER, F.R.S., who completed his eightieth year on February 6, was an active contributor to botanical literature during his tenure of the position of keeper of the herbarium and library at Kew Gardens, which he vacated more than twenty years ago. His earliest paper in this connection was an article on the Indian Species of Utricularia, published in the Journal of the Linnean Society, vol. iii., in 1859. Among his numerous subsequent publications, the more important have been:—The Atlantis Hypothesis in its Botanical Aspect (1862); On the Distribution of Northern Plants (1862); The Structure of the Stem in Dicotyledons, part i. (1862); part ii. (1863); Notes on the Loranthaceæ, with a Synopsis of the Genera (1863); Lessons in Elementary Botany (1864), reprinted at frequent intervals, with a new edition in 1881; Flora of Tropical Africa, vol. i. (1868); vol. ii. (1871); vol. iii. (1877); First Book of Indian Botany (1869); The Botany of the Speke and Grant Expedition, part i. (1872); part ii. (1873); part iii. (1875); Enumeration of Plants Collected by V. Lovett Cameron, Lieut. R.N., in the Region about Lake Tanganyika (1876); List of Plants Collected by Mr. Joseph Thomson on the Mountains of Eastern Equatorial Africa (1885); with many other papers of great value on African and Arctic plant collecting especially. The excellent quality of Prof. Oliver's work is well known; the high appreciation in which it is deservedly held may be gathered from the fact that, in 1884, the Royal Society bestowed on him one of its Royal medals, and in 1893 he was awarded the Linnean medal—the highest honour it can bestow—by the Linnean Society.

AT a special general meeting of the Geological Society of London on January 25, the following resolutions were passed:—(1) That the space now occupied by the museum be made available for the extension of the library. (2) That it is desirable that the society's collections of fossils, minerals, and rocks, with certain exceptions to be subsequently specified, be offered to one or more of the national museums, provided that guarantees be obtained that the specimens will be properly registered and rendered available for scientific purposes. (3) That it is not desirable that the society should accept money for any part of the collections, or in consideration of them. (4) That the council be empowered to approach such institution, or institutions, with the view of carrying the above resolutions into effect, and that the council shall call another special general meeting to express approval or otherwise of the arrangement proposed.

A COPY of the prize programme of the Société Batave de Philosophie expérimentale de Rotterdam for 1910 has reached us. In it some forty-eight questions are propounded, and answers are invited which have necessitated research work. The gold medal of the society, or its monetary value, as the author of the selected thesis may decide, will be awarded to the reply which is selected by a general meeting of members of the society. Memoirs should reach the principal secretary of the society not later than February 1, 1912, and should be in Dutch, French, German, or English, and not in the author's handwriting. The memoirs which are awarded prizes will be printed and published by the society, and twelve copies will be offered to each author. The questions for solution range over most branches of science. A few examples of the great diversity of subjects proposed are:—an experimental research on the cause of phosphorescence, particularly in lowly organised animal forms; an experimental study of the electrical properties of some metallic alloys; and an experimental determination, carried out with the greatest care, of the atomic weight of at least one element.

SIR BOVERTON REDWOOD, chairman of the Chemical Industries Committee, Board of Trade (Exhibitions Branch), announces in a circular letter that in the British section of this year's Turin Exhibition chemical and physical apparatus will be shown in a practical and novel manner. Generally speaking, no means are provided at exhibitions for demonstrating the utility of the instruments exhibited, and it has been decided to improve upon this plan by showing apparatus as it would be used in a laboratory. Arrangements are being made by which, it is anticipated, there will be on view at Turin at least two well-equipped chemical laboratories, with such work going on as will illustrate various processes. There will be a large space available for the display of chemical products and apparatus not in use in the laboratories. In the court devoted to scientific instruments, arrangements are in hand for the display of apparatus ready for work, electric supply, where needed, being provided. The equipment of a large dark-room is under consideration, and here it is proposed to show apparatus, such as oscillographs, spectroscopes, optical lanterns, and photometers. The organisation of these exhibits has been placed by the Exhibitions Branch of the Board of Trade in the hands of Dr. F. Mollwo Perkin, under the direction of a joint subcommittee of the Chemical Industries Committee and the mathematical and Scientific Instruments Subcommittee.

SINCE the report of the British Science Guild on the synchronisation of clocks was issued, the following additional information, showing how the post office are extending their operations, has been sent to the committee by the post office representative:—The post office has had a system of synchronisation in perfectly successful operation at Leeds and Birmingham post offices for the past eighteen months. In the former case, the system has been utilised for the correction of a large four-faced turret clock, and, of course, in both cases the system controls clocks exposed, as at all post offices, for public purposes, over the posting boxes and in the public offices. The system has been so successful that arrangements are being made for the clocks at the following post offices to be similarly dealt with:—Aberdeen, Belfast, Bristol, Glasgow, Manchester, Newcastle-on-Tyne, and Liverpool.

At Aberdeen (where electric clocks on the magneta system are already installed, in which case it is, of course, only necessary to synchronise the master clocks) the synchronising system has been extended by open wires to the clocks at certain branch post offices. Further, at Sheffield an electric-clock system driven by a synchronised master clock, which controls (in addition to the ordinary public clocks referred to above) a large double-dial bracket clock fixed outside the building, has been erected. A similar system is about to be installed at Taunton. It is hoped that before very long the post office will be in a position to offer facilities to the public for the synchronisation of clocks at such rental rates as should remove the main objections which have been urged to the general adoption of the principle.

IN connection with the subject of the synchronisation of public clocks, it is of interest to record that a time ball 4 feet in diameter has been provided on the summit of the dome of Messrs. S. H. Benson's building on the west side of Kingsway, and the ball is dropped at each hour by electric current. Unlike time balls which only work once a day, and require to be set up by hand daily before their fall, this one is wound up quite automatically by an electric motor shortly before each hour of daylight, and is released precisely at every hour by the Greenwich time signal. It was laid down as a condition by the architects that there should be no shock or jar occasioned by the fall, and this has been overcome by a system of counterbalancing, whereby the acceleration due to gravity is neutralised just before the ball reaches the bottom. The installation was designed by Mr. Hope-Jones, and carried out by the Synchronome Company, of 32–34 Clerkenwell Road, E.C.

A DEFINITE step towards the reorganisation of the irrigation of Mesopotamia, so long neglected, has been taken by the signing of a contract between the Turkish Government and the firm of Sir John Jackson (Ltd.), contractors and engineers, Westminster, for the construction of a large dam at the head of the Hindia canal, as reported in daily papers on January 31. This is a portion of the comprehensive scheme put forward by Sir William Willcocks, and has for its object the turning back of the waters of the Euphrates into its own bed instead of flowing down the Hindia canal, whereby a large area of country has become waterlogged. By this scheme water will be restored to the Euphrates channel, which is now dry in summer, and prosperity both on its bank and in the present marshy tracts along the Hindia canal will be greatly increased.

OF the four quarter days of the old May year, Candlemas Day, February 2, has become less marked than the rest. It would appear, however, from the following communication to *The Daily Mirror* that it is yet observed in Holland:—"Scheveningen (Holland), Thursday.—To-day is Woman's Day in Holland. Her slipper is in the ascendant. Your Dutch 'vrouw' is no believer in suffragette dreams of equality, no clamant seeker after votes for her sex. Only on one day in the year, February 2, she claims absolute autocracy. For that one day she is lord and master (baas). On awakening, 'mynheer' discovers his wife's slippers hanging conspicuously and ominously over his head. Throughout the day she flaunts her brief spell of emancipation in his face, and in the evening she gives a 'feast,' and then coquettes and contradicts and teases the very life out of him. At the end of the evening he gets his reward. The slipper domination is at an end. She acclaims him her king, her all-in-all baas, and crowns him with flowers and gladly slips back into her position as wife and lover."

THE port of Hull is shortly to have a fisheries museum, which will be appropriately situated in the western division of the city, where the population and manufactures are closely connected with the steam-trawl fishing industry; the cost of the building will be defrayed by Mr. C. Pickering. A suitable site has been granted in the new Pickering Park, and the Hull Museums Committee hope for the cooperation of the owners of fishing vessels, &c. The nucleus of the collection will be the fine collection of models of fishing methods and appliances, and preserved specimens, recently presented to the Hull Corporation by the Japanese Government. These specimens are all excellently made and are of great interest. It is suggested that the museum should illustrate the growth and evolution of the fishing and shipping industries at Hull, and fishes, both from a natural history and an economic point of view. Mr. Pickering has undertaken to help with regard to models of various types of trawlers, specimens of representative fish, &c. Such an institution should be of great educational value to Hull.

A COMMUNICATION from Sir Harry Johnston, published in NATURE of December 15, 1910, to the effect that three living okapies were then on their way to New York, is stated in the *Field* of January 28 to be incorrect. In answer to an inquiry from that journal, the acting director (Dr. H. Townsend) of the American Museum of Natural History—to which institution the specimens were reported to belong—states that no live okapies have been secured by the museum collector in the Congo. We submitted the note in the *Field* to Sir Harry Johnston, who replies as follows:—"I have nothing to add to my original statement or to the remarks on it in the *Field* of January 28 except to say that Dr. Bumpus, of the Natural History Museum, New York, did in a letter of last October give me the information regarding the capture of living okapis, which I quoted textually in my review in NATURE. I am sure Dr. Bumpus made the statement on good foundation. My review did not appear immediately it was sent in, consequently the announcement when published was a little old. What is really wanted by science is not any more mounted *skins* of okapis, but the whole carcase preserved for the careful dissection of the soft parts. This is even more important than the exhibition of live okapis as a curiosity."

THE Lord Mayor presided over a public meeting, held in the Guildhall on February 6, to consider the desirability of the systematic destruction of rats and other vermin in the interests of the public health as well as in those of agriculture and commerce. In moving a resolution to this effect, Sir James Crichton-Browne referred to the danger from plague-infected rats, and remarked that while there is no cause for panic, on account of the outbreak in Suffolk, there is cause for anxiety so long as any rats carrying the plague bacillus remain in the land. The following resolution was also adopted upon the motion of Sir Charles McLaren, seconded by Prof. G. H. T. Nuttall:—"That urgent representations be made to the Government as to the necessity for the immediate appointment of a Royal Commission for the purpose of inquiring into (1) the increase of vermin and the steps to be taken for their destruction; (2) the question of what creatures are or are not harmful to man and his industries; and (3) the safety and efficiency of the various viruses on the market and other means advocated for such destruction." It was decided to ask the council of the Royal Institute of Public Health to take steps to give effect to the resolutions adopted by the meeting.

HIS MAJESTY's battleship *Thunderer* was launched on Wednesday, February 1, from the yard of Thames Iron Works, Ltd. As this ship is the largest floated for the British Navy up to the present, the builders have to be congratulated on the enterprise and courage which has enabled them to overcome the difficulties inherent to the building of ships on the Thames. When finished, the new ship will have a displacement of 22,500 tons; her length is 545 feet and her breadth 88 feet 6 inches. Parsons' turbines, to give a speed of 21 knots, are being constructed at the builder's works at Greenwich. The launching weight of the vessel and cradles was about 9600 tons, and the ways were so designed as to keep the pressure under 2 tons per square foot. The inclination of the ways was 1 in 16, and about 10 tons of tallow, together with oil and soft soap, were used for lubrication. The launching operation passed off without hitch of any kind, and the vessel was immediately towed down the river to Dagenham, where the firm have had constructed a new ferro-concrete jetty for the purpose of enabling the ship to be finished.

A REPORT has just been published by Mr. F. Palmer, chief engineer to the Port of London Authority, in which is described a very comprehensive scheme for the improvement of the Port of London. In a summary of the report, *Engineering* for February 3 states that the net tonnage entering the Port of London has increased in recent years at the rate of about three million tons every ten years. The maximum size of vessels using the port has increased from 10,000 to 14,000 tons. The new scheme in its entirety will cost about 14,500,000*l.*, and provides, among other improvements, for four new docks and rearrangements and reconstruction for those at present in existence. The depth of water in all will be increased, and from the Millwall Docks seawards there will be a channel 600 feet wide, giving 20 feet at low tide and 41 feet at high tide. Just above the Albert Docks this will change to a channel of corresponding width, but of 10 feet greater depth, while a little lower it opens out to 1000 feet in width. As all the best docks at present are fully occupied, but little additional tonnage can be attracted except by the provision of new or improved facilities, and there seems little doubt that many of the suggested improvements will be carried out in the near future.

IN *The Times* of February 3 a correspondent says that another attempt to cross the Atlantic Ocean by airship will be made early this year. The enterprise is being promoted by a German syndicate, and it is reported from Kiel that the airship, named the *Suchard*, is practically complete, and will, after trials, be shipped to St. Vincent, Cape Verde Islands. The *Suchard* differs essentially from the Wellman airship. The gas envelope is constructed more or less on the lines of the Parseval dirigible, but it is of stouter material. In length it is 195 feet, and its greatest diameter is 55 feet. The cubic capacity is 9400 cubic metres, and an abnormally large air ballonet is fitted. Care has been taken to devise a system of balancing which will keep the vessel as nearly as possible at a uniform height. The motive power will be supplied by two petrol engines of 200 horse-power, mounted in a boat slung beneath the envelope. In the event of mishap to the envelope, necessitating its being cut adrift, the motors can be employed to propel the boat. The entire power plant and all the stores are to be placed in this boat. A light upper deck or platform is situated above the boat of the *Suchard*, which gives access to the envelope. The promoters claim that they will be able to cross the Atlantic in three ways, namely, by the dirigible, with the engines running and the trade winds helping; by balloon, in the case of the failure of the engines; or by motor-boat.

AN article by Prof. G. H. Bryan in the *Cornhill Magazine* for February deplores the loss of life by aëroplane accidents, and suggests that the trial-and-error methods by which the development of aërial navigation has been accomplished do not provide the quickest or the best means of solving the problem of stability or of producing machines by which the difficulty of flying will be reduced to a minimum. "The difficulty of flying straight," he remarks, "has been overcome, not by a complete investigation of the problem of stability and the consequent construction of stable aëroplanes, but by aviators learning to balance themselves on more or less unstable machines." Work is wanted in the laboratory, and experiments with models in the air, to provide the material required for the mathematical solution of the problem of maintaining equilibrium in the air under various conditions. While many valuable money prizes are offered for successful flights, practically no encouragement is given to any mathematical or other purely scientific investigator to devote one or two years of fairly continuous work to the study of the stability of motion of an aëroplane. There are plenty of mathematicians who are admirably equipped for such an investigation, but the pressure of their everyday duties, or the necessity of earning a modest livelihood, prevents them from undertaking the work except in their spare time. Prof. Bryan himself, working with Mr. Harper, finds that in ordinary circumstances "a machine is less liable to overturn by pitching, but some machines are more liable to overturn sideways when gliding downwards than when flying horizontally." He considers that most machines at present in use are more or less unstable laterally, and that the methods by which progress has been achieved have involved—to use the title of his article—unnecessary "Wastage of Men, Aëroplanes, and Brains."

THE report of the Public Health Committee of the London County Council, containing the report of the medical officer of health of the county, Sir Shirley Murphy, for the year 1909, has recently been issued. It contains a mass of statistical matter of the utmost value, as well as several special reports by the assistant medical officers on subjects of importance in public health. Of the latter, Dr. Hamer's on nuisance from flies and on the seasonal prevalence of vermin in common lodging-houses is of particular interest. A census of flies in selected localities, the species to which they belong, their seasonal prevalence and relation to intestinal diseases, are discussed.

AN article referring to the Chinese tree originally named *Cupressus Hodginsii*, by Mr. S. T. Dunn, appears in *The Gardener's Chronicle* (February 4). Dr. A. Henry, in consultation with Mr. H. H. Thomas, announces that from an examination of further material they make it the type of a new genus, Fokienia, intermediate between Cupressus and Libocedrus. It agrees with Cupressus in the shape of the female cones, and is similar to Libocedrus in the unequally-winged seeds and general characters of the foliage. Another announcement in the same issue relates to the discovery in a Dutch nursery of a fertile sport of the maidenhair fern *Adiantum Farleyense*, often mentioned for its sterility, *i.e.* non-production of spores. The new variety is said to be superior in other respects, inasmuch as it thrives at a lower temperature and bears the petioles more erect and rigid.

The difficulty of producing definite proof even for elementary physiological principles is exemplified in the two articles on the translocation of carbohydrates in plants contributed by Mr. S. Mangham to *Science Progress* (October, 1910, and January, 1911). Formerly the opinion was generally accepted that, while albuminous substances pass through the sieve-tubes, the carbohydrates travel chiefly, if not entirely, through the parenchymatous cells of the vascular bundle. In 1897 Czapek enunciated the view, which is here affirmed, that the sieve-tubes furnish the path for rapid translocation of the assimilates as a whole. The problem is discussed both with regard to the structure of the conducting tissues, more especially of the small veins in the leaf, and the results of physiological experiments. The weightiest arguments are derived from the interpretation of Schubert's examination of the leaf-veins and the author's experiments for tracing the sugars in the tissues by the formation of osazones. The latter method is only briefly indicated, but further details of the process and results are promised; meantime, the author is justified in stating that he has furnished strong evidence in favour of Czapek's theory.

We have received the Almanac for 1911 published by the Survey Department of Egypt. It has increased in size, and contains a large amount both of statistical and general information concerning Egypt and the Nile basin. Much information relating to such important matters as taxation, areas of jurisdiction, &c., which is not always readily accessible to the public, is here included.

In the report upon the rains of the Nile basin and the Nile flood of 1909, published by the Survey Department of Egypt, Mr. J. I. Craig gives full details of the rainfall and its effect on different parts of the river system. He points out that certain anomalous variations of the level of Lake Victoria in 1908 have been definitely traced to instability of the gauge at Jinja, and are not to be connected with possible crustal movements. The number of stations has increased, there being now 96 in Egypt and the Sudan, while data from 121 other stations in surrounding regions are utilised. In a final chapter he summarises recent investigations into the possibility of predicting the character of the flood.

In the January number of the *Geographical Journal* Prof. T. Park describes the area affected by the Tarawera eruption in New Zealand in 1886, its erosion since that date, and the development of new vegetation. The sheet of grey ash which then covered the dissected tableland on the shores of Bay of Plenty has now been deeply scored by rain, and many points of interest, such as the distribution of the black andesitic ash, may now be seen. Since 1890 the growth of vegetation, mainly bracken, tutu, veronica tree fern, blue gum, and acacia, has been rapid, some of the gum trees being now more than 30 feet high.

To the Bulletin of the St. Petersburg Academy of Sciences of December 1, MM. Dudetzky and Weinberg communicate a short paper on the microstructure of hailstones. These were collected during a thunderstorm at Tomsk (Siberia) on June 12, 1910, were mostly spheroidal in form, and generally 7 to 10 mm. in size. Their concentric spherical layers were alternately opalescent and transparent, and divided according to the rays by a quantity of air-bubbles, frequently oblong in shape. Many of the stones consisted only of one layer, sometimes quite transparent, in other cases milky. An interesting peculiarity presented itself in some of the stones, formed of several spherical layers, viz., the eccentricity of the milky central grain. This occupied a lateral part of the hailstone, and often formed but part of a sphere. In the stones examined it was difficult to indicate any relation between their crystalline and physical structure. The only fact that could be drawn from the visual study of the images of the thin plates on a screen was a certain enlargement of the crystalline grains with distance from the centre of the central layer.

According to a paper by Dr. L. A. Bauer in the January number of the *American Journal of Science*, it is proposed to take observations of the value of the gravitational acceleration on board the American magnetic ship *Carnegie* during her future voyages, beginning at Cape Town in April next. The method to be adopted is that suggested by Guillaume in 1894, and used on land by Mohn and at sea by Hecker. It consists in the observation of the height of the barometer and the boiling point of water with mercury thermometers of special construction, or with resistance thermometers. The principal difficulty in obtaining accurate results is the "pumping" of the barometer owing to the motion of the ship, and this, it is hoped, will be overcome by the construction and mounting of the instrument. The barometers and thermometers are to be compared at intervals with standard instruments, and observations in port are to be made on land and on water, and are to be compared with the results of pendulum observations wherever it is possible. By these means Dr. Bauer hopes to secure results free from the objections which can be urged against those of Hecker.

The new convertible Balopticon lantern, of which a catalogue has been issued by the Bausch and Lomb Optical Co., Thavies Inn, London, E.C., is designed for the projection of lantern-slides by transmitted light, opaque objects by reflected light, and for microscopical and vertical projection by the addition of the necessary attachments. The apparatus appears to be very ingeniously devised, as by its aid almost any projection work may be carried out efficiently that would otherwise require much larger and more complex arrangements. It must not be forgotten, however, that the brilliancy of the picture to be obtained with any projection apparatus depends primarily on the power of the source of light, so that the illuminant, particularly for opaque objects, should be an efficient one. In the present instance this point has not been overlooked, and as, in addition, the optical parts are of a high order, the results to be obtained are in every way satisfactory. Each one of the above-mentioned methods of projection may be obtained almost instantly as required, so that for lecture purposes, where objects of a varied character are to be shown, the apparatus can be used with ease.

The *Builder* for January 27 contains an interesting account of a method of strengthening a bridge by means of sheathing the steel trestles with reinforced concrete. The bridge operated on is that carrying the Wabash Railway over the River Missouri. Originally designed for the moving loads prevalent at the time, the trestles were quite inadequate for modern traffic requirements. After preliminary experiments, all the columns have been converted into octagonal reinforced concrete columns by applying concrete embedding a spiral coil of No. 6 American gauge wire wound with a pitch of 2 inches. The column bases consist of a rectangular concrete block reinforced by a network of steel rods near the outer surfaces. The struts bracing the four columns in each tower have been cased in concrete, the concrete being reinforced by eight half-inch rods, around which is a wrapping of wire netting. The connections between columns and struts are stiffened by reinforced concrete brackets. The concrete used was mixed in the proportions of one part Portland cement to three parts of coarse sand. Tests conducted at the University of Illinois show that the reinforced concrete column possesses about double the strength of the plain steel column prior to reinforcement.

THE London representative of the firm of E. Merck, of Darmstadt, desires us to say that the "Index" referred to last week (p. 453) can be obtained at the address of the London house, 16 Jewry Street, E.C., and that the price of the book is 6*s*. 6*d*.

THE first number of *The Irish Review*, a monthly magazine of Irish literature, art, and science, will be issued next month. The review will be for Ireland what such periodicals as *The Quarterly Review, The Edinburgh Review, Le Mercure de France*, have been for neighbouring countries. It will compete with no existing periodical, and will publish in its literary pages nothing of merely ephemeral interest. In each number will be an authoritative article on a subject of scientific or economic research as applied to Ireland.

MESSRS. FLATTERS AND GARNETT, LTD., 32 Dover Street, Manchester, have issued two new catalogues. One provides interesting particulars of a series of new lantern-slides, and is supplementary to the catalogue of lantern-slides published by this firm in November, 1909. Attention may be directed specially to the slides illustrating plant associations, by Mr. W. B. Crump; bird photographs from recent negatives; and the reproduction and development of *Pinus sylvestris*. The second list deals with optical lanterns and accessories. One novel item in the latter is a combined lantern-screen and stand which can be erected in two minutes.

OUR ASTRONOMICAL COLUMN.

NOVA LACERTÆ.—In his note to the Academy of Sciences (*Comptes rendus*, January 23) describing the spectra of Nova Lacertæ secured at the Meudon Observatory on January 15, M. P. Idrac directs attention to the great width and the structure of the bright hydrogen lines.

Each of the hydrogen lines $H\beta$–$H\zeta$ extends over about 40 Angströms, and in $H\beta$, $H\gamma$, and $H\delta$ there are strong maxima at about 12 Angströms from the centre of each band towards the red; the photograph is probably too weak to show them in $H\epsilon$ and $H\zeta$. The band at λ 464 is as strong as the hydrogen lines, and has hazy borders, its width being about 50 Angströms; there is also a bright line at about λ 437.

The spectra secured are too narrow to show absorption lines definitely, but one is suspected on the more refrangible side of $H\gamma$. Altogether, the spectrum appears to be of the nova rather than of the long-period variable type.

MARS AND ITS ATMOSPHERE.—A number of drawings of the surface features of Mars, reproduced and described in Circular No. 5 of the Transvaal Observatory, are of interest, inasmuch as they represent the observations of two unbiassed observers using a 9-inch refractor under favourable conditions. The observations were made during the latter part of 1909 by Mr. Innes and Mrs. H. E. Wood, and are depicted on forty-two separate discs; Mrs. Wood also contributes a composite map embodying the details seen on her separate sketches.

Mr. Innes saw many fine and elusive shadings, but no "canals," in the usual acceptance of the word, were seen by him. He directs special attention to the two conjugate, diametrical, double canals usually shown crossing Hellas, and states that he was never able to see more than a curious curved shading. On the other hand, Mrs. Wood, in her drawing of October 25 (No. 40) and on the composite map, shows Peneus and Alpheus in their conventional forms.

In Bulletin No. 180 of the Lick Observatory Prof. Campbell and Dr. Albrecht describe the results secured in an attempt to obtain evidence for water vapour and oxygen in the Martian atmosphere by the broadening or duplication of the corresponding terrestrial lines on large-dispersion spectrograms. As red-sensitive plates are now readily procurable, it was expected that this application of the Doppler-Fizeau principle, which occurred to Prof. Campbell in 1896, might prove fruitful. Spectrograms were secured, some under excellent conditions, in January and February, 1910, with a specially designed grating-spectrograph made at the observatory, and the displacements of the lines carefully measured.

The results indicate that the amount of water-vapour existing in the planet's atmosphere on February 2, 1910, was certainly less than one-fifth that existing above Mount Hamilton, where the air temperature was 0° C., the relative humidity was 33 per cent., and the absolute humidity was 1·9 grams per cubic metre; the zenith distance at mid-exposure was 55°. The amount of oxygen above unit area on Mars was, apparently, also small as compared with that in the earth's atmosphere.

COMETARY THEORIES.—In No. 4466 of the *Astronomische Nachrichten* Messrs. Roe and Graham, of the Syracuse University, suggest a new theory of comets which they believe to be based on phenomena in accordance with modern mathematical physics. Briefly, it is that the sun, as an intensely heated body in which violent chemical action is taking place, emits abundant streams of negative electrons, and so acquires a positive charge. Other bodies, such as the earth and comets, will act similarly under the action of some agent intimately associated with the ultra-violet light radiations which they receive. As the comet approaches the sun, the positive charge will tend to increase, and the mutual repulsion of the charged particles will overcome the relatively small cometary gravity, thus producing streamers away from the comet and the sun. Various associated problems are discussed in the paper, and various desirable lines of research are briefly enunciated.

In No. 4468 of the same journal Prof. Eginitis also discusses the physical constitution of comets as exemplified by the phenomena attending the recent passage of Halley's comet. After May 21, 1910, the tail appeared to be much brighter than before, and Prof. Eginitis attributes this to the fact that then we were looking at it by directly reflected solar light—the side illuminated by the sun's rays was exposed to us. Therefore, he argues, the material composing comets is but slightly luminous, and we only see it clearly when it is acting as a reflector of the solar light. From this it follows that the physical constitution of comets is not purely gaseous—the comet is a mixture of gas with solid corpuscles.

POLARISATION IN THE SPECTRUM OF *o* CETI.—When, in 1898, it was found that the bright $H\gamma$ line in the spectrum of Mira was triple, it was suggested that the phenomena might be due to the Zeeman effect produced by magnetic activity in the star. Polariscopic observations were not then possible, and the faintness of Mira in 1899 defeated the preparations made for the maximum of that year.

During the maximum of 1909 preparations were again made at the Lick Observatory, and photographs were secured, but no definite general conclusion accrued. As Dr. Wright explains, in Lick Observatory Circular, No. 183, the whole problem is hedged with grave difficulties, chief of which is that introduced by the possibly considerable changes of direction of the magnetic field in the star. All that can be deduced definitely from his observations is that they show that the multiple character of the lines is not due to a magnetic field maintaining a constant direction throughout the source.

THE EARTH'S ACTION ON SUNLIGHT AND HEAT.—Mr. James D. Roots sends us a pamphlet in which he enunciates a theory to answer the question: "What Becomes of the Sunlight and Heat Absorbed by the Earth?" Mr. Root believes it is converted to "radio-activity, and then by stages of change to electric current," which leaves the earth at the poles, completing a continuous cycle sun to earth, earth to sun. The story is not so continuous, and often consists of such statements as "The main currents rotate the earth," but it is reassuring to learn that Sir J. J. Thomson, in one passage of his "Electricity and Matter," "almost grasps the truth."

EXPERIMENTS ON COAL-DUST EXPLOSIONS.[1]

A PRELIMINARY record of experiments made with coal dust, and other work of various kinds, carried out by a committee of colliery owners on behalf of the Mining Association of Great Britain, has lately been published in an elaborate and splendidly illustrated volume.

In the introductory chapter the committee quotes the remarks of John Buddle (1803) regarding "the shower of red-hot sparks of the ignited dust which were driven along by the force of the explosion," and those of Faraday and Lyell (1884): "There is every reason to believe that much coal gas was made from this dust in the very air of the mine, *by the flame of the firedamp which raised and swept it along*, and much of the carbon of this dust remained unburnt from want of air."[2] A general list is then given of those who have taken part in the investigation since 1875 (not 1870 as stated), regardless of chronological order, and reference is made to the opinions expressed by the Royal Commission, 1891–4, and of a committee consisting of the members of the Royal Commission of 1906, which is still in existence, and an advisory board associated with it, to the effect that experiments with coal dust should be made on a larger scale than any hitherto undertaken. The circumstances which induced the Mining Association of Great Britain to undertake to find the necessary funds, which were estimated at 10,000*l.*, are also described.

The committee illustrates in cross-section some of the different galleries in which previous coal-dust experiments were made, as well as those now being employed in France and England, and finally sums up the results of the work of its predecessors as follows:—"These galleries or tubes have in no instance been of sufficient size to allow of the conditions prevailing in a mine being reproduced." "Neither were they of sufficient length to obtain the development of explosive force nor of sufficient strength to resist the latter if obtained. The inflammability of coal dust had been demonstrated by Faraday."

Again, in the first paragraph of chapter iii. the committee says:—"As has already been stated in the Introduction, one of the most important objects of this inquiry has been to demonstrate as conclusively as possible the great danger that exists from the presence of coal dust on the roadways of a mine, and by ensuring the absence of gas to definitely establish the fact that it is not essential that firedamp in addition to coal dust should be present for an explosion to be propagated."

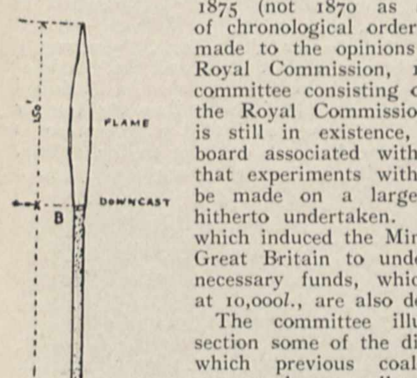

FIG. 1.

These historical references are singularly curt and inexact. Whatever may have been the actual motive that dictated them, they have the appearance of being an attempt to set aside any possible claim to having done really useful work by those who occupied the field in the interval between the time when Faraday showed by an experiment that flame is enlarged when coal dust is allowed to fall upon it and the present day. They appear to simulate ignorance of the fact that the dangers due to the presence of coal dust, both with and without the simultaneous presence of firedamp, was conclusively proved long ago—the explosion at Altofts Colliery in 1886 (Proc. Roy. Soc., vol. xlii. 1887) having been, itself, the culminating proof on a gigantic scale of the second alternative.

Does the British colliery owner, as personified in the committee, hope, by thus assuming the airs and manners of Sir Oracle to conceal his own laches in having hitherto, with few exceptions (of whom the late Mr. Archibald Hood may be taken as the most brilliant example), contributed nothing towards the solution of the coal-dust question, but contented himself with classifying those who were bearing the burden and heat of the day as faddists and theorists?

One can understand the grief and dismay of the French Government engineers who, by their inept criticism of the present writer's experiments and conclusions and of his description of Penygraig explosion (1880) (Proc. Roy. Soc., No. 219, 1882), and by their own abortive experiments with coal dust, lulled themselves and their fellow-countrymen to sleep twenty-eight years ago, on being rudely awakened by the Courrières explosion, with its holocaust of more than 1100 men.

One can sympathise with the confusion of the United States Government engineers at being caught lagging in the rear of an important movement.

But it is difficult to understand why one's own countrymen should be less generous than were the Prussian Government engineers, who showed Sir W. Thomas Lewis and the present writer a most violent explosion of air and coal dust, "without any admixture of firedamp," in their gallery at Neunkirchen on October 25, 1884, frankly avowed that they drew their inspiration from the present writer's earlier work, volunteered the statement that he was the inventor (*sic*) of the method of proving the explosiveness of coal dust in an experimental gallery, and added that his gallery of 1880–1 (for which the Government Grant Committee of the Royal Society provided the funds) had served as a model for their own.

These blots upon a work that is otherwise admirable in many respects ought to have been avoided at every hazard. There was plenty of room for the colliery owner to come in with his gigantic apparatus to demonstrate the dangers of coal dust to himself, his officials, and the community in general, without having to push others aside in the process.

The demonstrations with the Altofts apparatus are so overpoweringly convincing that, in the opinion of the present writer, the Government ought to make it obligatory on the part of everyone who holds a mine manager's certificate to have seen them. They constitute, as the committee itself properly observes, the most important function of the apparatus, before which all the other questions which it proposes to investigate pale into obscurity.

The second chapter is devoted to a description of the experimental gallery, the method of preparing the dust, and the means of raising and igniting it.

That part of the apparatus (Fig. 1) in which the explosions are effected is a straight tube AB, 7 feet 6 inches in diameter, made up of the outer shells of steam boilers with their ends abutting against, and fixed to, each other, 600 feet long, open at one end, closed at the other, and with a branch CD, 6 feet in diameter, also made up of boiler shells, which extends at right angles from the closed end of the tube AB to an exhausting ventilating fan at E.

The branch CD is bent four times at right angles to itself, and is provided with two relief valves at each bend, one at A and another opposite the junction at C, making ten altogether, which open when an explosion takes place, and thus protect the fan from injury. A segment in the bottom of the explosion gallery, with an arc 5 feet wide, filled with concrete, constitutes a level floor on which a line of rails of 25-inch gauge is laid. The rails rest on sleepers 3 feet apart, embedded in the concrete. Five rows of wooden shelves, 5 inches wide by ¾-inch thick, fixed on iron brackets, extend along each side of the gallery from

[1] "Record of the First Series of the British Coal Dust Experiments, conducted by the Committee Appointed by the Mining Association of Great Britain. A Record of the Experiments carried out during 1908 and 1909 at the Altofts Experiments Station." Pp. viii+212. (London: The Colliery Guardian Co., 1910.) Price 10*s.* net.

[2] The italics are the reviewer's.

A, which is called the downcast end, to F, a distance of 350 feet, which is shaded in the sketch.

For seven minutes before, and also while the experiment is being made, the fan draws air into and through the gallery from its open end at the rate of between 50,000 and 60,000 cubic feet per minute.

The dust employed in all the earlier experiments up to the twenty-fourth was obtained from the colliery screens, but in all subsequent experiments (exclusive of some made with dusts from other localities and from abroad) it has been produced by grinding nut-coal from the Silkstone pit of Altofts Colliery in a disintegrator. The composition and degree of fineness of the latter are as follows:—

		Intercepted by	
		100 mesh	7·25
Moisture...	3·21	... 150 ,,	7·50
Volatile matter	33·68	... 200 ,,	3·00
Fixed carbon...	57·60	... 240 ,,	9·25
Ash...	5·51	... Finer	73·00
	100·00		100·00

The quantity employed in an experiment is 1 lb. per linear foot, or 0·39 oz. per cubic foot of air-space. It is thrown on to the shelves by hand.

It is usually ignited by firing a charge of 24 oz. of gunpowder, tamped with 8 inches of dry clay, from a hole, 2 inches in diameter by 2 feet 9 inches deep, in a cannon, called the igniter, placed in the middle of the floor, pointing upwards at an angle of from 32 to 35 degrees, facing towards the mouth of the gallery and at a distance from it of anywhere between 260 and 360 feet, as the case may require. But when it is desired to take special pains to secure ignition, as, for example, when visitors are present, a second small cannon charged with 4 oz. of gunpowder and 3 inches of clay-tamping, placed at a point 90 feet nearer the open end than the igniter in such a position that it cannot ignite the dust, is fired first so as to raise a cloud of dust, which the air-current then carries inwards towards the larger cannon. Both cannons are fired electrically, the smaller one two seconds before the larger.

The discharge of the smaller cannon drives a cloud of dust 4 or 5 feet long out at the open end of the gallery; that of the larger cannon drives out a similar cloud between 30 and 40 feet long. Then comes a rush of dust, followed immediately by flame, which shoots out to an average distance of 156 feet, in some cases to 180 feet, accompanied by a loud report, which is said to be heard at a distance of 3½ miles. Finally, the flame rises up and ramifies into the cloud of coal dust which preceded its first appearance, now floating in the air above it, and a great volume of smoke and dust drifts slowly away.

In Fig. 2 the open end of the gallery is seen at the right-hand side; the white areas immediately in front of it and in the smoke-cloud represent the flame. Fig. 3 is a nearer view of the mouth of the gallery when an explosion is in progress.

All these phenomena, without exception, are identical, except as regards magnitude, with those produced with mixtures of coal dust and pure air, "without the presence of inflammable gas," in the Royal Society gallery in 1880–1, in the Prussian gallery at Neunkirchen in 1884 (see later), and in Hall's experiments in the Big Lady pit in 1890, all of which the present writer has seen, as well as the Altofts experiment.

On the other hand, the Altofts gallery is itself a mere toy compared to one of the galleries, 5300 feet, or nearly twenty times as long, in Altofts Colliery, through which the explosion sped in a straight line in 1886; and as the committee's own experiments, described in part ii., chapter ii., have shown that the pressure and velocity increase rapidly with the length strewn with coal dust, it seems somewhat absurd of the committee to propose to make minutely correct observations of pressure, velocity, temperature, the size, shape, and composition of particles of coked dust, and so on, with the idea that these observations will be of some practical value in solving questions relating to colliery explosions, which they rather indefinitely class under the far-reaching title of "chemical and physical phenomena."

A mine-waggon weighing 4½ cwt., placed on the rails at a distance of 6 feet inside the gallery, ricochets along the surface of the ground in front to a distance of several hundred feet when the explosion takes place. A similar experiment was witnessed by Sir W. Thomas Lewis and the present writer at the Prussian gallery at Neunkirchen, referred to above. The explosion itself is described in NATURE of November 6, 1884, p. 13, as follows:—"*Notwithstanding the entire absence of firedamp*, there was a true explosion of the most violent kind, and the clouds of afterdamp which streamed from every opening darkened the air in the neighbourhood of the gallery for two or three minutes."[1] A mine-waggon loaded with iron so as to weigh 15½ cwt., placed at the entrance to the gallery, was driven up an incline rising at an angle of 4° to a distance of 23 feet. The quantity of gunpowder used in the shot-hole was only 230 grams, or practically half a pound.

FIG. 2.—Flame issuing from Downcast End.

The observations (p. 21) regarding the position of deposits of coked coal dust on timbers fixed in the gallery to represent props in a mine are for several reasons, one of which is the baffling effect of the ventilating current, of no practical value as a means of throwing light upon the point of origin of an explosion in a mine.

Chapter iv., "On the Chemical Analysis of Coal Dust," and chapter viii., entitled "Laboratory Investigations," are intensely interesting and instructive, principally on account of the numerous, carefully thought-out devices described in the latter for obtaining, collecting, and analysing the volatile constituents of coal, and if published as a separate pamphlet would form a valuable addition to the library of everyone interested in the analysis of mineral fuels. The methods of estimating volatile matter, ash, and fixed carbon are practically the same as those recommended by Dr. Pollard in the Memoirs of the Geological Survey.[2]

In chapter v. the instruments intended "for investigating the mode of propagation of coal-dust explosions" (which, stated in plainer language, means those for measuring pressure, velocity, and temperature, and for

[1] The italics are the reviewer's.
[2] The Coals of South Wales (1908), p. 7.

collecting samples of the afterdamp), are described and illustrated. One of two methods of ascertaining velocity, which appears to be fairly satisfactory, consists in fixing strips of tin-foil, 4 inches long by ½ inch wide, in a horizontal position inside the gallery at intervals of 50 feet from each other, which, on being melted successively by the passage of the flame, break electric contacts in the same order, the results being recorded by an instrument of similar type to that usually employed for similar purposes.

The manometer is ingenious, and appears to work satisfactorily, but takes no account of negative pressure. It should be supplemented by adding another much more delicate instrument for the latter purpose.

No satisfactory instrument for recording temperature instantaneously has yet been devised. On the other hand, the contrivance adopted for collecting samples of afterdamp automatically is simple and efficient.

When there are obstacles in the form of "props and bars" (presumably of similar dimensions to the timbers employed for supporting the roof in the roadways of mines) fixed at a distance of 9 feet apart in the gallery, the pressure and velocity of the explosion are found to vary more or less directly with the length of gallery strewn with coal dust, through which the flame has to travel between the igniter and the mouth. In giving rise to greater frictional resistance, these obstacles apparently raise the pressure and temperature of the air advancing towards and rushing past them, and thereby promote a more rapid and intense combustion of the coal dust.

Two manometers, A and B, fixed at distances of 50 and 150 feet respectively from the mouth of the gallery, recorded the following maximum pressures per square inch when the point of ignition was at the respective distances from them shown in the following table :—

Number of experiment	B: Distance from igniter	B: Pressure	A: Distance from igniter	A: Pressure
	ft.	lb.	ft.	lb.
54	125	35	225	50
53	150	38	250	65
62	275	43	375	92

The highest pressure recorded, viz. 100 lb. per square inch, appears to have been in experiment 55, when a length of 150 feet next the mouth of the gallery was free from dust, the next following, 275 feet, strewn with dust, and the igniter was fired at the innermost end of the dust zone, that is to say, at a distance of 325 feet from the mouth, with presumably thirty-six sets of "props and bars" forming obstacles in the path of the explosion. The manometers were in the same positions as in the other experiments recorded above and below.

When there are no obstacles the pressures are much smaller, and appear rather to decrease than to increase with distance of travel, as shown below :—

Number of experiment	B: Distance from igniter	B: Pressure	A: Distance from igniter	A: Pressure
	ft.	lb.	ft.	lb.
50	125	11·9	225	8·75
51	150	9·8	250	8·3
110	275	8·5	375	9·2

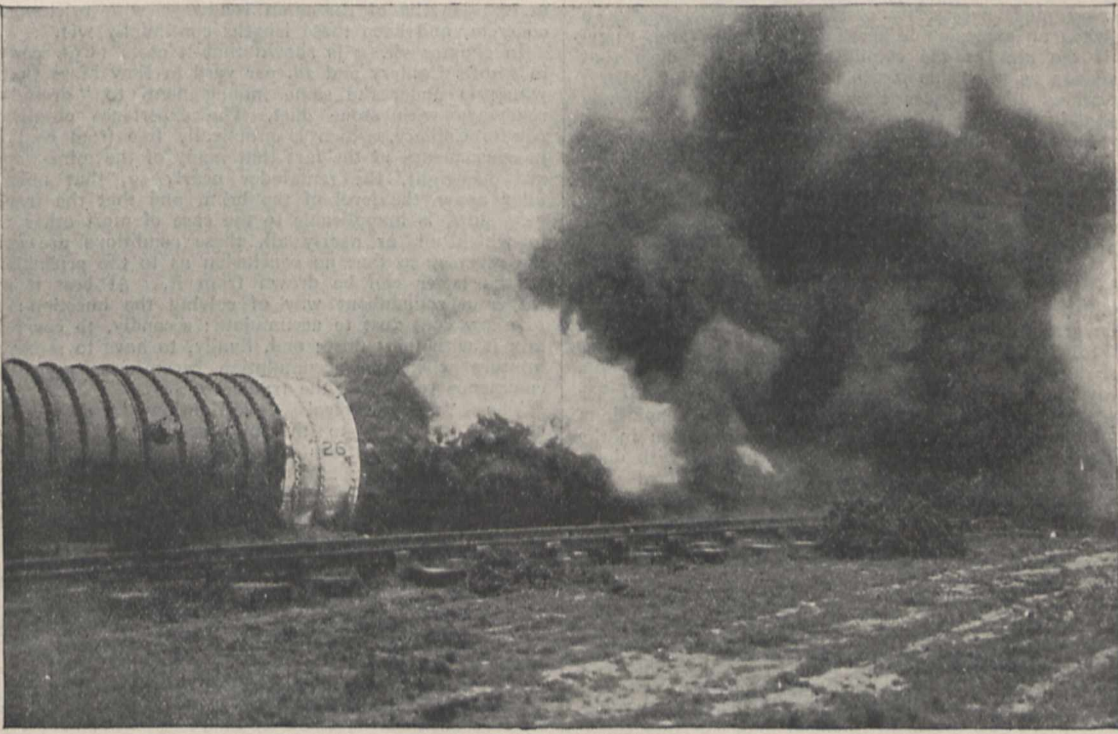

FIG. 3.—Flame issuing from the Downcast.

The records of velocity are as follows :—

First, with Silkstone coal dust and with obstructions in the form of "props and bars" in the gallery (pp. 155–6), it is stated that the velocity, between one contact-breaker 175 feet from the point of ignition and a second contact-breaker at manometer A (200 feet distant from the first) was 2014 feet per second in No. 62 experiment, and that between the point of ignition and a point 275 feet distant it was 475 feet per second in No. 53 experiment.

Secondly, with the same coal dust and without obstructions, the velocities between six points—the first at the igniter, the second 59 feet, the third 109 feet from the first, and so on, with an increase of 50 feet successively up to the sixth—were 39·7, 252·5, 72·5, 119·0, and 222·6 feet per second respectively.

Thirdly, with South African coal dust, and presumably with props and bars in the gallery, the velocities between five points—the first 12 feet distant from the igniter, the second 59 feet, the third 109 feet from the first, and so on, with an increase of 50 feet, as in the last case, up to the fifth—were as given below in feet per second :—

Number of experiment	1–2	2–3		3–4	4–5		Page
102	113·5	85·0	...	118·0	554·5	...	191
104	138·5	320·5	...	160·0	450·5	...	196
105	632·0	52·9	...	125·0	143·5	...	200

Considered as a whole, these results are so discordant that it is impossible to draw any other conclusion from them than that either the instruments are at fault or that there is some disturbing element at work, due, most probably to variableness in the quantity of dust suspended in the air in different sections of the gallery when the flame of an explosion is traversing it.

Owing to the very nature of the experiment, it is obviously impossible to provide that each section shall always contain the same quantity of dust, mixed with the same degree of uniformity in the air which occupies it, at the instant an explosion is passing through it. It is equally obvious that, unless that condition can always be rigidly complied with, the results cannot be concordant as between one section and another, although the sum of the results may seem to be fairly uniform when one explosion is compared with another. But the same absence of uniformity must necessarily obtain in the workings of a mine when an explosion is passing through it, and, therefore, if the aim of the committee is to reproduce that phenomenon as nearly as possible in their artificial gallery, the observed discordances show that they have already succeeded in doing so.

The haulage roads, along which the coal is conveyed from the working places to the shaft, contain larger quantities of very fine coal dust than any other parts of a mine, and ever since the time when the coal-dust theory of great explosions was first propounded,[1] they have been recognised as the routes along which explosions, commenced at any point in a mine, travel to every other part of the workings, however remote. This was well exemplified in the plan which accompanied the description of Penygraig Colliery explosion[2] (1880), previously referred to. It has also been recognised, of course, that if coal dust could be prevented from accumulating in the roadways, or be rendered innocuous by water or other means, the range and disastrous effects of explosions would be greatly limited. To prevent accumulation in the first place by the employment of mine-waggons with dust-tight bodies, *filled only to the brim and provided with covers*, is obviously the best possible expedient that could be adopted, and would be infinitely preferable to the present careless system of carrying the coal in all sorts of leaky or over-loaded waggons, from which it dribbles or falls upon the roads, and is then ground or trodden into the very dust which constitutes the danger.

Under existing conditions, as regards the mode of construction of mine-waggons, the production of coal dust is inevitable; and although there is no legislative enactment in this country compelling the mine-owners to do so, many of them already water the dust in their haulage roads once or twice a day in order to render it innocuous. But in many other mines water cannot be used for this purpose, as it causes the ground above or below the seam to swell or fall to pieces, and consequently the dust is allowed to remain dry. It has been proposed to give the owners of the latter class of mines the alternative of rendering the dust innocuous by covering it from time to time with inert dust, or with a hygroscopic or other salt. The committee have, accordingly, directed their attention to the question of using inert dust for this purpose, and made careful experiments, which are described in chapters vi. and vii., to ascertain, first, the effect that dust of this nature has in arresting the progress of an explosion, and, secondly, the cost of applying it practically in Altofts Colliery.

The inert dust for both purposes has been prepared by grinding the roof-stone of one of the seams of Altofts Colliery in a roller-mill at a cost of 2*s*. per ton.

In the five following experiments a standard length of 275 feet of the gallery was strewn with coal dust, the igniter was fired at the inner end of this zone, and the space at its outer end, 150 feet in length, was treated as follows:—

[1] Proc. Roy. Soc., vol. xxiv., p. 354 (1876).
[2] *Loc. cit.*

Number of experiment	Left dustless or strewn with stone dust or coal dust: Dustless ft.	Stone dust ft.	Coal dust ft.	Pressures recorded by the manometers: B lb.	A lb.
55	150	—	—	40	100
57	—	150	—	40	9
58	—	100	50	31	17·5
62	100	—	50	39·5	84
116	—	100	50	33·7	9·18

In experiment 55 the flame passed just beyond the outer end of the dustless zone; in 57 it penetrated 55 feet into the stone-dust zone; in 58 it penetrated 54 feet into the stone-dust zone; in 62 it passed through the dustless and coal-dust zones, and shot out 100 feet beyond the latter; in 116 it penetrated 22 feet into the stone-dust zone.

These experiments show that a zone of stone dust is more efficient in arresting an explosion than a dustless zone, and thus help to answer, but do not completely solve, one of the questions still being considered by the Royal Commission on Mines, as to whether it is desirable to compel the owners of mines in which water cannot be employed for the purpose of laying the dust to surround certain lengths of the main roadways with brickwork or concrete, and keep these lengths continually wet.

In chapter vii. it is shown that it costs 1·85*d*. per yard in Altofts Colliery and 2*d*. per yard in New Moss Colliery, which is under the same management, to "dress" the roadways with stone dust. The experience obtained in Altofts Colliery, which is practically free from coal dust, in consequence of the fact that many of the mine-waggons are dust-tight, the remainder nearly so, that none are filled above the level of the brim, and that the traffic is very slow, is inapplicable to the case of most other mines in which all, or nearly all, these conditions are exactly the reverse, so that no conclusion as to the probable cost in the latter can be drawn from it. At best it seems rather a roundabout way of solving the question: first, to allow coal dust to accumulate; secondly, to cover it or mix it with inert dust; and, finally, to have to remove the mixture when the accumulation becomes so great as to commence to impede the traffic.

The "Microscopical Investigations" described in chapter ix. refer to the microscopical examination of grains and aggregations of coked coal dust, grains of other matter, and fragments of fibrous substances that have been subjected to a high temperature, and are accompanied by twenty full-page beautifully coloured illustrations, which remind one more of a birds'-egg book than of a serious treatise relating to a subject connected with mining. It is not easy to see how these investigations are likely to affect the question one way or another, but possibly the committee may be able to extract some information from them that does not appear on the surface.

Chapter i. of part ii., written by Dr. Wheeler, the accomplished chemist and physicist attached to the testing station, entitled "The Mode of Propagation of Coal-dust Explosions: Introduction," purports to "record the main facts that have been established regarding the mode of propagation of coal-dust explosions," but does not deal with anything specially new or original.

The second chapter of part ii., and the appendix on "Experiments with Welsh, Scotch, and South African Coals," have been already referred to so far as seems to be necessary in the present place.

The volume concludes with lists of the illustrations and plates, and an index to the subjects, and is, as a whole, most creditable to the publishers. W. GALLOWAY.

EXPLORATIONS IN NEW GUINEA.

AT the meeting of the Royal Geographical Society on January 30, Dr. H. A. Lorentz gave an account of his latest journey in New Guinea, in the course of which he succeeded in reaching the snow-covered peaks of the main range. Much interest attaches to those regions in the tropics where perpetual snow occurs, with their transitions from the luxuriant vegetation of the equatorial zone to the scanty flora of the snow-line, which on the slopes of Wilhelmina Peak was reached at an altitude of about 4460 metres, and above this the mountain rose to 4750 metres. A former extension of glaciation in this part of the range down to the altitude of about 4000 metres was shown by striæ on the rock surfaces and the presence of a small, typical glacier lake, though no glaciers are existing in this part of the range now. The expedition encountered many difficulties in the journey from the coast to the mountain ranges in the interior, but, taught by the experiences of the first expedition, special arrangements were made to push up the North river so far and so rapidly as possible to avoid the delays and sickness incidental to a prolonged stay in the low and marshy region.

Besides the geographical information obtained, much work was also done in zoology and botany. A thousand birds' skins and ten thousand insects collected during the expedition are now being studied at Leyden, and numerous new species have been obtained; the Australian character of the fauna is well marked, and especially so among the fishes captured in the North river.

The botanical collection, ranging from the tropical to the Alpine flora, shows a majority of plants having a Malayan character, but there are so large a number of endemic forms that New Guinea and the adjacent islands seem to be separable as a botanical region from the Soenda Islands. Savannas, consisting largely of intruding species from North Australia, occur; but the Alpine flora, on the other hand, is said to be of a northern character, resembling that of the mountains of Java, Sumatra, and the Himalayas.

The Wilhelmina Peak is stated to consist of Alveolina limestone, and generally the geological age of the formations traversed was of comparatively recent date; eruptive rocks were only met with near Geelvink Bay. A very interesting collection of ethnological objects was obtained, and many observations were made concerning the Papuans living in the plains and those of the mountains.

The results of this expedition, together with those of the British expedition now in New Guinea, should greatly extend our knowledge of this region.

RADIO-ACTIVITY AS A KINETIC THEORY OF A FOURTH STATE OF MATTER.[1]

THERE are many points of resemblance between the movements of the molecules of a gas and the movements of those corpuscular radiations with which we have become acquainted in following up the discovery of radio-activity. In both cases we find that things of extremely minute dimensions are darting to and fro with great velocity, and in both cases the path of any one individual is made up of straight portions of various lengths, along which it is moving uniformly and free from external influence, and of encounters of short duration with other individuals, when energy is exchanged and directions of motion are altered. There is even a resemblance in the universality of each movement. The motion of molecules is a fundamental fact throughout the whole of our atmosphere, and, indeed, in all material bodies; the motion of the radiant particles emitted by radio-active substances is also widely distributed, and of great importance. Taking Eve's estimate of the usual ionisation of the air, we can calculate that in this room, in every second, some thousands of α and β particles enter into existence, complete their paths through all the atoms they meet, and sink into obscurity; some of them, viz. the α particles, as atoms of helium. These last move through definite and well-known distances in the air. For example, a third of those which are due to radium products move through a range of just above 4 cm., an equal number have a range of just below 5 cm., and again an equal number move through 7 cm., and the speed is so great that the life of each α particle as such is completed in about a thousandth-millionth of a second. They leave their mark behind them in the ionisation of the air through which they have passed, and in the heat into which their energy has been commuted. The former effect is easily detected by the sensitive measuring instruments which we now possess; the latter is too small to measure, and must be greatly increased by the aid of radium itself before it can be investigated. But on a large scale, which takes into account the distribution of radio-active material through the earth, the sea, and the air, the effects are of first-rate importance to the physical conditions of our earth.

If we compare the movements a little more closely, we find differences as interesting as the resemblances. The motions which the kinetic theory of gases considers are those of the molecules of which gases consist; in the case of radio-activity, the things which move are quite different. They are sometimes electrons, which have come to be called β rays when their speed is great, and kathode rays when it is somewhat less; or they are γ or X-rays, which are new things to us; or if as α particles they are helium atoms, such as we have known before, they move with excessive speeds which give them quite new properties. In general, the radiant particles move hundreds of thousands of times as fast as the gas molecules do, and it is, no doubt, on account of this fact, as well as through their usually extreme minuteness, that their power of penetrating matter is so great. When two molecules of a gas collide, they approach within a fairly definite distance, which we call the sum of the radii of the molecules, and the approach is followed by a recession and new conditions of motion. Each molecule has, as it were, a domain into which no other molecule can penetrate. But the defences which guard the domain are of no account to the vigorous movements which we are considering now. The radiant particles pass freely through the atoms, and their encounters are rather with one or other of a number of circumscribed and powerful centres of force which exist within the atomic domain, and act with great power when, and only when, approached within distances which are small in comparison with the atomic radius. It is on this account that the new theory opens out to us such possibilities of discovering the arrangement of the interior of the atom. Never before have we been able to pass anything *through* an atom; our spies have always been turned back from the frontier. Now we can at pleasure cause to pass through any atom an α particle, which is an atom of helium, or a β particle, which is an electron, or a γ or X-ray, and see what has happened to the particle when it emerges again, and from the treatment which it seems to have received we must try to find out what it met with inside.

The newer movement exists superimposed upon the other. Its velocities are so great that the gas (or liquid or solid) molecules are, in comparison, perfectly still. There is, as it were, a kinetic theory within a kinetic theory; there is a grosser movement of gas molecules which has long been studied, and in the same place and at the same time there is a far subtler and far more lively movement which is practically independent of the other. Your vice-president, Sir William Crookes, was the first to find any trace of it. The behaviour of the kathode rays in the vacuum tubes which he had made showed him that he was dealing with things in no ordinary condition. Whatever was in motion was neither gas, nor solid, nor liquid, as ordinarily known, and he supposed it must be possible for matter to exist in a fourth state. We have gone far since Sir William's first experiments. The X-ray tube and radium have widely increased our knowledge of phenomena parallel to those of the Crookes tube. But I think we may still be glad to use Sir William's definition.

There is another very striking characteristic of the newer kinetic theory which differentiates it sharply from the older. The experiences of any one of the radiant particles in an atom which it crosses are quite unaffected by any chemical combination of that atom with others; that is to say, by any molecular associations it may have. Naturally, this simplifies investigation. We may, no doubt, ascribe this state of things to the fact that a radiant particle is concerned rather with the interior of the atom than with the exterior, and that it is the latter which is of importance in chemical action.

Let us take notice of one more important difference. The molecules of a gas move with velocities which vary at every collision, yet vary about a certain mean. But the peculiar motion of the radiant particle is only tem-

[1] Discourse delivered at the Royal Institution on Friday, January 27, by Prof. William H. Bragg, F.R.S.

porary. For only a very short time can any ray be described as matter in a fourth state; at the end of it the extraordinary condition has terminated, the particle has lost its tremendous speed or suffered some other change, and the ray ceases to exist. Speaking technically, we are dealing with initial, not permanent, conditions.

Let us now come back to resemblances between the two kinds of motion, for there is one point of similarity which is not quite so obvious as others I have mentioned, and is, I think, of the greatest importance; in fact, it is largely on account of this similarity that I have ventured to put the two theories together for comparison.

When the first experimenters in radio-activity allowed their streams of rays to fall upon materials of various kinds, they found that the irradiated surfaces were the sources of fresh streams of radiation. The secondary rays were sometimes of the same nature and quality as the primary, sometimes not. Further, they found that the secondaries, on striking material substances, could produce tertiaries, and so on. The examination of all the variations of this problem—the investigation of the consequences of changing the primary, of changing the substance, and last, but not least, of changing the form of the experimental arrangements—has been the cause of an enormous amount of work. There is a large literature dealing with secondary radiations of all kinds which, I imagine, but few have read with any completeness, and the subject has become, on the surface at least, complicated and difficult. Now I believe that it is possible to clear away the greater portion of this complexity at a stroke by the adoption of an idea which makes it possible to describe and discuss the whole of these phenomena in a very simple way. When an encounter takes place between two gas molecules, we suppose that the sum of the energies of the two is the same after the collision as before, and, further, that there are just two things to consider—two molecules—after as well as before. I think that we may carry this idea over almost bodily to the newer theory. A radiant particle encounters an atom. The particle is a definite thing; it contains a definite amount of energy, and whether it is an α, or β, or γ, or X-ray, its energy is to be found almost entirely inside a very minute volume. The encounter takes place. When it is over there are still two things, an atom and a radiant particle, going away from it. The sum of the energies of the two is still the same, which means that we deny a possibility much considered at one time, viz. that in the encounter the atom could be made radio-active, and could unlock a store of energy usually unavailable. We suppose there is no energy to be considered except the original energy of the radiant particle, and we suppose that there are not now two or more radiant particles in place of the original one, which also is a limitation on previous ideas. It is a theory which ascribes a corpuscular form to all the radiations. Each particle, α, β, γ, or X, is to be followed from its origin to its disappearance, and we have nothing to think of but the one particle threading its way through the atoms. It loses energy as it goes, though little at any one collision, and it passes out of our reckoning when it has lost it all. There are no secondary radiations other than radiant particles moving in directions which are different from those in which they moved at first. Even when a kathode ray excites an X-ray in the ordinary Röntgen tube, or the X-ray excites a kathode ray in a manner almost as well known, it is hardly an exception to this rule. The kathode ray has an encounter with an atom and disappears; simultaneously the X-ray comes out of the atom, a circumscribed corpuscle carrying on the energy of the kathode ray. There is a change, but it extends only to the external characteristics of the carrier of energy. The X-ray passes through the glass wall of the X-ray bulb, or at least it does so sometimes; it may pass through other matter as well, but sooner or later it has a fatal encounter with an atom, and the reverse change takes place. In all cases, in that of the undeviating α ray, or the β ray which suffers so many deflections, or the γ or X-rays, it is a matter of tracing the movements of individual minute quantities of energy until they finally melt away.

Let us consider one or two simple experimental results from this point of view in order that we may illustrate this corpuscular theory, and at the same time may learn something of the properties of the corpuscles and of the arrangements of the atoms through which they pass.

We take first one of the simpler cases, the movement of an α particle through a gas. The relatively large mass of the particle gives it an effectiveness which the other radiations do not possess. It moves straight through every atom it meets, and ionises most of them. Very rarely does it suffer any deflection from its course until its velocity is nearly run down. Then, indeed, it does appear to depart considerably from the straight path, and it may be that it is much knocked about by collisions before it finally comes to comparative rest. In this way we may explain the distribution of the ionisation along its path, which increases slowly at first and rapidly afterwards, until the α particle has nearly finished its journey; it then falls off rapidly. Considering that the ionisation increases as the particle slows down and spends more time in each atom, and considering the more broken nature of the path near its end, the reason of these peculiarities is clear enough. Apart from its comparative simplicity, there are some other very interesting features of the particle's motion. It is found, for example, that the loss of energy which the particle incurs in crossing an atom is proportional to the square root of the atomic weight very nearly, and there is no certain explanation as yet of this curious law. And again, Geiger has examined the small scattering that does occur, and found that α particles when moving quickly may be swung round completely even by the thinnest films of gold leaf, though the number is so small that the effect would have remained undetected had it not been for the scintillation method which he and Rutherford have perfected. He has found that about one particle in 8000 is returned in this way from a gold plate, which need consist only of a few thicknesses of gold leaf in order to give the maximum effect.

Now let us take an example from the behaviour of the β rays. The β particle is so light that it is easily deflected, even though it moves several times as fast as the heavier α particle. Because it therefore possesses little energy its effects are much smaller, and no one has yet succeeded in handling a single β particle in the same way as Rutherford and Geiger have handled the other. We are obliged to content ourselves with observations of the effects of a crowd of β particles, since the combined action of many is necessary to give us an observable result; and at the same time that the β particle gives much less effect than the α, it has a much more irregular course, so that the problem is doubly difficult. We are, in fact, only just beginning to understand it. There is a compensation in the fact that its very liability to deflection makes it all the more interesting an object. It is possible—and this is the particular β-ray problem I wish to consider now—to examine the deflection of a single β particle by a single atom; the parallel result in the kinetic theory of gases has never, of course, been achieved.

Suppose that we project a stream of β rays against a thin plate and measure the relative number sent back, which we do by measuring the ionisations caused by the incident and returned rays respectively. We do this for varying thicknesses of the plate, and plot the results, as, for example, Madsen has done. His plate was made of gold leaves, which could be had of extreme fineness. From the relation thus obtained, it is possible to obtain with confidence the amount of β radiation that would be returned by the thinnest plate that could be imagined, only one molecule thick. In such case the particles turned back could have had but one collision, and we have achieved our purpose. Madsen's figures show that a plate weighing 4 milligrams to the square centimetre turned back a tenth of the β particles that fell upon it, and, so far as can be judged, the ratio of the proportion turned back to the weight of the plate would be almost doubled for very thin plates. We could go more into detail, and find the distribution of those that are returned; we should then have data from which we might determine in some measure the distribution of the centres of force inside the atom. We cannot follow this up now, but I would like to direct your attention to a curious indication which we obtain when we compare the results for gold with those which Madsen found for aluminium. They show that the lighter metal turns back fewer β particles, and that its power of absorbing a stream of rays is rather an absolute abstraction of energy. There is clearly an actual absorption effect, which is to be distinguished from the scattering effect. Indeed, the two effects are obviously of different importance in the two cases. When a β ray strikes a gold atom it must be much more liable to deflection than when it strikes the lighter atom of aluminium. On the other hand, I think it can be shown clearly that in ploughing through aluminium atoms there is a relatively quicker absorption of energy. We may illustrate this by a rough model. Let us stand an electromagnet upright on the table, and let us suspend another magnet so that it can swing over the fixed one and just clear it. If we draw back the swinging magnet and let it go towards the fixed one, the currents running so that the two repel, then as the moving magnet tries to go by there will be a deflection depending on the relative speed, the closeness of approach, and the strength of the poles. This may represent the turning aside of an electron by a centre of force inside an atom. Now let the magnet at the table be supported by a spiral spring so as to be still upright, but have some freedom of motion; then, when the experiment is repeated, the swinging magnet pushes the other more or less to one side; it is less deflected, but it has to give up some of its energy. This is exactly what happens in the case of the β particle. The centre of force in the gold atom behaves like the stiffer electromagnet on the table; it deflects the electron more, but robs it of less energy in doing so. It will not do to suppose the gold atom to differ from the aluminium atom simply in the number of centres of force, such as electrons, which it contains if it is supposed that they all act independently. There is some other fundamental difference, equivalent to a difference in the stiffness with which the electrons are set in their places. There are two things to be expressed in the behaviour of the atom towards the β particle, as has been pointed out several times. H. W. Schmidt has actually calculated them from experiments which gave them indirectly and somewhat approximately. The method I have just outlined gives one of them directly, viz. that which is called the scattering coefficient, and I think the other can also be found directly by a method which will serve as an illustration of the behaviour of γ rays.

We must first, however, consider the part which γ and X-rays play generally in this theory. Workers are by no means agreed as to the proper way in which to regard them, but there is no need to enter at once on a discussion as to their nature. It is well known that they have the most extraordinary powers of penetration, and are unaffected by electric or magnetic fields. They have one property which alone, as I think, brings them within our experience; that is to say, the power of exciting β rays from the atoms over which they pass. Were it not for this they would still be unknown. When we examine this production of β rays, we find that in the first place their speed depends on the quality of the γ rays which cause them, and not on the nature of the atoms in which they arise; in the second, that the β rays to a large degree continue the line of motion of the γ rays, as if the latter pushed them out of the atoms; and, lastly, that the number of the β rays depends on the intensity of the γ rays. It is these facts which suggest the simple theory I have already described. The γ ray is some minute thing which moves along in a straight line without change of form or nature, which penetrates atoms with far greater ease than the α or β particle, which is not electrified, and which sooner or later disappears inside an atom, handing on a large share of its energy to a β particle which takes its place. The absorption of γ rays is simply the measure of their disappearance in giving rise to β rays, one γ ray producing one β ray, and no more.

We find the same sort of scattering in the case of γ rays as in that of β rays. Of a stream of rays directed against a plate which it can penetrate easily, we find that a few are turned completely back, a very much larger number are only slightly turned out of their path, and the rest go on. The scattered rays are very similar to the original rays; there is no need to suppose that the original ray disappears, to be replaced by a secondary, any more than there is to suppose that α and β rays disappear and are replaced by others in similar cases. When, therefore, a γ ray enters an atom, three possibilities await it. The first is a negative one; it may go through the atom untouched, and this must happen in the majority of cases; the second chance is that of deflection, and the third that of conversion into a β ray, using the word conversion in a general sense, without going into details as to the nature of the process.

Now we may consider our γ-ray problem. Suppose a stream of these rays passing over a block of any substance, such as aluminium, or zinc, or lead. When they are really penetrating rays they are equally absorbed by equal weights of these materials, which means that in equal weights equal numbers of β rays spring into existence. If these β rays were able to move through equal weights of the metals, we should find in each metal the same "density" of β rays; and the important point is that this is independent of whether the rays are straight or crooked in their paths. If ten lines of given length were begun in every square centimetre of a sheet of paper, the ink used in drawing them would be independent of the straightness of the lines, but proportional to their length. Now if we make a cavity in each metal the β rays will cross it in their movements to and fro, and if a little air is introduced into the cavity, the ionisation produced in it will be a measure of the density of the β rays, and therefore the average distance each moves in the metal. Experiment shows that we get twice as much ionisation in a cavity in the lead as in a similar cavity in the aluminium, and we conclude that the β particle really has a longer track in the heavier metal. This experiment gives us the second constant of β-ray absorption, that is to say, the rate at which its energy is taken away from it; the other experiment gave the chance of deflection only. We see that the path of a β ray in aluminium is more direct, but of less length, than in lead; in the latter metal it has really a longer path, but it does not get so far away from its starting point because it suffers so many more deflections.

Finally, let us take a problem from the X-rays. Let us see how we may test the idea that X and γ rays do not ionise themselves, but leave all the work to be done by the β rays which they produce. Suppose a pencil of X-rays to pass across a vessel and to produce ionisation therein. It is convenient to use, not the original X-rays, which are heterogeneous, but the rays which are scattered by a plate of tin on which the primary rays fall. Such "tin rays," as we often call them briefly, are fairly homogeneous, and give kathode rays of convenient penetration. In some experiments of mine the rays crossed a layer of oxygen 3·45 cm. wide, having a density 0·00137, and the ionisation produced was 227 on an arbitrary scale. The result may be put in the following way. Suppose, provisionally, that all this ionisation is done indirectly; the oxygen has converted so much X-ray energy into kathode-ray energy, and these kathode rays penetrating their one or two millimetres of oxygen, which is all they can do, have ionised the gas. Then we may say that, in crossing a layer of oxygen weighing $3{\cdot}45 \times 0{\cdot}00137$, or 0·00473 gr. per sq. cm., enough kathode rays have been produced to cause an ionisation of 227 units, and therefore that a layer weighing one milligram per sq. cm. would produce 48 units in the same way. We now proceed to compare this production in oxygen with the similar effect in a metal such as silver. Stretching a silver foil across the chamber in the path of the rays, we find that under the same intensity of rays the ionisation is largely increased, and the change is due to kathode rays which the X-rays have generated in the silver. Not all these rays get out of the silver, but we can overcome this difficulty by taking silver foils of different thickness, drawing a curve connecting the effect of the foils with their thicknesses, taking the curve back to the origin, and so finding what would be the effect of a foil so thin that all the kathode rays did get out. In my case I found that a milligram of silver produced enough kathode rays to give an ionisation 1580. This is thirty-three times as much as the oxygen could do. Now, according to our theory, this should be because silver absorbs tin rays thirty-three times more than oxygen does, and experiment showed this to be very nearly the case. In finding the absorbing power of oxygen, I measured first those of carbon and oxalic acid, and then proceeded by calculation, for the absorption in a gas is difficult to determine.

Two interesting points appeared in this experiment. In the first place, the ratio between the two quantities of kathode rays, which appear on the two sides of a silver leaf through which the "tin rays" pass, is nearly constant for different thicknesses of leaf. With the thinnest leaf obtainable each quantity was about half its full value. It would have been desirable to have had still thinner leaves; but it is fairly clear that the ratio would be nearly the same for extreme thinness. The kathode radiation, which appears on the side of the leaf whence the X-rays emerge, is 1·30 times that which appears on the other, and we may take it that this would be the case even if the leaf were but one atom thick. Thus when an X-ray plunges into an atom in which its energy is converted into that of a kathode ray, the kathode ray may emerge at any point, but there is a 30 per cent. greater chance that it will more or less continue the line of motion of the X-ray than that it will not. In previous work on the conversion of γ-ray into β-ray energy, I have found that the β ray may practically be supposed to continue the line of motion of the γ ray, so that there is a great difference in behaviour of the two classes of ray in this respect. It is remarkable that the scattering of the γ rays shows also a much greater dissymmetry than is found in the case of the X-rays. It looks as if the β rays that appear when γ or X-rays impinge on atoms are related rather to the scattered than to the unscattered primary rays. Putting it somewhat crudely, no doubt, it might be said that when a γ or X-ray is deflected in passing through an atom, it runs a risk of being converted into a β ray in the process, so that β rays are found distributed about the atom in rough proportions to the secondary γ or X-rays. In the case of γ rays this practically amounts to their all going straight on at first; in the case of X-rays the distribution is more uniform.

Another interesting point arises in this way. When the X-rays from tin are allowed to pass into the ionisation chamber through increasing thicknesses of silver foil, the kathode rays grow at a rate which is not represented by the exponential curve usually assumed. The amount is for some time more nearly proportional to the thickness of the foil. A second foil adds its own effect without destroying much of the one on which it is laid. This may easily be ascribed to the relation of the ionisation due to the β particle to the energy it has to spend. The ionisation is nearly all at the end of the path, and the second layer does not absorb the rays made in the first because they are still at the beginning of their career.

These few experiments which I have described may serve to illustrate both the justice and the convenience of placing all these rays, α, β, γ, and X, in one class. We are tempted to consider them all as corpuscular radiations of some sort, and we then look upon our researches into their behaviour as attempts to understand the collisions of the various new corpuscles with the constituent centres of force in the atoms. But if we ascribe corpuscular properties to the γ and X-rays, we are led far away from the original speculations as to their nature. Stokes supposed them to be spreading æther pulses, but in his theory the energy of the pulse spreads on ever-widening surfaces as the time passes, and is utterly insufficient to provide the energy of the β rays which the γ or X-rays excite. Some sort of mechanism has to be devised by which the energy of the γ ray moves on without spreading, so that at the fateful moment it may be all handed over to the β ray, which carries it on. I had the hardihood myself to propose a theory of this kind. My idea was that the γ or X-ray might be considered as an electron which had assumed a cloak of darkness in the form of sufficient positive electricity to neutralise its charge. Nor do I see any reason for abandoning this idea, for it is at least a good working hypothesis. It means, of course, that not only does the energy of the β ray come from the γ ray, but the β ray itself.

Many insist that my neutral corpuscle is too material, and that something more ethereal is wanted, for it appears that ultra-violet light possesses many of the properties of X and γ rays. It can excite electrons to motion, and sometimes the speed of the electron depends on the quality of the light, and not on the nature of the material from which it springs. They propose, therefore, a quasi-corpuscular theory of light, γ and X-rays being included. The immediate objection to this proposal is that it seems to throw away at once all the marvellous explanations of interference and diffraction which Young and Fresnel founded on a theory of spreading waves, and I do not think anyone has yet made good this defect. The light corpuscle which is proposed is a perfectly new postulate. It is to move with the velocity of light, keeping a circumscribed and invariable form, to have energy and momentum, and to be capable of replacing and being replaced by an electron which possesses the same energy but moves at a slower rate, and, of course, it has to do all that the old light-waves did. The whole situation is most remarkable and puzzling. We are working and waiting for some solution which, perhaps, will come in a moment unexpectedly. Meanwhile, we must just try to verify and extend our facts, and be content to piece together parts of the puzzle, since we cannot, as yet, manage the whole. My object to-night has been to show you how we may conveniently bind together a large number of the phenomena of radio-activity into an easily grasped bundle, using a kinetic theory which has many points of resemblance to the older kinetic theory of gases.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—It is proposed to confer the degree of Master of Arts, *honoris causa*, upon Mr. K. J. J. Mackenzie, university lecturer in agriculture.

On Thursday next, February 16, a Grace will be offered to the Senate recommending that a site on the Downing Ground be assigned for a building for the department of physiology, to the east of the School of Agriculture. At the same Congregation a further Grace will also be brought forward recommending that a space to the south of, and adjoining, the proposed building for the department of physiology, be assigned as a site for a laboratory of experimental psychology.

OXFORD.—On February 4 Prof. T. W. Edgeworth David, C.M.G., F.R.S., delivered a public lecture before the University, in which he described the part he had taken in Sir Ernest Shackleton's Antarctic Expedition of 1907–9, including the ascent of Mount Erebus and the reaching of the South Magnetic Pole. On February 7 the honorary degree of D.Sc. was conferred on Prof. David.

The report of the committee for anthropology for the year 1910, just presented to Convocation, contains a record of continuous and healthy development of the study in Oxford. The salary of the curator of the Pitt-Rivers Museum has been raised from 200*l.* to 500*l.* per annum, and a readership has been founded in social anthropology, to which the secretary to the committee, Mr. R. R. Marett, Fellow of Exeter College, has been appointed. A large number of lectures have been delivered in the course of the year under the general heads of physical anthropology, psychology, geographical distribution, prehistoric archæology, technology, social anthropology, and philology, besides special lectures for Sudan probationers, and addresses on the art of prehistoric man in France, by M. Emile Cartailhac.

The consideration of the proposed amendments to the statute on faculties and boards of faculties has been resumed by Congregation.

IT is announced in the *Revue scientifique* that Prof. Hans Meyer has presented 150,000 marks to the University of Leipzig for the inauguration of an institute of experimental psychology.

WE have received from the honorary secretary of the Association of Teachers in Technical Institutions a copy of a letter sent by the association to the principal of the University of London directing attention "to the marked inequality of the requirements of the examiners for a 'pass' in the respective subjects" for the intermediate and final B.Sc. external examinations. Tabulated statistics, drawn up by the association from the University Calendar, show that in 1909 the following percentages of candidates, entering for the various subjects of science in the intermediate external examination, failed:—chemistry, 46·9; physics, 30·7; pure mathematics, 25·3; applied mathematics, 14·4; botany, 47·8; zoology, 28·8; and geology, 14·3. The corresponding numbers in the B.Sc. examination of 1909 were:—chemistry, 58·5; physics, 30·5; pure mathematics, 35·4; applied mathematics, 42·1; botany, 33·3; zoology, 14·3; and geology, 14·3. The principal is asked to bring these and other points for consideration before the Senate and Council for External Students, since, in the opinion of the association, a serious injustice is being done to students and teachers.

WE learn from *Science* that the bequests from the Kennedy estate for educational and public purposes are even larger than had been anticipated. Columbia University receives 472,000*l.*, New York University 190,400*l.*, and Robert College, Constantinople, 360,000*l.*; the bequests to the New York Public Library and the Metropolitan Museum of Art are about 560,000*l.* Barnard College and Teachers College, Columbia University, each receive 20,000*l.*, as do Hamilton College, Elmira College, Amherst College, Williams College, Bowdoin College, Yale University, Tuskegee Institute, and the Hampton Institute. Lafayette College, Oberlin College, Wellesley College, Berea College, and Anatolia (Turkey) each receive 10,000*l.* *Science* also states that Mr. Carnegie's latest gift of 760,000*l.* to the Technical Institute in Pittsburgh is to be used approximately as follows:—460,000*l.* for increase of present endowment, 275,000*l.* for new buildings, 20,000*l.* for additional equipment, and 5000*l.* on grounds. The residue of the estate of the late Dr. Seesel, valued formally at "not more than 50,000 dollars," is divided between Yale and the University of Leipzig. With the income there is to be founded at each institution the "Theresa Seesel Fund" in memory of his mother, to be used for researches in biology.

THE first volume of the report for the year ended June 30, 1910, of the U.S. Commissioner of Education has been received from the Bureau of Education at Washington. As usual, the publication of purely statistical information is postponed for the later volume. The commissioner, Dr. Elmer Brown, in his introduction to the volume ably summarises the tendencies and advances in the various grades of education which may be regarded as the outstanding features of the educational work of the year under review. The part of the introduction dealing with higher education is of special importance. Dr. Brown points out that by its higher education the place of the United States in the world's civilisation and its prestige before the more enlightened nations are largely determined. "It is," he says, addressing his countrymen, "a patriotic duty of the highest order that our colleges and universities, in all of the States, should get away from the more injurious forms of competition and enter into more effective cooperation." He enumerates many weaknesses requiring correction. He urges that an agreement among the colleges with respect to admission requirements, which should do away with minor differences that harass the preparatory schools, would rid the educational situation of some of its most serious embarrassments. There is, he continues, a great deal of possible division of labour, particularly as regards instruction and research, which is not yet realised. Much has yet to be done in the way of a general survey of the present provision in American institutions of higher education for advanced instruction with the view of determining where enlargement is needed. The excessive variations in the worth of American academic and professional degrees is still, says Dr. Brown, a cause of reproach abroad, and involves much injustice among Americans at home.

A NATIONAL conference will be opened at the Guildhall on February 28, at 3.30 p.m., by the Lord Mayor, with the object of securing a national system of industrial training. The conference has been organised by a special committee of the elected representatives of the chief associations of employers and workers and educational authorities. The intention is to urge upon the Government to supplement our present system of elementary education by providing by legislation a complete system of industrial, professional, and commercial training. Several resolutions will be submitted at the conference, among which may be mentioned the following:—"That this conference views with grave concern the large number of children annually leaving school without practical training for definite vocations, and resolves that a national system of industrial, professional, and commercial training should be established, to which the children shall pass as a matter of course (unless the parents are prepared to undertake their future training) and without interval, for a definite period, to be thoroughly trained for entry to the particular calling for which they are best fitted, such training to be under fully qualified instructors. That the Government be urged to provide by legislation such a complete system of training, free to all scholars, and the expenses thereof defrayed from the National Exchequer." The National Industrial Education League, which it is proposed to establish at the meeting, will be composed of 2500 organised bodies of workpeople engaged in trade union, cooperative, and educational work, and, so far as can be at present ascertained, they represent more than three millions of workers, comprising 365 trades and professions in 421 cities and towns. Intending supporters of the league can obtain further information on application to the honorary secretaries, Craig's Court House, Charing Cross, London, S.W.

AT the meeting of the Royal Society of Arts on February 1, presided over by Lord Cromer, Mr. P. J. Hartog read a paper on examinations in their bearing on national efficiency. He raised the important question as to whether it was not possible to test "general ability," and to separate the ablest candidates by methods involving less strain both on the successful and the unsuccessful candidates? Would it be possible, without reintroducing the evils of jobbery, to follow the lines laid down by Lord Cromer in the Egyptian Civil Service, and by Lord Selborne in choosing candidates for the Navy? He suggested the appointment of a Royal Commission to deal with the whole question, with a suitable reference, such as "To investigate and report upon the methods and efficiency for their purpose of examinations carried on by Government departments and other public bodies in the United Kingdom; to inquire into the influences of examinations on the previous education of candidates; and to suggest such changes as may seem desirable." The commission, he said, should be a small one, presided over by a statesman with experience of affairs, and there should be no attempt to achieve the impossible by including in it representatives of all parties concerned. Lord Cromer opened the discussion which followed. He compared the merits of competition and selection for securing the best candidates for any office. The principle of selection, he maintained, if only it can be properly carried out, possesses merits superior to those of competition. The former may or ought to result in the creation of leaders of men. The latter tends rather to produce a dull level of mediocrity. Of late years there has been a tendency, notably in the military, naval, and diplomatic services, to adopt the principle of selection in dealing with all the later stages of the careers of public servants more thoroughly than formerly. This movement, far from being arrested, should be pushed still further. The case of first appointments presents, naturally, greater difficulties. Some few years ago it became necessary to create a Sudanese Civil Service. In the first instance, the appointments were practically made by Lord Cromer. He found it, he said, a difficult task, but whatever success has attended the administration of Egypt during the last thirty years has been mainly due to the care which was taken in selecting and promoting officials.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 2.—Sir Archibald Geikie, K.C.B., president, in the chair.—Colonel Sir D. **Bruce**, F.R.S., Captains A. E. **Hamerton** and H. R. **Bateman**, and Dr. R. Van **Someren**: Experiments to investigate the infectivity of *Glossina palpalis* fed on sleeping-sickness patients under treatment.—Colonel Sir D. **Bruce**, F.R.S., and Captains A. E. **Hamerton**, H. R. **Bateman**, and F. P. **Mackie**: Experiments to ascertain if *Trypanosoma gambiense* during its development within *Glossina palpalis* is infective.—Captain R. **McCarrison**: Further experimental researches on the etiology of endemic goitre.—H. Hamshaw **Thomas**: The leaves of Calamites (Calamocladus section). Most of the material investigated originally came from the Halifax Hard Bed of the Lower Coal Measures. Most leaves were very small, being only 1–2 mm. long and 0·8–1 mm. broad. They are falcate in shape, and were borne on slender twigs in alternating whorls of four. The structure of these slender twigs differs somewhat from that of the young Calamitean stems already described by Williamson and others, but it may be compared in some features with the structure of the young stems of some modern Equisetums. The tissues of the small leaves show a concentric arrangement. In the centre there is a vascular bundle consisting of four or five small tracheides, surrounded by thin-walled elongated cells. The bundle is surrounded by a zone of cells with dense black contents, termed by Hick the melasmatic tissue, and is probably comparable with the bundle-sheath of the leaves of modern plants. The cells of the palisade-like assimilating tissue abut on to this; they have large spaces between them. The epidermis is thinner on the concave side of the leaf, and the stomata are situated on this face only. The latter are characterised by transversely striated guard cells, similar to those seen in many species of modern Equisetums. These leafy twigs seem to be identical with the impression species *Calamocladus charaeformis* (Sternb.); their structure seems to indicate that they grew in a pendulous manner. Specimens have been obtained showing variations in structure from the normal type. Four other types of leaf have been discovered differing in size and in arrangement of tissues. In all of these there is a very conspicuous strand of sclerenchymatous fibres running up the adaxial side of the leaf, and forming a large part of its apex. These fibres become more conspicuous in the longer leaves. In some types the thin-walled (phlœm) tissue of the bundle is much reduced, or even absent. The melasmatic tissue also varies considerably in amount. Some of these longer leaves were probably identical with *C. grandis* (Sternb.), others with *C. equisetiformis* (Schloth.). They are characterised by a more compact structure, with smaller and fewer intercellular spaces. The structure of the smaller leaves probably indicates that they grew in a moist situation, or where the atmosphere was humid. The larger leaves are more xeromorphic in character. The results obtained from this work indicate that the Calamites were truly microphyllous.—Dr. J. O. Wakelin **Barratt**: Complement deviation in mouse carcinoma. The object of the present investigation is to ascertain if in mouse carcinoma antibodies are produced in respect of the tumour. The method followed is an application of the complement deviation test, an extract of mouse tumour being employed as antigen. The experiments made fall into two groups. In one the serum of the rabbit or of man was employed as the source of complement; in the other the serum of the mouse served as the source of complement. In both cases the same result was obtained, namely, that the complement deviating power of the serum of mice with tumours was sometimes greater than that of normal mouse serum, but not unfrequently the serum of a mouse with a tumour was found to be identical in respect of its complement deviating power with that of a normal mouse.

Linnean Society, January 19.—Dr. D. H. Scott, F.R.S., president, in the chair.—C. H. **Wright**: Flora of the Falkland Islands. An endeavour has been made to define the distribution of plants in the islands and to show what changes have taken place in the flora since the publication of the "Flora Antarctica" in 1847. The plants are chiefly of dwarf habit, often with aromatic leaves, and conspicuous, often scented, flowers, which are produced chiefly between November and January. The earliest to appear is *Draba funiculosa*, Hook. f., in September. The extermination of the fox (*Canis antarcticus*) has rendered possible the keeping of sheep, with the result that plants previously common have now become rare; amongst these are the tussac grass (*Poa flabellata*, Hook. f.), cinnamon grass (*Hierochloe redolens*, R. Br.), and blue grass (*Agropyron repens*, Beauv.). *Primula farinosa*, var. *magellanica*, Hook. f., while still abundant, is much dwarfed in those islets where sheep have been introduced. *Veronica elliptica*, Forst. f., attains a height of 7 feet, and is the tallest plant on the islands, the next being *Chiliotrichum amelloideum*, Cass. (the Fâchima plant). *Azorella caespitosa*, Cav. (the balsam-bog), forms hard masses up to 10 feet long and 4 feet high, which rapidly decay on being wounded. The flora shows a great affinity with that of Magellan and Chile.—C. **Crossland**: The geological and geographical position of Khor Dongonab.—Mr. Hugh Scott summarised the following five reports:—R. E. **Turner**: Fossorial Hymenoptera. The author enumerates twenty-five species, of which thirteen are from the Seychelles, eleven from Aldabra and the adjacent islands, while one (a common Eastern form) was only found in the Chagos.—Prof. J. J. **Kieffer**: Two families of Diptera, the Cecidomyiidæ (gall-flies) and the Chironomidæ. No species of either family has previously been recorded from the Seychelles, and they have been but little collected in the tropics as a whole. Hence it is not very surprising that the twenty-four species of Cecidomyiidæ and the forty-eight species of Chironomidæ described in these papers are all new. The Cecidomyiidæ all belong to genera which are not usually gall-formers; the Chironomidæ, with one exception, all belong to European genera, and forms of larger size are absent. These families cannot at present throw much light on the affinities of the Seychelles fauna as a whole, owing to their not having been much studied in other lands in the same region, but it is of great importance that one should begin to gain some knowledge of their representatives in such places as the Seychelles.—Dr. K. **Kertész**: Report on a family of Diptera, the Stratiomyiidæ. This deals with nine species, of which two are new to science; two new genera are also described, one being established to receive an already known species. Of the seven species of Stratiomyiidæ from the Seychelles and Aldabra which are not new, one is also known from Madagascar, and the other six from various Eastern localities, such as Cocos-Keeling and various islands of the Eastern Archipelago so far as the Philippines.—E. **Meyrick**: Microlepidoptera of the groups Tortricina and Tineina. The author states that in these groups the Seychelles and Aldabra faunas must be considered separately. From the Seychelles he recognises 111 species, of which twenty-one are almost certainly imported, while the remaining ninety are probably endemic. These ninety consist in part of an "ancient but highly specialised fauna," analogous to the somewhat similar, but more primitive, fauna found in Mauritius and Réunion, and in part of forms which may have been derived sporadically from various parts of the Indian region. Among the material from Aldabra, Mr. Meyrick recognises nine species, all new, but belonging to widely distributed genera.

Mineralogical Society, January 24.—Prof. W. J. Lewis, F.R.S., president, in the chair.—F. H. **Butler**: Kaolin. The kaolinite in the Glamorganshire Coal Measures originated in the decomposition of felspar by carbonated underground water. The secondary mica and quartz of the Carboniferous grits and greisens are due primarily to the formation of potassium carbonate and alumohexasilicic acid (Morozewicz), the acid breaking up into silica and alumdisilicic acid (*i.e.* kaolin less water of crystallisation), and the latter combining with the carbonate to yield muscovite and free carbonic acid. Kaolinite is destroyed concurrently with the growth of schorl in kaolin rock, and cannot, therefore, be a product of boration.—Dr. G. T. **Prior** and Dr. G. F. H. **Smith**: Schwartzembergite. Analyses recently made by the former show that this mineral is a complex iodate and oxychloride of lead, $Pb(IO_3)_2 \cdot 3[PbCl_2 \cdot 2PbO]$.—A. **Hutchinson**: An improved form of total reflectometer. The instrument is a goniometer of the suspended type with a large base plate, to which a telescope and collimator, a microscope bisecting the angle between them, and other apparatus can be clamped, and is intended for the measurement of minute crystals, and for the determination of the optic axial angle of biaxial crystals, and of the refractive indices by Kohlrausch's method.—T. **Crook**: A case of electrostatic separation. The apparatus consists of two copper plates, one of which is coated on one side with a layer of shellac. Good conducting minerals are attracted to the shellac-covered surface of the upper plate when it is charged by means of an electrophorus.

Institution of Mining and Metallurgy, January 25.—Mr. Edgar Taylor, president, in the chair.—*Adjourned discussion.* H. C. **Bayldon**: Notes on Chilian mills in Russia. In this paper the author provides a useful and instructive treatise on the slow-running Chilian or "Edge runner" mill, invariably used in Russia for crushing gold ores as a preliminary to amalgamation, &c. After a brief historical summary, the paper gives descriptions of the standard type of Chilian mill now in use, and of the milling methods adopted in Russia, which are followed by notes on an improved type of Chilian mill and milling plant recently introduced. The descriptions are suitably illustrated, and there are ample statistics relating to mills and their efficiency. The author is of opinion that if the same amount of thought and attention were devoted to this type of mill as has been given to the heavy stamp *plus* tube mill combination in South Africa, it would prove a serious rival and give a product nearer to the ideal aimed at on that goldfield.—N. A. **Loggin**: Notes on placer mining, with special reference to hydraulic sluicing. The author here gives the results of a wide experience in placer mining conducted on the hydraulic sluicing system in the form of a collection of practical hints with regard to the whole of the process involved, from the initial determination of the value of the gravel to be mined down to the most suitable location of the dump. As might be anticipated, the chief points dwelt upon relate to the arrangement of an efficient supply of water to feed the "giants" and "deflectors" at the face of the mine, as this constitutes the *crux* of the problem, next in importance to which comes the construction of the flume in which the gravel is washed and relieved of its gold contents.

EDINBURGH.

Royal Society, December 19, 1910.—Prof. Bower, vice-president, in the chair.—Prof. A. C. **Seward**: The Jurassic flora of Sutherland. This contained a general account of the fossil plants collected by Hugh Miller, Dr. Marcus Gunn, and Mr. Archer from the Kimeridgian strata on the coast of Sutherland. Dr. Gunn's collection has been recently acquired by the British Museum. Thanks were expressed to Mr. H. B. Woodward for notes on the geology of the Sutherland plant beds. The flora of Sutherland, with a few types collected by Hugh Miller at Eathie (Cromarty), may be regarded as representing the Jurassic flora of Scotland as a whole, the specimens recorded from western localities being very few and fragmentary. The Scottish Jurassic flora includes several widely distributed species previously described from the Inferior Oolite series of Yorkshire and elsewhere, together with some Wealden types. From a botanical point of view, the Kimeridgian flora of Sutherland is interesting chiefly on account of the additional evidence it affords of the general uniformity of the Jurassic vegetation of the world, and as demonstrating the occurrence in north-west Europe in the Jurassic era of such genera as Hausmannia, Laccopteris, Araucarites, &c., which are now represented by species in the southern tropics or in south temperate latitudes.—Dr. A. A. **Lawson**: Phase of the nucleus known as synapsis. The argument was that synapsis was due, not to contraction, as generally supposed, but to growth.—Prof. R. J. A. **Berry**: The sectional anatomy of the head of the Australian aborigine.

January 9.—Prof. Hudson Beare, vice-president, in the chair.—Alan W. C. **Menzies**: A method for determining the molecular weights of dissolved substances by measurement of lowering of vapour pressure. The apparatus was so arranged that the temperature of the liquid, with the dissolved substance in it, was sustained at the temperature of the vapour coming from the boiling pure liquid, while, at the same time, part of the surface of the impure liquid was subjected to the pressure of this vapour, while the rest of the surface was subjected to the pressure of its own vapour, which was somewhat less, because of the dissolved substance. The difference of pressure was balanced by the difference of height of the two surfaces of the liquid. The method was found to be easy of manipulation, and to lead to satisfactory measurements.—Dr. George **Green**: The *modus operandi* of the prism. The action of a prism on a light "pulse" incident upon it was illustrated by means of the analogy between the pulse problem and the hydrodynamical problem presented by a point disturbance moving uniformly over a liquid surface. Taking the ship-wave pattern to represent the general form of wave disturbance within a prism immediately after the incidence of a light pulse, the author applied the theory of group velocity to arrive at the general features of the wave system after emergence from the prism, deriving the usual formula for the resolving power.—Dr. John **Brownlee**: The relation of the mono-molecular reaction of life processes to immunity. The simple law of exponential decay was found to govern many of these processes. An interesting example was the mortality due to scarlet fever at different ages; the statistics for two large towns showed that this mortality amongst children diminished exponentially with increase of age.

PARIS.

Academy of Sciences, January 30.—M. Armand Gautier in the chair.—H. **Deslandres**: Researches on the movements of the solar atmospheric layers by the displacement of the lines of the spectrum. Lack of symmetry and peculiarities of the phenomenon. The author gives a short historical survey of the whole of the work done in this field, and proceeds to discuss in detail the observations made at the Observatory of Meudon from 1892 onwards. Special attention is given to the displacements of the K_3 line and the views which have been put forward to explain the observed facts.—G. **Lippmann**: The action of external forces on the pressure of saturated vapours and the gases dissolved in a liquid. The lowering of the vapour pressure of a liquid in a capillary tube was first demonstrated by Kelvin. The explanation put forward by Kelvin involves the constancy of the vapour pressure throughout the whole column of the liquid, the variation being assumed to be produced in a discontinuous manner in the meniscus. The author proposes another explanation, according to which, for equilibrium, the tension of a dissolved gas varies with the level according to the same law as the pressure of the gas in the interior of the liquid. Saturated vapour can be regarded as a particular case of this theorem.—M. **Gouy**: The existence of a periodic element in the magneto-kathodic radiation. It is known that in a high vacuum the magneto-kathode bundle emitted by a wire serving as a kathode forms a luminous sheet, separated from the kathode by a dark space. Under certain conditions, dark and light fringes appear in this luminous portion. It has been found that the maximum intensity corresponds to rays the lengths of which are exact multiples of a certain length, a, which is inversely proportional to the value of the magnetic field.—D. Th. **Egoroff**: Sets of measurable functions.—R. **Bourgeois**: A cause of an instrumental error in the measurement of a base line. In the determination of a base line at Blida, invar wires, standardised at the International Bureau, were used. Certain discrepancies appeared in the results, outside the ordinary experimental error, and these were finally traced to the inclinations of the rule from the horizontal. The error was eliminated when the measurements were made in opposite directions over the same line and the mean taken.—Torres **Quevedo**: A mechanical construction for the linkage expressed by the formula $d\beta/d\alpha = \tan \omega$.—Auguste **Righi**: The probable ionising action of the magnetic field. Some experiments are described in which the discharge potentials between metallic electrodes in an exhausted tube were measured in magnetic fields of varying strength. The hypothesis that the magnetic field can produce ions offers a possible explanation of the observed facts.—C. **Limb**: Compounding alternators by means of electrolytic valves.—E. **Urbain**, Cl. **Scal**, and A. **Feige**: A new type of arc lamp having a mercury kathode and giving white light. An arc is struck in a quartz tube between an anode of tungsten and a kathode of mercury. The light is practically white, spectroscopic examination showing a continuous spectrum with the mercury lines superposed. The yield is high (0·45 watt per candle), and the arc works with a potential difference of 12 volts; the voltage can be increased by the presence of an inert gas in the tube.—J. **Boselli**: Reaction velocities in heterogeneous systems.—Louis **Hackspill**: The density, coefficient of expansion, and change of volume on fusion of the alkaline metals. The metals (cæsium, rubidium, potassium, and sodium) were distilled in a high vacuum immediately before each experiment and directly into the experimental tube. The expansion of the liquid metal was measured directly without the intervention of any other liquid; for the expansion of the solid, pentane was employed as the indicating fluid. It was found, incidentally, that benzene and toluene are rapidly attacked by liquid cæsium without any evolution of gas; the nature of the compounds formed is being investigated.—Daniel **Berthelot** and Henry **Gaudechon**: The photolysis of complex acids by the ultra-violet rays. The action of uranium salts as catalysers. Details are given of the decomposition products of various dibasic, ketonic, and alcohol acids when exposed to ultra-violet light. The addition of small quantities of uranium salts, without altering the nature of the gases evolved, increases the velocity of the decomposition from four to six times.—A. **Job** and P. **Goissedet**: A crystallised green manganitartrate.—E. E. **Blaise** and L. **Picard**: The action of the chlorides of the α-alkoxy-acids upon the mixed organo-metallic derivatives of zinc.—P. L. **Viguier**: α-Bromocrotonic aldehyde. A description of the products of the reaction of this aldehyde with hydroxylamine, semicarbazide, hydrazine, phenylhydrazine, and urethane.—V. **Grignard** and Ch. **Courtot**: Some new derivatives of indene.—Marin **Molliard**: Nitrogen and chlorophyll in galls.—P. A. **Dangeard**: The determination of the active rays in the chlorophyll synthesis.—Henri **Labré** and L. **Violle**: The ingestion of mineral acids in the dog. The amount of bases secreted in the urine is increased by the ingestion of hydrochloric acid.—M. **Doyon**, A. **Morel**, and A. **Policard**: A demonstration of the exclusively hepatic nature of antirhombine. The extraction of this substance by a solvent for nuclear bodies.—Clément **Vaney**: Researches on the development of *Hypoderma bovis*.—E. **Pinoy**: The form of *Sporotrichum Beurmanni* in human lesions. Its fructification in the interior of the capillaries. The visibility of the parasite is largely dependent on the exact method of staining, and it is shown that in human lesions caused by this parasite the organism is more abundant than has been hitherto supposed.—L. **Bruntz**: The physiological signification of the leucocyte reactions of infections and intoxications.—L. **Mercier** and R. de Drouin **de Bouville**: Lepidorthosis in *Leuciscus rutilus* of the lake of Nantua.—L. **Cayeux**: The existence of limestones containing Gyroporella in the Cyclades.—Louis **Gentil**: The Riffian deposits of Morocco.—Louis **Fabry**: The registration of small artificial earthquakes at a distance of 17 kilometres. Small earthquakes caused by subsidences in mining districts have been recorded on the seismograph of the Marseilles Observatory.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 9.

ROYAL SOCIETY, at 4.30.—(1) Certain Physical and Physiological Properties of Stovaine and its Homologues; (2) The Effect of some Local Anæsthetics on Nerve: Dr. V. H. Veley, F.R.S., and W. L. Symes.—(1) Experimental Researches on Vegetable Assimilation and Respiration. VIII. A New Method for Estimating the Gaseous Exchanges of Submerged Plants; (2) Experimental Researches on Vegetable Assimilation and Respiration. IX. On Assimilation in Submerged Water-plants and its Relation to the Concentration of Carbon Dioxide and other Factors: Dr. F. F. Blackman, F.R.S., and A. M. Smith.

ROYAL SOCIETY OF ARTS, at 4.30.—Indian Superstitions: R. A. Leslie Moore.

ROYAL INSTITUTION, at 3.—Problems of Animals in Captivity: P. Chalmers Mitchell, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—*Adjourned discussion*: Long Distance Transmission of Electrical Energy: W. T. Taylor.—Extra High Pressure Transmission Lines: R. Borlase Matthews and C. T. Wilkinson.

MATHEMATICAL SOCIETY, at 5.30.—The Application of the Mathematical Theory of Relativity to the Electron Theory of Matter: E. Cunningham.

FRIDAY, FEBRUARY 10.

ROYAL INSTITUTION, at 9.—Robert Louis Stevenson: Sir Sidney Colvin.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Anniversary Meeting.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Rivers and Estuaries: W. H. Hunter.

PHYSICAL SOCIETY, at 8.—Annual General Meeting.—Presidential Address: The Caloric Theory of Heat and Carnot's Principle: Prof. H. L. Callendar, F.R.S.

MONDAY, FEBRUARY 13.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Further Explorations in Bolivia: Major P. H. Fawcett.

ROYAL SOCIETY OF ARTS, at 8.—Brewing and Modern Science: Prof. Adrian J. Brown.

TUESDAY, FEBRUARY 14.

ROYAL INSTITUTION, at 3.—Heredity: Prof. F. W. Mott, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Further discussion*: The Detroit River Tunnel, between Detroit, Michigan, and Windsor, Canada: W. J. Wilgus.—*Probable Paper*: Coast Erosion: W. T. Douglass.

WEDNESDAY, FEBRUARY 15.

ROYAL SOCIETY OF ARTS, at 8.—Modern Machine Bookbinding: G. A. Stephen.

ROYAL MICROSCOPICAL SOCIETY, at 8.—On some New Objectives and Eye-pieces by R. Winkel, of Göttingen: E. M. Nelson.—On the Recent and Fossil Foraminifera of the Shore-sands of Selsey Bill, Sussex. Addendum: E. Heron-Allen and A. Earland.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Variation of the Depth of Water in a Well at Detling, Maidstone, compared with the Rainfall, 1885–1909: R. Cooke and S. C. Russell.—The Actinograph; an Instrument for Recording Changes in Radiation: A. W. Clayden.—New Cloudiness Charts for the United States: K. M. Clark.

SOCIETY OF DYERS AND COLOURISTS, at 8.—The Enzymes of Malt, and their Employment in the Textile Industries: R. J. May.

THURSDAY, FEBRUARY 16.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: The Constitution of the Alloys of Aluminium and Zinc: Dr. W. Rosenhain and S. L. Archbutt.—The Production and Properties of Soft Röntgen Radiation: R. Whiddington.—Experiments on Stream-line Motion in Curved Pipes: Prof. J. Eustice.

ROYAL GEOGRAPHICAL SOCIETY, at 5.—Research Meeting. Some Antarctic Problems: Prof. Edgeworth David, F.R.S.

LINNEAN SOCIETY, at 8.

ROYAL INSTITUTION, at 3.—Problems of Animals in Captivity: P. Chalmers Mitchell, F.R.S.

ILLUMINATING ENGINEERING SOCIETY, at 8.—*Dicussion* on School Lighting. Openers: Dr. James Kerr and Dr. N. Bishop Harman.

FRIDAY, FEBRUARY 17.

ROYAL INSTITUTION, at 9.—The Stimulation of Digestive Activity: Prof. H. E. Armstrong, F.R.S.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Annual General Meeting. *Further discussion*: Modern Electrical Dock-equipment, with Special Reference to Electrically-operated Coal-hoists: W. Dixon and G. H. Baxter.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Uses of Chemistry in Engineering: J. Swinburne, F.R.S.

CONTENTS.