THURSDAY, DECEMBER 11, 1902.

COOPERATION AMONG INSTRUMENT MAKERS.

L'Industrie Française des Instruments de Précision. Catalogue publie par le Syndicat des Constructeurs en Instruments d'Optique et de Précision.

Microscopes and Microscopical Accessories. Carl Zeiss, Jena; *Physical Apparatus*, Max Kohl, Chemnitz; *Physikalische Apparate*, Ferdinand Ernecke.

THE German catalogue of scientific apparatus at the Paris Exhibition has been frequently mentioned in the pages of NATURE, and its value to students of physics has been noted.

The first work under review in the present article is a consequence of its publication. It is a catalogue of French apparatus of great interest in itself and of real value to the man of science in that it enables him to obtain information in a small compass as to instruments of French construction.

The arrangement differs in some respects from that of the German catalogue, on which it is avowedly based. The object of the latter was to give a complete view of German trade and manufacture; hence the catalogue was arranged in subjects, the apparatus in each subject being grouped under the makers' names; the French catalogue is arranged alphabetically under the makers' names. An index "Table des Specialités" enables the reader to find out readily which of the numerous firms in the catalogue make any special class of apparatus and to refer to the descriptions of their products. For most purposes, the German plan seems more convenient. For a man wishing to buy a spectroscope, it is simpler to have all the spectroscopes grouped together; the plan, however, does not serve to call marked attention to the whole output of any one large firm, and it is natural for a society of instrument makers to arrange their joint catalogue according to the French pattern.

It is not easy in a review to give a full account of the catalogue; it covers some 270 quarto pages, it is clearly printed and well illustrated. The long list of names it contains reminds us what science owes to the skill and workmanship of French mechanicians; it is impossible to turn over the pages without recognising names which are honourably known wherever science has penetrated, and apparatus which has aided and rendered possible some of its greatest discoveries. One name we miss, that of R. König, now no longer with us, who will live, through his acoustical apparatus, as a genius of construction.

The introduction by Cornu, which must have been one of his last pieces of work, adds to the value of the book. M. Cornu gives an interesting history of the development of scientific instruments in France, and of the close alliance between the man of science and the instrument maker from early times up to the present day, and then, noting how instruments of precision have become part of one's daily life, draws attention to the necessity for continued close connection between science and the commercial side of an industry if that industry is to flourish.

The example of Germany has lessons for France as well as for us in England, and mechanical tools introduced in America have become a necessity in French workshops no less than in English. The French instrument-making industry feared for a moment a dangerous rivalry and the diminution of its own trade through the advance of new comers proclaiming themselves so fully equipped.

The catalogue is in part the outcome of this; it helps to show, as M. Cornu claims, that the French industry has nothing to fear from its foreign rivals.

"To complete its successful preparation for the struggle, it is only necessary to adopt, in addition to what it has done, the powerful weapons of association and discipline —a discipline voluntarily accepted in view of general interests; then an intelligent union will lead all efforts to converge towards one common end instead of wasting them in those barren struggles which the thirst after immediate interests provokes in short-sighted minds."

We in England have no Association of Instrument Makers and no catalogue of instruments of precision. The Optical Society, it is true, is doing its best to strengthen the position of opticians, but it is far from covering the whole field.

Does not the fact that our French colleagues have followed the example set by Germany give us food for reflection, and lead us to inquire whether association and discipline might not be helpful to us also?

And this query is pressed home by three recent catalogues of scientific apparatus which have been issued by German firms; the first in English, the second in English, French and German, the third in German. Messrs. Zeiss's list deals with their microscopes, and is most complete. As usual with their lists, it is fully illustrated, while the information about the instruments is given in a convenient form. Details as to the lenses are tabulated, and it is easy to select the particular combination of object-glass and eyepiece most suitable for any desired end. The set of apochromatic objectives is very complete; lenses of 2 and 3 mm. focus and 1·4 numerical aperture are on the market; these, it is stated, are made of permanent glass. The list is an object lesson of the results technical art and skill can produce when resting on a basis of sound scientific investigation.

Messrs. Max Kohl, whose agents in this country are Messrs. Isenthal and Co., have issued a catalogue of nearly 700 pages. They supply almost everything required for teaching purposes in a physical laboratory. Their goods are well known, and the list affords striking evidence of the progress of science in education, in Germany at any rate, if not here. Much of the apparatus is extremely well arranged for the purpose for which it is designed, and the list is one which is sure to be of value in every physical laboratory.

Messrs. Ernecke's catalogue contains an account of their goods, with illustrations of a high class. Though smaller than that of Max Kohl, it commands attention by the wide range covered and the general excellence of the get up. Lists such as the above must prove of advantage to German trade in all countries of the world and be powerful aids in international competition. Their convenience is obvious. We in England specialise more; we go to one firm for resistance boxes, to another for telescopes, and have nothing exactly corresponding to a vast emporium such as that of Max Kohl. All the more reason, therefore, for the association and discipline urged on his French colleagues and co-workers by Cornu.

R. T. G.

AMERICAN FOOD AND GAME FISHES.

American Food and Game Fishes: a Popular Account of all the Species found in America North of the Equator, with Keys for Ready Identification, Life Histories and Methods of Capture. By David Starr Jordan and Barton Warren Evermann. Pp. l + 573; illustrated with coloured plates and text drawings, and with photographs from life. (London: Hutchinson and Co., 1902.)

DRS. JORDAN AND EVERMANN, who have recently enriched science by the publication, under the auspices of the Smithsonian Institution, of a great work in four volumes describing in detail the 3300 species of fishes distinguished by them in North and Central America, reviewed not long ago in the columns of NATURE, have now prepared another book, intended to

"furnish that which well-informed men and women, and those who desire to become well informed, might wish to know of the food and game fishes which inhabit American waters."

This book, teeming with interest from the full accounts, presented in a charming manner, of the habits, distribution and uses of the more important forms from the point of view of the angler, has been lavishly got up in America. The coloured pictures, as well as the photographs taken from life with marvellous success by Mr. A. Radclyffe Dugmore, could not be surpassed in excellence, and the numerous "process-blocks" which have already appeared in various American publications will, thanks to the perfect accuracy with which the fishes have been delineated, greatly facilitate identifications. Authors and publishers are to be congratulated on the production of such a book, which will undoubtedly have the effect of enlisting a more scientific interest in fishes on the part of many who have hitherto looked upon them as mere objects of sport or curiosity, and to whom the use of the more technical treatises on the subject would be distasteful. In deference to such readers, the systematic aspect has been reduced to the narrowest limits that appear compatible with the proper recognition of the numerous genera and species dealt with. It is to be hoped that not a few whose interest is sure to be awakened by a perusal of this charming book will later turn to the more technical work by the same authors, and improve their knowledge through a study of the relationships existing between the various families of fishes, which are here merely defined without any allusion to the higher groups into which they fall.

American taxonomists have always shown a particular predilection for reducing all divisions of the system to the narrowest possible limits. This tendency is carried to the extreme by Messrs. Jordan and Evermann, who inform us in the introduction that not only the lampreys and hags are to be excluded from the class Pisces, but also the sharks and rays, the lung-fishes and Polypterus, which they regard as only fish-like creatures, fishes in the broad sense of the term, but not "true fishes," and are therefore excluded from the work. Ganoids, on the other hand, are still maintained among fishes proper. In conformity with this method of excessive multiplication of systematic divisions of all grades, the various forms of Salmonidæ which are usually regarded as subspecies, such as the land-locked salmon and the varieties of *Salmo clarkii*, *gairdneri* and *fontinalis*, are all dealt with as distinct species—twenty-six species instead of the four admitted by the same authors in their previous work. True, a few pages before, the authors pertinently remark that

"The non-migratory species (subgenus Trutta) occur in both continents, are extremely closely related and difficult to distinguish, if, indeed, all be not necessarily regarded as forms of a single exceedingly unstable and variable species. The excessive variations in colour and form have given rise to a host of nominal species. European writers have described numerous hybrids among the various species of Salmo, real or nominal, found in their waters. We have thus far failed to find the slightest evidence of any hybridism among American Salmonidæ in a state of nature. Puzzling aberrant or intermediate individuals certainly occur, but such are not necessarily hybrids."

Bearing in mind the authors' tendency to excessive multiplication of species and higher divisions, it is not a little surprising to read in the introduction that the "true fishes" of the whole world are estimated at only 12,000 species, arranged in about 200 families. A careful computation which has recently been made by the reviewer, applying somewhat different canons of classification, has resulted in numbers that are not very different, viz. 11,200 for the species and 160 for the families. The number of species in the American authors' estimate is even far below that given in the article "Ichthyology" in the supplementary volumes of the "Encyclopædia Britannica," viz. 17,000.

The usefulness of the work is enhanced by special chapters on the external characters of fishes from the descriptive point of view, on fly-fishing (by Mr. E. J. Keyser), a glossary of technical terms, and an artificial key to the families of American food and game fishes.

The copy received for review bears the mark of a London publishing firm. But the identical book was issued in May last by Messrs. Doubleday, Page and Co., at New York.

G. A. B.

HUMAN ANATOMY.

Text-Book of Anatomy. Edited by D. J. Cunningham, F.R.S. Pp. xxix + 1309; 824 wood engravings from original drawings. (Edinburgh: Pentland, 1902.)

AT the present time the human anatomist tries to sit as comfortably as he may on the two stools of science and practice. It must be admitted that few do it with success. While his posture evokes the indulgent smile of the man of science, the professed zoologist and morphologist, the man of practice, the surgeon and physician, regards it as altogether unprofitable and impracticable. To reconcile the views of these two contending factions, to make the theory of anatomy assist in its practical application to the sick and the facts of anatomy illumine the laws of mammalian morphology, is the first and chief difficulty of anyone who now or afterwards undertakes the preparation of a text-book on human anatomy. No living anatomist is likely to be more successful in overcoming this difficulty than Prof. D. J. Cunningham, who is deservedly held in the highest esteem by the surgeon and physician, as well as by the man of science. While admitting that Prof. Cunningham has been more successful than any one of his predecessors, one rises from the study of this work with the feeling that, in spite of rapid improvement, it will take decades of progress to make the theory of anatomy fit its facts as a glove does the hand.

Not a single decade has passed during the last two centuries without someone proclaiming from the housetops that at last the whole field of human anatomy is explored and finished, and yet the annual output of new research has continually increased. The manner in which this work is produced is evidence of the rapid growth of the subject. It is no longer possible for one man to be intimately acquainted with the more recent work or to supply first-hand information in each of the many departments into which human anatomy has been subdivided, and hence the necessity for a collective effort. Works of reference like the English Quain, the French Poirier, the German Bardeleben, necessarily demand the combined services of specialists, but here, even in a work designed to meet the needs of candidates for a pass degree, the same necessity has been felt. The editor has been fortunate in the selection of his collaborators. To Prof. Young, of Owens College, and Prof. Robinson, of King's College, London, have been assigned the sections on embryology and the vascular system; to Prof. Thomson, of Oxford, that on osteology; to Prof. Paterson, of Liverpool, the muscular and nerve systems; to Dr. Hepburn, of Edinburgh University, the section on joints; to Prof. Howden, of Durham University, the section on the organs of special sense; to Prof. Birmingham, of Dublin, the organs of digestion; to Prof. Dixon, of Cardiff, the urinogenital system; to Dr. Stiles, the section on surgical anatomy; while the editor himself undertook the central nervous system. It may be said at once that each contributor has given, not only the best that is known, but has also made original contributions to his particular section. Some of the sections, such as those on the nervous system, the alimentary system and embryology, gave their authors a greater opportunity than did others, and these opportunities have not in any single case been allowed to slip by.

There is a unity in the work which may be explained by the fact that all the contributors, with one exception, are pupils of the veteran leader of the Edinburgh anatomists, Sir William Turner, to whom the book is most worthily dedicated. This work has all the merits and also all the defects of the Edinburgh school. There are the full and lucid descriptions of the important things, but there is also an over-strenuous endeavour to be thorough by the introduction of masses of unimportant or irrelevant detail. Turn, for instance, to the description of the spermatozoon, and it will be found that the medical student is expected to master more than fifty details concerning its structure; or turn to the descriptions of a bone, a muscle or an artery, and the same crowding of detail will be found. A student who thoroughly prepares himself from this work will present himself to his examiners loaded with more than 60,000 anatomical facts, 75 per cent. of which will appeal to his memory more than to his intelligence, and only a small percentage of which will be of use to him in the practice of his profession. It is a primary defect of the Edinburgh school that, owing to its detachment from the hospitals, it has come to regard the study of anatomy as an end in itself instead of being only the scaffolding on which a student has to lay his knowledge of physiology. On the combined basis of anatomy and physiology he has subsequently to build his knowledge of pathology, surgery and medicine, and all the efforts of the anatomist and physiologist must be bent so as to reach this end. The student, when he comes to build out his mental picture of the circulation, respiration and locomotion of the human body, will find that this work will afford scarcely a better anatomical scaffolding than older and less complete works.

One feels that Prof. Cunningham has let slip an opportunity that occurs to a man only once in a century. With such a powerful syndicate of anatomists behind him he could have disregarded the prejudices of examiners, relegated thousands of useless anatomical details to the limbo of oblivion and made his subject once again live. That he has not done so shows that the principle on which present systems of anatomy are designed meets with his deliberate approval, and it is on those broad lines that most thinking men will join issue with him.

During his study of this work the reviewer has laid it side by side with Bell's "Anatomy," another triumph of the Edinburgh school, but of a century ago. The opinion has been forced on him that the design of the older book is the better of the two. All through Bell's pages, in spite of some crude theories, inaccurate facts and passing personalities, anatomy is made to coquet with physiology and morphology, and all three are invariably made to serve as handmaidens to the surgeon and physician. The ideal treatise of human anatomy will be produced by the man who accepts the principles of the anatomists of the beginning of last century and applies them to the facts at the disposal of anatomists at the beginning of the present one.

The illustrations of this work are all well designed and artistically finished, but the poorness of its binding and its narrow margins, which give it a general appearance of meanness, are out of keeping with the high standard of its contents and the artistic demands of the present-day medical student.

A. KEITH.

DIFFERENTIAL CALCULUS FOR BEGINNERS.

Differential Calculus for Beginners. By Alfred Lodge, M.A., with an Introduction by Sir Oliver J. Lodge, D.Sc., F.R.S., LL.D., Principal of the University of Birmingham. Pp. xxv + 278. (London: George Bell and Sons, 1902.) Price 4*s.* 6*d.*

PROF. ALFRED LODGE is so well known among mathematicians as an authority on the teaching of geometry and kindred subjects that the addition of his brother's name to the title-page may appear superfluous.

The introduction by the latter contains a brief statement of the uses and purposes, not only of the differential calculus, but also of the integral calculus and of differential equations. The present volume, however, deals exclusively with the differential calculus, and that only so far as it refers to functions of one and two variables. A notable and important exception to this limitation, however, occurs in the chapter on successive differentiation, where the notion of $D^n y$ naturally leads to that of $D^{-n}y$, in other words, the *n*th integral of *y*. Here, however, the notation D^{-n} is alone used, the familiar "F-hole of a violin" being conspicuous by its absence. Probably the latter symbol might advantageously be eliminated from our mathematical notation altogether, were it not for the important difference between differentiation and integration introduced by the appearance of the inevitable "constant of integration" which leads to the further notion of "definite integrals."

The amount of attention given to graphs will be welcomed by the great majority of teachers, and chapter vi., which deals with the application of graphic methods to the approximate solution of equations, is an important feature which ought certainly to occur at some stage or other of an ordinary mathematical curriculum, and may probably be inserted here quite as well as elsewhere. The feature which is most calculated to arouse criticism is the adoption of the method of differentials as the basis of the whole work. The author states that he has found this method most useful and helpful to the student of physics and mechanics, but it has the great disadvantage of throwing into the background something which is very important, namely, the notion of a limit. In examinations there has recently been a tendency on the part of candidates, when asked to find from first principles the differential coefficient of sin *x*, to send up the following answer:—

$$\frac{d(\sin x)}{dx} = \frac{\sin(x + dx) - \sin x}{dx} = \frac{\sin x + dx\cos x - \sin x}{dx}$$
$$= \frac{dx\cos x}{dx} = \cos x.$$

Even this might be excused if the candidates showed an intelligent appreciation of the meaning of what they were writing down, but as soon as they are asked to differentiate x^x, log sin *x*, or anything which is not in the book, they exhibit hopeless ignorance, thereby proving conclusively that the stock differentiations have been merely written down by rote.

There is no doubt a tendency on the part of another class of writer to rush to the opposite extreme by making the student read long discussions on continuity before introducing him to the notation of the calculus. But cannot a happy mean be found by introducing the notions implied in the relation $dy = f'(x)dx$ *immediately after* the principal algebraic and transcendental functions have been differentiated by means of the method of limits? Apart from this matter of opinion the book appears to be excellent.

We are glad to see the author does not relegate Taylor's and Maclaurin's theorems to the end of the book. In a logical treatment, that might possibly be their proper position, but the postponement would prevent many readers from acquiring an intimate familiarity of what are probably the most important theorems in the whole of the calculus. G. H. B.

GALL-INSECTS.

Monographie des Cynipides d'Europe et d'Algérie. By l'Abbé J. J. Kieffer. Vol. I. Ibalynæ et Cynipinæ. With 27 plates. Pp. vii + 687. (Paris: Hermann, 1897-1901.) Price fr. 40.

THE present work is a portion of the great series of monographs commenced by the late E. André, under the title of "Spécies des Hymenoptères d'Europe et d'Algérie," by himself, his brother and other specialists, among whom are the Rev. T. A. Marshall and the Abbé Kieffer. The character of the work is well known to all hymenopterists, and in this regard we need only say that another volume will complete the Cynipidæ, including the parasitic subfamilies Allotriinæ, Eucoilinæ and Figitinæ, and will also include the families Evaniidæ, Stephanidæ and Trigonalidæ, and full systematic and synonymic catalogues and indices to both volumes, the first volume containing only an index of families and genera, and a table of contents.

In addition to the systematic portion of the work, the structure, metamorphoses, broods, galls, parasites, biology, bibliography, classification, geographical distribution, &c., of the Cynipidæ are discussed at considerable length; and the author mentions in his preface that though, when he undertook this work in 1896, few or no Cynipidæ were known from any of the more southern countries of Europe or from Algeria, he has now obtained, through the kindness of various contributors whom he mentions, considerable information on these countries, though much of it reached him too late for the first volume and will have to be deferred to the supplement in vol. ii.

Notwithstanding the insignificant appearance of the Cynipidæ, on which the Abbé remarks, they are of extreme scientific interest on account of the alternations which the various broods present of winged and wingless, and sexual and sexless, individuals at different times of the year, in which respect they have much resemblance to the Aphidæ, though the Cynipidæ, unlike the latter, are seldom or never to be regarded as destructive insects, one reason for which may be that the Cynipidæ (or at least certain species) are liable to the attacks of an inordinate number of small parasitic Hymenoptera, chiefly belonging to the Chalcididæ, so that an entomologist may breed a great variety of Hymenoptera from (say) a large quantity of galls of *Cynips kollari*, without obtaining a single specimen of the original species which formed the galls.

Although the insects themselves are inconspicuous, their galls are conspicuous enough, and some of the large fleshy eastern galls on oaks, such as the Apple of Sodom, resemble brightly-coloured fruit; while the moss-like galls, such as the bedeguar on the wild rose, are likewise very pretty objects. One peculiarity of these insects is that a considerable number of the species are attached either to oaks or roses, though some few are met with on other trees. They are also among the few insects which yield products of great value to the human race, the most important of which, of course, is ink; but various galls have been, or are still, used for illumination, for tanning, in medicine, for chemical purposes, and in the case of a few species, even for food.

Though some of our earlier hymenopterists, such as

Haliday and Walker, paid some attention to Cynipidæ, others, such as Stephens and Smith, almost entirely neglected them; and it was not until Mr. P. Cameron published vols. iii. and iv. of his "Monograph of the British Phytophagous Hymenoptera" that we had a satisfactory account of our British species. On the continent, more had been done by Mayr, Adler and others, and now the Abbé Kieffer has furnished us with a full account of the European and Algerian species of these interesting but still somewhat neglected insects; and although every monograph or catalogue always helps to make itself incomplete by stimulating the activity of all observers who are sufficiently interested in the subject to take up or to continue the study, yet the book may reasonably be expected to hold its place as the leading authority on the subject for many years to come. W. F. K.

OUR BOOK SHELF.

Chemisches Praktikum. I Teil. Analytische Übungen. By Dr. A. Wolfrum. Pp. xviii + 562. (Leipzig: W. Engelmann, 1902.) Price 10*s*. net.

THE object of the author is to present a course of practical instruction in analytical chemistry on a technical basis. It is intended that the student shall be confronted throughout his course of work with the technical application of the principles and methods which he makes use of in the laboratory. The author hopes by this means to improve the training of the student whose aims are directed towards chemical work in the arts and manufactures.

The subject-matter is divided into three sections, under the headings qualitative, quantitative and technical analysis. In the first section, the ordinary reactions of the metals and acids are given, ionic nomenclature being employed. The rare metals are dismissed by a consideration of thorium and cerium, these alone in the author's opinion being of sufficient technical importance to merit discussion. The qualitative analysis of organic substances is then treated, the reactions for the most important organic radicals being given. The section concludes with a long list of important organic compounds for which the special tests are given, as well as directions for ascertaining the presence of the most frequently occurring impurities.

In the section on quantitative analysis, the order of treatment is, gravimetric estimation of the metals and acids, elementary analysis of organic compounds, volumetric analysis and estimation of the most important atomic groups of organic compounds. Twenty pages are devoted to the methods of determining molecular weights of organic compounds and fifteen to gas analysis, but, singularly enough, not a single diagram is appended to illustrate the special apparatus used in operations with gases.

Under technical analysis, which forms the subject of the last 200 pages, is discussed the analysis of water, fuels, ores and metallurgical products, products of the chemical manufacturing industries, artificial mineral colouring matters, artificial manures, lime, cement, clay, raw materials and products of the sugar industry, ethereal oils, aniline colours and products used in the manufacture of these colours.

The book, as will be seen, contains a wealth of material. It is doubtful, however, whether such a work could be placed with good results in the hands of the average student of chemistry. The amount of material accumulated by the author within such a small compass is so great that the efficiency of the book as a working guide for the student must necessarily suffer. All experienced teachers are aware that a book which the average student is to use in his daily work in the laboratory must contain full working details, and the "Chemisches Praktikum" does not.

As a reference book, however, it will without doubt be found very useful in the laboratory, and for such a purpose can be warmly recommended. H. M. D.

The Coal-fields of Scotland. By Robert W. Dron. Pp. vi + 368. (London: Blackie and Son, Ltd.) Price 15*s*. net.

NUMEROUS descriptions have been published of the Scottish coal-fields from the time of Ball, Milne and Landale to our own day. Most of these, however, have been scattered through the volumes of scientific journals or published in official reports which, as a rule, have been badly printed, expensive, and insufficiently made known to the public. By far the most important contributions to the subject are those to be found in the maps and memoirs of the Geological Survey. These publications contain a storehouse of information; they were the first, and are still the most detailed and complete, review of the whole geological structure of the coal-fields. The maps present a graphic picture of the disposition of the coal-seams and the extent to which they have been dislocated and folded. The memoirs furnish a large amount of information which could not be embodied in the maps, and both taken together form the basis on which all subsequent descriptions must rest. The progress of development has led to the opening of some new fields and to the exhaustion of others, since the appearance of the Survey publications, but we understand that arrangements have been made for an official re-examination of the coal-fields and the preparation of new editions of the maps. The work of the Survey will thus be brought up to date, and will maintain the high position which it has always held.

Without these official maps and memoirs, Mr. Dron could not have produced the volume which he has just published. He acknowledges, in his preface, in a general way that he has freely utilised "all available sources of information, including the publications of the Geological Survey." It would have been well, however, had he made more specific acknowledgment of his obligations. No one who is not familiar with the subject would suspect from his chapters how deep his indebtedness is all through the book. The occasional allusions to the Survey work seem strangely inadequate in comparison with the fulness of his references to private individuals of whose assistance he has availed himself. The maps, for instance, with which he embellishes his book are reduced (not very satisfactorily) from those of the Geological Survey, but there is no reference to the source from which they are derived. The volume, though it has no originality, supplies a convenient summary of what is at present known regarding the coal-fields of Scotland, and may be useful as a popular handbook of the subject.

A Glossary of Popular, Local, and Old-Fashioned Names of British Birds. By C. H. Hett. Pp. vi + 114. (London: H. Sotheran and Co., 1902.) Price 1*s*.

TO the last edition of his "Bird Notes," the author appended a glossary of synonyms of the British species. The present little volume is an amplification of that glossary, and appears to be as nearly complete as possible. The work commences with a classified list of the British species (in which we notice that the author is a conservative in the matter of nomenclature), and then follows the glossary. It should enable amateur ornithologists residing in country districts to identify all the local birds without difficulty. R. L.

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.*]

Suggested Nature of the Phenomena of the Eruption of Mont Pelée on July 9. Observed by the Royal Society Commission.

ALTHOUGH Dr. Anderson and Dr. Flett were able, at the largely attended meeting of the Royal Society on November 20, to add little to what they had published in their preliminary report three months ago, beyond exhibiting the very full and excellent series of photographs of the affected regions of the Soufrière and Mont Pelée eruptions, they succeeded in exciting renewed interest in the problem of the nature of that eruption of Mont Pelée on the evening of July 9, which they had the exceptionally good fortune to witness under most favourable conditions. The photographs and perfect description of this particular outburst give it an unsurpassed value as a contribution to the scientific history of volcanoes, and the Royal Society has therefore the greatest reason to congratulate itself upon the success—a success almost beyond the most sanguine expectation—of its commission to Drs. Anderson and Flett to visit the scene of these eruptions.

We can now hardly hope [that any fuller knowledge of the nature of an eruption of the kind witnessed by these geologists will be forthcoming through future observations. What is now to be done in order to clear up what remains obscure is experimental work in the laboratory. To me it seems that only one point requires investigation before we shall have a definite conception and understanding of the phenomenon at the base of such outbursts as those in the West Indies, as well as that of the Bandaisan eruption, or rather explosion, in Japan, closely similar to them in its essential features.

From the text of the published report, modified a little in the accounts given at the meeting, we know that, after spasmodic bursts of steam, dust, and stones, and discharges of torrents of water and mud, the climax of the eruption came as the welling-up in the crater and overflow, like that of a liquid, of red-hot dust, which descended the mountain side, at first relatively slowly, but with ever-increasing velocity, like an avalanche of snow. This avalanche of incandescent sand was accompanied by a dense cloud, black as night, which soon concealed it from view and swelled out in convolutions with terrible energy until it reached perhaps one mile high and two broad. After this, it ceased to enlarge and gradually lost its dense blackness through ash settling down and leaving nothing visible but white steam.

There was, therefore, (1) a flow of incandescent sand down to the sea, mainly by gravitation, but with a velocity apparently surpassing that of a torrent of water; and (2) the expanding motion of the superincumbent, black cloud, together with its rapid motion along the course of the stream of sand, *from which it never lifted*. Just after the overflow of sand from the crater, there must have been an enormous outrush of steam and, perhaps, other gases, and this will have had some effect in driving the cloud through the air; but the progressive formation and the appearance of the cloud forbid the belief that this effect could have been considerable. That the cloud enlarged upwards rather than laterally was due to its consisting of heated steam, for although the dust which it carried with it will have impeded the velocity of its expansion, it will not have lessened its extent.

There can be only one conclusion drawn as to the cause of the free motion and rapid rush of the torrent of sand and of the swelling, convoluting cloud, and that is the continuous evolution of water vapour from every particle of the moving hot sand. Possibly some other gas may also have escaped, but if so only in relatively small quantity, as otherwise the water vapour would not so easily have condensed and become visible. Violent friction between the issuing steam and the solid particles may sufficiently account for the extensive electric discharges. The continuous escape of this water from the particles of the hot sand, at such a high temperature, even though in small quantity, would surround every particle with a compressed atmosphere of steam sufficient to keep it apart from all others, and thus produce a quasi-liquid mass which, on account of the density of the sand, would gravitate strongly and at the same time would, by virtue of the interstitial compressed steam preventing all rubbing together of solid particles, give the mass its marvellous mobility. That this would be so is easily borne out by facts familiar to the chemist and physicist. One of these was, indeed, brought up by Sir William Ramsay in the discussion which followed upon the reading of the papers, namely, the behaviour of precipitated silica when heated, which, however, he attributed to a movement of particles in gases similar to that of Brownian movements of particles in liquids. When any fine dust or powder, which is non-coherent whether cold or hot, gives off sufficiently fast a gas or vapour when heated, it will, when smartly heated, swell up and become mobile, sometimes almost as mobile as liquid ether, keep a horizontal surface when its containing-vessel is tilted, and admit of being poured like a liquid into another vessel. Because of its frequent presence in the work of inorganic chemical analysis, precipitated silica is, perhaps, the most widely known example of this behaviour. In ordinary circumstances, the silica acts in this way almost wholly in consequence of its continuing to liberate up to even a blowpipe heat the water always present in some form of combination with it. Probably, too, it and all such light powders owe for a moment part of the movement of their particles from each other merely to the rapid expansion of the air in the interstices of the powder when the containing vessel is quickly heated, but the escape of hygroscopic or other moisture is obviously the principal cause. When the silica is kept steadily heated, it loses most of its mobility. Other hygroscopic or vapour-condensing powders behave similarly; very finely divided charcoal powder is generally a good example; magnesia alba is another, which gives out both carbonic acid and water.

Light bodies are naturally best fitted for the observance of this phenomenon, but manganese binoxide when evolving oxygen shows it, and even platinum black will throw up dust and enlarge. Indeed, it is a common phenomenon for a slightly coherent powder suddenly heated in a platinum crucible to float in motion as a moulded mass in an atmosphere of gas generated from itself by the hot walls of the crucible. Not inapposite instances of the power of escaping vapour to hold up bodies is that familiar phenomenon of liquid water or alcohol assuming the spheroidal state, that is, rolling about on a hot plate without touching it, being couched on a bed of its own continuously evolved vapour. Where experiment is now wanted is to find out what andesitic minerals will, under great pressure, combine chemically or physically, but intimately, with water at a red out heat and then retain it sufficiently when the pressure is released for an appreciable though short time to elapse before the regeneration of the steam is ended.

A modification of the explanation here given suggests itself which would do away with the necessity for the existence of such combinations of water with rock materials. It is that as the incandescent sand flowed over the soil, it generated the steam from the damp earth or hydrated rocks beneath it in such quantity as to buoy up the sand from the soil and separate its particles. In accordance with this view would be the observation that the hot sand visibly (that is, without obscuring cloud) poured over the lip of the crater and then as it flowed down obscured itself in cloud. On the other hand, the escape of gas or vapour caused by cooling is not an unknown phenomenon, while against this view is the difficulty to explain when holding it the production of the sand within the crater. Drs. Anderson and Flett speak of the dust as lava blown to pieces by the expansion of the gases it contains. I would suggest that the production of the sand just in that way is inconceivable; for if the lava had been molten, it would have been scattered in drops and vesicles in all directions, and only if solid would it have become dust, while in either case it would not have remained as a mass of sand, but have been scattered to the winds. The production of sand or dust, if it really was produced in the crater, will have been a disintegration of rock masses by the pressure diffused through them of the condensed water, with which they were impregnated and perhaps combined, a disintegration leading up to the falling to dust of the masses while they were still under sufficient pressure to prevent scattering.

The strong escape of steam from the sand would, of course, carry up much of the dust with it and thus constitute the black cloud, while its cauliflower-like expansions were apparently only an exaggerated form of what is to be seen over a seething cauldron or a stream of boiling water. EDWARD DIVERS.

November 22.


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The Paradox of the Piano Player.

WHEN a number of notes in different parts of the keyboard of a pianoforte are struck by means of levers actuated by a common pneumatic pressure, it appears to be the universally prevailing belief that the only variations possible are those in which the whole chord is made to sound louder or softer by increasing or decreasing the pressure. It is commonly regarded as an impossibility to vary the *relative* intensities of the sounds produced by the various notes so as to make, *e.g.*, the bass parts sound louder and the treble softer, or *vice versâ*.

On the other hand, dynamical considerations suggest that the intensities of the sounds excited in the different strings of the piano depend, not only on the total pressure applied to the mechanism, but also on the way in which this pressure is made to vary during at least part of the interval from the instant at which the key is first touched to the instant at which the hammer leaves the strings. A short, sharp impulse suddenly cut off should produce its greatest effect on the notes of higher pitch, while a heavy, sustained or increasing pressure should make its effect most marked on the lower notes of the instrument. During the last few months, I have given considerable attention to the practical application of this theory, and the effects which I find it possible to produce, provided that the accentuation is performed at exactly the right instant of time, are most remarkable. The treble or bass parts may be made to stand out in so conspicuous a way as to make it difficult to believe that different notes of the chords are not struck by different human fingers. The matter opens up a wide field of discussion, and suggests considerable possibilities in the way of quantitative laboratory measurements. For the present, it may be sufficient to suggest that those of your readers who possess the new musical instruments of the twentieth century suitable for the purpose should, if they have not already done so, perform the experiment for themselves; they will soon be rewarded by being able to enjoy their music in a way they have never enjoyed it previously. G. H. BRYAN.

Cost of Scientific Education in Germany and England.

I NOTICE, in the issue of NATURE of December 4, that you quote Mr. Holzapfel's letter to the *Times* on the cost of scientific education in Germany and England. Although, unfortunately, there can be no dispute as to the great difference between the fees charged in Germany and in England, I think it right that the fees of King's College should be correctly stated. The sum quoted by Mr. Holzapfel represents the charge made for chemistry and *physics*; for chemistry only it was 34*l*. 18*s*. for the year. I have no knowledge of the amount of instruction which the other son obtained for 7*l*. at Aachen. WALTER SMITH, Secretary.

King's College, London, W.C., December 9.

THE REPRODUCTION OF COLOURS BY PHOTOGRAPHY.

THE services which photography has rendered to science are now well recognised, and its value for urposes both of observation and record is well known and admitted. It is probably not so well known that methods now exist by which not only the form, but the colour, of natural objects can be represented with approximate fidelity. We are fortunate in being able to illustrate this fact by a plate giving some excellent reproductions of birds' eggs, produced under the superintendence of Mr. H. E. Dresser, entirely by photographic methods, and without the intervention of an artist.

There is no need to dwell on the value of such work. For many scientific purposes it is as important to record colour as shape, and if this can be done in a trustworthy manner, a new and useful power is placed at the disposal of the teacher of science and of the writer of scientific books. The difficulty about the three-colour process of photography is that it is extremely difficult to make certain that the colours are reproduced with sufficient accuracy for scientific work. Accuracy enough for pictorial purposes is easily attained, but absolute truth to nature is quite another thing. The reasons for this are various. The photographic gradation of light intensities, in the case of both white light and of its various components, is generally different from the visual gradation, and even if accuracy is ensured in a narrow range of tones, it is hardly possible to make certain of its being secured in wider ranges. Another difficulty is that pigments have to be employed, and such pigments can never, of course, give pure colours. The consequence of this is that in the production of the picture it is necessary to vary the intensity of the different colouring agents employed until a satisfactory result is obtained. There is thus considerable room for judgment and dexterity, and the final result is not automatic, but depends on the artistic skill of the person who produces the picture. The whole process is, it must be admitted, of the character of a makeshift, but at the same time, when carefully employed it is a makeshift of considerable practical use.

Mr. Dresser, in the article printed below, deals only with the representation of natural objects for purposes of book illustration. An equally valuable application of the process is for the production of lantern slides for purposes of demonstration, and, as many of our readers are well aware, the process is beginning to be largely used for such purposes. A lantern slide coloured by hand is at best but a poor thing, and though a few very skilful operators—such as Mr. Cyril Davenport, of the British Museum—have by a combination of microscopic sight and great deftness of manipulation succeeded in producing some remarkable results, even these will hardly stand the large amount of magnification required by the lantern. Now a slide made by the three-colour process will stand as much enlarging as any ordinary photographic slide, and will give a reasonably close approximation to the natural colours of the subject. The process is applicable to any specimen which can be photographed. Excellent reproductions of microscopic objects have thus been produced; botanical specimens, birds, beetles and butterflies have all been rendered with great beauty and with really close accuracy to nature. Those who were present at Prof. Poulton's lectures at the Royal Institution last session had the opportunity of admiring the exquisitely coloured pictures he showed of insects, all produced by the process, which, first practically demonstrated by Mr. F. E. Ives, has since been further developed by Mr. Sanger Shepherd and others in this country.

Although, as said above, absolute accuracy is very difficult, or even impossible, to ensure—certainly not by automatic means—it is not too much to say that any photographer ought, after a very little practice, to be able to produce useful and serviceable illustrations for lecture purposes if he is content with something which, though not perhaps the best possible, is infinitely superior to anything which can be produced by painting an ordinary monochrome lantern slide.

Mr. Dresser in his remarks places, perhaps, needless stress on the difficulties of the process, and we are not quite disposed to agree with him as to its unsuitability for many purposes which he mentions. Although the exposures he gives may have been necessary by reason of the conditions under which his pictures were produced—namely, the photographing of the objects life size through a ruled screen and by the use of daylight at a time of the year when the light is not very good—it is a very different matter when it is required to produce illustrations for the lantern. In an ordinary studio, the exposure may take from, say, three minutes to a quarter of an hour through the red screen, which of course takes the longest time, while for out-of-door views in bright sunshine, with a moderate aperture of the lens, it is a matter of seconds only.

As a supplement to Mr. Dresser's account of the work he has carried on, we have added a summary of the account of the process given by Sir Henry Trueman Wood at the Royal Society's conversazione last May, when the rationale of the process was demonstrated.

THE THREE-COLOUR PHOTOGRAPHIC PROCESS.

To produce a photograph in colour direct from nature has for many years past been the dream and cherished aim of many photographers, but, so far as I can ascertain, these efforts have not met with success. By a happy combination, however, of the camera and the printing press, the so-called three-colour process has been so far perfected as to have become a commercial success, and, though still, perhaps, in its infancy, bids fair to become a serious rival to chromolithography, not only on account of its accuracy, but also because of its cheapness. Moreover, in the case of a larger number of copies being required, the total cost is considerably below that of chromolithography.

Upwards of twenty years ago, when the publication of my "Birds of Europe" was drawing to a close, I commenced to collect materials for a companion work on the eggs of European birds. When, however, it arrived at a question of illustrations, I found that I could not get plates sufficiently well and cheaply executed by any then known process. Besides which I could find no artist who could reproduce eggs in water-colour satisfactorily, and indeed, at the present time, I know of only one, a Danish artist, who can paint eggs with sufficient accuracy, and he is at present engaged on the illustrations for the British Museum "Catalogue of Eggs." Nor can he copy all sorts of eggs correctly, for in some species the markings are so minute and varied that no artist could exactly reproduce them.

In 1900, however, I saw a plate of fruit, photographed directly from the object, without the intervention of an artist, and reproduced by the three-colour process, which gave me the idea that it would be specially suited for the reproduction of natural history objects, and I at once commenced a series of experiments to test it with the assistance of Mr. I. D. Geddes, manager to Messrs. André and Sleigh, Ltd., of Bushey, Herts, and to his active cooperation I am indebted for the success that has crowned my endeavours. To produce the coloured picture three negatives are made from the objects on specially sensitised plates, which are exposed through "light filters" placed behind the lens. These filters separate out the colours of the objects into what are known as the primary colours—approximately red, blue and green. The negatives so obtained are then employed in the usual manner for the production of half-tone blocks—that is to say, each of the three pictures representing the separated red, blue and green images are etched as type blocks on copper for printing in the ordinary press, and it must be noted that the pictures as engraved on the copper blocks are made up of very fine dots. The plates are printed in the colour complementary to that of the filter through which each was taken, *i.e.* the red-filter picture in blue, the green in red and the blue in yellow. The printing of the plates is effected on three presses, one for each colour; the yellow image is first printed, then the red over the yellow printing, and, lastly, the blue over the red and yellow, and in each case the colour is allowed to dry before the next colour is printed. The registration of one colour over the other must be accurate, otherwise a blurring of the whole picture occurs. The colours used for printing are mixed each to a standard tint, which is only departed from in very exceptional cases.

The length of exposure for the process varies very much according to the conditions. As carried out for me by Messrs. André and Sleigh, in which the pictures were taken with a light-filter, a prism and a ruled screen interposed, the exposures were very long, the blue, approximately, ten to fifteen minutes, the green thirty to forty minutes, and the red nearly two hours. This process is eminently adapted for the copying of paintings, but the sole aim of the experiments made has been with a view to reproduce natural history objects, and more especially eggs, without the intervention of an artist.

Mammals cannot be photographed from living examples, as the exposure required is too long, and can only be done from paintings, for the reproductions are so very accurate that if photographed from stuffed specimens it is painfully apparent that they were stuffed. The same may be said with regard to birds, but when photographed from well-stuffed skins every character is most accurately reproduced, and such plates are consequently of extreme scientific value. Some fishes and crustaceans retain their colours for some time after death, whereas others fade almost immediately; the former of these can in most cases be reproduced from the specimens direct, but as regards the latter it will be necessary to employ an artist.

Shells of all kinds are specially adapted for this process, as colour-photography brings out even the bright iridescent colourings so characteristic of some species.

Flowers and plants, however, present serious difficulties, owing also to the long exposure required. Cut flowers will move and fade, and growing plants are sure also to move within three hours and thus spoil the pictures. Butterflies, moths and other insects can be photographed from the specimens direct if these are perfect, but they are often slightly damaged in catching, or in drying they become somewhat distorted, and any slight imperfection cannot be hidden, but is most faithfully reproduced; hence it is generally advisable to photograph from water-colour drawings of these objects.

Birds' eggs have chiefly occupied my attention, and with these I have been most successful, so much so that I purpose now to bring out my work on eggs, illustrated by this process from the eggs direct, without the intervention of an artist. At first I found a difficulty with the shadows, and tried the effect of a dark background; but as this took from the characteristic colours of some species, I had to revert to a pale background, and by degrees have overcome the difficulties, as will be seen from the plate accompanying the present article. The eggs figured on this plate are as follows:—

Figs. 1, 2, 3, eggs of the Lesser Kestrel, *Falco cenchris*; Figs. 4, 5, eggs of the Honey Buzzard, *Pernis apivorus*; Fig. 6, egg of the Levant Sparrowhawk, *Astur brevipes*; Fig. 7, egg of the Shikra Sparrowhawk, *Astur badius*; Figs. 8, 9, 10, eggs of the Blackwinged Kite, *Elanus coeruleus*. All these specimens have been selected to show the greatest variation in these eggs, and also to test the process. H. E. DRESSER.

PRINCIPLES OF THREE-COLOUR PHOTOGRAPHY.[1]

The reproduction of the camera picture in its natural colours is still an unsolved problem, for Lippmann's results can hardly be said to have passed the experimental stage. They still lack practical application. All that can be done by photographic means is to select and combine colours, so as to produce an approximately correct reproduction of the colours of any natural object. The colour itself must be provided by the use of dyes, stains or pigments.

The principal application of the three-colour process

[1] Subject-matter of a demonstration given at the conversazione of the Royal Society on May 14 by Sir H. Trueman Wood.

is for the production of printed illustrations, but for purposes of demonstration its application to the production of pictures for exhibition by the lantern is much more convenient. By the use of a triple lantern the light from a single source can be divided up into three beams. If in the path of the beams we place screens of coloured glass of colours corresponding with the three primary colour sensations—red, green and blue—we have, of course, a disc of each colour projected on the lantern screen. If by moving the lantern lenses the three discs are caused to overlap, the colours will be mixed and combined. Where all three colours overlap there will be a white patch. Where only two overlap there will be a patch caused by the combination of those two colours, and this of necessity will be complementary to the third. We have therefore on the screen a coloured pattern showing white, the three primaries and their three complementary colours.

If in front of each lens of the lantern we introduce a simple pattern cut out of black paper, we shall, when the three images are separated on the lantern sheet, get three coloured reproductions of the three patterns. If they are of a suitable shape and suitably arranged we can combine these into a variegated pattern on the screen. We may take, for instance, such a simple pattern as a half-circle; then if we arrange the three half-circles in such a way that they do not coincide when projected together on the lantern sheet, but combine and overlap so as to form one complete circle, this circle will be divided into six sectors, three of which will show the primary colours and the other three their complementaries.

This simple experiment shows that it is possible to get a coloured picture by means of a black and white pattern and the three coloured glasses. In it, however, only the complementary colours are shown, because equal amounts of the primaries are combined. To get other tints, varying amounts of one or more of the component colours have to be used. Experimentally this is easily done by introducing in front of one of the lenses of the lantern an optical wedge—a sheet of glass coated with a neutral-tinted film, graduated from transparency at one end to opacity at the other. By cutting out, say, more or less of the red, we get a series of browns, greyish blues, &c.; by diminishing the green we get salmon colour, yellow ochre, &c. By this means it is evident that any desired tint which the human eye can appreciate can readily be produced.

Now a picture is only a complicated coloured pattern, and if we can analyse a picture and resolve its colours into the three components, arranged in their proper shapes, the combination of these three components will reproduce the picture as regards both shape and colour. Such analysis is possible by photography. A photograph taken through a red screen gives us the red component, and by using blue and green screens the blue and green components can be obtained. It is to be remembered that these photographs are merely monochrome photographs. They are simply ordinary photographs taken by a portion of the light of the spectrum, instead of by the whole of it. Making positive prints from negatives thus produced and projecting them on the screen, they show like ordinary lantern slides, except that each picture looks rather incomplete. In the red-light picture blue objects are but faintly reproduced. In the blue-light picture the red objects appear but feebly. When the coloured glass screens are interposed in front of the monochrome positives we get three pictures coloured red, green and blue respectively, and a combination of these on the sheet shows the original object in all its varied colours.[1]

[1] The ingenious photochromoscope of Mr. Ives works on precisely similar principles, except that the three coloured pictures are combined in the eye of the observer, instead of on the lantern screen.

The use of the triple lantern, however, is not very convenient, and there are certain drawbacks to its employment, though it suggests a possible means for the production of kinematograph pictures in colour. This is not yet possible, but it is conceivable that photographic films might be made capable of taking instantaneous pictures through the coloured screens, and that mechanism of sufficient accuracy could be constructed to register a series of three such pictures on a screen, so that they might be shown in the way animated photographs are now shown.

For practical purposes it is more convenient if we can have our coloured pictures in the form of an ordinary slide, which can be shown in the ordinary single lantern. Now it is quite obvious that with a single lantern we cannot use three coloured screens, one in front of the other. In the triple lantern we are mixing coloured lights, adding colour to colour. The superposition of one screen upon another in a single lantern merely means that only those rays will pass which can get through both screens, and the three screens together in the lantern would, of course, obstruct all the light, and the result would be nothing but darkness. With the triple lantern we are using a method of addition; with a single lantern we must use a method of subtraction or absorption.

The end can, however, be attained by the use of a film of bichromated gelatin, coated on a celluloid support. The film is printed and washed in the usual manner of carbon printing. The resulting relief in colourless gelatin is then stained the complementary colour to that by which the negative was taken. The need for employing the complementary colour is not difficult to understand. The bright parts of the red-screen positive represent bright red light. The dark parts represent the absence of red light, red shadows. When the film is stained, the transparent parts take little or no stain, the denser and thicker parts take the stain in proportion to their thickness. They should therefore be stained the opposite to red, the complementary to red (it is convenient to think of it as "minus red"), or blue-green. So the green-screen print must be stained "minus green," or pink, and the blue-screen print must be stained "minus blue," or yellow.

If we now take the three films and put the blue film in the lantern, we get a blue picture on the sheet. Putting in front of this the yellow film, our picture becomes partly blue, partly yellow and partly green, and we have some accession of detail. Adding again to this the pink film, we get at once all the different colours of the original object, and the picture is recognised as a practically correct reproduction of the original.

If the three films, instead of being mounted in such a way that they can be shown in the lantern, are stripped from their supports and superposed one above the other on a sheet of white paper, we get a coloured picture suitable for use as a book illustration. This process is quite practical, but it is by no means easy, and, of course, it is useless for the production of large numbers. For commercial purposes no process can be of much service which is not applicable to the printing-press. Now it must be familiar to most people that a printing-block can be produced from any photographic negative. The methods by which this is effected are well known, and they are in constant use, the great bulk of the black and white illustrations in magazines and newspapers being now produced by them. It is, therefore, not difficult to see that if from each of our negatives we make a printing-block and use the three blocks to print—the blue-screen block in yellow ink, the green-screen block in red ink and the red-screen block in blue ink—we are merely varying the process by substituting films of printing-ink for films of stained gelatin. This is, indeed, in barest outline the method by which the very numerous coloured illustrations made by the three-colour process are all produced.

FIRE-WALKING IN FIJI.[1]

IN connection with the Coronation festivities at Suva, there was to have been a fire-walking ceremony, but, owing to the illness of the King, the Government of Fiji decided that nothing could take place ; however, a large party of excursionists from New Zealand managed unofficially to obtain an exhibition of the fire-walking. The following notes have been abstracted mainly from an account by Mr. Walter Burke, in the Christchurch *Weekly Press* (July 16, 1902) and from a condensed report in the *Evening Star* of a paper read before the Otago Institute by Dr. Robert Fulton, which some time next year will be published in the *Transactions*.

FIG. 1.—The Natives walking on the heated stones. (From the Auckland *Weekly News*.)

The ceremony was performed on the island of M'Benga, near Suva, by members of the Nga Ngalita tribe, all of whom are credited with being specially gifted in the way of heat-resistance. In the centre of a space cleared in a coconut grove was a circular pit, about 20 feet in diameter and 2 feet in depth, the earth from the centre being piled round the periphery. Poles were placed radiating from the centre, dry palm fronds were placed on these and firewood stacked above. Finally, large stones were heaped on the top until the whole pile was several feet in height. The fire was lit about forty-eight hours before the ceremony took place, and it was kept fed with fresh supplies of wood. Eventually the whole mass glowed with a white heat ; it was not comfortable to stand within a few feet of it, and also it was dangerous, as large splinters of stone flew far and wide.

As the hour for the exhibition approached, the natives brought green saplings about 20 feet in length, armfuls of green branches, and masses of green vines of great length and considerable thickness. The following is from Mr. Burke's account :—

"The fire is now sinking, and occasionally a large stone drops through. There is little smoke and the stones fairly glow. Now the workers close in. The smaller vines are fastened in loops at the ends of the long saplings. A loop is dropped over the end of a log not yet burnt out, and with loud chants the log is drawn out. This is repeated till no logs are left. The ends of the saplings continually burst into flames as they touch the stones. At last there seems to be nothing left in the pit but stones, some of which are shivered to pieces by the great heat. The large hawser-like vine now comes into use. This is thrown across the pit to one side, and with the saplings the men force it down into the glowing stones. Now dozens of willing hands pull at the ends, and the stones are turned over and over and flattened out. Many stones that were at the bottom are now on top, and *vice versâ*. This is done until the stones present a fairly even surface, but critical men, still unsatisfied, probe amongst the stones with the saplings and turn the smoothed side uppermost. While they are doing this, the green saplings blaze vigorously.

FIG. 2.—On the burning leaves. Immediately after the fire-walking, green leaves were thrown on the hot stones. The fire-walkers then leaped back on to the leaves, which burned and gave off great masses of smoke. In this illustration, the men can be seen dimly through the smoke. (From the Christchurch *Weekly Press*.)

"Now all is ready for the grand finale. The workers step back. One of the men who is to walk comes out for the examination by Drs. Smith and Fulton, of

[1] The interesting illustrations which accompany this article have been reproduced from the Auckland *Weekly News* and the Christchurch *Weekly Press*, in which several other pictures of a similar remarkable character are given. As several months would elapse before permission to use these illustrations could be obtained from New Zealand, we have taken the liberty to reproduce two from the periodicals mentioned. It would be a pity to delay bringing pictures of such scientific interest before readers of NATURE.—[ED.]

Dunedin, who are unable to discover anything out of the ordinary. The chief asks for silence and a hush falls on the scene. The assembled natives break into loud cries, and along a track in the jungle-like growth can be seen a party of ten Fijians fantastically dressed.

"Without hesitation or haste, they step on to the stones and walk round the pit, taking some ten to fifteen seconds to complete the circuit. They step off quickly, and in a moment great masses of green leaves are thrown on to the centre. The fire-walkers rush back and press down the leaves with their feet and hands. The steam rising from the leaves envelops them in a cloud. Baskets of native food are passed in, and more green leaves are heaped over until a mound is made."

Dr. Fulton states that the man Dr. Smith and he examined before the fire-walking was of fine physique, with a pulse a little over 90 and the hands and feet cooler than the rest of the body. The feet were perfectly clean and odourless, and no preparation could be detected on them. The soles were yellowish-white, perfectly smooth and pliable, and like soft kid. The man wore a *sulu* (petticoat) of dry hibiscus bark and canna leaves, with small anklets of dry bracken. Each man as he walked kept his eyes on the stones. One man was examined afterwards; his pulse was about 120; the soles of the feet seemed cool, if not cold, but on running the hand up the leg, a most pronounced difference in temperature was observable; on the calf, it was like that of a man in a high fever. None of his vegetable clothing was scorched, not even the dry bracken anklets, and the short, black, crisp hairs on the legs were not singed. Dr. Fulton went to the edge of the pit immediately after the ceremony and stirred up some of the stones with his foot. He stood for a second on one or two and found that they did not brown his boots, though evidently they were too hot to handle. He asked a native to get him one of the stones, and the man coolly walked up and began to move about the heated stones with his bare feet. This was not one of the "fire-walking" men, but one of those who had come from Suva. He raked out a piece of stone from the heap, but it was too hot to hold in the hand.

The explanation Dr. Fulton offers is as follows. The arrangements for heating were peculiar; if what was required was merely a surface of red-hot stones to walk upon, it would be easier to lay flat stones in the pit and to maintain a huge fire on them. The stones took forty-eight hours to get to their "proper" condition, and the subsequent cooking of the food took two days instead of an hour or so. The stones also were found to cool very slowly. The same stones are never used twice. They are gradually heated until split by the expansion of the contained water, and are then carefully arranged fractured side upwards. The stone that was examined was an augite-andesite of ordinary type. Prof. Park, of the Otago School of Mines, found that, taking the thermal conductivity of copper as equal to 1000, that of andesite is 6·67, that is, it is a very feeble conductor of heat. In testing the radiation, iron being the standard at 100, andesite is 48. Thus the fractured, or inside, surface of the stone, owing to its slow conductivity, does not receive nearly the amount of heat one would expect, and, owing to the slow radiation of heat, the foot is not burnt when coming into contact with the stone for a second or less; as a matter of fact, the sole of the foot was at no time in contact with a hot stone for more than half a second. The foot is naturally cold or artificially cooled; it is a well-known fact that one can bear with cold feet for a long time (up to a minute in some instances) heat from a fire which would be insupportable for five seconds at ordinary foot temperature.

A good deal has been written at various times on walking on heated stones or glowing embers. It will be in the knowledge of our readers that there was published in NATURE of August 22, 1901, an article on Tahitian fire-walking, by Prof. S. P. Langley, in which a somewhat similar explanation was given. It is satisfactory to find that these investigations by scientific men agree, on the whole, with one another in principle, and that a rational explanation is forthcoming for a sensational performance which unskilled white observers usually regard as mysterious or even as miraculous. The walking on glowing embers, which is well known in parts of India, as recently described in the *Bulletin* of the Madras Government Museum (vol. iv. 1901, p. 55), probably has another solution. The fire-walking ceremonies in India, Japan and elsewhere require to be carefully studied by trained observers. A. C. H.

THE PRESENT STATE OF WIRELESS TELEGRAPHY.

IT is now eighteen months since we last attempted in these columns to take a general survey of the development of wireless telegraphy. In the history of a science which has enlisted the services of so many skilled experimentalists, each of whom has made rapid progress along his own lines, eighteen months is a comparatively long period; as a result, we are compelled to-day to regard the subject from a very different point of view. At that time, there were practically only two systems—Mr. Marconi's and Prof. Slaby's—which had advanced to such a degree of perfection that they deserved special consideration. To-day, it would hardly be too much to say that in every civilised nation there are one or more inventors with a carefully worked-out and tested system ready for general use. Particulars of these different systems have been published from time to time and have been duly referred to in NATURE; unfortunately, the information published is not, as a rule, of the kind that one most desires to obtain; too often it is obviously "inspired," and consists for the most part of insufficiently supported claims to successful syntonisation, or to record making in the way of long-distance transmission or rapid signalling, information which is very acceptable to the daily papers, which forget one day what they have published the day before, but of little use to those who are seriously interested in the subject.

So far as can be judged, the various systems differ chiefly in matters of detail, the design of circuits and the special construction and arrangement of apparatus; improvements depending on the introduction of a principle fundamentally new are few and far between. We do not wish to underrate the value of these detailed improvements; they are, as we well know, often the talismans converting failure into success, but their interest is mainly for the specialist It is not our intention, therefore, to enter into a detailed examination of the different systems; to do so would only involve us in a mass of technicalities from which the reader would probably "come out by that same door where in he went." Those who wish for this information must be referred to the technical Press or to the files in the Patent Office, where they will probably find, as, for example, in the two hundred odd claims in Mr. Fessenden's patents, all the particulars they desire. We propose rather to treat the subject on a broader basis, and to endeavour to form an estimate of how far wireless telegraphy in its present state has fulfilled the expectations that have been raised in the past or justifies hopes that may now be entertained for a future of wide utility.

The first question that one feels inclined to ask is, At what end are all these inventors aiming? Is it to devise a system of wireless telegraphy to compete with the ordinary telegraphic methods, or is it for what seems to us the more useful purpose of creating a means of communication where none now exists, especially between ship and ship and ship and shore? It would seem that in some instances, as, for example, that of the Marconi Company, the former purpose is almost as much in view as the latter. In the former case, there can be no question but that absolute syntonisation is necessary; in the latter, it is less important and even in some respects undesirable, but, on the other hand, it is essential that the different systems should work together so that any ship should be able to signal to any station. It would be a great misfortune if this principle is lost sight of in the rivalry between competing methods and if we thereby lose what seems to be in reality the greatest benefit wireless telegraphy can confer, the increase of the safety and convenience of travelling by sea. This is, we think, the most urgent problem that wireless telegraphy presents to-day, and we trust that it will find a really satisfactory solution at the coming Berlin Conference.

The attempts which have been made at syntonisation are, indeed, far from encouraging. It is true that almost every inventor claims that he has solved the problem, but all the experiments that have been quoted are open to criticism. It is important to recognise what a successful solution really means; it is not sufficient to demonstrate, as has been done many times, that two messages can be transmitted or received at the same time by the same installation without interference; that, in short, duplexing is possible: this is a great step, no doubt, but to solve the problem it is necessary that the tuned transmitter shall affect no other receivers than those syntonised with it, and that the tuned receiver shall respond only to the proper waves; this, it will be seen, is a requirement much harder to satisfy. As an example, showing how far existing practice is from satisfying these conditions, we may quote the case of the recent long-distance work done by the Marconi Company. Mr. Marconi, it will be remembered, has several times claimed to have solved the problem of syntonisation, and, confident of having done so, issued a challenge last February to Sir W. Preece or Sir O. Lodge to intercept any of his messages, offering to put a station, in the neighbourhood of his Poldhu station, at their service. This challenge has been answered in a conclusive manner during the past month by Mr. Nevil Maskelyne, who showed that the installation which he was working at Portcurnow had been receiving the messages sent to the *Carlo Alberto* on her recent cruise from England to Italy (see the *Electrician*, vol. l., pp. 22 and 105). It is clear, therefore, that, with no special preparation on either side, it is possible to tap the signals that are being sent by the Marconi Company over long distances, and in face of this the claims to a real solution of the syntonisation problem fall to the ground. We doubt whether any other system would stand the same test.

But if on this side the outlook is somewhat dispiriting, in other directions matters are more encouraging. This year has witnessed the remarkable achievements by the Marconi Company in long-distance work. It has been shown that it is possible to signal across the Atlantic, a distance of more than 2000 miles over water; and in the cruise of the *Carlo Alberto* signals were transmitted a distance of 750 miles over land and water. To cover these great distances, the power used at the transmitting station has to be correspondingly great; in consequence, the signalling was only from Poldhu to the ship and not in the reverse direction. The importance of these experiments, however, lies rather in the conclusive demonstration of the fact that it is only a question of providing sufficient power to signal over any distance, however great, and therefore no fears need be entertained of the utility of the wireless telegraph being limited by considerations of distance. No other experimenter has attained such success in long-distance work as Mr. Marconi, but no other experimenter has used such large power for transmission. Unfortunately, sufficient particulars are not available to enable a comparison to be made between the distances attained with different systems using the same amount of power; this is a point on which the publication of trustworthy data would be of the highest value. An interesting phenomenon brought out by Mr. Marconi's long-distance work is the effect produced by daylight on transmission. It is found that the signals carry much further during the night (*i.e.* night at the transmitting station), the result being due, it is suggested to the discharging effect of sunlight on the aërial wire (see NATURE, vol. lxvi. p. 385).

With reference to long-distance work, the interesting experiments of M. Guarini with an automatic repeater may be quoted. This inventor designed an apparatus which should pick up a message received from one station, A, and pass it on to a second station, B, which was out of the range of the signals transmitted direct from A. The principle of this apparatus will be understood from the accompanying diagram (Fig. 1), in which, for the sake of clearness, only the essential circuits are shown. The aërial wire A at the repeating station is connected through the contact 1 of the relay R_1 and through the primary of a transformer T to earth; it is also connected through the spark gap S to earth. The coherer is connected in series with the secondary of T and a condenser. When a signal is received, the resistance of the coherer is broken down, and the battery B_1 sends a current through it and the relay R_2, thus closing at the contact 3 the

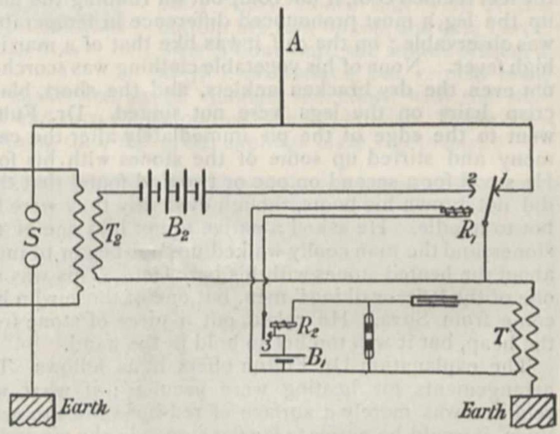

FIG. 1.—Diagram of Circuits in Guarini's Repeater.

circuit of the relay R_1. The contact arm of R_1 swings over to 2, thus disconnecting the aërial from the receiving circuit and closing the primary of the induction coil T_2, thereby causing a spark to pass across the gap, which means that the signal is sent out again from the aërial A. The coherer being tapped back, the various circuits are opened, and the arm of R_1 returns to its original position and so is ready to receive the next signal. Experiments were carried out between Antwerp and Brussels (42 km.), the repeating station being at Malines, about half-way between the two; the results were promising, though the repeater did not prove absolutely trustworthy.

We may now turn from the consideration of the results achieved to the apparatus that has been used. In the transmitting apparatus, attention has been chiefly devoted to devising means of generating oscillations of definite wave-length. None of these call for special comment. In some cases, for obtaining the spark, alternating-current generators have been employed in connection with step-up transformers instead of induction coils. This is the case in the de Forest system, which, it may be remarked, claims the record for speed of forty-eight words per minute; the alternator generates, at 500 volts, 60 cycles, and this is stepped up to 25,000 volts for sparking; the signals are formed by interrupting the primary circuit of the transformer by means of a specially designed key. The difficulty of breaking a large current in this way is considerable, and has obviously proved a stumbling-block to the Marconi Company, as it forms the subject-matter of two or three patents taken out by Prof. Fleming and the Company. Some of the methods described therein are exceedingly ingenious, but, unfortunately, space does not allow us to describe them here, especially as their bearing on wireless telegraphy is only indirect.

With the exception of the magnetic detector devised by Mr. Marconi and tested during the cruise of the *Carlo Alberto*, practically all the different systems make use of the coherer principle for receiving. The actual type of coherer used differs considerably in the several cases. For long-distance work, it has generally been found most suitable to use a coherer which requires no tapping back, but spontaneously returns to its normal condition, this being connected in parallel with a telephone. One of the chief advantages of this arrangement lies in the fact that the energy required to give audible signals in the telephone is much less than that needed to work a relay. There are several different coherers working on this principle—the principle really of the microphone; in the system devised by M. Popoff, carbon granules form the loose contacts, the resistance, which is normally high, being broken down by the received waves and the coherer then restoring itself to its original condition; the change

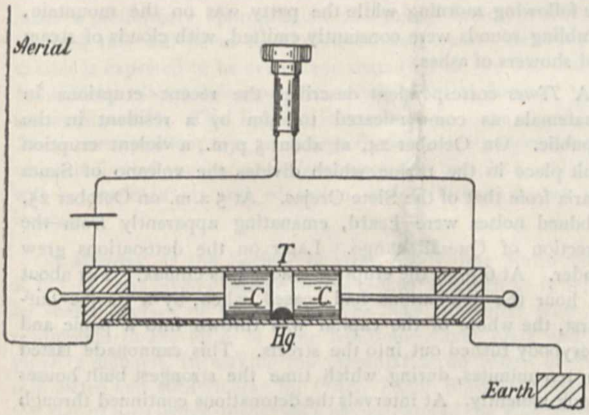

FIG. 2.—Castelli Coherer and Connections.

in the current through the coherer causes a click in the telephone. In the de Forest system, an electrolytic "anticoherer" is used; this has a paste, composed of a viscous material, loose conducting particles and an electrolyte, between suitable electrodes. In the normal condition, the conducting particles bridge the gap and give the receiver a low resistance; electrolysis is set up by the received oscillations and the consequent polarisation greatly increases the resistance. Of the coherers of this type, the greatest interest attaches to the Castelli coherer. This, invented by a semaphorist in the Italian navy, was used by Mr. Marconi in his first Transatlantic experiments. Its construction is shown in Fig. 2. Two iron or carbon electrodes, C C, fit into the tube T and are connected by a single drop of mercury Hg. The connections shown are, of course, the same in the case of the two other coherers just described. When electrical oscillations reach the tube, the mercury coheres to the electrodes, but returns at once to its normal condition when the stimulus ceases. The magnetic detector to which we have made reference above was described by Mr. Marconi in a paper read before the Royal Society last June. Fig. 3 shows the principle of its construction. It consists of a core of thin iron wires, I, over which are wound two coils of fine copper wire, C_1 and C_2. The outer core, C_1, is connected to a telephone receiver and the inner, C_2 to the aërial and earth or to the secondary of a transformer the primary of which is connected to the aërial and earth. The iron core is magnetised by a permanent magnet, M, at one end, which is rotated by clockwork so as to produce a continual slow change in the magnetisation, which, however, owing to the hysteresis, lags behind the magnetising force. When oscillatory currents pass through the inner coil, there is a sudden decrease in the hysteresis, due apparently to the molecules being released from restraint; a corresponding sudden variation in the magnetisation of the iron results, and this induces a current in the outer winding connected to the telephone.

Such, in brief, are the more important advances that have been made in the practice of wireless telegraphy during the past year. In addition, much work has been done on the purely scientific side of the subject, the action of the coherer in particular having been submitted to somewhat rigorous examination, work which has already produced results which may prove bot of great physical and great practical value. It may fairly be said that we know now, with a considerable degree of certainty, some of the more useful services which wireless telegraphy may be relied upon to perform. Already its commercial application is considerable; many ships, in the navies of this and other countries and in the merchant services, are equipped with wireless telegraphic apparatus which has, we believe, fully justified its instal-

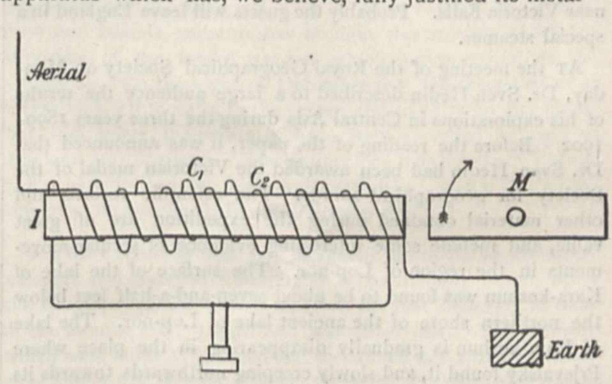

FIG. 3.—Diagram of Marconi's Detector.

lation. It is in this direction that we look with the most confidence for a steady increase in its application, and we would rather hear of a few more ships being thus equipped than of another "S" being transmitted across the Atlantic.

MAURICE SOLOMON.

NOTES.

THE Paris correspondent of the *Times* announces the death of M. Dehérain, professor of vegetable physiology in the Museum of Natural History, and of M. Hautefeuille, mineralogist at the Faculty of Sciences. Both were members of the Paris Academy of Sciences. The death is also announced of M. Alexandre Bertrand, one of the original founders of the fine museum of St. Germain, of which he had been curator since 1862. He was also professor at the École de Louvre of national archæology, and his fame as an archæologist was world-wide.

THE great dam on the Nile at Assuan is to be inaugurated by the Duke and Duchess of Connaught as we go to press with this number. Sir Benjamin Baker, K.C.M.G., has been appointed to be a Knight Commander of the Order of the Bath, in recognition of his services in connection with the construction of the Nile reservoir. Other honours conferred in connection with the work are:—To be G.C.M.G., Sir William Edmund Garstin, K.C.M.G., Under-Secretary of State for Public Works in Egypt. To be K.C.M.G., Major R. H. Brown, R.E., C.M.G., and Mr. W. Willcocks, C.M.G., of the Egyptian Irrigation Department. To be C.M.G., Mr. A. L. Webb, Mr. K. E. Verschoyle, Mr. M. Fitzmaurice and Mr. G. H. Stephens.

THE suggestion that the British Association should meet in South Africa in 1905 was mentioned in these columns some time ago. The following statement with reference to the meeting has now been published in the daily papers:—Reuter's Agency is informed that the suggestion that the British Association should hold its annual meeting for 1895 in South Africa emanated from the new South African Association of Science, of which Sir D. Gill, Astronomer Royal for the Cape, is president. Before the last meeting of the British Association at Belfast, invitations were sent from the municipalities of Cape Town, Kimberley, Bulawayo and other centres in South Africa, and it is understood that these have been accepted, and that the session of 1905 will be held in South Africa. Scientific papers will be read at various centres in the South African Colonies, and visits will be paid to various places of interest. A sum of 7000*l.* has been collected in South Africa for the entertainment of the Association. While in Rhodesia, the men of science will be the guests of the Chartered Company, who will place the railways at their disposal and, among other things, take them by special train to the Zambesi, where they will stay at the new hotel to be erected near Victoria Falls. Probably the guests will leave England in a special steamer.

AT the meeting of the Royal Geographical Society on Monday, Dr. Sven Hedin described to a large audience the results of his explorations in Central Asia during the three years 1899–1902. Before the reading of the paper, it was announced that Dr. Sven Hedin had been awarded the Victorian medal of the Society for geographical survey. The scientific records and other material obtained during the expedition are of great value, and include some interesting evidence of secular movements in the region of Lop-nor. The surface of the lake of Kara-koshun was found to be about seven-and-a-half feet below the northern shore of the ancient lake of Lop-nor. The lake of Kara-koshun is gradually disappearing in the place where Prjevalsky found it, and slowly creeping northwards towards its ancient bed, where Dr. Hedin believes it will be found at no great distance of time. The lake is getting choked with mud and drift-sand and decaying vegetable matter; while, on the other hand, the northern part of the desiccated desert is being eroded and furrowed by the winds, and is thus growing deeper and deeper every year. As the lake moves, so do the vegetation and the various animals of the desert. They, as well as the fisher-folk, with their reed huts, follow after to the new shores, while the old lake gradually dries up. There are reasons for believing that in the far-off future the same phenomena will recur again, but in the reverse order, though the natural laws which will effect the reversal will remain precisely the same. Whenever that occurs it will be possible to determine the length of time required for these periodic changes. Dr. Hedin pointed out, however, that it is already known that in the year 265 A.D. the lake of Lop-nor lay in the northern part of the desert. Lop-nor is, as it were, the oscillating pendulum of the Tarim River, and each oscillation probably extends over a space of a thousand years or more.

THE following men of science have been elected honorary members of the Cambridge Philosophical Society:—Profs. Bayley Balfour, A. H. Becquerel, E. Fischer, Richard Heymons, J. H. van 't Hoff, M. Jordan, H. F. Osborn, W. K. von Röntgen, Corrado Segre and Hugo de Vries.

THE Antarctic relief ship *Morning*, carrying provisions for the *Discovery*, now in Antarctic regions, sailed from Wellington, New Zealand, on December 6.

THE *Times* correspondent at St. Thomas, in a message dated December 6, reports that Mont Pelée has been dangerously active during the past week. There has been a heavy fall of ashes, and vessels were advised not to approach the coast.

AN ascent of the Soufrière while still in a state of activity was made, on October 28, by Mr. J. P. Quinton, of the Botanic Station of Sierra Leone. Mr. Quinton and his party were the first to try the ascent since the eruption of October 15–16. Some of the ridges they had to cross were not more than six inches wide, with a fall of a thousand feet on either hand. The ascent took two and a half hours stiff climbing. Mr. Quinton found that the new crater had unwarrantably been held responsible for the mischief of October 15; only the old crater was doing anything. This was discharging volumes of steam and water, and was throwing stones and ashes to a height of 30ft. or more. But no lava at all seems to have been ejected. The steam comes up through a fissure in the south wall of the crater, hangs along in a depression close in under the south-eastern wall, and, finally gaining the summit, is blown over to the west, making it look as though it were coming from the new pit. The old crater is very much wider than it used to be and more funnel-like. Red-hot stones and ashes are piled up on all sides—in some places over the rims. All through the night and the following morning while the party was on the mountain, rumbling sounds were constantly emitted, with clouds of steam and showers of ashes.

A *Times* correspondent describes the recent eruptions in Guatemala as communicated to him by a resident in the republic. On October 24, at about 5 p.m., a violent eruption took place in the ravine which divides the volcano of Santa Maria from that of the Siete Orejas. At 5 a.m. on October 25, subdued noises were heard, emanating apparently from the direction of Quezaltenango. Later on the detonations grew louder. At 6 p.m. the eruption reached its climax. For about an hour the detonations had ceased, when, by a terrific outburst, the whole of the capital was thrown into a panic and everybody rushed out into the streets. This cannonade lasted for ten minutes, during which time the strongest built houses shook violently. At intervals the detonations continued through the night and in a less degree afterwards. The explosions were heard in the south of Nicaragua, and a telegram was received from San Salvador stating that the inhabitants had rushed into the streets in terror on hearing the noise. Quezaltenango was thirty-six hours in total darkness, during which time a heavy rain of ashes and sand had been falling. The manager of the Sabinas Estate, which lies just above the scene of the eruption, says that at about 5 o'clock on October 24 they were alarmed by a series of earthquakes of a throbbing nature, which appeared to come from below them. Almost simultaneously, a cloud of steam was seen to issue from the ravine already mentioned, about a league away. Soon ashes and sand, accompanied by small stones, commenced falling, and two hours later the odour of sulphur and gases was so great that he could hold out no longer, and he left on foot for Retalhuleu, a distance of some thirty miles. Reports from the other planters confirm the fear that the whole of the Costa Cuca, probably the richest coffee zone in the country, is totally ruined.

AMONG the lectures to be delivered at the Royal Institution before Easter, we notice the following:—Prof. H. S. Hele-Shaw, six lectures (adapted to young people) on locomotion, on the earth; through the water; in the air (experimentally illustrated); Prof. Allan Macfadyen, six lectures on the physiology of digestion; Sir William Abney, three lectures on recent advances in photographic science; Sir Robert Ball, three lectures on great problems in astronomy; Mr. A. J. Evans, three lectures on pre-Phœnician writing in Crete and its bearings on the history of the alphabet; Sir Clements Markham, three lectures on Arctic and Antarctic exploration; Mr. G. R. M. Murray, three lectures on the flora of the open ocean; and six lectures by Lord Rayleigh. The Friday evening meetings will begin on January 16, when a discourse will be delivered by Prof. Dewar on low temperature investigations; succeeding discourses will probably be given by Dr. Tempest Anderson, Prof. W. E. Dalby, Prof. S. Delépine, Principal E. H. Griffiths, Dr. A. Liebmann, Prof. J. G. McKendrick, Prof. Karl Pearson, Prof. E. A. Schäfer, Prof. W. A. Herdman and Lord Rayleigh.

AFTER the formal acceptance, by the British Government, of the invitation to take part in the Universal Exhibition which is to be opened at St. Louis on May 1, 1904, it was decided to prepare and distribute an illustrated descriptive pamphlet for the guidance of intending exhibitors and visitors from the United Kingdom. The booklet sets forth the plan of the Exposition, gives estimates of the men and the historic events to be commemorated, provides a comprehensive review of the various exhibits, and explains the relations which foreign countries, the Government of the United States and the States of the Union bear to it. About twenty-five foreign countries, including Great Britain, France, Germany and Italy, have decided to take part in the Exhibition. France has already made a preliminary appropriation of 650,000 francs, and it is believed this will be at least doubled next year. Germany's exhibit is expected to be even finer than that at the last Paris Exhibition. Japan has made an initial grant of 800,000 yen (about 80,000*l.*). The British Government is to be asked, a *Times* correspondent says, to enlarge the scope of its acceptance, which is limited thus far to the assurance that complete exhibits will be made in art and education, and facilities afforded to industries.

ON Monday, at the Society of Arts, Sir George Birdwood, K.C.I.E., was given evidence of the regard in which he is held by many leaders of thought, for he was presented with a testimonial in the form of some handsome silver plate and a purse of money. In making the presentation on behalf of the committee and subscribers, Sir Owen Tudor Burne alluded to the fact of Sir George Birdwood's having entered the East India Company's service forty-eight years ago. Being afterwards stationed at Bombay, he became one of its leading citizens, founding, among other beneficial works, the Victoria and Albert Museum and the Victoria Gardens, besides greatly enlarging the local branch of the Royal Asiatic Society and throwing open its membership to public-spirited and learned Hindus, Mohammedans and Parsees; he was mainly instrumental in raising the necessary funds for the building and endowment of the Bombay University, and was also the author of various writings on Indian art and botany and Indian local and Imperial questions.

THE bending of two alabaster slabs in the Alhambra palace at Grenada was mentioned by Mr. Spencer Pickering (p. 81) in connection with a letter by Dr. See (p. 56) on the bending of a marble slab under its own weight. Dr. Bleekrode, writing from The Hague with reference to the Alhambra slabs, remarks that they are nearly 3 metres long, and are 23 centimetres wide and 5 centimetres thick. The curvature begins at a distance of about 1 metre above the floor and the radius is nearly 9 metres. The pressure is estimated to be equal to about 1600 kilogrammes. Dr. Bleekrode points out that the Alhambra was built at the end of the thirteenth century and began to deteriorate nearly two hundred years ago. He suggests that possibly if the masonry causing the pressure were removed, the slabs would become flat again, in which case the bending would have to be regarded merely as an effect of elasticity.

DR. T. A. JAGGAR, JUNR., of Harvard University, in a letter to *Science*, directs attention to a peculiar sequence followed by the great eruptions of Mont Pelée this year. Since May 5, eruptions of the first magnitude have occurred at intervals of increasing length, as will be noticed from the following dates of violent disturbances of the volcano;—May 5–May 8 three days; May 8–May 20, twelve days; May 20–June 6, seventeen days; June 6–July 9, thirty-three days; July 9–August 30, fifty-two days. The progressive increase of the interval between the eruptions does not follow any simple arithmetical law, but from a graphic representation of the facts a curve is obtained which suggests that the interval after August 30 has a length of 112 days. If that is the case, a great eruption of Mont Pelée might be expected to occur about December 20.

DURING the past week, this country has experienced abnormally cold weather, and sharp frosts have occurred at night, while the day temperatures have on several occasions only risen slightly above the freezing point. North-easterly and easterly winds have for the most part prevailed, and at times they have blown with considerable strength; snow has fallen in many places, and in the south of England the ground remained covered for some days. The cold spell has been caused by the extension of the European area of high barometric pressure over our Islands, and this has brought this country under the influence of the severe weather which has prevailed on the continent. On the night of December 6–7, the thermometer at Greenwich fell to 24°·5 in the screen and to 18°·7 on the grass, but still lower temperatures have been recorded in parts of England and Scotland. The anticyclone over northern Europe has apparently become fairly well established, and with its continuance the weather is likely to remain cold.

WE have received from Dr. Hergesell, president of the International Aëronautical Committee, a preliminary report upon the scientific balloon ascents made on the first Thursday in each of the months July, August and September last. The ascents, which were made by manned and unmanned balloons and kites, were joined in by Austria, France, Germany, Hungary and Russia on the continent, by England (Mr. Alexander), Scotland (Mr. Dines), and Blue Hill Observatory, in the United States. Readings at altitudes near or exceeding 10,000 metres were obtained in the following cases:—Berlin (July), −52°·5 C. at 15,690m., ground temperature 9°·4. Strassburg (August), −41°·7 at 10,160 m., temperature at starting 18°·4, and about half an hour later (5h. a.m.), −53°·1 at 11,900m., ground 16°·2. Berlin, −68° at 18,500m., ground 13°·5. Bath, −47°·2 at 9305m., temperature at starting (8h. a.m.) 15°·6; the greatest height reached was 11,350m. Strassburg (September), −54°·7 at 12,200m., ground 17°·7. Pavlovsk, −49°·7 at 11,100m., temperature at starting 13°. The ascents were made under the following barometric conditions:—In July, high pressure existed over the western part of Europe; in August and September, areas of low barometric pressure were prevalent.

WE have received from Dr. Robert Bell, acting director of the Geological Survey of Canada, the western sheet of the geological map of the Dominion, on a scale of fifty miles to an inch. It is very clearly printed in colours, and will be of much service as an index map to the structure of the country.

IN an article on the composite gneisses in Boylagh, West Donegal (*Proceedings* Royal Irish Academy, vol. xxiv., 1902), Prof. G. A. J. Cole argues that we have the intermingling and incorporation of two dissimilar masses of stratified and igneous material, and that the gneisses have resulted from the complex metamorphism to which the masses have been subjected.

MR. R. T. HILL (*Journal* of the Franklin Institute, August–October) gives a graphic account of the Beaumont oil-field, a district within the area of the coast prairie of the Texas, Louisiana and Mexican region. The oil was discovered in 1901 by a drill-hole through 1100 feet of clay and quicksand. A year later there were 136 wells, now there are 214, and more are being drilled. During the first year, 5½ million gallons of oil were obtained, and five or six times this amount is estimated as the product for 1902. The prairie land extends for nearly 400 miles along the Gulf of Mexico and from ten to fifty miles inland. The strata at a depth probably comprise bituminous Eocene clays, and they are overlaid by later Tertiary and Pleistocene sands and clays, nearly 3000 feet in thickness, which contain the oil; and these, again, are covered by prairie deposits of sea-mud and sand. A drill-hole has been carried to a depth of 3050 feet without touching the Eocene. In some localities, hot water has been struck below the oil, and the oil itself is sometimes hot. Gas has been encountered in some of the bore-holes. It is remarked that the water becomes not only hotter but more saline with increasing depth, thereby raising its capacity for the collection and flotation of oil, which is preserved in the porous strata overlying the Eocene clays and is sealed up by the superincumbent muddy sediments.

PROF. O. COMES, of Portici, Naples, has prepared a series of chronological charts which furnish data concerning the introduction, cultivation and general spread of tobacco for all important countries throughout the world.

WITH the present contribution (No. 13), Sir George King has brought the "Material for a Flora of the Malayan Peninsula" to the end of the Calycifloræ. The genus Begonia furnishes 19 species, of which 14 are new to science; most of these were collected in Perak, several at altitudes varying from 3000 to 7000 feet. Two new species of Mastixia are also described. As in the case of the Thalamifloræ and Disciflorae, a complete list of Calycifloral species has been published separately.

THE possibilities of pitcher plants as a trap for catching the American cockroach, *Blatta americana*, are pointed out in the October *Bulletin* of the Trinidad Botanical Department. Planted amongst orchids, they may materially help the cultivator to keep this pest in check, and are more especially suitable since they require similar conditions of heat and moisture. A note on the "Nitrogen Content of Flowers" emphasises the manurial value of those of the Immortelle, and Nicaragua shade plants which are sown amongst cacao plants. A new fruit obtained from the Bocas Islands and provisionally determined by the Kew authorities as *Anamomis esculenta*, judging from its flavour and aroma, seems likely to furnish good table fruit.

THERE is a strong physiological tendency displayed in the *Bulletin* of the College of Agriculture connected with Tokyo University. Several papers by Mr. K. Aso deal with the action of certain poisonous substances when supplied as food to seedlings. Salts of manganese, even in weak solutions, have an injurious effect, but if the solution is diluted to contain about 0·002 per cent. of the salt, then the result is stimulating. Similar stimulating effects were obtained with very dilute solutions of other poisonous salts. The same author contributes a suggestive paper on the oxidising enzymes in plants. Mr. M. Toyonaga, on the animal side, obtains results which are in keeping with Prof. O. Loew's hypothesis that the amount of calcium varies with the size of the nucleus.

WE have received a copy of vol. v. No. 1 of the *Bulletin* of the College of Agriculture at Tokio, which, among other contents, includes a memoir on the embryology of silkworms, by Mr. K. Toyama.

IN the November issue of the *American Naturalist*, Prof. B. Dean continues the discussion of the origin of vertebrate limbs—this time from the point of view of the flotation and balancing of the body in the sharks. It is concluded that the pectoral, and not the pelvic, fins have shifted their position with the advance of development, in accordance with the exigencies of the physiological factors referred to, and it is urged that this affords strong evidence in favour of the lateral fold theory.

WE have to chronicle the appearance of a new biological serial, *Broteria*, issued by the College of St. Fiel, Lisbon, and named in honour of the celebrated Lusitanian botanist, Dr. F. d'Avellar Brotero, who died in 1887. Although the new journal will embrace biological subjects of any kind, its special object is the fauna and flora of the district immediately surrounding the College of St. Fiel. In addition to a number of papers not specially connected with the area in question, the present issue contains one on the Lepidoptera of St. Fiel.

THE Manchester Museum has issued a second edition, revised and enlarged by Dr. Hickson, of Prof. Milnes Marshall's admirable descriptive catalogue of the series of embryological models in the collection. Since the appearance of the first edition, the development of the torpedo has been added to the series. Number 9 of *Notes* from the Manchester Museum is devoted to observations on the nomenclature and identification of the British cephalopods, by Mr. W. E. Hoyle, reprinted from the *Journal of Conchology*. The author shows that the substitution of the name Polypus for the familiar Octopus, although much to be regretted, is inevitable, unless priority in nomenclature is to be altogether discarded.

"THE Solution of the Eel Question" is the title of a highly interesting paper, by Dr. C. H. Eigenmann, published in vol. xxiii. of the *Transactions* of the American Microscopical Society. After a summary of the investigations and discoveries of Grassi and Colandruccio in Italy in regard to the developmental history of the European eel, the author records the discovery of the larva ("Leptocephalus") of the American eel—a species which differs from its Old-World relative, both in the adult and immature condition, by the smaller number of vertebræ. In August, 1900, Dr. Eigenmann had the opportunity of examining some eels' eggs from the surface of the Gulf Stream—the first taken elsewhere than in Italy—which there is every reason for regarding as those of the conger-eel. To the larval form of the American eel, the author—somewhat unnecessarily, in our opinion—applies the name *Leptocephalus grassii*. In discussing the question whether eels ever breed in fresh water, the author states that while there is nothing inherently impossible in this, yet no decisive evidence of its occurrence has been hitherto recorded. No eels' eggs have at present been taken in fresh water, and the statement that eels found in land-locked basins must of necessity breed there is by no means conclusive.

WE have received a copy of *The Scientific Roll and Magazine of Systematised Notes* (Bacteria, vol. i. No. 6), conducted by Mr. Alexander Ramsay. It contains a few notes on various bacteriological subjects culled from various authors, and an essay on specific descriptions.

IN its issue for November 29, the *Lancet* publishes as a supplement an exhaustive account of the manufacture and nature of Cognac brandy. A number of analyses are given showing how brandy differs from other spirits and indicating how the genuine may be distinguished from the spurious. The former is the product of distillation and maturation of a grape wine, the latter is derived from potato or grain spirit. The subject is of considerable importance from a medicinal point of view.

THE Public Health Department of the City of London directs attention (Report of the Medical Officer of Health, No. 52) to the filthy and dangerous habit of indiscriminate spitting, the chief source, probably, of tuberculous infection. Many cities in the United States, Canada, Australia and in Europe have made the habit a penal offence, and the Corporations of Liverpool, Manchester and Glasgow and the County Council of Glamorgan have bye-laws prohibiting it in public places. The Medical Officer for the City suggests that similar powers should be obtained by the Corporation of London for dealing with it.

NEW editions have been published of "Palæontology, Invertebrate," by Mr. Henry Woods (Cambridge University Press) and "Maps, their Uses and Construction," by Mr. G. James Morrison (Edward Stanford). The former is the third edition and Mr. Morrison's book is a second edition, which has been revised and enlarged.

THE twenty-fourth annual volume of the *Proceedings* of the United States National Museum, published under the direction of the Smithsonian Institution, contains, like all its predecessors, an abundance of valuable information on anthropological, biological and geological subjects. It is impossible in this place to refer to each of the separate contributions. Messrs. Jordan and Snyder review many classes of the fishes of Japan, separate papers being given to the discobolous, gobioid, gymnodont, hypostomide, lophobranchiate, labroid, salmonoid and trachinoid fishes. Messrs. Wirt Robinson and M. W. Lyon provide an annotated list of mammals collected in the vicinity of La Guaira, Venezuela, while Dr. Leonhard Stejneger deals with the batrachians and reptiles of the same locality. In another paper, the last named author describes a new bullfrog from Florida and the Gulf Coast. Mr. D. White gives an account of two new species of algæ of the genus Buthotrephis, from the Upper Silurian of Indiana. The fossil fresh-water shells of the Colorado desert form the subject of a paper by Dr. R. Stearns. The humming-birds of Ecuador and Colombia are catalogued by Mr. H. C. Oberholser. Illustrations and descriptions of new, unfigured or imperfectly known shells, chiefly American, in the U.S. National Museum are given by Mr. W. H. Dall. The larks of the genus Otocoris are described in detail by Mr. H. C. Oberholser. Many of the papers are accompanied by numerous admirable illustrations, those connected with Mr. Oberholser's paper being especially good.

THE additions to the Zoological Society's Gardens during the past week include a Patas Monkey (*Cercopithecus patas*) from West Africa, presented by Mr. E. Chaplin; a Virginian Eagle Owl (*Bubo virginianus*), a Mexican Eared Owl (*Asio mexicanus*) from Argentina, presented by Miss Irene Thornton; a Graceful Ground Dove (*Geopelia cuneata*) from Australia, presented by Miss Cooper; a Glass Snake (*Ophiosaurus apus*) European, presented by Mr. C. H. Rawlins; a Derbian Wallaby (*Macropus derbianus*) from Australia, deposited; four Black-necked Swans (*Cygnus nigricollis*) from Antarctic America, received in exchange.

OUR ASTRONOMICAL COLUMN.

NEW COMET 1902 *d* (GIACOBINI).—A telegram from Kiel, dated December 3, announces that the fourth new comet of this year was discovered by M. Giacobini at Nice on December 2d. 12h. Its position at 10h. 0m. (Nice M.T.) was R.A. = 7h. 17m. ·6, Dec. = 1° 58′ S., and it is moving in a northwesterly direction. A second telegram, dated December 4, says that the comet was observed by Herr Graff at Hamburg on December 3d. 11h. ·5, and its position for 15h. 0m. (Hamburg M.T.) was R.A. = 7h. 17m. ·4, Dec. = 1° 51′ S. The daily movement in declination is +3′, and the projected path of the comet passes near to the border line between the constellations Gemini and Orion.

THE VARIABILITY OF α ORIONIS.—From an examination of his observations of the comparative magnitudes of Betelgeux and β Orionis which he has made during this year, Herr J. Plassman has confirmed the recent variation of magnitude in the former star, and he considers that the peculiarities of the variations merit further and continuous attention on the part of variable-star observers (*Astronomische Nachrichten*, No. 3830).

ACTIVITY OF THE LUNAR CRATER LINNÉ.—In *Circular* No. 67 of the Harvard College Observatory, Prof. E. C. Pickering gives the micrometric measures of the bright spot surrounding Linné which were made at Harvard by Prof. W. H. Pickering, using the 15-inch equatorial, before and after the passage of the earth's shadow in the eclipse of October 16.

These measures show that the bright spot has materially increased in size since similar measures were made in 1898 and 1899, and, further, that the change in size during the passage of the umbra was surprisingly great, so great that Prof. W. H. Pickering found it necessary to reassure himself that the object he was measuring was indeed Linné. This increase of size amounted to 2″·75, instead of 0″·14 obtained by the same observer during the eclipse of 1899 (*Popular Astronomy*, vol. viii. p. 58).

Prof. E. C. Pickering attributes the change in the normal size to increased activity on the part of the crater, and the large increase of diameter during the eclipse to the fact that, owing to this increased activity, there was on this occasion more moisture around the crater to condense.

The increase in normal size was confirmed by measures made on October 20, when the spot had begun to shrink owing to the increased amount of evaporation in the fierce sunlight, for the value obtained then (4″·61) was sensibly larger than that obtained (3″·41) during a similar phase in 1898.

REDETERMINATIONS OF THE VELOCITY OF LIGHT AND THE SOLAR PARALLAX.—A communication from M. Perrotin to No. 21 of the *Comptes rendus* describes the experiments which have been made recently, at the Observatory of Nice, to redetermine with greater accuracy the velocity of light, using the toothed-wheel method of Fizeau under improved conditions.

In previous experiments, the beam of light was made to travel a distance of 12km. (7·452 miles) and back, but in the recent experiments it was reflected from a mirror placed at a distance of 46km. (28·566 miles) from the source, an objective of 0·76m. diameter being used at the plane of emission and one of 0·38m. diameter as the collimator.

As a result of 1109 observations, the final value obtained for the velocity was 299,880km. (about 186,225·5 miles) per second, and the probable error is less than 50km. per second.

In addition, M. Perrotin also gives the final value obtained for the solar parallax, from observations of the planet Eros, made at Nice, as 8″·805 ± 0″·011, and from this deduces a value of 20″·465 for the "constant of aberration," thus confirming the value adopted by the International Astronomical Conference of 1896.

THE "ANNUAIRE ASTRONOMIQUE."—This year-book of astronomy for 1903, compiled by M. Camille Flammarion and published at the low price of 1·50 francs, is one of the most complete and useful books of its kind. It gives practically all the data required by the amateur astronomer or meteorologist, amongst which may be mentioned the solar, lunar and planetary elements for the year, the various phenomena such as eclipses, occultations, meteors, comets, &c., tables of the positions, distances and proper motions of the brighter stars, particulars of double stars, many useful meteorological tables, and a valuable *résumé* of the more important astronomical and meteorological events of 1902, the whole being freely illustrated by interesting photographs and curves.

METEOROLOGY AT GREAT ALTITUDES.[1]

AN International Aëronautical Congress was held at Berlin, May 20 to 24, 1902, on the occasion of the third meeting of the International Committee for Scientific Aëronautics, appointed by the Paris Meteorological Conference of 1896. Of this committee there were present the president, Prof. Hergesell, of Strasburg, Prof. Assmann and Mr. Berson, of Berlin, General

[1] Abridged from a Report contributed by Mr. A. Lawrence Rotch to the U.S. *Monthly Weather Review* for July.

Rykatchef and Colonel Kowanko, of St. Petersburg, Prof. Cailletet and M. Teisserenc de Bort, of Paris, and the writer, who is the American member. There were also present at the Congress, by special invitation, about one hundred military and civil aëronauts and representatives of meteorological institutions, the writer representing the United States Weather Bureau by request of its chief.

The opening of the Congress in the great hall of the Reichstag building was a brilliant event. Prince Frederick Henry of Prussia appeared for the Emperor of Germany. Both the Imperial and the Prussian Governments were represented, and the chief European nations, except France, sent the commanders or officers of their military balloon corps. After the usual formal greetings, the representative of the Prussian Minister of Instruction spoke as follows:—

"The Royal Government is much impressed with the importance and necessity of an exchange of ideas between the savants of all nations in matters concerning meteorology and terrestrial magnetism, since international cooperation in these branches of science is the indispensable forerunner of progress. This was indeed recognised as early as 1780, by the founding on German soil of the 'Societas meteorologica Palatina,' which undertook the task of beginning systematic weather observations in Europe, with the hope of extending them to other parts of the world. On account of the existing state of affairs, its efforts were of short duration and for a long time savants were allowed to labour independently, but with the foundation of magnetic investigations by Gauss and Weber, the sagacious idea of organisation acquired new life and pressed for realisation, especially through the development of navigation, which has the greatest interest in the accurate observation of weather phenomena on the ocean. The Antarctic discoveries of James Ross, and the successful efforts of American navigators to shorten ocean voyages, gave a new impulse, and so there arose the proposition of organising a meteorological service at the first congress of the maritime nations held at Brussels in 1854, although it was not until 1873, during the Vienna Exposition, that the first meteorological congress convened there laid the foundation of an international weather service. The international committee, appointed at that time, met at first annually, but later at intervals of two or three years. With its increasing activity, the necessity of dividing the work manifested itself, and thus special commissions were formed, of which one meets here to-day and whose third gathering will probably be as fruitful as its preceding meetings. In a field where there is only interest in research, may the bonds uniting the representatives of cultured nations ever become closer!"

In the name of the Prussian Meteorological Institute, its director, Dr. von Bezold, remarked that early investigators perceived the importance of aëronautics for meteorological researches. "When Charles, the inventor of the hydrogen balloon, made his first ascension in 1783, he took with him a barometer and a thermometer, as did the American aëronaut (Jeffries), who ascended from London during the next year. It was not until very lately that Germany took part in this work, or about the year 1880, but then, with an instrument markedly superior, namely, Assmann's aspiration-psychrometer, and through the munificence of the German Emperor, she was enabled to carry out the work on a large scale. For the second time, the representatives of scientific aëronautics now meet on German soil and thereby recognise the importance of our efforts. But much indeed has been done for this new research by M. Teisserenc de Bort at Trappes, near Paris, through the perfection of the *ballon-sonde*, the unmanned balloon carrying self-recording instruments, and by Mr. Rotch, of Blue Hill, through his application of kites. Both methods are so good that by their use a great impetus has been given to meteorological research, whereby it is easily understood that there should be uniform rules for their employment. Looking backward, it may be said that the international meetings for the organisation of meteorological research, in 1854 at Brussels, in 1873 at Vienna and in 1879 at Rome, are landmarks in the progress of the science, and that when, in September, 1896, the International Committee for Scientific Aëronautics was appointed, the plan had been so well considered and the technical necessity was so evident that there was entire unanimity in the deliberations and resolutions. The originator of the idea of the unmanned balloon was the late Gaston Tissandier, who enthusiastically explained the scheme to the speaker in 1886, although nearly ten years elapsed before its realisation. This work will be fruitful, for wind and clouds have no political boundaries and the sun belongs to us all. Consequently, we are all striving, for various reasons, toward the same goal, and the motto *viribus unitis* will be, as ever, the decisive measure of the result."

Prof. Cailletet, of Paris, responded for the foreigners present, and then Prof. Hergesell, after thanking the preceding speakers, said, in the course of his remarks:—

"Everywhere—in Paris, Strasburg, Munich, St. Petersburg and Berlin—aëronautical experiments for the scientific exploration of the atmosphere had taken place, and since a general wish was expressed to unite the separate efforts in a common cause, a favourable time to do this seemed to be in the autumn of 1896 at the conference in Paris of the directors of the meteorological institutes. France, the cradle of aëronautics, was the chosen ground, because there, independently of the German and Russian experiments, a most promising method of investigation had been developed that had already produced good results; for the French experimenters, Colonel Charles Renard and Messrs. Hermite and Besançon, all members of our Commission, had simultaneously put into execution the plan of exploring the highest strata of the atmosphere with free balloons carrying only self-recording instruments. Not the least service of our Commission has been to render the method of unmanned balloons comparable with the exact measurements in manned balloons as they are made in Berlin. During our first meeting, in April, 1898, at Strasburg, the difficult problem of obtaining a uniform instrumental equipment was solved in a general way. Since then, our manned balloons, here and abroad, carry the aspiration-psychrometer, which Dr. Assmann, in cooperation with the late Captain von Sigsfeld, has devised, and the unmanned balloons are provided with the normal registration apparatus which the indefatigable Teisserenc de Bort has constructed so skilfully. The registration balloon from that time has been the most powerful tool in dynamical meteorology and has furnished astounding data for the cold atmospheric strata up to a height of 20 kilometres, which are confirmed to a height exceeding 10 kilometres by the ascensions of the brave Berlin aëronauts, Berson and Süring, who have ascended so far in these regions. Since November, 1900, on the first Thursday of every month, simultaneous ascensions have occurred in Paris, Strasburg, Munich, Berlin, Vienna, St. Petersburg and Moscow, and on May 5, 1902, the 213th registration balloon of the International Commission was sent up. The observations have proved that the temperature does not steadily decrease upward, but that strata exist which often possess great differences of temperature. This stratification is one of the most important objects of the present investigation. And the future? Systematic meteorological research is at present carried on over only a small portion of the globe. Even in Europe, in the north there is lacking Scandinavia, and in the south Italy and Spain; but the presence of representatives of these countries at our meeting gives the hope of speedy cooperation. A plan for a meteorological cruise of a steamer to fly kites will also be discussed, for the meteorological exploration of the Tropics must be extended, and the participation of England in our endeavours gives us hope that India may be claimed as a region for investigation. *Per aspera ad astra*—that may be setting our goal too high, but, *per aspera ad altas et ignotas regiones*, up to the regions which hide the great secret where the weather comes from—that we certainly should fix as our goal."

At the second meeting, General Rykatchef, director of the Central Physical Observatory at St. Petersburg, spoke on the preliminary results attained with kites, *ballons-sondes* and manned balloons during the past five years in Russia. Scientific aëronautics in Russia date only from 1899, with the exception of some years of preparatory work. Still, there have been a large number of ascensions; 13 of the 60 kite-flights were above 3000 metres, while the *ballons-sondes* reached 14,200 metres. The inclement climate of Russia occasions many unusual difficulties, for instance, the kite wire on the reel becomes thickly coated with frost, rendering the unwinding difficult, or both wire and kites in the air are so thickly incrusted with frost work (five millimetres or more) that the kites often fall to the ground. Kites were used chiefly at the stations in Pavlovsk and St. Petersburg, and thereby special details were obtained in the lower strata of the diurnal and annual influence on the vertical decrease of temperature up to 3000 metres. It was found that in summer and during the daytime the decrease of temperature with increasing height proceeds more rapidly, and, on the contrary, that in winter and during the night hours there are large inversions of temperature. In anticyclones, large inversions occur in the lower strata and a rapid decrease of temperature in the higher strata. General Rykatchef exhibited an anemometer, constructed by his assistant, Mr. Kusnetzof, for the registration of wind pressure during kite flights. The instrument has bridled Robinson cups which act like a dynamometer and record the gusts of wind on a revolving drum. In closing, the speaker announced that the Czar had given a considerable sum of money for the continuation of this investigation of the different strata of the atmosphere in Russia by means of balloons and kites.

M. Teisserenc de Bort, of Paris, presented the results of his observations of the decrease of temperature in the high atmosphere, as obtained from the ascensions of 258 *ballons-sondes*, which had reached or exceeded 11,000 metres, the total number of ascensions being 540, all of which were made at night to avoid the effect of insolation. The concordant and remarkable result is that, in the layer between 8000 and 9000 metres, the decrease of temperature becomes slower, ceasing entirely at 11,000 metres, while above that height a warming may set in, with fluctuations of 1° to 3° centigrade, making the temperature here on the average nearly constant. In the summer, this isothermal layer apears to lie somewhat higher, or between 13,000 and 14,000 metres. It is lower during the prevalence of a depression, but 4000 metres higher during a high pressure. so that the zone exceeds the height of the cirrus clouds. The lowest temperatures, occurring in a high pressure, were −67° and −72°, but in March the exceptionally low temperature of −75° centigrade was observed. Whether the absolute minimum of temperature has been reached here requires further proof, and as to the cause of this striking phenomenon there are only conjectures. Have we at these great heights aërial conditions working on a grand scale, where the cyclonic whirls of the lower atmosphere do not penetrate and the currents flow uninterruptedly?

Prof. Assmann said that the observations of the Berlin Aëronautical Observatory, although obtained by a somewhat different method, led to the same conclusion as that which had been reached at Trappes. Above 10,000 metres, the temperature oscillates and does not appear to decrease, although beyond the variable stratum, at 17,000 metres, and recently as high as 19,500 metres, the temperature was again found to decrease, so that the possibility of an absolute minimum of temperature is by no means excluded. The Berlin observations were executed with specially constructed balloons of Para rubber, which entirely avoided in the daytime the influence of solar radiation on the instrument, which was enclosed in double polished tubes.

Prof. Palazzo, Director of the Central Meteorological Office at Rome, announced that Italy would now participate in the international scientific exploration of the atmosphere. Through the aid of the Minister of Agriculture, three stations for kites are proposed; one on Mount Cimone (2165 metres), another on Etna (2942 metres) and a third outside of Rome, near the Fort of Monte Mario. The Minister of War has ordered that the ascensions by officers of the balloon corps shall take place on the days of the international ascents. Information was given about the observatory for the study of the physics of the atmosphere, now in construction on Monte Rosa at a height of 4560 metres, which is expected to be completed next summer. In connection with this communication, there was a discussion concerning the interest of scientific aëronautics in physiological investigations, which will form an important part of the work of the high-work observatory mentioned.

Prof. Assmann, Director of the Aëronautical Observatory of the Prussian Meteorological Institute, described his registration balloon of caoutchouc or Para rubber, which was one of the novelties of the meeting. The ordinary *ballon-sonde*, made of silk or paper and open at the bottom, has the great disadvantage that, when it approaches equilibrium in the upper strata of the atmosphere, its velocity of ascent decreases and the effect of insolation on the thermograph becomes greater, without it being possible to determine afterwards the place where the solar disturbance began during the ascent or where it disappeared during the descent; in fact, it is only in certain cases that we can distinguish between the insolation influence and the curious thermal anomalies that have been described by Teisserenc de Bort and Hergesell. The use of a closed balloon made of elastic material has this advantage, that in proportion as the enclosed gas expands, the ascensional force is increased, so that the balloon rises faster with augmenting height until it bursts, and then falls to the ground with diminishing velocity, because checked by a parachute. The meteorograph of Prof. Assmann has no clock movement, the time being unimportant; but a disc is turned by the metallic thermometer while the barometer draws a pen horizontally across the disc, and so the spiral curve indicates heights and corresponding temperatures. The apparatus exhibited weighed but 380 grams, and with the protecting basket 500 grams. Since ink would freeze at great elevations, the trace is made by a pen containing a solution of saltpetre, which writes on the disc coated with lamp-black, treated with a solution of "tonsol." The chemical reaction gives a red trace that cannot be obliterated by handling or by immersion in water. The time required for an ascent to 15,000 metres is about one hour and for the descent two hours, so that the balloons do not travel very far and are usually recovered within three days. The diameter of the envelope at the start is 1 or 2 metres only, and it does not require to be completely filled with hydrogen to exert the necessary initial lift of 2 or 3 kilograms.

Dr. Valentin, of Vienna, spoke on the sluggishness of thermographs in registration balloons. Prof. Hergesell believed that it was better to employ the most sensitive and accurate thermometers rather than to try to determine the corrections for sluggishness. He exhibited such an instrument, as did M. Teisserenc de Bort. The French instrument has the Bourdon tube insulated by a block of hard rubber, which prevents the injurious conduction of heat. Comparisons between an instrument insulated in this way and one not insulated gave differences which increased with the height of the balloon and at 12,000 to 14,000 metres reached 6°, an amount that justified the insulation.

At the third meeting, the subject of kites and kite stations was opened with a paper by the writer on the exploration of the atmosphere over the ocean. The use of the kite on land is limited to favourable circumstances, since the wind must have a velocity of at least 5 or 6 metres per second to raise the kites and cannot exceed a certain maximum strength without endangering the wire by an excessive pull. At sea, however, the motion of a steamer at a velocity of 10 or 12 knots will almost always produce a suitable kite wind, if it does not already exist. In order to demonstrate this, in August, 1901, the writer crossed the North Atlantic on a steamer and found five out of eight days suitable for flying kites. Only on one day was the relative wind too light and on two days too strong, but the wind would always have been favourable had it been possible to alter the course of the vessel. These successful results led the writer to propose a meteorological kite expedition to the trade wind and equatorial regions of the Atlantic Ocean, where almost nothing is known of the upper currents. To defray part of the expense, application has been made to the Carnegie Institution for a grant of 10,000 dollars, but it was considered that the recommendation of the present Congress might aid in securing favourable action. Applause showed the approval of the meeting, which was voiced by Drs. von Bezold and Hergesell. The former, especially, pointed out the importance and the pressing need of meteorological observations over the ocean, where, in consequence of other methods of warming and cooling the air, very different conditions must exist than prevail over the land, and our ignorance of them is no longer to be tolerated. Prof. Köppen, of Hamburg, expressed himself in a similar manner, and made the interesting announcement that, according to the programme of the Scandinavian Hydrographic Congress to explore the Baltic and North seas in the interest of the fisheries, four cruises a year were proposed on which meteorologists would be given an opportunity to study the atmosphere above these seas. Prof. Wagner, of the University of Göttingen, said that the Göttingen Society of Sciences had, at the request of the Aëronautical Committee, furnished the geophysical expedition which was sent to Samoa about a year ago under the leadership of Dr. Tetens with kites and instruments, in order to obtain meteorological observations above that island and on the return voyage over the Pacific Ocean. Dr. Hergesell mentioned that on the Lake of Constance meteorological kite flights were to be undertaken, Count von Zeppelin furnishing the vessel and the meteorological service of Alsace-Lorraine the apparatus. General Rykatchef promised, on the part of the Russian Government, that similar observations would be executed over the northern portion of the Baltic as well as over the Black Sea. On the motion of Dr. Hergesell, the plan of Mr. Rotch for a meteorological kite-expedition in the South Atlantic was fully approved, and the hope was expressed that, with the aid of Government funds, the project might be realised in the near future. Mr. Berson remarked that it was of the greatest importance that the British as well as the Dutch Governments should encourage meteorological observations in the monsoon region, and Major Trollope, speaking for Great Britain, said that he would endeavour to have this done.

M. Teisserenc de Bort showed a diagram of the results obtained from continuous soundings of the atmosphere, or those made as frequently as possible at his observatory at Trappes, viz., on thirty-six days in January and February, 1901, when kites and registration balloons (*ballons-sondes*) were sent almost daily into the higher atmosphere to an extreme height of 12,000 metres. The plotted results throw doubt on the assumption that the barometric depressions bring higher temperatures and the barometric maxima lower temperatures, and give an interesting demonstration of the diversity and complexity of the atmospheric phenomena of which it is the aim of international aëronautics to ascertain the laws.

The fourth meeting was principally occupied with the subject of high ascents, and an apparatus for breathing oxygen at great altitudes was shown by Prof. Cailletet.

Dr. Süring spoke on the ascension which he had made with Mr. Berson on July 31, 1901, to the height of 10,800 metres, the greatest height yet reached by man. He insisted upon the importance of such high ascents to control the observations otherwise obtained and to make those that require direct vision. Especially are the strata from 5000 to 10,000 metres not yet adequately explored, and for weather changes they are of great importance, as is indicated by the scarcity of clouds near 4000 metres and above 6000 metres.

Lieutenant von Lucanus, in the name of the German Ornithological Society, asked aëronauts to observe the various heights at which birds are found. It is now supposed that the height above the ground at which birds fly does not generally exceed 400 metres, and only occasionally reaches 2000 metres, the zone usually remaining below the lower clouds. Still, much uncertainty prevails concerning the tracks of birds, and especially the heights of flights, and information is greatly desired.

The fifth session was mostly devoted to a discussion of observations of atmospheric electricity and terrestrial magnetism in balloons. Prof. Hergesell explained that electrical measurements are of such vital interest that the academies of Berlin, Munich, Göttingen, Leipzig and Vienna were to have been represented at this meeting by Profs. von Bezold, Ebert, Wagner, Wiener and Exner. The latter, who is the Nestor of this branch of physics, was prevented from attending, but Prof. Elster, of Wolfenbüttel, was present among the experts. Prof. Ebert, of Munich, said that constituents containing electrical charges had been found recently in the air through their physical properties. These carriers of electricity are called "ions," or, more correctly, "electrons." At the earth's surface, their presence may be shown by the dissipation apparatus of Elster and Geitel, and the smallest quantity of electricity may be recorded by means of an electrometer. The speaker had adapted this apparatus for use in balloons, and, by employing an aspirator, a fixed quantity of air could be drawn over the dissipating body and absolute measurements made of the amount of free electricity contained in a cubic metre of air. It is of importance in geophysics to know how the capacity of the air for positive and negative electrons varies with altitude, and therefore the speaker had made such determinations, finding near the earth many more positive than negative electrons, but whether this is a result of the negatively charged earth is uncertain. In the high strata, the inequality tends to disappear, but considerations that throw doubt on the balloon observations relate partly to the electrical discharges produced by the ultra-violet light rays and partly to the indeterminate moment of aspiration in a rising or falling balloon. Prof. Ebert considered the cooperation of aëronauts valuable, and cited as a result of the investigation in the Alps that in the foehn wind an excess of positive electrons is found, and this disturbance of the electrical equilibrium perhaps may cause the foehn sickness. Prof. Elster described two experiments that proved the existence of the electrons, one being the radiation of Becquerel rays after two hours from an insolated and stretched copper wire charged with 2000 volts. It was agreed by both experts that the cleaner and clearer the air the more electrons it contains.

Before closing the Congress, the resolutions proposed, after undergoing certain modifications, were adopted by the committee in executive session, the Congress itself being only a consulting and advisory body. Besides the resolutions mentioned already, it was determined that the international ascents of balloons and kites during the next year should take place, as has been the case this year, on the first Thursday of every month, and that at least one of the *ballons-sondes* liberated at any station should be sent up one hour before sunrise in order that its records may not be affected by solar radiation, and also that the balloon may be seen when it falls to earth in the early morning. The Richard thermograph, with Teisserenc de Bort's insulating device, should be used, and the Hergesell instrument having a tube of German silver, instead of the Bourbon tube filled with alcohol, was also recommended on account of its sensitiveness and durability. Ascensions at other hours and with different apparatus are discretionary. The president, Prof. Hergesell, in summing up the results of the Congress, which he regarded as eminently satisfactory, laid special importance on the meteorological kite flights that were proposed over seas, lakes and mountains, and hoped that the British Government, by similar work in India, would help in the investigation of the great Asiatic monsoon region. A grant of money was requested from the German Government to enable the Prussian Meteorological Institute to cooperate with the writer in his proposed investigation of the atmosphere over the Atlantic Ocean. It was announced that in order to facilitate international researches in scientific aëronautics, the formation of an organisation, sustained by the various European nations, would be attempted.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—AN election will be held at Brasenose College in March, 1903, to an ordinary fellowship, of the value of 200*l*. a year, tenable for seven years, after an examination in the subjects recognised in the Honour School of Animal Physiology. Weight will be attached to work exhibiting research in some subject of physiological study.

The electors to Dr. Lee's readership in chemistry will appoint a reader in January, 1903, and they invite candidates to submit their names and qualifications before January 1. The reader must lecture in two at least of the three University terms, and, in addition to the duties performed for the University, he may be required, as an official student of Christ Church, to take part in the educational work of the house by giving lectures or other instruction in chemistry and directing the work of the chemical laboratory.

Convocation has granted 200*l*. to the Wykeham professor of physics to defray the expenses of fittings for his laboratory.

CAMBRIDGE.—The reader in geography and the lecturers in ethnology and geology have arranged for a series of lectures and practical courses to serve as a training for persons wishing to undertake exploration or desirous of contributing to our knowledge of foreign countries. The series will be held during the Lent term, and will include history of geographical discovery, principles of physical geography, map-making and map-reading, and geography of Europe, by Mr. Oldham; anthropogeography, practical ethnology, by Prof. Haddon; geomorphology and geology, by Mr. Marr; plane-table and photographic surveying, by Mr. Garwood; and elementary astronomical surveying, by Mr. Hinks. The courses will be open to members of the University and others. The fee for all is 3*l*. 3*s*. Further particulars may be obtained from Prof. Haddon, Museum of Archæology, Cambridge.

A syndicate has been appointed to consider what changes, if any, are desirable in the regulations that affect the mathematical portions of the pass examinations of the University, in particular of the previous examination. The members of the syndicate are:—The Vice-Chancellor, Mr. C. Smith, Prof. Forsyth, Dr. Hobson, Mr. W. L. Mollison, Mr. C. A. E. Pollock, Mr. W. Welsh, Prof. G. B. Mathews, Mr. S. Barnard, Mr. W. M. Coates, Mr. E. T. Whittaker and Mr. A. W. Siddons. It is probable that the syndicate will recommend changes analogous to those which have been introduced in connection with the University local examinations, especially as regards the dominance of Euclid.

THE council of University College, Liverpool, has appointed Major Ronald Ross, C.B., F.R.S., to the Sir Alfred Jones chair of tropical medicine and parasitology, recently founded with the aid of special subscriptions to the University fund.

AT a meeting of the general committee of the Principal Viriamu Jones memorial fund, recently held at University College, Cardiff, it was decided to raise a fund of 1000*l*. to erect a statue to the memory of the late principal. To carry out this object and to raise the necessary funds, an executive committee was appointed.

AT a meeting of business men of Manchester and district held on Monday, the Lord Mayor being in the chair, the following resolution was unanimously adopted:—"That the increasing competition and keenness of modern business life and its greater complexity call for a more thorough mental training of persons aspiring to be heads and managers of commercial and industrial establishments, and that this meeting heartily approves of the further development of the higher education bearing on commercial life now provided in the Owens College by the establishment of a Faculty of Commerce on the lines of the draft scheme now submitted."

THE prizes and certificates were presented to successful students of the Northampton Institute, Clerkenwell, on the evening of December 3, by the Lord Chancellor. The principal, Dr. Walmesley, reported a marked improvement during 1901 over the previous year in the number of medals and exhibitions gained in open competition by his students. Before the presentation of prizes, the Lord Chancellor said, in the course of a short address, that suitable technical education would enable the commerce of this country to achieve again the reputation which in some aspects had been diminished in modern times. In this matter, foreigners had been assisted by their Governments and had been provided with educational establishments at the expense of their countries.

THE fifth annual London conference of science teachers will be held on January 9 and 10, 1903, at the South-Western Polytechnic, Chelsea. At the first meeting, the chair will be taken by Mr. Henry Ward, chairman of the London Technical Education Board, and addresses will be delivered by Mr. Usherwood, on the experimental teaching of geometry, and by Mr. Frank Castle, on the teaching of workshop mathematics. Sir William Anson will preside at the second meeting, and addresses on the teaching of geometry will be given by Messrs. S. O. Andrews, W. D. Eggar and A. W. Siddons. Prof. Farmer, F.R.S., will be the chairman at the third meeting, when experimental plant physiology and the rational teaching of botany will be the subjects taken up by Mr. H. B. Lacey and Miss Lilian Clarke respectively. Prof. Callendar, F.R.S., will take the chair at the last meeting, when an address will be given by Mr. Newth on experimental illustration in the teaching of chemistry, and one by Mr. Busbridge on making lantern slides. Free admission to the conference will be granted to as many teachers as the room will accommodate, and application for tickets should be made to Dr. Kimmins, Dame Armstrong House, Harrow-on-the-Hill, or to Mr. C. A. Buckmaster, 16 Heathfield Road, Mill Hill Park.

WE announced last week that the name of Sir John Williams, Bart., had been mentioned in connection with the vacancy caused by Sir Michael Foster's resignation of his seat in Parliament as member for London University. Since then we have received a circular containing the invitation sent by a committee of graduates to Sir John Williams to become a candidate for the vacant seat, and the reply in which he accepts it. After referring to the new conditions of work of the reorganised University of London, Sir John remarks in his reply to the chairman of his committee, Sir J. F. Rotton:—"For the further development of the teaching side of the University and the realisation of our expectations with respect to its work, the creation of schools of original research is necessary. The gifts of generous donors do not and will not suffice to meet the expenses which they will entail, and I am of opinion that such schools form fitting objects of support from the State. Such establishments are a necessity for the growth of that scientific learning which is essential for the progress of trade and the prosperity of the country, as well as for the education of the community. Questions of public health—the prevention of epidemics, the securing of efficient vaccination, the housing of the people, the supply of unpolluted water, the disposal of refuse—engage the attention of Parliament from time to time; questions in the discussion of which the knowledge of those who have been trained in the laws of health and disease, and their application in practice, will prove of great value. To such I would give my earnest attention." Sir Philip Magnus has been asked by an influential body of graduates representing educational institutions to become a candidate for the seat, and has accepted the invitation. Both Sir John Williams and Sir Philip Magnus would give general support to the present Government as Unionists.

THE following announcements of gifts to higher education in the United States have been made in *Science* since the beginning of September:—Mrs. Phœbe Hearst's gifts for archæology and anthropology at the University of California amounted to 111,000 dollars during the last academic year. The University of Pennsylvania has received 100,000 dollars from Dr. E. W. and Clarence H. Clark for a chair in Assyriology, to which Dr. Hilprecht has been appointed. Dr. and Mrs. C. A. Herter, of New York City, have given 25,000 dollars to Johns Hopkins University. Dr. Howard A. Kelly has given 10,000 dollars for an extension of the gynæcological ward of the Johns Hopkins Hospital. Mr. John D. Rockefeller has offered to give 500,000 dollars to Teachers' College, Columbia University, on condition that the sum of 440,000 dollars be collected from other sources—190,000 dollars to pay the outstanding debts and 250,000 dollars for further endowment. The college has received from Mr. and Mrs. B. Everett Macy 175,800 dollars for the increase of the endowment funds and 98,709 dollars for the completion of the Horace Mann School. Princeton University receives 140,000 dollars under the will of the late Mrs. Susan Dod Brown. The bequest to the Princeton Theological Seminary made by Miss Mary Winthrop, of New York, amounted to 1,400,000 dollars. Yale University receives about 171,000 dollars as the residuary legatee of the estate of Mr. E. W. Southworth. The Ohio Wesleyan University receives 150,000 dollars under the will of the late Mr. Francis B. Loomis, of Cincinnati; and Vassar College receives 10,000 dollars by the will of the late Mr. Adolph Sutro, of San Francisco. Clark University will receive the sum of 1,577,000 dollars from the estate of the late Jonas G. Clark. This is in addition to the 500,000 dollars already paid on account of the collegiate department. These gifts and promises cover a period of three months and only include those known to have been made, yet they amount to nearly five million dollars, that is, about one million pounds.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, November 28.—Prof. S. P. Thompson, president, in the chair.—Prof. Perry read a paper on a slide-rule for powers of numbers. Soon after the reading of Mr. Lanchester's paper in 1895—the radial cursor: a new addition to the slide-rule—Prof. Perry made slides to assist in computing m^n, where m and n are any numbers. He then came to the conclusion that no great accuracy was obtainable; but on trying the method again, he has recently found that it is very convenient and sufficiently accurate for gas- and steam-engine work. These computations can be made with a table of values of log (log m) used in conjunction with an ordinary table of logarithms. In the rule exhibited, the D line is replaced by a scale such that the distance from the mark 10 to the mark m represents log (log m) to the same scale of measurement as that to which the distance from 1 to n on the C scale represents log n. The values of m range from 2 to 1000, and those of n from 1 to 10 or from 1 to ·1 used backwards. The author showed how, with one operation, the rule could be used to find the value of $m^{\frac{a}{n}}$, $m^{\frac{1}{n}}$, and the logarithm of any number to any base. If the answer on scale D is less than 2 or greater than 2000, or if the exponent n is negative, indirect methods involving two operations are necessary. Prof. Perry has replaced the ordinary D line by the log log scale, because in his opinion this line is the one least used by workers with the slide-rule. The use of the log log scale was described by Roget in 1814, and the author's object in bringing the matter forward lies in the fact that

Dr. Roget's paper seems to be almost unknown, and it is only in these modern days that the computations for which he invented the rule have to be frequently made.—Prof. H. L. Callendar exhibited a lecture experiment for the determination of the mechanical equivalent of heat. The experiment was carried out with a modified form of the apparatus exhibited and described by Prof. Callendar at the meeting of the Physical Society held on June 20.

Geological Society, November 19.—Prof. Charles Lapworth, F.R.S., president, in the chair.—The Semna Cataract or Rapid of the Nile, a study in river-erosion, by Dr. John Ball. Inscriptions placed on the rocks at Semna, between the second and third cataracts, under the twelfth and thirteenth dynasties, serve as a means of gauging the local changes due to river-erosion during a period of about 4200 years. Horner, in 1850, came to the conclusion that "the only hypothesis which could meet the requirements of the facts observed would be either the wearing away of a reef or barrier at the place in question—a process requiring too long a period—or the existence at some distant period of a dam or barrier, formed perhaps by a landslip of the banks, at some narrow gorge in the river's track below Semna." The author is in favour of the former explanation. Rapid erosion with the formation of pot-holes is observed to be now taking place, and the author calculates that if 200 cubic metres (approximately 500 tons) of rock per year has been removed from the barrier, the lowering of it would amount to 2 millimetres a year, or in 4200 years 7·9 metres, the depth of the present river below the lowest group of inscriptions dating from the time of Amenemhat III. The yearly discharge of the Nile past Semna is nearly 100,000 million tons of water, and the author considers that the removal of 500 tons of rock under existing conditions in a year is not only not impossible, but highly probable, as all this erosion only amounts to 5 milligrams of rock per ton of silt-laden water. This erosion is compared with the classic instance of the River Simeto in Sicily. At Assuan and Silsilla, the river has suffered considerable lowering within geologically recent times, probably brought about by the removal of long pre-existent hard barriers. The sluices of the new dam at Assuan may in the future give a quantitative determination of silt-erosion in granite, and it would appear to be not difficult to ascertain at Semna the rate of pot-holing. The formation of new pot-holes $1\frac{1}{2}$ feet deep, in an artificial channel in rock in Sweden, has been observed to take place in eight or nine years, and the author hopes in future to attempt some measurements of this kind at Semna.—Geological notes on the North-West Provinces (Himalayan) of India, by Mr. Francis J. Stephens. The country examined extends in a north-westerly direction across the line of strike, from the borders of Nepal and South-eastern Kumaon to north of the Alakmunda River in the vicinity of Badrinath and the Marra Pass. The summary of the author's observations leads him to "suppose that there are at least three distinct limestone or calcareous series in Kumaon and Garhwal, and that schists and quartzites, with several isolated patches of granitic rock, form a large part of the remaining formations."—Tin and tourmaline, by Mr. Donald A. MacAlister. The author gives a possible explanation of the reactions by which tin oxide could be separated from solution in magmas containing alkaline borates.

Mineralogical Society, November 18.—Dr. Hugo Müller, F.R.S., president, in the chair.—Mr. F. E. Lamplough contributed a note on proustite crystals, on some of which an unusual trigonal pyramid $\{7\bar{3}\bar{3}\}$ is the dominant form, and on others the pyramid $\{9\bar{4}\bar{4}\}$ These forms are associated with $r\{100\}$, $e\{011\}$, $v\{20\bar{1}\}$, $a\{10\bar{1}\}$, and in one case with $\{\bar{1}\bar{1}.7.7.\}$.—Prof. W. J. Lewis described crystals of mispickel and iron pyrites from the Binnenthal, and crystals of quartz and sphene from the Ofenhorn.—Mr. R. H. Solly gave an account of various minerals from the Lengenbach, Binnenthal. These included large crystals of baumhauerite differing in habit from those previously described by him and exhibiting several new forms, an unique crystal of binnite weighing more than 8 grams, and fine specimens of dufrenoysite partially covered by minute crystals of seligmannite. On the latter, ten new forms were observed, and from measurements made on twelve brilliant crystals the axial ratios were determined to be $a:b:c = 0·92332:1:0·87338$. The presence of copper was detected and the streak was chocolate-brown. Mr. Solly also discussed the crystallography of a presumably new mineral from the Lengenbach, five minute but brilliant crystals of which were found on a crystal of rathite. In these crystals, no plane or axis of symmetry could be determined, and each crystal was grown in a different position.—Mr. G. F. Herbert Smith exhibited a special form of protractor, and described the method of using it for plotting poles on a sphere in gnomonic projection and for determining the angles between poles and between zones graphically from the diagram.—Mr. G. T. Prior discussed the connection between the molecular volumes and chemical composition of some crystallographically similar minerals. He pointed out the chemical relationships (similarity in form of the chemical molecule with approximately the same number of atoms) of the members of the hamlinite-beudantite-jarosite group of rhombohedral minerals and showed that the molecular volumes exhibited an approach to equality. In the case of several sets of crystallographically similar minerals, it was found that when the chemical formulæ were made similar in form by taking suitable multiples of the simplest formulæ, then the molecular volumes calculated for these new formulæ were approximately equal. On this principle, from the crystallographic similarity of rutile to zircon, of anatase to calomel and of brookite to tantalite and wolfram, the following formulæ for the three forms of titanic acid were deduced, viz. rutile (Ti_2O_4), anatase (Ti_4O_8), brookite (Ti_6O_{12}).—Mr. Prior also contributed a note on phonolitic rocks from St. Helena and Ascension. These were compared with similar rocks from the Great Rift Valley and from Abyssinia, and the striking uniformity of the volcanic rocks of the African continent was pointed out. It was suggested that this was only a part of a wider generalisation according to which the volcanic eruptions of the great Atlantic volcanic chain (including its two transverse European branches and the minor chain down the east side of Africa) are characterised by the association of basalts and alkali-rich phonolitic rocks, whereas andesites are the prevailing lavas of the two great Pacific chains.—Mr. L. J. Spencer described the crystalline form of carbides and silicides of iron and manganese, crystals of which had been placed at his disposal by Mr. J. E. Stead. He showed that crystals of the metallurgical products, spiegeleisen, ferro-manganese and silico-ferro-manganese, of which the general chemical formula is $(Fe,Mn)_3(C,Si)$, are of two kinds—(1) rhombic with a prism-angle of $67\frac{1}{2}°$; (2) anorthic with a prism-angle of about 60°.

Linnean Society, November 20.—Prof S. H. Vines, F.R.S., president, in the chair.—Mr. R. Morton Middleton, gave an account of the dissertation by Linnæus on *Siren lacertina*, annotated by the author, which he had found in a dealer's possession and since then had been presented to the Society by the treasurer.—Mr. W. C. Worsdell showed a series of anomalous virescent flowers of *Helenium autumnale*, six strong plants in the garden at Friar Park, Henley, the residence of the treasurer, being thus affected.—Mr. H. E. H. Smedley exhibited large wax models of the fossil seeds of *Stephanospermum akenioides* and Lagenostoma, the latter occurring in the Lower Coal-measures of Lancashire; he also showed a model of a recent Cycad for comparison.—Rev. T. R. R. Stebbing, F.R.S., V.P., having taken the chair, the president reminded the Society that exactly a year ago he had the honour of giving an account of some observations upon the action of the enzyme contained in the secretion of Nepenthes. That enzyme, he then explained, not only possesses the property of peptonising the higher proteids (*e.g.* fibrin), but is also proteolytic, decomposing the proteid molecule into non-proteid nitrogenous substances such as leucin and tryptophane. The proof of this is afforded by the fact that liquids containing proteids that have undergone digestion give the tryptophane reaction; that is, a pink or violet colour on the addition of chlorine-water. Since that time, many other plants have been investigated with the object of ascertaining, (1) whether or not a digestive enzyme were present, and (2) of determining the nature of its action. In almost all cases, the presence of a proteolytic enzyme has been demonstrated. The experiments definitely establish the fact that an enzyme which actively proteolyses the simpler forms of proteid is present in all parts of the plant-body. But the question as to the precise nature of this enzyme still remains to be answered. Where proteolysis is accompanied by peptonisation, it may be inferred that the enzyme is allied to the trypsin of the animal body. Where no peptonisation, but only proteolysis, can be detected, it seems probable that the enzyme is allied to the erepsin recently discovered by Cohnheim in the small intestine. Possibly more than one enzyme may be active in certain cases. The conclusions arrived at depend entirely upon the trust to be placed upon the tryptophane reaction as evidence of proteolysis. From what is known as to its chemical composition and as to the conditions of its formation in digestion, there can be no doubt that tryptophane is a product of the disruption of the proteid molecule. The point that had more particularly to be determined was whether the substance giving the colour-reaction with chlorine in these experiments is really tryptophane. The isolation of tryptophane is a difficult process, and was not attempted. The chemical identity of the substance is, however, established by the fact that its chlorine compound was found to give the same absorption spectrum as does that of tryptophane, namely, a band in the green on the yellow side of the thallium line.—Mr. A. G. Tansley gave an account of the relation of histogenesis to tissue morphology, dealing with a few points bearing on the relation of histogenesis at the apex of the stem in the Pteridophyta to the morphology of the tissue regions in the adult stem.—Mr. L. A. Boodle followed with a paper entitled "Stelar Structure of Schizæa and other Ferns."

DUBLIN.

Royal Irish Academy, November 10.—Prof. R. Atkinson, president, in the chair.—Sir Robert Ball, F.R.S., communicated a paper on the reflection of screws and allied questions. Let there be any system of straight lines and take any arbitrary plane S. Let P be a point on one of the straight lines, and let fall a perpendicular PT upon the plane S. Produce PT to P′ so that P′T = PT. Then the point P′ is the reflection of P. If we repeat this process for every point of the original system of straight lines, we obtain the reflected figure. The fundamental theorem is as follows:—The reflection of two reciprocal screws also forms a reciprocal pair provided the signs of the pitches of both screws be changed. From this we deduce the following theorems: (1) The reflections of a set of coreciprocal screws also form a set of coreciprocals; (2) the reflection of an n-system of screws is also an n-system.—Dr. R. F. Scharff read a paper on the Atlantis problem. After dwelling upon the historical aspects concerning the former existence of a continent beyond the Strait of Gibraltar known to the ancients as "Atlantis," Dr. Scharff referred to the attempts which had been made to solve this problem from a faunistic point of view. He disagreed with Dr. Wallace in his opinion that the fauna of the Atlantic Islands had been derived from occasional means of dispersal, and contended that the origin of their fauna was mainly due to former land-connections with Portugal and Morocco. The paper also dealt with the wider question of the existence of a land-connection between the Old World and the New in the same latitudes, the author maintaining that such a land-bridge had persisted until Miocene times.—Prof. C. J. Joly read a note on the multi-linear quaternion function in relation to projective geometry. When a quaternion is interpreted as a point-symbol, the equation $p=fq$ represents the general homographic transformation in space from one set of points q to another set p, f being a linear quaternion function. Also if f' is the conjugate of f, the equations $Sq(f+f')q=0$, $Sq(f-f')q'=0$, represent the general quadric surface and the general linear complex. Starting from these results, which were communicated to the Academy last year, the author proposes to consider the bilinear function $f(pq)$. The equation $p=f(eq)$ represents a homographic transformation when e is regarded as a constant quaternion, and by varying e, a four-system of homographic transformations is obtained the properties of which may be easily studied. The equation $p=f(qq)$ represents the general quadratic transformation. From a bilinear function $f(pq)$, five other fundamental functions may be obtained; the first and second conjugates, viz. the conjugates with respect to p and to q; the *promutate* $f(qp)$, and its first and second conjugates. The equation $Sqf(qq)=0$ represents the general cubic surface, and associated with this surface are systems of linear complexes $Sef(pq)=Sef(qp)$, just as the linear complex and the quadric are connected with a single function. The trilinear function $f(pqr)$ leads to similar results. In particular, if a and b are two constant quaternions, the equation $p=f(a, b, q)$ represents the complete group of linear transformations, any particular transformation being determined by suitable values of a and b.

PARIS.

Academy of Sciences, December 1.—M. Bouquet de la Grye in the chair.—On the temperature of inflammation and on the combustion in oxygen of the three varieties of carbon, by M. Henri Moissan. The temperature at which carbon enters into active combustion with oxygen differs with the variety of carbon, being higher as the carbon is more polymerised. Diamond becomes incandescent in oxygen between 800° and 875° C., graphite between 650° and 700° C., amorphous carbon between 300° and 500° C., but in each case the visible combustion is preceded by a stage during which the carbon is oxidised, this action taking place with a velocity which decreases the lower the temperature. Amorphous carbon is slowly oxidised in either moist or dry oxygen at a temperature as low as 100° C.—Experimental researches on adrenaline, by MM. Ch. Bouchard and Henri Claude. Experiments carried out with rabbits showed that the injection of 0·5 milligram of adrenaline per kilogram of body weight, and in one case as little as 0·2 milligram, was rapidly fatal. The animals survived a dose of 0·1 mgr. per kilogram, and it was found possible, by gradually increasing the amount injected, to diminish the susceptibility to the toxic effects of the adrenaline.—The heart in its normal state and during pregnancy, by MM. Ch. Bouchard and Balthazard. The orthogonal projection of the heart was traced by the aid of the X-rays and a fluorescent screen in forty-nine subjects, and a preliminary table of the results is given.—Observations regarding physiological injections, by M. Yves Delage. The injection of colouring matters such as ammonium carminate and indigo carmine for localising with precision the excretory functions is regarded as being likely to lead to fallacious conclusions. The colouring matters used are not normal excretion products, and because in certain animals some of these substances are eliminated by the normal organs of secretion, it does not follow that this is always the case. The line of argument strictly followed out would even lead to the conclusion that the nervous system is excretory because it fixes methylene blue.—On the Laplace-Abel integral, by M. G. Mittag-Leffler.—On the conditions necessary for the stability of equilibrium of a viscous system, by M. P. Duhem.—The tracing of pressure curves, by M. E. Vallier.—M. Deslandres was elected a member in the section of astronomy in the place of the late M. Faye.—On some consequences of certain developments in series analogous with trigonometric expansions, by M. W. Stekloff.—On some congruences with several unknowns, by M. R. Levavasseur.—On a generalisation in continued fractions, by M. Auric.—On uniform transcendentals, defined by differential equations of the second order, by M. R. Liouville.—A method of evaluating temperatures in the thermodynamic centigrade scale, by M. Ponsot. The method suggested by M. Pellat requires the simultaneous measurement of three magnitudes, the electromotive force of a thermoelement, the Peltier effect at one of the junctions and the temperature of this junction in an ordinary thermometric scale. The method suggested by the author is simpler as the latter determination is dispensed with.—The acceleration of gravity on the mean parallel, by M. J. Collet.—On the composition of gaseous hydrates, by M. de Forcrand. By the application of the thermodynamical method indicated in previous papers by the author, the probable formulæ of the hydrates of various gases are calculated; in nearly all cases, the hydrate has six molecules of water.—The transformation of pyrophosphoric acid into orthophosphoric acid, by M. H. Giran. By cooling syrupy pyrophosphoric acid down to −10° C. for three months, the acid was obtained in the crystallised form, and this was used for new thermochemical determinations.—Manganese aluminate, by M. Em. Dufau. By heating a mixture of alumina and oxide of manganese in the electric furnace, an aluminate identical with that previously described by Ebelmen is obtained, which on analysis proved to have the composition Al_2O_4Mn. It formed clear yellow transparent octahedral crystals, and although stable under conditions of ordinary temperature, is readily oxidised when heated in contact with air.—On the estimation of manganese, by M. H. Baubigny. An account of the precautions required for the estimation of manganese in acid solution by means of ammonium persulphate.—The action of bromine and chlorine on the mono-nitro-veratrols, by M. H. Cousin. In this paper, the constitutional formulæ of a certain number of trisubstituted derivatives of pyrocatechol and its methyl esters are determined, and two new nitro-derivatives are described.—On the reduction of acetol, by M. Andre Kling. The action of several reducing agents upon acetol was studied under various conditions, and the results lead the author to conclude that the constitution usually assigned to this compound is not correct, and that its constitution is better explained by the formula $CH_3{\cdot}C(OH){\cdot}CH_2$ (with the C(OH) and CH_2 linked through O).—The action of fatty amines upon the dibenzoate of ethylene, by M. Marcel Descudé.—The action of halogen esters upon ammonim thiosulphocarbamate, by M. Marcel Delépine.—On the ichthyological fauna of the fresh waters of Borneo, by M. Léon Vaillant.—On the fishes of the Chondrostome group in the fresh waters of France, by M. Louis Roule.—The morphological and anatomical variations presented by the gizzard in some Coleoptera, by M. L. Bordas.—On the polychætal annelids in fresh water, by M. Ch. Gravier. Excretion in the Cirripedes, by M. L. Bruntz.—The application of a character of ethological order to the natural classification, by M. L. Matruchot.—The distribution of sphærulins in vegetable families, by M. Louis Petit.—The present state of the volcano of Martinique, by M. Lacroix.—On the evolution of the spermatid in the *Notonecta glauca*, by MM. J. Pantel and R. de Sinéty.—On the presence of paranucleolar acid corpuscles in the cells of *Locus niger* and *Locus coerulens*, by M. G. Marinesco.—The ratio of the weight of the liver to the total weight of the animal, by M. E. Maurel. Adult animals have less liver per kilogram weight than young animals of the same species. In the same species of animal, when differences of volume correspond to different varieties, as in the dog, the quantity of liver per kilogram of animal is higher as the animal is smaller. This proportion also varies with the nature of the food.—On the variations of phosphorus in animal tissue, by M. A. L. Percival.—Physiological researches on the effects of cervical sympathicectomy, by MM. Moussu and Charrin.—Muscular hæmoglobinuria, by MM. Jean Camus and P. Pagniez.—On the formation of the *anticorps* in the serum of vaccinated animals, by MM. A. Calmette and E. Breton.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 11.

ROYAL SOCIETY, at 4.30.—On Certain Properties of the Alloys of the Gold-Silver Series: The late Sir William Roberts-Austen, F.R.S., and Dr. T. K. Rose.—The Spectrum of γ Cygni: Sir Norman Lockyer, F.R.S., and F. E. Baxandall.—Abnormal Changes in some Lines in the Spectrum of Lithium: H. Ramage.—Quaternions and Projective Geometry: Prof. C. J. Joly.—An Error in the Estimation of the Specific Gravity of the Blood by Hammerschlag's Method, when Employed in Connection with Hydrometers: Dr. A. G. Levy.
INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Photometry of Electric Lamps: Dr. J. A. Fleming, F.R.S.
SOCIETY OF ARTS, at 4.30.—Domestic Life in Persia: Miss Ella C. Sykes.
INSTITUTE OF ACTUARIES, at 5.30.—Lecture on Statistics (Measurement of Groups): A. L. Bowley.
MATHEMATICAL SOCIETY, at 5.30.—(1) The Integration of Linear Differential Equations; (2) The Determination of the Finite Equations of a Continuous Group: Dr. H. F. Baker.—The Expression of the Double Zeta and Gamma Functions in Terms of Elliptic Functions: G. H. Hardy.—Sets of Intervals. Part II., Overlapping Intervals: W. H. Young.—Series connected with the Enumeration of Partitions: Rev. F. H. Jackson.—The Abstract Group simply Isomorphic with the Group of Linear Fractional Transformations in a Galois Field: Prof. L. E. Dickson.—The Continuation of the Series for arc sin x: Prof. M. J. M. Hill.—The Functions associated with the Parabolic Cylinder in Harmonic Analysis: E. T. Whittaker.

FRIDAY, DECEMBER 12.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Ephemeris for Physical Observations of Jupiter, 1903–1904: A. C. D. Crommelin.—Cape Double Star Results, 1902: R. T. A. Innes.—On Jacobi's Method of Facilitating the Numerical Solution of Equations arising in the Theory of Secular Perturbations: H. C. Plummer.—Note on Binding Together Réseaux and Plates: J. A. Hardcastle.—*Promised paper*:—Distribution of Stars as derived from a Discussion of the Bonn, Schönfeld and Cape Photographic Durchmusterungs: F. A. Bellamy.
PHYSICAL SOCIETY, at 5.—A Portable Capillary Electrometer: S. W. J. Smith.—On Astigmatic Aberration: R. J. Sowter.—Experiments on Shadows in an Astigmatic Beam: The President.—Vapour-Density Determinations: Sir W. Ramsay, F.R.S., and Dr. B. B. Steele.—A Lecture Experiment on Gaseous Diffusion: Prof. L. R. Wilberorce.
EPIDEMIOLOGICAL SOCIETY, at 8.30.—The Bearing of Outbreaks of Food Poisoning upon the Etiology of Summer Diarrhœa: Prof. Sheridan Delépine.

MONDAY, DECEMBER 15.

SOCIETY OF ARTS, at 8.—The Future of Coal Gas and Allied Illuminants: Prof. Vivian B. Lewes.
ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Explorations in North-west Mexico: Carl Lumholtz.

TUESDAY, DECEMBER 16.

ROYAL STATISTICAL SOCIETY, at 5.—English Railway Statistics: W. M. Acworth.
INSTITUTION OF CIVIL ENGINEERS, at 8.—The Rupnarayan Bridge, Bengal-Nagpur Railway: S. Martin-Leake.

WEDNESDAY, DECEMBER 17.

CHEMICAL SOCIETY, at 5.30.—A Reagent for the Identification of Carbamide and of certain other Nitrogen Compounds: H. J. H. Fenton.—The Rate of Decomposition of Diazo-Compounds. Part II., Diazo-Compounds of the Naphthalene Series: J. C. Cain and F. Nicoll.—(1) The State of Carbon Dioxide in Aqueous Solution; (2) Qualitative Separation of Arsenic, Antimony and Tin: J. Walker.—The Hydrates and Solubility of Barium Acetate: J. Walker and W. A. Fyffe.—The γ β-Dimethylglutaric Acids, and the Separation of Cis- and Trans- Forms of Substituted Glutaric Acid: J. F. Thorpe and W. J. Young.
ROYAL METEOROLOGICAL SOCIETY, at 7.30.—The Climate of Cyprus: C. V. Bellamy.—The Eclipse Cyclone of 1900: H. Helm Clayton.
GEOLOGICAL SOCIETY, at 8.—Note on the Magnetite-Mines near Cogne: Prof. T. G. Bonney, F.R.S.—The Elk (*Alces machlis*) in the Thames Valley: E. T. Newton, F.R.S.—Observations on the Tiree Marble, with Notes on Others from Iona: A. K. Coomáraswámy.
ROYAL MICROSCOPICAL SOCIETY, at 8.—The Genus Diaschiza: F. R. Dixon-Nuttall and Rev. R. Freeman.—A New Arrangement for Taking Photomicrographs in Colours: E. R. Turner.
SOCIETY OF ARTS, at 8.—The South Russian Iron Industry: Archibald P. Head.

THURSDAY, DECEMBER 18.

LINNEAN SOCIETY, at 8.—Notes on Copepoda from the Faeroe Channel: Thos. Scott.—Amphipoda of the *Southern Cross* Antarctic Expedition; Alfred O. Walker.—The Deep-Sea Isopod *Anurus branchiatus*, Bedd.: Dr. H. J. Hansen.
INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Notes of Recent Electrical Designs: W. B. Esson.

FRIDAY, DECEMBER 19.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Electricity Supply from Double Current-Generators: P. R. Wray.
INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Recent Practice in the Design, Construction and Operation of Raw Cane Sugar Factories in the Hawaiian Islands: J. N. S. Williams.

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