THURSDAY, FEBRUARY 23, 1905.

RECENT ENGLISH HISTORY.

Social England. Edited by H. D. Traill and J. S. Mann. Vol v., pp. lii+864; vol. vi., pp. lvi+948. (London: Cassell and Co., Ltd., 1904.) Price 14*s.* net each volume.

An Introductory History of England. By C. R. L. Fletcher. Pp. xvii+397. (London: John Murray.) Price 7*s.* 6*d.*

Studies on Anglo-Saxon Institutions. By H. M. Chadwick. Pp. xiii+420. (Cambridge University Press, 1905.) Price 8*s.* net.

IN the fifth and sixth volumes of "Social England," lately re-issued in an illustrated edition (1904), considerable prominence is given to subjects of scientific as well as of historical interest. Thus Mr. T. Whittaker (rather more adequately than in earlier stages) writes on philosophy and natural science in the eighteenth century and the Napoleonic age, and for the same period Mr. D'Arcy Power discusses medicine and public health, Mr. Raymond Beazley exploration and the advance of geographical knowledge, and Mr. G. T. Warner manufacturing progress, machinery, and the transformation of industry (v., 31–47, 56–73, 145–55, 292–307, 321–33, 408–35, 543–6, 560–84, 625–45, 756–60, 805–22).

In the final or nineteenth century volume, geology, chemistry, astronomy, physics, biology, anthropology, engineering, mining and metallurgy, applications of electricity, and the railway system of the United Kingdom are also treated, in addition to our old friends philosophy, medicine, and exploration. The list of scientific writers is much enlarged, and comprises Prof. T. G. Bonney, Mr. Robert Steele, Mr. H. C. Jenkins, Lord Farrer, Miss A. M. Clerke, Mr. W. G. Rhodes, Mr. O. G. Jones, and Dr. J. Scott Keltie (vi., 76–95, 239–90, 413–48, 675–793, 892–927).

Among these contributions we may especially notice, for the sake of illustration, that of Dr. Keltie on British exploration, 1815–85. Here we have a good, clear, business-like summary (very well illustrated, especially by contemporary maps) of a great and significant chapter in the life-history of the English people. But the amount of matter to be treated is so vast, and Dr. Keltie is so conscientious in his determination not to omit a reference, however brief, to every important personage and event within the limits of his subject, that the narrative becomes at times a chronicle of the nature of "materials for history." Thus, in tracing the course of British explorations in Central Asia and the Far East alone, the work of Moorcroft, Wood, Shaw, Forsyth, Hayward, Trotter, Carey, Bell, James, Younghusband, Basil Hall, Collinson, Fortune, Blakiston, Ney Elias, Sladen, Margary, Gill, Baber, Colquhoun, McCarthy, Williamson, Gilmore, Alcock, and Mrs. Bishop is summarised in two pages. It is no doubt difficult to avoid such treatment, and the secretary of our Geographical Society is an excellent chronicler; but it is perhaps open to question whether a more selective and less annalistic method might not have been followed in this as in certain other articles, such as the "Engineering" of Mr. O. G. Jones, where a more philosophic style is adopted with marked success.

The British history of the nineteenth, or even of the eighteenth, century in one volume, even though that volume run to 930 pages, is an undertaking of no small difficulty; as the assistant editor—and true chief pilot—of the venture, Mr. J. S. Mann, himself admits. Intellectual and industrial achievements are now so multifarious that they can hardly be dealt with in the same book as the political and social history. Science has become more than ever cosmopolitan; processes in the great staple trades have undergone developments far too specialised for the ordinary reader; to a vast number of secondary and miscellaneous industries and interests it is impossible to assign any adequate recognition; a bare enumeration, the recognition of an allusion, is all that can be spared for whole chapters of national progress during the last age. To such themes as railways, merchant shipping, the machinery of commerce, the new developments in social organisation, art, and literature, it seems almost useless to devote a few pages; while the subject of colonial history has only to be mentioned for the most casual reader to recognise the increased complication which the nineteenth century has brought to the national story.

Even since 1885, where the editors originally drew their line (evidently with some later regrets that this boundary could not be shifted down to the close of the Victorian reign), the local government of the United Kingdom has been profoundly modified; new methods have been introduced into industry; shipbuilding has taken a fresh start; legal reform has made notable progress; labour questions have been attended by many fresh developments; and an Imperial and Conservative movement (or reaction) of the most far-reaching character has influenced every side of national life and consciousness.

All the more heartily, then, we can congratulate the editors, contributors, and publishers of "Social England" on the measure of success they have realised, on the immense body of valuable information (sometimes a trifle unsifted, sometimes marred by error, but on the whole highly creditable) which is presented in these volumes, on the impartiality and truly scientific spirit which pervade almost the whole of the work, and by no means least, on the suggestive and representative illustrations by which the best of all possible commentaries is afforded to the text.

Mr. Fletcher's "Introductory History of England" down to the accession of the Tudors, where the author fixes, for his purpose, the close of the Middle Ages, is a brave and vigorous attempt to get away from dulness without losing touch of truth, to invest the story of mediæval England with an interest which is lacking in such arid text-books as have become only too plentiful of late. As we might expect from

Mr. Fletcher, the book he has now given us is eminently characteristic, full of his own energetic, practical activity, his love of health, fresh air, and good exercise.

"When I began," he tells us, "I had foolish hopes that it might be a book some boys would take up for amusement, but I soon discovered that twenty-three years of teaching had made it impossible for me to do more than smear the powder with a thin layer of jam. We cannot render our dreams of the past (however convinced we may be of their truth) into an intelligible consecutive story."

Here, it seems to us, there is both truth and untruth. Mr. Fletcher's story is, in the main, highly intelligible and adequately consecutive (though one may make an exception of the Anglo-Saxon period, where the author seems at times almost to sink to Milton's notions of "kites and crows"); but how can any true student regard English history as if it were a nauseous drug, to be made palatable by some device? Should one not rather look at it as a storehouse from which a good judgment is needed to draw forth those treasures best suited to the audience one addresses—to the specialist this, to the general reader that, to the working man one thing, to the merchant, the professional man, or the politician another?

Yet though Mr. Fletcher anxiously disclaims the idea of pouring information into anyone, and still more anxiously repudiates the ambition of helping anybody to pass any examination, he has certainly given us here a sketch of living men by a living man, and everyone who is not a pedant, everyone who desires to remember that history is the life-record of humanity, will be grateful to him for this book. Peculiarly interesting is the picture attempted of an imaginary village in pre-Norman, Norman, and post-Norman times, with its three fields, for wheat, barley, and pasture, its arable strips, its green common or waste, its water-meadows, its pig-grazing woods, its no-man's land, and its bull-croft—as successful an attempt to realise the township-manor as any popular treatise has supplied in English of recent years; while a word must also be said in praise of the capital little chapter of geological history, illustrated by a serviceable map of N.W. Europe in the Old Stone age, with which Mr. Fletcher commences.

Mr. Chadwick's "Studies on Anglo-Saxon Institutions" supplies a useful corrective to the studied vagueness with which Mr. Fletcher treats our English history. Here a careful re-examination of the evidence bearing on some of the most interesting problems of early English history and sociology is attempted with distinct success. The writer's object has especially been to call attention to those branches of the subject which have hitherto suffered from comparative neglect. Thus he has dealt very lightly with Mercian and Northumbrian history because he had nothing of importance to add to previous work; but evidence relating to Kent, Sussex, Essex, and the Hwiccas has been reviewed and re-stated with great care, and with the belief that some fresh results have been attained. The most valuable portion of the volume seems to be that dealing with the old English monetary system (accompanied by a useful excursus on Frankish coinage, pp. 1–75). And next to this the reader may be recommended to the chapters dealing with the history of the older counties (Kent, &c., pp. 269–307) and with the origin of the nobility (pp. 378–411). Great caution marks all Mr. Chadwick's work, and this quality is never more useful than in such a difficult period as the Anglo-Saxon. But his treatment of our early charters is also noticeable for its courage; when, even in obviously spurious documents, names and titles otherwise unknown are met with, the author, with a daring that will perhaps greatly shock some dogmatists, ventures to think that such names and titles are not necessarily products of imagination. To find one who will say this, and who will appeal moreover for a fairer hearing in the examination of tradition, popular as well as ecclesiastical, is certainly refreshing at the present moment.

STEREOCHEMISTRY.

Materialien der Stereochemie. (In Form von Jahresberichten.) Band i., 1894–1898; Band ii., 1899–1902. By C. A. Bischoff. Pp. cxxxvi+1977. (Brunswick: Vieweg and Son, 1904.) Price 90 marks.

IN the course of his reply to a letter from the Chemical Society of London congratulating him on the completion of the twenty-fifth year of his doctorate, Prof. Emil Fischer writes as follows:—

"The time when the fundamental principles of our science were laid down, and when it was possible for the individual investigator to stamp the impress of his own mind upon it, is long since past, and in the gigantic structure, which it now represents, each fellow-worker can only finish some small fragment, or it may be, if he is fortunate, a pretty balcony or a striking turret."

The two ponderous tomes, in which Prof. Bischoff records the advances made in stereochemistry from 1894 to 1902, illustrate in a very striking manner this ever-increasing tendency to specialism in chemical research, which Fischer emphasises in the sentence just quoted.

Although Pasteur, in 1861, by his classical experiments with the isomeric tartaric acids, may be said to have laid the foundation of stereochemistry, the growth of this branch of chemical science was at first slow, since it was not till 1873 that Wislicenus pointed out as a consequence of his work with lactic acid that differences between compounds of identical structure must be ascribed to differences in the spacial arrangement of their atoms within the molecule. The publication in the following year by van't Hoff and Le Bel of their theory of the asymmetric carbon atom gave an immense impulse to experimental work, so that optically active compounds, which in those earlier days were numbered by tens, may now be counted by thousands.

The rapid development of stereochemistry is not, however, restricted to the field of optically active compounds. The researches of Victor Meyer and of Bischoff are fundamental in that branch where the

normal and abnormal courses of many reactions are interpreted from a stereochemical standpoint. Then again, the study of geometrical isomerides, such as substances of the ethylene type with the so-called double linkage between carbon atoms, of polymethylene and heterocyclic compounds, of compounds with a double linkage between a carbon atom and a nitrogen atom, and finally of compounds with a double linkage between two nitrogen atoms, has engaged the attention of many prominent contemporary workers.

The well-known "Handbuch der Stereochemie," by Walden and Bischoff, gives a comprehensive survey of stereochemical literature up to the year 1894. Owing to the rapid developments of the last ten years, however, this work has lately lost much of its initial value as a source of reference. This defect is now remedied. In the "Materialien der Stereochemie" we have an addendum to the "Handbuch," the literature of each successive year from 1894 to 1902 being classified in a manner which cannot fail to prove of the utmost service. The subject matter for each year is treated under four sections, namely, general stereochemistry, optical isomerism, geometrical isomerism of optically inactive compounds, and interdependence of spacial relationships and chemical reactions. A brief description of each paper quoted is usually given. The first section on general stereochemistry, in addition to the bibliography of special monographs published during the particular year, embraces references to chemical dynamics, crystallography, spectroscopy, &c., in so far as those subjects have any stereochemical bearing. In the three other sections the papers of more general interest are first quoted; then follow references to the more special papers which are not quoted chronologically, but are conveniently classified according to their subject matter.

The field reviewed in the first subdivision of the fourth section deals with ring systems, and is so vast that, as a rule, only references are given to the innumerable papers quoted. On the other hand, the papers on polymerisation, substitution, addition reactions, hydrolysis, &c., included in the same section are dealt with in more detail.

The general student will find this work unreadable. The author contents himself with the abstract he gives, and hardly ever ventures on any criticism. Little or no attempt is made to differentiate between the important and the unimportant, and in this respect it seems to the present reviewer that more prominence might with advantage have been given to such research as is acknowledged by all to be outstanding. From the point of view of the specialist, however, the work is admirable. Its value lies not so much in the information actually afforded by the abstracts themselves as in the remarkably complete bibliography which it presents. The ardent stereochemist, who in his own particular sphere may be tempted to exclaim, "Zwar weiss ich viel, doch möcht' ich alles wissen," will assuredly find in this work an aid to the realisation of his desire.

A. McK.

A TRAVELLER'S GUIDE TO INDIA.

The Imperial Guide to India, including Kashmir, Burma and Ceylon. Pp. xi+244; with illustrations, maps, and plans. (London: John Murray, 1904.) Price 6*s.* net.

THE large and constantly increasing number of tourists and sportsmen who visit our Indian Empire during the winter, together with the smaller section who extend their trip so as to include a summer sojourn in Kashmir or some other Himalayan district, must create an extensive demand for a work like the one before us, and the wonder is that an attempt has not been made long ago to supply such a manifest want. In the present volume, which is got up in convenient size and shape for the pocket, and printed in small although clear type, with the chief items in caps. or block type, the anonymous author seems, on the whole, to have discharged a by no means easy task in a thoroughly satisfactory and painstaking manner. Indeed, so far as a somewhat extensive personal experience of the country permits of our forming a judgment, we may say that, as a viaticum and itinerary, which is, of course, its main purpose, the work is well-nigh all that can be desired so far as its somewhat limited space permits. Although necessarily brief, the descriptions of the towns, cities, and stations, and of the railway or other routes by which they are reached, are in the main excellent, and convey a very large amount of useful and necessary information. The various routes are also carefully planned and thought out, and will enable the tourist to find his way about and to visit much of what is most worth seeing with the least amount of discomfort and difficulty. Whether, however, the "selected Hindustani phrases" at the end of the volume will enable the tourist to make himself understood by the natives of even the Hindustani-speaking provinces may be more than doubtful.

But the author has not been content to make his work a mere itinerary. On the contrary, he treats his readers to brief dissertations on the ethnology, natural history, and geology of the Indian Empire, with scrappy pieces of information with regard to the sport to be obtained. With respect to this aspect of the volume, we are compelled to say, in the first place, that the author has not allowed himself sufficient space to make the information he attempts to convey of any real value, and secondly, that it would have been well had he taken expert advice and assistance.

One fault about the introductory chapter is that it is too "parochial." The volume professes to treat of India, Ceylon, Burma, and Kashmir, but this chapter, although the reader is not told so, seems to refer only to India proper. For instance, we are told that shooting licences are not required (p. 10), and yet we find (p. 186) that these are necessary in Kashmir. Again, in the ethnological paragraphs we find no reference under the heading of non-Aryan races to either the Veddas of Ceylon, the Burmese, or the Mongoloid tribes of the north-east frontier, while the classification of the natives of the peninsula merely by religion leaves much to be desired. The general description of Indian scenery—inclusive of natural history and

geology—is, moreover, little short of ludicrous. What, for instance, are we to say of a writer who describes the rocks of the Himalaya as Archæan, although he does qualify this by stating later on that a band of Cretaceous (which is incorrect) and Tertiary rocks skirts the foot of the range? The reference to the Mesozoic rocks of the peninsula is also misleading, and we should like to know what "similar scenery in Europe" is recalled by the traps of the Ghats. A few coloured plates of more or less characteristic Indian mammals and birds relieve the necessarily dry details of the work, but it would have been better if the author had made up his mind what name to employ for the Indian antelope, instead of calling it *Antelope* (in error, by the way, for *Antilope*) *bezoartica* on p. 12 and *A. cervicapra* on the plate. When a future edition of this otherwise excellent little work is called for it may be hoped that the introductory chapter will be re-written with the aid of some one who has at least a smattering of elementary information with regard to the geology and zoological products of the country. R. L.

OUR BOOK SHELF.

Bacteriology and the Public Health. By Dr. George Newman. Third edition. Pp. xx+497. (London: John Murray, 1904.) Price 21*s.* net.

Dr. George Newman is well known as a public health expert and bacteriologist, and his contributions to the literature of preventive medicine have attracted considerable attention both in this country and abroad. The present volume may be regarded as an elaboration of his previous writings, and is, in most respects, thoroughly up to date.

There are thirteen chapters, dealing with subjects as follows:—the biology of bacteria, bacteria in water, bacteria in the air, bacteria and fermentation, bacteria in the soil, the bacteriology of sewage and the bacterial treatment of sewage, bacteria in milk and milk products, bacteria in other foods, bacteria in disease, tuberculosis as a type of bacterial disease, the etiology of tropical diseases, the question of immunity and antitoxins, and disinfection. There is also an appendix on technique and a welcome index.

The chapters dealing with some of the pressing administrative problems of the day are specially worthy of commendation.

The chapter on bacteria in milk is an admirable dissertation, and the author deserves much credit for his judicious handling of a mass of conflicting opinion and apparently irreconcilable facts. For the benefit of those who regard the bacterial diseases of animals, some of which are preventable, as of little economic importance, the following quotations (p. 324, p. 319, p. 203, p. 204) may be given:—

"In 1903 there were in Great Britain as many as 1463 outbreaks of glanders in which 2490 horses were attacked. This is the highest number of outbreaks since 1892, when they numbered 1657. The prevalence of this disease is localised often to certain counties and districts. In 1903, 855 of the 1463 outbreaks occurred in the county of London."

"In 1903 there were 761 outbreaks of anthrax in Great Britain, in which 1127 animals were attacked. This is the largest return recorded since the passing of the Anthrax Order in 1886."

"It is a well known fact that tuberculosis is a common disease of cattle. Probably not less than 20 to 30 per cent. of milch cows in this country are affected with it."

"In the United Kingdom in 1901 there were 4,102,000 milch cows. If we take 2 per cent. of these as having tuberculous udders, it gives us 80,000. The average annual yield of milk per cow may be taken as, at least, 400 gallons, which means that from these 80,000 tuberculous udders 32,000,000 gallons of milk are obtained."

It is perhaps unnecessary to add that glanders, anthrax, and tuberculosis afflict man as well as the lower animals.

The book, judged as a whole, is a most valuable contribution to the literature of preventive medicine. It will prove most useful to medical officers of health, medical men, bacteriologists, veterinary surgeons, trade experts, and many others. The lay reader will find it replete with information, and written in a lucid and agreeable style.

In a sense, the present volume is a later edition of "Bacteria," which was noticed by the present writer in these columns in 1899; but the new publication is amplified and improved to such an extent as fully to merit this second notice. A. C. Houston.

Die bisherige Tätigkeit der Physikalisch-technischen Reichsanstalt. (Brunswick: Vieweg and Son, 1904.)

Die Tätigkeit der Physikalisch-technischen Reichsanstalt im Jahre 1903. (Berlin: Springer, 1904.)

In these publications is given an interesting account of the progress of the Reichsanstalt from its foundation in 1887 to the present time. From the first pamphlet by the president, Dr. Kohlrausch, we find that the total number of instruments tested up to the end of 1903 was 290,000, an average of nearly 20,000 a year. If, however, we deduct from this the number of clinical thermometers and of safety fusible plugs for boilers, the aggregate is reduced to 50,000, or an average total of about 2800 a year for all other instruments. Against this figure we may compare the totals taken from the report of the National Physical Laboratory for 1903, from which it appears that the aggregate for the year for instruments and tests of all kinds was 30,817, or, excluding clinical thermometers, 11,424.

An interesting recent development of the Reichsanstalt is the opening at various towns throughout Germany of five branch stations, where electrotechnical instruments can be verified. The report concludes with a long list of the recent original papers published by the members of the staff.

It is not possible to give in the space here available anything like an insight into the manifold contents of the second publication—the report of the Reichsanstalt for the year 1903. The researches mentioned include the expansion of water between 0° C. and 100° C., and of numerous materials from liquid air temperatures upwards, the laws of radiation, light units, and magnetic permeability. Full details are given as to the numerous instruments tested.

J. A. H.

The Principles of Inorganic Chemistry. By Wilhelm Ostwald. Translated by Dr. Alexander Findlay. Second edition. Pp. xxxi+799. (Macmillan and Co., Ltd., 1904.) 18*s.* net.

The best proof of the excellence of this work and its appreciation by English-speaking students is that a new edition has been found necessary after such a comparatively short time as two and a half years. The work, unlike many text-books on chemistry, forms interesting reading, and this is greatly caused

by the excellence of Dr. Findlay's translation. The present edition is practically a reprint of the first, except in so far as a few pages have been added on radio-active phenomena, in connection with the metals thorium and uranium; a necessarily short description is given of compounds of radium, and a sketch of the transformations undergone by that curious element in arriving at a stable condition. W. R.

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.*]

A Contemplated Magnetic Survey of the North Pacific Ocean by the Carnegie Institution.

A PROJECT for a magnetic survey of the North Pacific Ocean by the Department of International Research in Terrestrial Magnetism has been favourably acted upon by the executive committee of the Carnegie Institution of Washington, and authorisation has been given to begin the work this year. An initial allotment of 20,000 dollars has been made to cover the expenses for the current year.

As is well known, the state of our knowledge of the distribution of the magnetic forces over the greater portion of the earth—the oceanic areas—owing to the paucity of precise data, is exceedingly unsatisfactory. This fact is especially true for that great body of water the Pacific Ocean, rapidly developing in great commercial importance.

Captain Creak, for many years superintendent of the Compass Department of the British Admiralty, now retired, says:—"The North Pacific Ocean is, with the exception of the voyage of the *Challenger*, nearly a blank as regards magnetic observations, and I therefore think the Magnetic Survey proposed will be of great value."

Hence, except for data from occasional expeditions and such as were acquired in wooden vessels a long time ago, the present magnetic charts used by the navigator over this region depend largely upon the observations on islands and along the coasts. Such land observations, however, are rarely representative of the true values because of prevalent local disturbances. It is, therefore, impossible to make any statement as to the correctness of the present charts. The demands of science, as well as those of commerce and navigation, require a systematic magnetic survey of this region under the most favourable conditions possible, and that the work be done under the auspices of some recognised research institution in order to ensure that the scientific aspects of the work receive their adequate recognition.

The eminent physicist and magnetician Prof. Arthur Schuster states as his opinion:—"I believe that no material progress of terrestrial magnetism is possible until the magnetic constants of the great ocean basins, especially the Pacific, have been determined more accurately than they are at present. There is reason to believe that these constants may be affected by considerable systematic errors. It is possible that these errors have crept in by paying too much attention to measurements made on islands and along the sea coast. What is wanted is more numerous and more accurate observations on the sea itself." Furthermore, the superintendent of the United States Coast and Geodetic Survey, Mr. O. H. Tittmann, says:—"There is no doubt in my mind that a survey for that purpose would result in obtaining data of great and permanent value, and that it should be undertaken."

Additional quotations could be given; the above, however, are representative, and show sufficiently the great importance of the proposed work and the fruitful results that may confidently be expected. It is hoped that upon the completion of the magnetic survey of the North Pacific the means will be forthcoming for extending the survey so as to include other oceanic areas. An effort will furthermore be made to secure the interest and cooperation of all civilised countries, so that we may look forward to the completion of a general magnetic survey of the accessible portions of the globe within about fifteen years. Thanks to the awakening and renewed interest in magnetic work shown on all sides, I fully believe that this hope will be realised.

The matter of prime consideration in magnetic work at sea is the elimination of the effects resulting from the ship's own magnetism as due to her construction and equipment. Such effects are especially troublesome to eliminate when it is proposed to obtain not only the magnetic declination at sea, but also the other magnetic elements (the dip and the intensity of the magnetic force). The plan therefore to be attempted this year, as worked out by Mr. G. W. Littlehales, Hydrographic Engineer of the United States Hydrographic Office, and Consulting Hydrographer of the Department of Terrestrial Magnetism of the Carnegie Institution, is, in brief, as follows:—"To charter a wood-built, non-magnetic, sailing vessel of about six hundred tons displacement, which starting out in summer from San Francisco, shall pursue a clockwise spiral course embracing the entire North Pacific Ocean. The object of planning such a course is to gain continuous advantage throughout the survey of the dynamical agencies of the atmosphere and the ocean, in passing in succession into each of the five degree quadrangles into which the chart [1] is divided, and in which observed values of the three magnetic elements need to be obtained.

"The seasonal shifting of the permanent centres of barometric pressure will cause a variation from month to month of the conditions of wind and current that are represented on this particular chart, but if the departure from San Francisco be taken in the summer, the chain of meteorological events will contribute toward the maximum progress over the course passing thence along the west coast of America to the vicinity of the Galapagos Islands, thence across the Pacific in latitude between two and three degrees north, thence along the eastern side of the Philippine Archipelago and the Empire of Japan, thence eastward in about latitude fifty-two degrees north, thence to the latitude of San Francisco, and thence continuing through the series of areas, bounded by parallels of latitude and meridians of longitude each five degrees apart, lying next on the mid-ocean side of the circuit last made, and proceeding gradually and by successive circuits into the central region of the North Pacific."

The total length of the course marked out is about 70,000 knots; however, each of the first circuits practically closes at San Francisco, so that, if it is found that the method pursued is not the best, the work can readily be terminated or modified. From inquiries made, it would appear that the entire work of observation and reduction can be accomplished in three years. The cost per month of the field work, inclusive of all expenses and services, will be approximately fifteen hundred dollars. Counting eight months of continuous service per annum, the total annual outlay is estimated at about twelve thousand dollars.

This project, as a result of careful consideration and solicitation of expert opinion, is believed to be thoroughly feasible. It permits of useful comprehensive results being immediately obtained, and is one which can be interrupted without any important waste of antecedent expense whenever circumstances may render a discontinuance or a modification of the original plan advisable.

The region it is proposed at present to survey fortunately contains magnetic observatories in requisite number and proper distribution for furnishing the necessary corrections to be applied to the observed magnetic elements in order to reduce them to a common epoch. Thus continuous records of the magnetic variations required for this purpose will be available from the following stations:—Sitka, Mexico, Honolulu, Manila, Shanghai, Tokio. In addition, it is hoped that there may be soon a magnetic observatory in California or vicinity for lending effective cooperation, and that the German Government will continue its magnetic observatory at Apia throughout the period of the survey. Also excellent opportunities for controlling instrumental constants and obtaining required additional data will be afforded by stations on the coasts and on islands.

It should also be pointed out that the plan of the courses

[1] The course to be followed was shown in red ink on a U.S. Hydrographic Office Pilot Chart of the North Pacific.

as mapped permits ready adjustment of the observed quantities for closed areas, in accordance with the potential hypothesis, and it may even permit, to a certain degree, the testing of the accuracy of this assumption, though as regards the latter more can be said at the end of a year's work.

While it is not anticipated that any marked irregularities in the distribution of the earth's magnetism will manifest themselves over the deep waters of the Pacific, it may confidently be expected that in the neighbourhood of the islands and along the coasts distortions and irregularities will be revealed. With the aid of the results of the detailed magnetic survey of the United States and Alaska, opportunity will therefore be afforded of studying the effect of the configuration of land and water upon the distribution of the magnetic forces. The first circuit, passing as it does along the American and Asiatic coasts, will yield especially interesting results in this respect. Thus, for example, along the Aleutian Islands marked local disturbances will be disclosed. Reports are received frequently from mariners in this region regarding the unsatisfactory behaviour of the compass; it is therefore greatly to be desired that a systematic magnetic survey of the waters in this region be made.

L. A. BAUER.

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Recently Observed Satellites.

IN reply to Sir Oliver Lodge's letter in NATURE of January 26 (p. 295), it may be said that while it is perfectly possible that the newly discovered satellites are captured comets (see *Harvard Annals*, liii., p. 60), yet the chances against the actual occurrence of the required conditions at exactly the right times, even in one case, are exceedingly large; in two cases they are practically prohibitive.

With regard to a possible meteoric constitution, it is known that the density of the four larger satellites of Jupiter is extremely small—but little above that of water. That their discs are frequently found to be elliptical when seen under favourable conditions has now been noted by more than a dozen different astronomers. The regularly recurring changes in their ellipticity, noted by several observers, taken in connection with the small density of these bodies, can hardly be explained in any other manner than by a meteoric constitution. Such being the case, it is highly probable, as Sir Oliver Lodge suggests, that the newly discovered satellites are similarly constituted.

A reply to his further suggestion that they are now in process of dissolution is impossible in the present state of our knowledge. If formed according to the nebular hypothesis, however, as seems most probable, and if they have accordingly existed through the æons during which their primaries have been contracting to their present dimensions, it seems highly unlikely that they should not yet have reached a permanent condition.

WILLIAM H. PICKERING.

Cambridge, Mass., U.S.A., February 9.

Compulsory Greek at Cambridge.

THE proposals of the Studies and Examinations Syndicate in regard to certain changes in the Previous Examination are to be submitted to the Senate on March 3 and 4. Members of the Senate may record their votes on either of these days between 1 and 3, or between 5 and 7 p.m. The controversy has chiefly turned on the proposal to abolish compulsory Greek, and it is mainly on this question that the issue will be decided.

All the five Graces are important, but Grace II., which raises the main issue, is the most important of all.

The secretaries of the committee in support of the recommendations of the syndicate will be glad to hear from non-resident members of the Senate who have not already intimated their intention of supporting the proposed reform. It is believed that amongst resident members of the Senate a majority will vote in favour of the new scheme, but the decision is largely in the hands of non-resident voters. As it is proposed to issue a final list of supporters shortly before March 3, it will be a convenience if additional names are sent to Mr. A. C. Seward, Emmanuel College, Cambridge, at once.

R. VERE LAURENCE,
H. RACKHAM,
A. C. SEWARD.

Cambridge, February 21.

THE experiences of Mr. Willis and others suggest that mine may be in point. Mr. Willis was behind in classics. He wasted 105½ hours on Greek and passed. His present knowledge of Greek, he adds, is *nil*.

Mathematics were my difficulty. Being destined for Cambridge, I was specially coached in mathematics at school. Arrived here I was again coached, but failed. Coached once more I passed, having wasted, not one, but several hundred hours on that study. Needless to say, my knowledge of mathematics is *nil*.

My case is that of hundreds. Why, then, are not compulsory mathematics to be reformed away? Because they can be used in trades and professions for the making of money. But the things that put one touch of art in the life of a dull boy, that open his eyes for once to another world, where "utility" does not count—they, forsooth, must be dispensed with because in the market they have no value. And, verily, they are without price.

Away from Cambridge, an intelligent lady was lately speaking to me of her nephew at the University of Birmingham. Knowing nothing of our pending "reform," she said: "He is going to be an engineer. But he has got to waste his time passing in French, and German, and English. He will never want them again in his whole course. It is absurd."

W. BATESON.

Cambridge, February 17.

Secondary Radiation.

IN a paper recently published (*Transactions* Royal Dublin Society and *Phil. Mag.*, February) I described some work on secondary β radiation given off by substances when exposed to β (and γ) rays from radium. The paper gave the relative intensity of this secondary radiation for only a few elements, but the results from these few indicated that the greater the atomic weight the greater was the secondary radiation.

I have since tested a large number of elements, and found this rule to hold without a single exception. The list of substances tested was a very varied one, including carbon, magnesium, aluminium, chromium, iron, nickel, copper, zinc, arsenic, selenium, molybdenum, silver, tin, antimony, tungsten, platinum, mercury, lead, and bismuth.

The secondary radiation is not proportional to the atomic weight; it increases less rapidly than the atomic weight.

This very general result appears to be of interest as bearing on the subject of radio-activity and atomic structure in general, but cannot be further discussed here.

J. A. MCCLELLAND.

University College, Dublin, February 13.

Tenacity to Life of a Grass-snake.

A GRASS-SNAKE which the writer had in his possession for eighteen months has just died.

A fact which seems worthy of note is the length of time during which this snake fasted. The last time the snake fed was June 11, 1904, the meal consisting of a small frog. From that time until the date of its death, February 2, it took no food, although constantly offered it. The animal thus existed for close on eight months without food. During the whole of this time it appeared in good health, and was, at times, most animated. No approach to hibernation was observed, and only for a little more than a week before its death did the snake seem out of health. The body was not unduly thin.

E. V. WINDSOR.

Barnet, February 7.

NOTES ON STONEHENGE.[1]

IV.—THE EARLIEST CIRCLES (*continued*).

THE conclusion at which I have arrived is that the older temple dealt primarily, but not exclusively, with the May year; the newer temple represented a change of cult, and was dedicated primarily to the solstitial year. In both, however, the sunrises and sunsets of the June-December and May-November years could be, and doubtless were, observed. I direct attention to the following considerations in support of this theory.

(1) The blocks of unworked sarsen, perhaps dating from a time when the use of stone tools for working stone in Britain was unknown, are precisely those which give us the alignments, both for the May and June years.

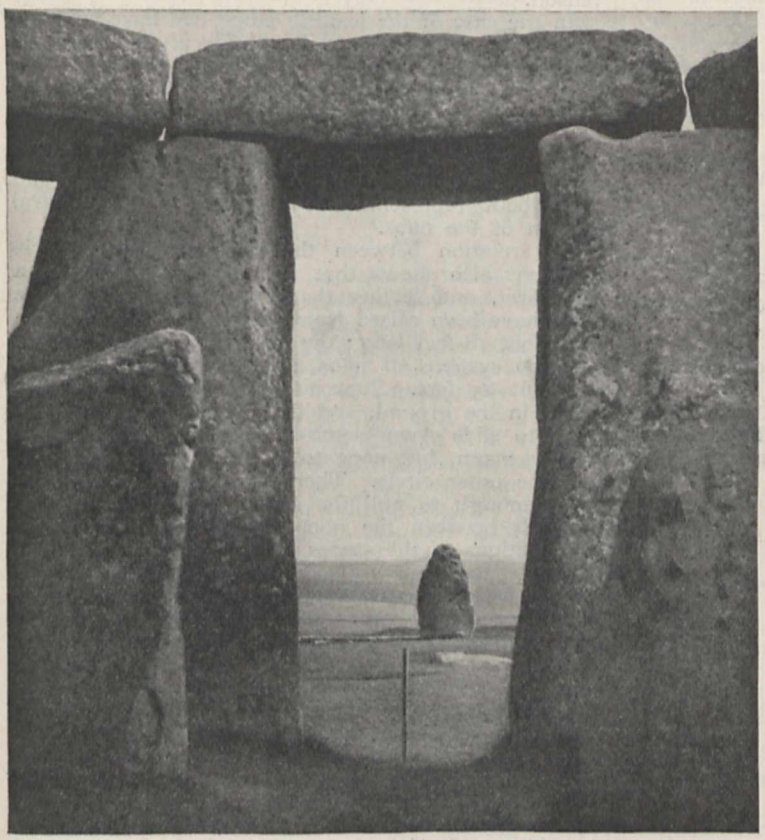

FIG. 10.—The vertical rod is placed in the axis, and marks the common direction of the present temple and avenue, which passes about 3 feet to the N.W. of the Friar's Heel.

(2) The blue stones, unworked for the same reason, may have originally composed two circles and a central stone as a start point for these alignments. The central stone, marking the centre of the two concentric circles, would naturally stand half-way between the N.W. and S.E. exterior sarsen stones.

In this first simplest form we should have the equivalent of the ancient temple described by Virgil, with the uncovered altar at the centre after the Etruscan fashion.

> "Ædibus in mediis, nudoque sub ætheris axe,
> Ingens ara fuit."

It is sad to think that at Avebury not so very many years ago there were two such double circles as those I postulate. They have now almost entirely disappeared. The central observing place, a cove, in the northern circle still remains with some of the stones of the outermost circle; all the rest have been taken up, broken, and used for building. Truly the English are a "practical" people.

(3) At the reconstruction, about 1680 B.C., the solstitial cult was made predominant, and for some reason or other it was determined to change the centre of the circles in the new structure, and throw the N.E. alignment nearer the north, still remaining parallel to its old direction.

There may possibly have been two reasons for the reconstruction of the temple about the time I have named. At the date mentioned the place of sunrise from the old centre, which I have indicated, was hidden by the Friar's Heel, unless the observer, the high priest, were raised some few feet above the ground at its present level. It may have happened, then, that the difference of the sunrise place, brought about, as we now know, by the gradual reduction of the obliquity of the ecliptic, had shown itself in a very unmistakable way to the priests; in 2680 B.C. it was certainly well to the north of the Friar's Heel, and occupied an uninterrupted horizon, so that they might well wish to secure a clear horizon for the future; this they found by moving the centre of the circles, and therefore the solstitial line, a few (about 4) feet further to the N.W., still preserving their ancient pointer.

But this is not all. Colonel Johnston, the director of the Ordnance Survey, has obligingly pointed out to me that the present centre of Stonehenge, Sidbury Hill to the N.E., and the earthworks at Grovely Castle and Castle Ditches to the S.W., all lie exactly on the solstitial line in 1680 B.C. The top of Sidbury Hill may, then, have been taken for the new pointer, in which case the earthwork camp some 30 feet high on the top had not been built, for it lies a little to the north-west of the line.

(4) While it was determined to erect a temple on a much larger scale by the addition of a larger exterior circle of sarsens and a naos also of trilithons, it was also determined to utilise the unworked blue stones composing the two circles. But while the new sarsens were shaped where they were found (for the very good reason stated by Prof. Judd), the blue stones were taken up and trimmed *sur place* as the new more northerly line and the new centre, to say nothing of the new naos, necessitated their re-arrangement. In this way the excess of blue stone chippings found by Prof. Gowland is simply and sufficiently explained.

(5) It is quite possible that the rebuilding of the temple in 1680 B.C. was part of a very large general plan which could only have been undertaken by a large, powerful and comparatively civilised tribe or people under strict government, commanding the services of skilled mathematicians, for Colonel Johnstone's revelations do not stop at the continuation of the Stonehenge solstitial line to Sidbury and Grovely Castle.

The absolute straightness of this line might have been secured by fires at night, but there is more in

[1] Continued from p. 368.

it than this. Stonehenge, Old Sarum, and Grovely Castle occupy the points of an equilateral triangle of *exactly* six miles in the side, and the three sides are continuations of the entrances at Stonehenge and Old Sarum and of a ditch running through the centre at Grovely Castle. Further, the centre of the triangle

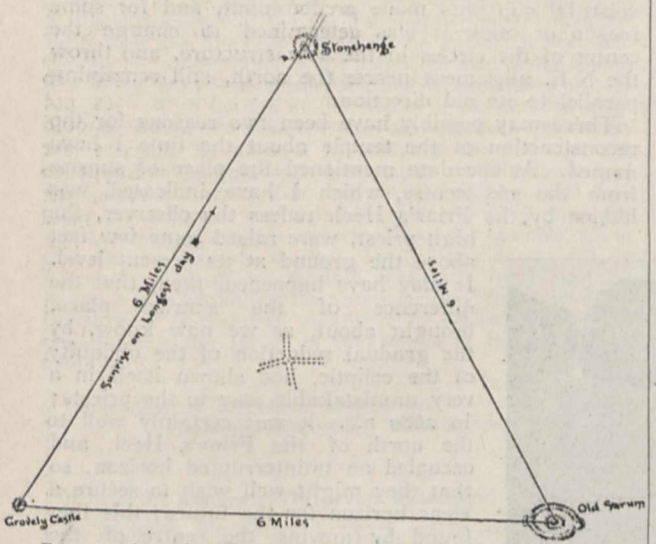

FIG. 11.—The equilateral triangle formed by Stonehenge, Old Sarum, and Grovely Castle.

is on the oldest cross roads in that part of Salisbury Plain.

The figures will show this, and also the curious position of other earthworks, as well as the fact that the line Stonehenge—Old Sarum passes *exactly*

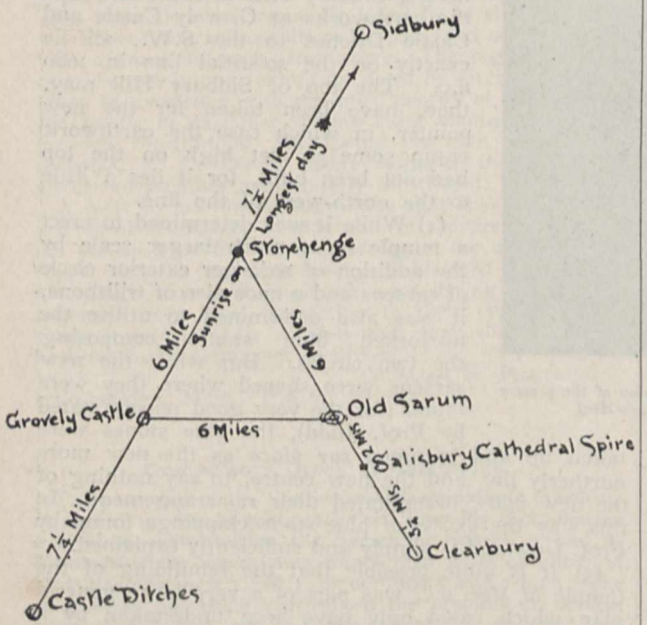

FIG. 12.—Showing the prolongations of the sides of the equilateral triangle.

through Salisbury spire, which again is exactly two miles from Sarum. We ought to restore the old name, Solisbury.

(6) It is probable that the avenue and vallum were added when the line of orientation was moved to the N., placing the new centre to the N.W. of its original position. In this way we can explain how it is that the Friar's Heel lies to the S. of the central line of the avenue, and that the N.W. and S.E. stones are situated at different distances from the vallum.

(7) The number and spacing of the sarsen stones in the new great circle were so chosen that the use of the N.W. and S.E. stones to mark the May new year's day originally could be replaced by observations through one of the trilithons. This was necessary if the May year was to be considered at all, as the use of the N.W. and S.E. stones was blocked by the new outer circle.

Now, on the hypothesis of an earlier temple, it becomes quite clear, from the method of erecting the sarsens revealed by Prof. Gowland's excavations, that the stones comprising the two concentric circles must have been removed, even if there were no other reason.

In the case of the leaning stone, we have evidence that it was erected from the inside of the circle, as the perpendicular wall of chalk is on its S.W. side. If all the other naos sarsens were erected in the same way, there could have been no upright blue stones in the naos. They must have been set in the places they occupy afterwards, because the upright members of the naos trilithons are well over 20 feet long, and this about represents the distance to the central portion of the naos.

The relation between the naos and outer circle trilithons also shows that the naos must have been built first, and further that the outer circle sarsens must have been raised from the inside. Those fallen are about 18 feet long; the average distance between the two systems of naos and outer circle trilithons is about 23 feet. Supposing the outer sarsens are 4 feet in the ground, and that there was a slope for them to slide down some 6 feet long, there would just be room, but none to spare, between the naos and the outer circle. There certainly would not be room enough to pull the stones upright unless the intervals between the naos sarsens were used, and the positions of the stones show that they could not have been conveniently so used, in some cases at all events; we may assume that to pull the stones finally into their perpendicular positions ropes at least as long as those employed by Mr. Carruthers would be needed.

In any case the blue stone circles must have been away, whether removed from their old positions or not, when the naos and sarsen circle were put up.

On this point Prof. Gowland is quite clear.

He writes: "That the stones of the central trilithon were erected from the inside of the circle has been conclusively demonstrated by the excavations, hence the 'blue stones' in front cannot have been erected before them. Moreover, the 'blue stone,' No. 68, the base of which was laid bare in Excavation V., was found to be set in the rubble which had been used to fill up the foundation of No. 56, and further, in a lower layer than its base, there were two small blocks of sarsen with tooled surfaces.

"Whether the outer sarsens were set up from the inside of the circle like the trilithons, or from the outside, is a point which can only be settled by future excavations. If from the inside their erection must have preceded that of the trilithons, and hence of the 'blue stones.'

"On the other hand, should the outer sarsens have been raised from the outside, it would not be possible for the 'blue stones' to have been placed in position before them, as they would then have seriously interfered with if not altogether prevented the erecting operations."

We may take it, I think, that the ring was erected

from inwards, sufficient ground only being available outside for "a long pull and a strong pull."

In former notes I have referred to Mr. Cunnington's remarks on the remains of the syenite trilithon, and his suggestion that it formed part of an older temple. He expressed the view that the structure of Stonehenge as we know it with its trilithons was, in fact, suggested by it.

Now if we attempt to find the place it occupied before it fell by seeing where it would be most symmetrically placed in relation to the adjacent stones of the blue stone circles still standing, we are led to an interesting result. Using the old centre as determined from the N.W. and S.E. stones we find that the May sunrise would be seen through the small syenite trilithon. In this way also we can account for the fact that so far as is known this is the only trilithon which existed in the old blue stone circle; it may well have been that the centre and diameter of the new blue stone circle were so regulated as to retain it in position; I have already remarked that this was done in the case of the older unhewn sarsens, as a memorial of the past.

NORMAN LOCKYER.

THE APPROACHING TOTAL SOLAR ECLIPSE OF AUGUST 30.

THERE are many special features about the total solar eclipse of August of the present year. In the first place, perhaps the chief of these is that it will occur about the time when the solar atmosphere is greatly disturbed, or in other words, at a time when the number of sun-spots is about a maximum. Second, the localities from which it may be observed are well distributed over land surfaces, and some are easily accessible from the British Isles. Thirdly, observers will have to wait many years before another favourable eclipse occurs. That in 1907 will be visible in Central Asia, but its occurrence in January will deter many from seeing it. The two eclipses in 1908 will be visible only from the Pacific and South Atlantic. The eclipse of 1909 will occur in June in Greenland, while that in 1910 will be visible only from the Antarctic regions. In 1911 only a short portion of the end of the eclipse track will pass through a part of South Australia. It is therefore the eclipse of 1912, that will take place in April in Spain, which will be the next easily accessible one to observe; but as totality will only last 60 seconds, its duration will be brief compared with that of this year, which will last for more than 3½ minutes.

Further, the fact that the approaching eclipse occurs in a month, such as August, when a great number of people are taking their summer holiday, and therefore can more easily leave these shores, should ensure the presence of many volunteer observers at the more easily reached stations. In the present instance the zone of totality commences in Canada towards the south of Lake Winnipeg, skirts the extreme south of Hudson's Bay, passes a little to the north of Nova Scotia, and then crosses the Atlantic. In Europe it strikes Spain (Fig. 1) on its north-west coast line, and leaves the eastern coast, enveloping the islands of Majorca and Iviza. Reaching Africa in the neighbourhood of eastern Algeria (Fig. 2), it passes through Tunis, Tripoli, Egypt, and the Red Sea, and finally terminates in Arabia.

In Spain an opportunity is afforded of making observations at some stations of high altitude, for the eclipse track includes several lofty mountains. For instance, Penas de Europa, south-west of Santander, and 8000 feet high, is one of numerous possible observing peaks, and advantage should be taken of this or some other elevated region.

It will thus be seen that there is plenty of scope for observers to scatter themselves along the line of totality, and this should be done as much as possible. The low altitude of the sun during totality at Labrador (27°) and Egypt (24°) renders both these regions somewhat unfavourable for the best observations, but there parties should at any rate be present. The former region can undoubtedly be left to Canadian and American observers, for it does not seem necessary that European observers should journey so far when more favourable stations are nearer at hand. The close proximity of Egypt to many European countries renders this part of the zone of totality easily accessible. Here the central line of totality passes just a little north of Assuan, the outer limits enclosing Edfu on the north and Darmut on the south.

The probable weather conditions at the different stations form an important item in eclipse matters, for clouds can easily mar the work of even the best

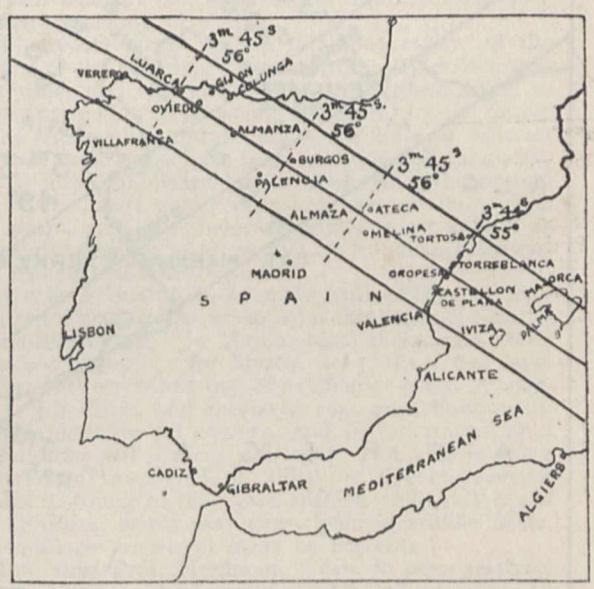

FIG. 1.—The path of totality across Spain. The duration of totality and the altitude of the sun at that time are given for four different stations along the line.

organised expedition. Omitting Labrador, a station that will not be occupied by observers from this country, the north-western portion of Spain does not seem to be particularly favoured with the required weather conditions. According to Señor F. Iñiguez, the director of the Astronomical and Meteorological Observatory of Madrid, this locality during August is not only cloudy and damp, but storms are of frequent occurrence. Such a report, however, should not prevent one party at least from taking up a position there, but it should suggest to many who had up to the present made up their minds to observe in that locality to seek stations further along the line, and not congregate at a very probably unfavourable station such as this appears to be. At stations towards the east the conditions seem to be more suitable the closer the Mediterranean side is approached, and, according to the authority mentioned above, the probability of fine weather on this coast is very high. Inland stations will probably have the disadvantages of dust and heat combined.

Perhaps one advantage of the north-west over the east coast is that the former will be very much the cooler, but in eclipse matters sky conditions precede temperature considerations.

With regard to such matters as suitable sites for instruments, their safety, guards for camps, building materials, &c., the Spanish Government can be depended upon to render every assistance to those who apply through the proper channels, and the valuable aid they gave to parties during the eclipse of 1900 is still in the memory of many observers.

Those who wish to know something about the routes to Spain, the methods of travel and approximate cost, will find some interesting and useful information in an article recently writen by Mr. G. F. Chambers, and published in the *Journal* of the British Astronomical Asociation (vol. xv., No. 2, p. 93). Another source of information specially useful to those visiting Spain is a publication just received from the Astronomical Observatory of Madrid, entitled

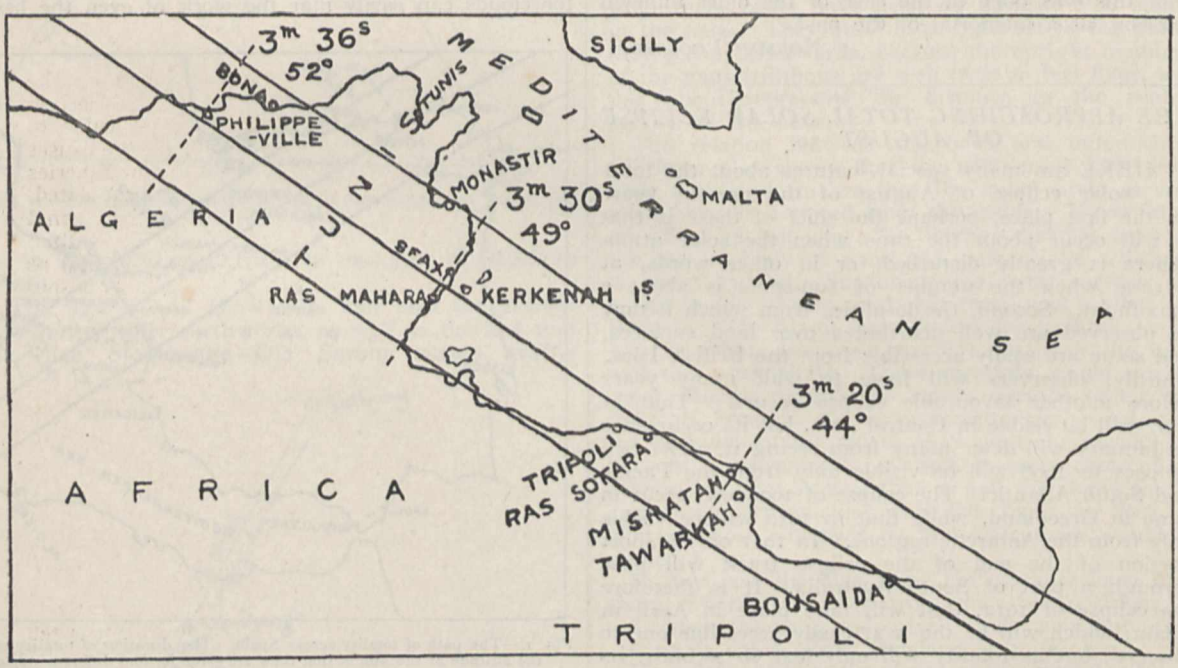

FIG. 2.—The path of the totality track in northern Africa. For three stations the duration of totality and the altitude of the sun during the eclipse are marked on the map.

"Memoria sobre el Eclipse Total de Sol del dia 30 de Agosto de 1905." This has been prepared by the director, Señor Francisco Iñiguez, and contains details about climate and many useful maps, in addition to data about the eclipse itself.

The weather conditions for the stations situated in Algeria, Tunis, and Tripoli seem to be very favourable, and should be made the most of. For Algeria, and more especially for the neighbourhood of Philippeville, we have some useful facts which have been communicated through M. Mascart by M. A. Angot, of the Bureau Central Météorologique, Paris. Dealing first with cloud and rain, we learn that during the months of July and August Philippeville is the clearest and driest of all the coast stations in Algeria, the mean rainfall for these months amounting to 4 and 10 millimetres respectively out of a total of 807 millimetres for the whole year. The average number of rainy days for each month totals two or three. Storms are rare, but increase towards the interior. If we represent clear sky by 0 and sky covered by 10, then 2 or 3 would represent the condition of cloudiness at Philippeville.

As regards temperature, the diurnal variation has an amplitude of 9° C. or 10° C., the mean temperature being 24° C. (75° F.). By night the temperature would thus be about 18° C. or 19° C. (64° F. or 66° F.), and at two hours after noon the maximum day temperature would reach 29° C. or 30° C. (84° F. or 86° F.). For stations situated some tens of miles inland there is a very rapid increase of day temperature.

The prevailing winds in August vary from N.E. to N.W., *i.e.* are sea winds; they are not strong, and are not much augmented by the sea breeze.

In Egypt the prospect of fine weather in August is also very great, so that observers who go to that region need not be very anxious, at any rate about clouds.

It is impossible at present to give a full or even final statement regarding the distribution of parties along the line of totality, but the following preliminary, but incomplete, list may be of interest, and indicates not only the regions that will be occupied by most of the British expeditions, but the chief types of observations that are proposed during the brief interval of totality. For the greater part of this information I am indebted to Major E. H. Hills, C.M.G., secretary of the Joint Permanent Eclipse Committee of the Royal Society and Royal Astronomical Society:—

Labraaor.

Lick Observers		Search for intra-mercurial planets. Large scale corona photographs.

(Canadian parties probably.)

Spain.

Mr. John Evershed.	Near Burgos...	Prismatic reflector photography of chromosphere and corona.

Prof. Callendar ... Prof. A. Fowler ... Mr. W. Shackleton.	Near Oropesa.	Experiments on coronal radiation. Photography of the red and green regions of the spectrum of the chromosphere and corona.
Lick Observers		Search for intra-mercurial planet. Large scale corona photographs. Polarisation observations. Spectroscopic photographs of chromosphere and corona.
Algeria.		
Sir Norman Lockyer Dr. W. J. S. Lockyer Mr. C. P. Butler ...	Near Philippeville	Prismatic camera (three prisms) photographs of chromosphere & corona. Large scale prismatic reflector photographs of chromosphere & corona. Small scale photographs of corona.
Mr. H. F. Newall...	Near Bona ...	Spectroscopic and polariscopic observations.
Tunis.		
The Astronomer Royal ... ... Mr. F. W. Dyson... Mr. Davidson ...	... Sfax ...	Photographs of the corona on 4-inch and 1¼-inch scales. Spectra of chromosphere & corona with Major Hills's spectroscopes.
Egypt.		
Prof. Turner ... ... Mr. Bellamy	... ...	Polariscopic observations. Corona photographs with Abney doublet. (Large scale photographs of the corona ?)
Lick Observers		Search for intra-mercurial planets. Large scale corona photographs. Integrating spectroscopic photographs.

One of the novelties that will be attempted during this eclipse will be the photography of the eclipsed sun by means of the three-colour process. The camera that will be employed will probably be one having three lenses, so that the exposures through the three coloured screens can be made simultaneously, the correct ratio of the exposures being obtained by adjusting the apertures of the lenses.

When it is considered that in addition to these parties there will most probably be expeditions from several other countries, such as Spain, Portugal, Holland, France, Germany, Italy, Russia, Egypt, &c., and probably one or two more United States expeditions, there is a great opportunity not only for occupying a large number of different stations along the line, but of gaining a quantity of valuable material to enlarge our knowledge of solar physics.

WILLIAM J. S. LOCKYER.

THE CEYLON PEARL FISHERIES.[1]

LITTLE enough is done by the State in this country in the matter of aiding scientific research, and this is especially true of biological science. To this attitude of indifference, or aloofness, we have grown accustomed; abroad it is a subject for uncomplimentary comment. This attitude cannot be due to the conviction on the part of our ministers that "science is bankrupt," since when some great industry is threatened by injuries which legislation is powerless to check, or some pest is threatening the welfare of the community, the aid of the man of science is at once invoked.

The Pearl Fishery Commission is a striking example of the intervention of the State to aid a crippled industry by calling in the aid of the biologist.

The series of barren years alternating in some mysterious way with years of plenty puzzled those engaged in this fishery for more than two centuries, and, moreover, seriously reduced the profits of the fishing. To fathom this strange uncertainty, and if possible to find means whereby more uniform harvests could be ensured, the Government submitted the matter to a commission of inquiry, which has been held under the auspices of the Ceylon Government. The results of this inquiry have abundantly justified those responsible for its inception, and should do much to establish the advisability of instituting inquiries into other problems to which we could point that can only be dealt with by trained and experienced biologists.

The second part of Prof. Herdman's report to this commission in no wise suffers by comparison with the first volume. It is a very mine of information, yielding rich lodes of fact without the trouble of any preliminary crushing or sifting.

This report opens with a luminous review of the history of the principal fisheries from 1801 to the present time, and should prove of the highest value to those engaged in pearl fishing in future, for the causes of the rise, zenith, and decline of the different fisheries between these dates have been analysed and tabulated.

It is now established beyond doubt that the normal life of the pearl oyster does not average more than five years, and that these, especially to an animal so peacefully disposed as an oyster, are full of catastrophes and rumours of catastrophes!

By way of illustration as to the truth of this, we may well select an instance or so from this report. On the "Kondatchi Paar" in March, 1902, there were about 5,750,000 oysters. By March, 1903, these had been almost entirely wiped out of existence—eaten by star-fish! File-fishes and enormous rays also show an insatiable appetite for oysters, and in the course of a few months will devour millions! Not seldom these oysters are smothered or killed by the invasion of hordes of young of their own species. But this is not all. Shifting sands may overwhelm incredible hosts, and millions are swept away by currents.

Man, says Prof. Herdman, "can do comparatively little to mitigate the severity of such influences as tell against the life and prosperity of the Pearl Oyster."

But it is just because he can do so little that there is so great a need of a vigilant and intelligent watch being constantly kept on the different fishing grounds. To a very considerable extent, Prof. Herdman has shown that man can make good these ravages, or snatch the remnant at least of a disappearing host from destruction. His plan is to transplant young oysters from beds known to be dangerous into more sheltered areas. This rescue work is to be further turned to account by using the waifs and strays, which are to be garnered by the inspection vessel, for re-stocking old beds, where they may grow and thrive—and become infected by the chosen parasite to keep up the growth of pearls of great price!

To ensure this infection is one of the problems which Mr. Hornell, the inspector of fisheries, is to solve.

The life of the pearl oyster is, as we have remarked, about five years, and it is from those of this age that the finest pearls are obtained. Herein lies a danger, since there is always a strong temptation to delay fishing as long as possible to ensure big pearls. Unless, as Prof. Herdman points out, these beds be carefully watched, one of the many catastrophes which attend pearl oysters may carry off this precious crop before

[1] "Report to the Government of Ceylon on the Pearl Oyster Fisheries of the Gulf of Manaar." By W. A. Herdman, D.Sc., F.R.S., &c. Part ii. Pp. viii+300. (London: The Royal Society, 1904.)

it can be gathered. A case in point is given by Prof. Herdman. The Mutuvaratu Paar, which lies to the south-west of Karativo Island, yielded during 1889, 1890, and 1891 some 117,000,000 oysters, which realised very nearly 1,000,000 rupees—the only fishery since 1814 that has returned so large a sum. The oysters raised during these three years steadily increased in value, those lifted in 1891—the oldest—being by far the most valuable. "But the record," he remarks, "shows the risk there is in trying for the enhanced value by delaying the fishery once the oysters are over 5 years of age. In 1891 this bed must have been 6 years old, and they are described as rapidly dying off, many being dead and putrid."

There are prospects of a good fishing for next year and 1906, but the results of 1907 and the succeeding years depend largely, it is pointed out, on extensive measures of transplantation being undertaken without delay. This Mr. Hornell will doubtless accomplish.

Prof. Herdman's memoir on the anatomy of the pearl oyster adds much to our knowledge of the subject, and contains some valuable observations on the living animal. As an instance of the latter we may cite his remarks on the functions of the foot. These, he points out, "are three-fold: the distal ventral surface subserves locomotion; the median and posterior parts effect attachment by means of the byssal fibres; and lastly, on account of the general mobility of the organ, and probably of its sensory nature, the tip is of great use in clearing the gills and mantle from the intrusive particles that cannot otherwise be got rid of."

FIG. 1.—Pearl-fishing Fleet at work on the Cheval Paar.

It is concerning the latter function that we would direct special attention here. In the living animal Prof. Herdman has observed the foot "pushed between the gill-plate, and over the inner surface of the mantle gently stroking the surface and insinuating itself into the crevices, thus freeing the parts from any foreign bodies . . . that might cause inconvenience."

Mr. Hornell observed one oyster, which had sustained an injury to the mantle, pass the foot-tip gently around the edges of the wound so as to work off the particles of dirt collected there. The tip was even passed *through* the wound to make the cleansing the more thorough.

Concerning the byssus, it is interesting to notice that the operation of dredging for oysters for transplantation in no wise injures the animal when anchored by the threads of which this is composed. Under a great strain these break, and are renewed again within an hour or so, the root of the old byssus being sloughed off.

Some interesting points concerning gill structure are given, especially with regard to the passage from interfilamentar junctions by ciliated discs to junctions by organic union.

With regard to sense organs, the pearl oyster is not very well provided. But a distinct response is shown to the stimulus of light and shadow—"a sensibility which may be termed dermatoptic," and appears to be located in the edges of the mantle and the surface of the foot, where patches of more or less deeply pigmented epithelial cells are met with.

All kinds of creatures seem to find the pearl oyster a particularly "toothsome" morsel, man alone excepted, who prefers to make manure of their bodies for the sake of possible pearls contained therein.

No less than seven different kinds of parasitic worms are now known from the pearl oyster, six of which are new species described in this volume. Of these, only one, a cestode larva (*Tetrarhynchus unionifactor*), appears to be concerned in the formation of cyst pearls. This fact is interesting, inasmuch as the formation of similar pearls in European mussels is due to the cercaria of trematodes.

As to the sequence of hosts called upon to nurse this precious cestode of the pearl oyster to maturity much uncertainty prevails. It was thought that file-fishes and elasmobranchs were the intermediate vertebrate hosts, and this will probably prove to be the case.

Certain novel features seem to be foreshadowed in the life-history of this parasite when the chain of evidence is complete.

To begin with, it would appear that it enters its first host—the pearl oyster—as a free-swimming planaria-like larva, inasmuch as certain larvæ of this type, but containing calcareous corpuscles recalling those of cestodes, were taken in plankton, and these bear, in many features, a close resemblance to the earliest encysted larvæ found in the pearl oyster.

It is assumed that these free-swimming forms are tetrarhynchids, though hitherto it has been believed that tetrarhynchid larvæ make their way into their first hosts while still encased within the egg-shell. The bothriocephalids have free-swimming larvæ, but these are ciliated. That the larvæ in question must be tetrarhynchids seems certain, since older larvæ, showing several stages of development, belonged unquestionably to the genus Tetrarhynchus.

It was believed that these larvæ were next ingested by file-fishes (Balistes), but it now appears that the tetrarhynchid larvæ of Balistes, of which three species are described in this report, are quite distinct forms, distinguished by the presence of a vesicle, which is wanting in the pearl oyster larvæ. Further, the more advanced larvæ of the pearl oyster have arrived at a later stage of development than the larvæ found in Balistes.

The final stage of the pearl oyster cestode was supposed to be undergone within the body of an elasmobranch which fed upon Balistes. But, so far, the only elasmobranch tetrarhynchid which the authors have examined was obtained from the spiral valve of a sting ray (*Taeniura melanospilos*), and this larva was of a species quite distinct from either the Balistes or oyster larvæ. It is to be noted, however, that from this ray two perfect specimens of Balistes were taken.

Thus, though we may yet find that the sequence of hosts is as was indicated in the first volume of this report, we are at present left somewhat in doubt. In due time, doubtless, Messrs. Shipley and Hornell, the authors of this really fascinating section, will solve the riddle.

We have dealt at some length on this matter because, apart from its interest as a sequence of stirring events in the life-history of a very humble organism, it has considerable importance from an economic point of view: since, when the chain of evidence is complete, it may be possible, as was first suggested by Keelart in 1857, to raise the percentage of pearls by infecting oysters in other beds with their parasites.

Prof. Jeffrey Bell contributes some notes on the echinoderms, appended to a description of the species collected, by Prof. Herdman. Although these notes barely fill three pages, Prof. Bell has crowded into this space some trenchant criticisms and some really valuable facts.

The reports on the arthropods are full of interesting matter, and deal with a large number of new species; but we venture to think that a longer summary of the principal results arrived at would have added to the usefulness of these chapters. Dr. Calman's work on the Cumacea will be welcomed, inasmuch as no species of this group have hitherto been described from any part of the Indian Ocean.

The collection of cephalopods has been worked out by Dr. W. E. Hoyle. Though small, it contained one new species of unusual interest. This was a small octopus, which has been named *Polypus arborescens* on account of the presence of curious branched processes scattered all over the body, some of which are surmounted by a tuft of fibrils. After a most careful study Dr. Hoyle is still uncertain as to their purpose. He dwells at considerable length upon their microscopical structure. He is satisfied that they are not parasitic organisms, nor are they, he considers, glandular or phosphorescent organs. The fact that no nerves have been traced to them would seem to show that they are not tactile bodies, yet on the whole he considers that it is this function which they perform. Prof. Herdman, who has studied the living animal in a small tank, describes these mysterious processes as being contractile, and "kept frequently moving—uncoiling to a considerable length and then curling up again suddenly." This seems to suggest that they may be alluring organs comparable to the waving flag of the angler-fish or the long, worm-like tongue of the "mata-mata" tortoise.

The fishes collected during this investigation have been described by Mr. J. Johnstone. Twelve species in all are dealt with.

The most interesting feature of this report is that concerning the supposed naso-pharyngeal passage in Cynoglossus. Kyle, in 1900, described in this genus a curious nasal sac, which, he believed, communicated with the mouth by means of a pore in the floor of the sac, a feature which he regarded as of considerable morphological importance.

Mr. Johnstone examined several species belonging to this genus, and in no case did he find this naso-pharyngeal passage. But what is really interesting is the fact that he found this cavity, on more than one occasion, inhabited by a copepod. Since this creature anchors itself by hooks, the presence of an occasional hole in the floor of this chamber is not to be wondered at!

There is a wealth of plates in this volume, all of which are as good of their kind as one could wish. The same cannot be said of one or two of the text figures, however, which leave much to be desired—notably the figure of the dissection of a pearl oyster on p. 43.

Yet another volume is required to complete this report; this is promised early next year. Judging by the standard set by the two volumes now issued, the complete work will form one of the most valuable commentaries on a great industry yet issued.

W. P. P.

NOTES.

AT the invitation of the British Association, the local committee in Johannesburg has nominated the following as vice-presidents and secretaries respectively of the different sections for the meeting in South Africa, the general arrangements of which were described in NATURE of February 2 (p. 323):—*Mathematics and Physical Science*—vice-president, Dr. Breyer; secretary, Mr. R. T. A. Innes. *Chemistry*—Mr. J. R. Williams, Mr. W. A. Caldecott. *Geology*—Dr. Corstorphine, Dr. Molengraaff. *Zoology*—Dr. Gunning, Dr. Pakes. *Geography*, Mr. E. H. V. Melvill, Mr. F. Flowers. *Economic Science and Statistics*—Mr. S. Evans, Mr. Robert A. Ababrelton. *Engineering*—Mr. S. Jennings, Mr. E. Williams. *Anthropology*—Dr. Schonland, Mr. A. von Dessauer. *Physiology*—Sir Kendal Franks, Dr. A. Mackenzie. *Botany*—Mr. Burtt Davy, Prof. Pearson. *Educational Science*—Mr. E. B. Sargant, Prof. Hele-Shaw.

THE Hunterian oration delivered by Mr. John Tweedy at the Royal College of Surgeons on February 14, and abridged elsewhere in this issue, contains several interesting references to the growth of natural knowledge by the use of the experimental method, with illustrations from John Hunter's work. It has been said that though Hunter had never read Bacon, his method was as strictly Baconian as if he had. Mr. Tweedy pointed out that this view is based upon a complete misinterpretation of the Baconian system. Francis Bacon himself neither knew nor understood the physical sciences, and his spirit was much less modern than that of his illustrious namesake, Roger Bacon, who lived three hundred years before him. John Hunter did not follow the mechanical methods of the Baconian system, but he possessed every moral and intellectual qualification for useful scientific research—a fertile imagination ready to suggest possible relations of facts, openness of mind, and a conscientious scientific spirit that submitted every hypothesis to the test of observation and experiment, taking nothing on trust. Mr. Tweedy occupied the chair at the festival dinner held at the college in the evening of February 14, when there were present, among others:—Prof. C. Allbutt, Sir W. Broadbent, Sir Lauder Brunton, Sir D. Duckworth, Sir Harry Johnston, Sir Norman Lockyer, Sir W. Ramsay, Prof. C. Stewart, Sir W. T. Thiselton-Dyer, Prof. W. A. Tilden, and Sir F. Treves.

THE death on February 9, at the age of forty-four, of Mr. F. O. Pickard-Cambridge makes a break it will be impossible to fill in the ranks of British arachnologists. From boyhood he had devoted himself to the study of English spiders, and was rightly regarded as the leading authority upon this subject. He completed, moreover, in 1904, his monograph of the Central American spiders for

Godman and Salvin's "Biologia," and this work, supplemented by the determination of specimens in the British Museum and of the collections made by himself on the Amazons, gave him a quite special knowledge of the Neotropical species. He unfortunately left unfinished his revision of the generic nomenclature of spiders, and also the county records of Arachnida he was compiling for the "Victoria History." Mr. Cambridge was an admirable draughtsman, as is testified by the plates illustrating the many papers he contributed to scientific societies and periodicals.

MATHEMATICIANS will have heard with regret that Mr. Robert Tucker died on January 29. He received his university education at St. John's College, Cambridge, of which he was a scholar, and was placed among the wranglers in 1855. He became a schoolmaster, and was for many years head mathematical master at University College School. His original contributions to mathematics deal chiefly with configurations of points, lines and circles related in special ways to a fixed triangle, and one system of circles, which he discovered, is called after his name. He was also the editor of Clifford's "Mathematical Papers." In 1867 he became one of the secretaries of the London Mathematical Society, founded in 1865. From that time forward he made the society his peculiar care, and the success which it has attained is almost entirely due to him. He retained the office of secretary for thirty-five years, editing the *Proceedings*, and conducting the correspondence with authors and referees—a delicate duty in respect of which he established an admirable tradition. He also wrote an account of the early history of the society. In all his work he was business-like and thorough, and at the same time modest and unselfish.

THE new wing which is to complete the Armstrong College of Science in Newcastle-on-Tyne will be opened by the King next year.

THE Société nationale d'Agriculture de France has awarded to Prof. Wm. B. Alwood, of Charlottesville, Va., a diploma and silver medal for his recent work in pomology, especially as relates to the fermentation of by-products from apples.

THE anniversary meeting of the Geological Society was held at Burlington House on Friday, February 17. Dr. J. E. Marr, F.R.S., was elected president. After the presentation of the medals and prizes already announced (p. 253) the president delivered his anniversary address, which dealt with the classification of the sedimentary rocks.

ARRANGEMENTS have been made whereby messages may be sent to Cunard mail steamers at any stage in their voyage across the Atlantic. During the first three or four days after the vessels leave Liverpool the messages will be sent from Poldhu, Cornwall, direct to the steamer. During the next three or four days the messages will be forwarded by cable to the North American Continent, and repeated thence to the approaching ship.

WE learn from the *Times* that the Treasury has agreed to place at the disposal of the Board of Trade 500*l*. per annum for four years for the purpose of taking practical steps to encourage and investigate the development of the cotton-growing area of the Empire. This sum will be used (1) for the payment of scientific assistants, who would themselves do part of the proposed work and would also set free members of the existing staff of the Imperial Institute for the purpose; and (2) for defraying the cost of equipment. It has also been notified, in connection with the mineral survey which the Government of Northern Nigeria has in contemplation, that a sum of 300*l*. per annum will be paid to the Imperial Institute in order to defray the expenses of examining specimens of minerals, &c., sent to the scientific and technical department so long as the survey is in progress, probably a period of three years.

ON Saturday next, February 25, Mr. D. G. Hogarth will begin a course of two lectures at the Royal Institution on "Archæology." On Tuesday, February 28, Prof. Karl Pearson will deliver the first of three lectures on "Some Recent Biometric Studies." On Thursday, March 2, Prof. H. H. Turner will commence a course of three lectures on "Recent Astronomical Progress," and on Saturday, March 11, Prof. J. J. Thomson will begin a course of three lectures on "Electrical Properties of Radio-active Substances." The Friday evening discourse on March 3 will be delivered by Chevalier G. Marconi, on "Recent Advances in Wireless Telegraphy," and on March 10 by Prof. J. J. Thomson, on the "Structure of the Atom." Mr. Perceval Landon will give two lectures, on April 4 and 11, on "Tibet," Mr. A. Henry Savage Landor's lectures on "Exploration in the Philippines" having been deferred until after Easter.

THE annual report of the council of the Institution of Mechanical Engineers was read at the annual general meeting of the institution on February 17. The first report, by Prof. David S. Capper, to the steam-engine research committee, has now been completed, and, together with a preliminary report on progressive speed and pressure trials carried out previous to March, 1896, will be presented at the March meeting. Since the presentation, in January, 1904, of the late Sir William Roberts-Austen's last report, the alloys research committee has continued its work at the National Physical Laboratory. Dr. Glazebrook, director of the laboratory, has arranged a series of investigations on specimens of nickel steel presented by Mr. R. A. Hadfield. It is anticipated that a further report will be presented this year by the committee, communicating the results of these researches. Further investigations having great practical importance are now being considered. Prof. F. W. Burstall reports that the two specially constructed large gas-engines and a gas-holder erected in the new power house of the Birmingham University are now available for the gas-engine research committee's experiments. A scheme of experiments, indicating the methods of working, is under consideration, and it is hoped that the next report will be ready for presentation at the opening of next session. A gift of 100*l*. towards the expenses of carrying on the research has been received from Dr. Ludwig Mond, F.R.S. The series of experiments on initial condensation in steam cylinders, which Prof. T. Hudson Beare is carrying out with special apparatus for the purpose, are in active progress, but are still incomplete. The results obtained so far, however, justify the hope that the committee will be able to present, during the year 1905, an interim report dealing with the results obtained in the experiments on non-jacketed cylinders. It is intended to hold the next summer meeting in Belgium, in view of the International Exhibition to be held at Liège this year.

WE have received from Messrs. John Wheldon and Co., of Great Queen Street, a copy of a catalogue of zoological and sporting books and papers arranged geographically. To those who are working on faunas and distribution the list will be distinctly useful.

IN vol. v., No. 5, of the *Records* of the Australian Museum, Mr. R. Etheridge describes the remains of a plesiosaurian reptile of the genus Cimoliosaurus from the Upper Cretaceous of White Cliffs, New South Wales, which have been completely opalised. This is the second skeleton of the genus which has been obtained from these deposits in an opalised condition. Precious opal occurred only here and there—more especially in the transverse processes of the neck—in the second specimen, the richness of the colour of which bore no comparison to that in the example first obtained.

MR. W. E. CLARKE, of the Edinburgh Museums, sends us a paper from the *Annals of Scottish Natural History* for January on the vole and the shrew of Orkney. The vole, which it will be remembered was recently discovered and named by Mr. Millais, turns out to be remarkably interesting, for it appears to come nearest to the water-vole, although its dentition is of the type of the common field-vole. The shrew, Mr. Clarke believes, will probably turn out to be the pigmy species. Mr. Clarke has been assisted in his investigation into the structure of the vole by Prof. O. C. Bradley.

DR. GILCHRIST'S presidential address to the South African Philosophical Society at the meeting in August last, which is reported in the latest issue of the *Transactions* of that body, deals with certain features of the marine fauna of South Africa. It is shown that as the Cape seas receive currents from different parts of the ocean, so the fauna is of a particularly varied type, containing North Atlantic, Antarctic, and Indian types, and even an element from the Far East.

THE subject of the affinity of the endothiodont reptiles is resumed by Dr. R. Broom in part iv. of vol. xv. of the *Transactions* of the South African Philosophical Society. The author emphasises their relationship to the dicynodonts, and shows that, while in the endothiodonts the tendency has been to increase the development of the molars, in the dicynodonts the latter teeth have been completely eliminated. In our own opinion, Dr. Broom's work tends to show that both groups should be included in a single family.

THE report of the director of the botanic gardens and domains, Sydney, for 1903 refers to the changes in the gardens consequent upon the extension into the inner domain. Tree-planting in the Centennial Park has been continued, the additions during the year being principally *Acacia binervata, Eucalyptus botryoides,* woolly-butt, *Tristania conferta,* brush-box, and species of Casuarina. Many of the various species of Eucalyptus have suffered from the attacks of a coccid identified as *Eriococcus coriaceus.*

THE Philippine Islands are yielding a number of interesting plants. A second list by Mr. E. D. Merrill has been issued as a publication, No. 17 of the Bureau of Government Laboratories, Manila. The author distinguishes twelve species of Terminalia in his synopsis of the genus, three being new. Among other new plants are four species of Pandanus, three of Illipe (=Bassia), and a climbing Dischidia belonging to the section Conchopyllum in which the leaves flattened against the supporting tree trunk serve as a shelter for ants.

A PROGRESS report on the strength of structural timber by Dr. W. K. Hatt forms *Circular* No. 32 of the forestry series published by the United States Department of Agriculture. Tests were made with long-leaf pine, *Pinus palustris,* loblolly, *Pinus taeda,* and a red fir, known also as Oregon pine, *Pseudotsuga taxifolia.* Long-leaf pine is the standard timber of construction, but is not always obtainable in long pieces, when red fir takes its place; red fir produces long, straight timber, but shows considerable variation in quality; loblolly being principally sap-wood has to be treated with preservatives if it is required for external work. Experiments were also made with sweet gum, *Liquidambar styraciflua,* to ascertain whether the timber could be bent and put to the same uses as hickory, but the results were not favourable.

WHEN we consider the enormous mass of material which has been accumulated regarding the quantity of rain which falls, it is remarkable how little attention appears to have been given to the number and size of the drops. A very simple and ingenious method of studying raindrops is described in a paper in the *Monthly Weather Review* for October, 1904, by Mr. W. A. Bentley. The raindrops are allowed to fall into a layer of dry flour one inch deep, which is exposed to the rain for a few seconds. The flour is allowed to stand for some time, and the pellets of dough, each representing a raindrop, are then picked out and may be preserved. The method was tested by allowing measured

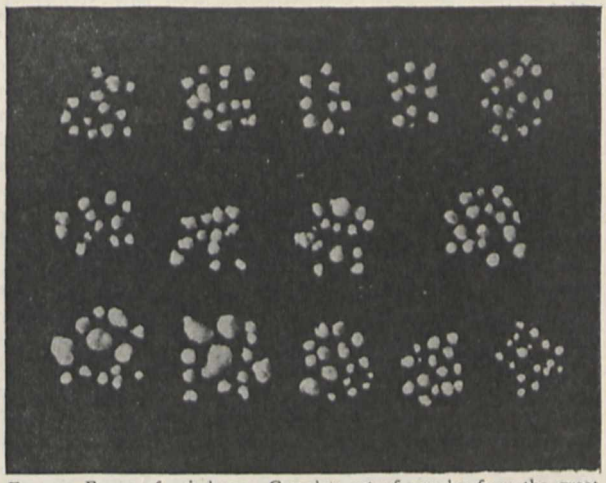

FIG. 1.—Forms of raindrops. Complete set of samples from the great general storm of August 20, 1904. Duration of storm, fifteen hours. One raindrop sample per hour was taken throughout the storm.

drops of water to fall from a height into the flour; it was found that the dough pellet differed but little in size from the drop which produced it. In the paper a series of interesting photographs of such dough-pellets is given, illustrating the variation in the size of the raindrops during the course of showers of different types. The largest drops met with somewhat exceeded a fifth of an inch in diameter; this is in agreement with the observations of Wiesner (quoted by Hann in his "Lehrbuch"), which gave 7 mm. as an upper limit. Mr. Bentley gives tables showing the relative frequency of occurrence of drops of various sizes in rain from various kinds of clouds.

WE have received from the secretary of the English Ceramic Society a copy of its *Transactions* for the session 1903–4. The society, which has its headquarters at Tunstall, Staffordshire, is still in its infancy, but it would appear that its existence is likely to exert considerable influence for good on the future development of the English potteries. The *Transactions* contain papers describing attempts to solve special problems in the industry, and the keen discussion which followed their delivery is indicative of the interest with which they were received. There can be

little doubt that such a society must tend to the spread of knowledge and the improvement of method in pottery manufacture.

AN interesting paper by R. Kremann on the melting point of dissociating substances and the degree of dissociation during melting is contained in the *Sitzungsberichte* (1904, vol. ciii., part vii.) of the Imperial Academy of Sciences of Vienna. From theoretical considerations involving the law of mass action, melting-point curves are deduced for substances, such as the compounds of phenol with aromatic bases and with picric acid, at different degrees of dissociation. By comparing the shape of these curves with those obtained, for instance, on adding aniline to the compound of aniline and phenol, the actual degree of dissociation of these substances during melting may be very approximately ascertained. Incidentally, the important result is established that the addition of one of the products of dissociation of the compound may in many cases cause a rise in the melting point without there being question of the formation of an isomorphous mixture. The results obtained are applied to an investigation of the additive compounds of nitrosodimethylaniline with various aromatic bases.

IN an inaugural dissertation for a doctorate at Bonn University, Herr Jacob Steinhausen presents the results he has obtained during a research on "enhanced lines." Adopting the English name originally proposed by Sir Norman Lockyer, the author gives a detailed description of the enhanced lines and their different appearances in various spectra, and then describes the apparatus and methods employed by him in his own research. Using a small grating of 1 metre radius, which produced a dispersion such that 10 Ångström units extended over 0·595 mm. on the plate, he photographed and compared the arc and spark spectra of the elements Al, Sb, Pb, Cd, Mg, Hg, Bi, Sn, Zn, Ba, Ca, Sr, and Tl, using in most cases metallic poles for the spark, and powdered metal, or salt, on carbon poles for the arc. The wave-lengths are only given to the nearest unit, and will, therefore, need re-determining, with a larger dispersion, before they become of any great use for stellar identifications. In discussing the nature of the lines the author adopts an error made by Prof. Kayser ("Handbuch der Spectroscopie"), viz. that in accounting for spectral variations Sir Norman Lockyer has always considered only the temperature of the spark as the cause; yet it is now more than thirty years since the discoverer of enhanced lines explicitly stated that the possible effects of electrical variations must be included in the general term "temperature."

SOME ten years ago Prof. H. Moissan, in the course of his work on the production of carbides in the electric furnace, prepared aluminium carbide and showed that in contact with water pure methane was evolved, thus giving a new and direct synthesis of this important hydrocarbon. In the current number of the *Comptes rendus* (February 13) Prof. Moissan and M. Chavanne give an account of their determinations of the physical constants of pure marsh gas prepared in this way. The methane, after being freed from traces of moisture and less volatile impurities by passing through a tube cooled to −85° C., is solidified by cooling with liquid air, and any more volatile gases present pumped away. The gas allowed to boil off from the crystals was proved to be pure by a combustion analysis, and possessed at 0° C. and 760 mm. pressure a density of 0·5547, the theoretical density being 0·555. The melting and boiling points were measured by means of an iron-Constantin thermocouple, previously standardised against a petroleum ether thermometer, the crystals melting sharply at −184° C. and boiling at −164° at atmospheric pressure. The authors add that the methane, purified in this way, always possessed a sweet, faint garlic odour, which cannot be attributed to impurities, and must be regarded as due to the gas itself. The reaction between solid methane and liquid fluorine was studied at the same time; the two substances instantly combined, the reaction being accompanied by a bright flash and a violent explosion, completely pulverising the glass tubes.

A TWELFTH edition of Mr. W. T. Lynn's booklet on "Remarkable Comets" has been published by Messrs. Sampson Low, Marston and Co., Ltd.

THE Cambridge University Press has published the first number of a new scientific periodical entitled the *Journal of Agricultural Science*. The magazine is edited by Messrs. R. H. Biffen, A. D. Hall, T. H. Middleton, and T. B. Wood, in consultation with Messrs. W. Bateson, F.R.S., J. R. Campbell, and W. Sommerville. It is intended to circulate among agricultural teachers and experts, and will be issued, as material accumulates, in parts of about one hundred pages. Each volume will consist of four parts. The first number appeals to workers in many departments of agricultural research, and among the articles it contains may be mentioned those on Mendel's laws of inheritance and wheat breeding, by Mr. R. H. Biffen; the influence of pollination on the development of the hop, by Mr A. Howard; the importance of the removal of the products of growth in the assimilation of nitrogen by the organisms of the root nodules of leguminous plants, by Mr. J. Golding; the analysis of the soil by means of the plant, by Mr. A. D. Hall; variation in the chemical composition of the swede, by Mr. S. H. Collins; soil analysis as a guide to the manurial treatment of poor pastures, by Messrs. T. B. Wood and R. A. Berry; and the improvement of poor pastures, by Prof. T. H. Middleton. The magazine should prove of interest and help to all teachers of agricultural science as well as to those engaged in research in this field of knowledge.

THE third part of Herr C. K. Schneider's "Illustriertes Handbuch der Laubholzkunde" has just been published by the firm of Gustav Fischer, Jena. The first two parts were reviewed in NATURE of November 24, 1904 (vol. lxxi., p. 76), and a further notice will appear after the work, consisting of about nine parts, has been completed.

OUR ASTRONOMICAL COLUMN.

EPHEMERIS FOR COMET 1904 *e*.—The following is an extract from a continued ephemeris for comet 1904 *e*, as calculated from M. Fayet's elliptical elements by Dr. E. Strömgren, and published in No. 3994 of the *Astronomische Nachrichten*:—

Ephemeris 12h. (M.T. Berlin).

1905	α (true) h. m. s.	δ (true) ° ′	log *r*	log Δ	Brightness
Feb. 25	3 10 47	+30 7	0·1669	0·1233	0·46
Mar. 1	3 22 3	+32 0	0·1711	0·1359	0·43
,, 5	3 33 44	+33 47	0·1757	0·1486	0·39
,, 9	3 45 49	+35 25	0·1805	0·1611	0·36
,, 13	3 58 16	+36 56	0·1855	0·1736	0·33

The comet is now becoming very faint, and is travelling in a north-easterly direction through the southern part of the constellation Perseus. On March 11 it will pass near to ξ Persei.

REVISED ELEMENTS FOR BORRELLY'S COMET (1904 *e*).—When publishing the previous set of elements for comet 1904 *e*, M. Fayet explained that, as his computations were based upon the results of only a few observations, they could only be regarded as approximate. Now, however,

the observations extend over nearly a month, and M. Fayet has made another research regarding this comet's orbit, obtaining the following set of elements as his result :—

$$\left.\begin{aligned} T &= 1905 \text{ Jan. } 16\ 65370 \text{ (M.T. Paris)} \\ \Omega &= 76^\circ\ 41'\ 34''\cdot49 \\ i &= 30^\circ\ 31'\ 58''\cdot75 \\ \omega &= 352^\circ\ 13'\ 58''\cdot98 \end{aligned}\right\} 1905\cdot0$$

$$\log q = 0\cdot145175$$
$$\log e = 9\cdot792206$$
$$\mu = 503''\cdot932$$

These elements give a close agreement with the places determined by independent observations, and indicate that Borrelly's 1904 comet is, really, of the short-period type, completing its orbital revolution in about seven years, instead of six years as given by the previous elements (*Comptes rendus*, No. 5, 1905).

THE SUN'S ROTATION.—During the years 1899, 1900, and 1901 Prof. N. C. Dunér made a further series of observations of the rotation velocity of the sun at different heliocentric latitudes. Combining the results with those obtained by him during a similar research prosecuted in the years 1887–1889, and now corrected, he found the values given in the following table :—

ϕ	v	n	$\xi \cos \phi$	ξ
°	km.		°	°
0·4 ...	+2·08 ...	183 ...	14·770 ...	14·77
15·0 ...	+1·97 ...	180 ...	13·989 ...	14·48
30·1 ...	+1·70 ...	184 ..	12·072 ...	13·95
45·0 ...	+1·27 ...	181 ...	9·018 ...	12·75
60·0 ...	+0·81 ...	183 ...	5·752 ...	11·50
75·0 ...	+0·39 ...	184 ...	2·769 ...	10·70

wherein ϕ = the heliocentric latitude, v = the rotational velocity of the sun's edge, n = the number of observations, and ξ = the daily rotation angle (*Astronomische Nachrichten*, No. 3994).

SECONDARY SHADOW ON SATURN'S RINGS.—During a series of observations of Saturn made at Aosta (Italy) in October, November, and December, 1904, Signors M. Amann and Cl. Rozet observed a secondary shadow, other than that of the planet, projected on to the illuminated surface of the rings. First seen on October 20, this shadow was thinner and much less accentuated than that of the planet, whilst its curvature was in the opposite sense to that of the latter body. From October 20 to November 15, despite the fact that numerous opportunities of observing it occurred, the shadow was not seen, but from the latter date until the end of December it was shown on twenty-six drawings of the system. On seven drawings made between December 22 and 27, the shadow appeared bifurcated where it traversed the inner ring, and on November 28 and 29 a third line of shadow, narrower and feebler than the preceding and much further from the planet, was seen (*Comptes rendus*, No. 5, 1905).

OBSERVATIONS OF THE ZODIACAL LIGHT.—During a sojourn on the summit of Mont Blanc on September 21 and 22, 1904, M. A. Hansky made a number of observations of the Zodiacal Light, and found that its form was that of a spherical triangle having its apex near to the ecliptic. At 3h. 40m. (M.T. Paris) the altitude of the apex was 52°, the length of the triangle, reckoned from the centre of the sun, was 80°, and its breadth was, at the horizon, 25°, and in the plane of the sun's axis 30°. The latitude of the apex was +2°, and three zones were distinguishable in the light. The first of these had the form of a spherical triangle and was very feeble, the second was more parabolic, whilst the form of the third was a parabola.

In his paper, published in the *Comptes rendus* (No. 6, 1905), M. Hansky indicates the points of resemblance between this phenomenon and the corona, and makes a number of speculations as to the true nature of the light. He concludes by saying that he believes it to be an electrical phenomenon of the same type as the corona, and that it is, probably, simply a prolongation of the coronal streamers.

PERMANENT NUMBERS FOR THE MINOR PLANETS DISCOVERED DURING 1904.—In No. 3994 of the *Astronomische Nachrichten*, the permanent numbers allotted to the minor planets discovered during 1904 are given. The list contains the numbers 522 to 548, inclusive, thereby showing the number discovered during last year to be twenty-seven. The provisional designation, the name of the discoverer, the date of discovery, and the authority for the orbit are also given for each planet. A number of notes explain the absence, for various reasons, of several bodies, to which provisional designations were allotted, from the final list.

STUDIES IN EUGENICS.

AT a meeting of the Sociological Society on February 14 Mr. Francis Galton communicated two papers :—(1) restrictions in marriage, and (2) studies in national eugenics.

In the first paper he remarked that marriage, as one of the social agencies that influenced the racial qualities of future generations, came within the purview of eugenics. It belonged to the practical policy arising out of eugenic science, to promote such choice in marriage as should tend to the reproduction of the higher types of individual. Anthropological investigation had shown marriage to be one of the most modifiable of social institutions. Hence the assumption was warrantable that with the gradual incorporation of eugenic conceptions in the social ideal, there would proceed a concomitant change in the customs and conventions affecting marriage. The paper then proceeded to illustrate by actual examples the modifiability of marriage customs. In one or other of its many forms polygamy was now permitted—by religion, customs and law—to at least one-half of the population of the world, though its practice might be restricted, on account of cost, domestic peace, and the insufficiency of females. In Christian nations the prohibition of polygamy, under severe penalties, by civil and ecclesiastical law had been due, not to any natural instinct against the practice, but to consideration of social well-being. Hence it might be inferred that equally strict limitations of freedom of marriage might, under the pressure of worthy motives, be hereafter enacted for eugenic and other purposes. Endogamy, or the custom of marrying exclusively within one's own tribe or caste, had been sanctioned by religion and enforced by law in all parts of the world, but chiefly in long-settled nations, where there was wealth to bequeath and where neighbouring communities professed different creeds. Endogamous systems of marriage rested on customs determined by a certain religious view of family property and family descent. Eugenics dealt with what was more valuable than money or lands, namely, with natural inheritance of high character, capable brains, fine physique and vigour, in short, with all that was most desirable for a family to possess. It aimed at the evolution and preservation of high races, and it well deserved to be strictly enforced. In every society there existed conventional restrictions of the nature of "taboo," though not necessarily called by that name. If non-eugenic unions were prohibited by such taboos, none would take place. Marriage selection was very largely conditioned by motives based on religious and social convention. Persons who were born under the various marriage systems lived under such rules without any objection. They were unconscious of their restriction.

Under the heading "Studies in National Eugenics," Mr. Galton communicated what he described as "an unauthorised programme" of what he conceived to be the duties of the Francis Galton research fellowship in national eugenics. The topics to be considered he classified under the following headings :—(1) Estimation of the average quality of the offspring of married couples from their personal and ancestral data. This included questions of fertility, and the determination of the probable error of the estimate according to the data employed. (2) Effects of action by the State and by public institutions. (3) Other influences that further or restrain particular classes of marriage. (4) Heredity. The facts, after being collected, should be discussed, for improving our knowledge of the laws both of actuarial and of physiological heredity, the recent methods of advanced statistics being of course used. (5) Bibliographical compilations. (6) Extension of eugenic studies by wider cooperation. (7) Certificates. With regard to the last named, he said that in some future time, dependent on circumstances, he looked forward to a suit-

able authority issuing eugenic certificates to candidates for them. They would imply more than an average share of the several qualities of at least goodness of constitution, of physique, and of mental capacity.

The discussion on the papers was opened by Dr. Haddon, who said Mr. Galton sought to establish a science of eugenics, he took it, because the postulates of eugenics were an inevitable corollary from the general doctrine of organic evolution—in the building up of which Mr. Galton had played a notable part. The evolution of the species having reached a self-conscious stage in man, it followed of necessity that increasingly rational and coordinated attempts should be made to guide and direct the evolutionary process towards definable and verifiable ideals. It was, as he understood it, the aim of eugenic studies to ascertain the means available for this rational guidance of human evolution, and the defining of the ideals towards which it should be directed. There was ample warrant in anthropological data for the assumption that in the development of marriage customs there was a tendency towards adaptation to higher social purposes.

Dr. F. W. Mott said there were two general ways towards the rational improvement of the stock:—(1) by checking the reproduction of the unfit, and (2) by encouraging the reproduction of the fit. For the former purpose the readiest means would be the segregation of defective children while quite young, and the curtailment of their social privileges as they grew to maturity. As regards means towards the encouragement of fertility in the higher types, he suggested as an initial tentative in practical measures a further development of the present system of marriage registration. Why, for instance, should not medical as well as legal certificates of marriage be procurable at registry offices? The former would be of the nature of a bill of health, certifying that the contracting parties reached a certain standard of hygienic requirement. Such certificates would of course be voluntary, but since they would be valuable not only to their possessors but also to their children, they would tend to come into general usage. In any case he considered it a matter of national importance that Mr. Galton's conception of eugenics should be most seriously considered. The first desideratum was to get it accepted as a legitimate and hopeful study.

Mr. Ernest Crawley said Mr. Galton's paper showed how anthropological studies could be made fruitful in practical politics. Sociology should be founding its science of eugenics upon anthropology, psychology, and physiology. He hoped that while chiefly considering the normal individual it would not forget the special claims of those abnormal persons whom we call geniuses. In a well ordered State they should be considered before the degenerate and the diseased. As regards marriage customs, he took it as an assured generalisation of anthropological science that there are two permanent polar tendencies in human nature, first against unions in the same home, and secondly against too promiscuous marriage. Many customs assumed by early anthropologists as normal types were, he believed, mere sports—such as group-marriage, and marriage of brother and sister. Polygamy he believed to be an example of a certain tendency in man to confuse sexual (*i.e.* organic), with matrimonial (*i.e.* social) concerns. They must beware of this confusion, and therefore be on their guard against its possible effects in studying eugenics. Mr. Galton's suggestion that religion was called upon to play a part in the development of eugenics he considered to be a sound deduction from history and anthropology. In the sanctification of marriage, religion had one of its earliest and greatest functions; and as primitive religion, in this as in other respects, was based upon the best knowledge of primitive times (*i.e.* upon primitive science), so the most developed form of religion should be illuminated by the most advanced form of knowledge (*i.e.* by contemporary science).

Dr. E. Westermarck said he entirely agreed with Mr. Galton's contention that restrictions in marriage as they existed in the simpler social formations, so they might be further modified and developed for eugenic purposes amongst the most highly civilised peoples. The germ of eugenic intentions was well seen amongst savage and barbarian peoples in those customs which imposed a test of fitness on the husband before marriage. In Kaffir tribes, for instance, a man may not marry until he has demonstrated his strength and courage and competence in the chase by killing a rhinoceros. In the Malay Archipelago there are peoples where the marriage test consists in the collection of a number of skulls from hostile tribes. Among the Arabs of Upper Egypt, the young aspirant to marriage must evidence his courage and self-control by suffering—with smiling countenance—a severe ordeal of whipping by the relatives of the bride. He considered that on this question of marriage, whereby the individual was brought into both organic and social relation with the species, moral teachers had before them one of the greatest of tasks, in inculcating a keener sense of foresight in the individual. There was perhaps hardly any other point in which the moral consciousness of civilised men stood in greater need of intellectual training.

As contributions to the discussion, a considerable number of written communications were received, from the following amongst others:—Dr. Havelock Ellis, Mr. A. H. Huth, Dr. Max Nordau, and Profs. Yves Delage, J. G. McKendrick, Posada, Sergi, Steinmetz, Tonnies, and Weismann. The last named raised the question whether, when a hereditary disease like tuberculosis has made its appearance in a family, it is afterwards possible for it to be banished entirely from this or that branch of the family, or whether, on the contrary, the progeny of those members who appear healthy must not sooner or later produce a tuberculous progeny. He himself considered that a tainted stock might produce a branch entirely free from that specific disease.

Mr. Galton, in the course of his reply, said it gave him satisfaction to find that no one amongst his critics had impugned the conclusion which his memoir on "Restrictions in Marriage" was written to justify.

THE ABSORPTION OF LIGHT BY THE ATMOSPHERE.[1]

THE great attention that has been paid during the last few years to the subject of photometry has brought into prominence the problem of the amount of light absorbed by the atmosphere. At the same time, the improvement that has taken place in the instrumental means, which renders possible the detection of minute changes in lustre, has required the use of accurate corrections by which the effect of the earth's atmosphere can be eliminated from the observations. The corrections which have been applied to photometric measures have been based generally on empirical or interpolation methods rather than on a strictly physical basis. There are several reasons which have contributed to this unsatisfactory condition of the problem. The difficulty of computing the length of the path of the ray of light in its passage through our atmosphere, the want of homogeneity in the constitution of the atmosphere itself, our ignorance of the law of the temperature gradient at considerable heights above the surface, and of the distribution of water and dust particles near the surface, have all complicated a subject the theory of which under ideal limiting conditions may not be very difficult. Bouguer left a very satisfactory theory, based, however, on the assumption that the path of the ray was rectilinear. Laplace attacked the subject from the side of the theory of refraction, but practically did not much advance it. From that time onward, the question has rather been left in the hands of observers, who have been content to make their observations homogeneous by the employment of an interpolation formula, based on the results of their actual practice.

Dr. A. Bemporod thinks that the time has come for the discussion of a physical theory of the extinction of light in the atmosphere, and certainly his pamphlet bearing this title is a most welcome contribution to this subject. It may be that in some sense it is a premature effort. That is to say, that the data for a complete solution of the problem do not exist. The series of observations which are now being conducted by means of kites and balloons, and which have for their object the examination of the different

1 "Zur Theorie der Extinktion des Lichtes in der Erdatmosphäre." By Dr. A. Bemporod. Pp. 78. (Mitteilungen der Grossh. Sternwarte zu Heidelberg.)

strata of the atmosphere at various distances remote from the surface, may be expected to throw some additional light upon the constitution of the gaseous envelope through which the light passes, and, moreover, there is the troublesome and disturbing question of selective absorption, the importance of which the author fully admits, but does not consider numerically in his work, which may play a very important part in the future theory of atmospheric extinction. But any improvement which may hereafter be made will not invalidate the calculations, so far as they refer to the mass of the air through which the light beam penetrates.

Dr. Bemporod divides his work into five sections. In the first he presents the problem in its most general form, and defines the function $F(z)$, the so-called path of the ray in the atmosphere. Chapter ii. exhibits a critical examination of the theories of Bouguer, Lambert, Laplace, and of some others less well known. In the next the author discusses the hypotheses of Ivory and Schmidt on the constitution of the atmosphere. Of the two, Schmidt's hypothesis of a uniform decrease of the temperature with the height above the surface gives the best agreement with the observed temperatures derived by Assmann and Berson from balloon ascents. The latter hypothesis is the one therefore selected for development, but both Ivory and Schmidt give practically the same values for extinction, while Laplace's theory at the zenith distance of 87° appears to be a tenth of a magnitude in error. Chapter iv. explains the formation of the extensive numerical tables that accompany the work, and in the last the author has some remarks on the influence of geographical position on the absorption, as well as of the effects of oscillations in temperature and pressure. The whole forms a valuable addition to a subject of great interest and importance.

JOHN HUNTER AND HIS INFLUENCE ON SCIENTIFIC PROGRESS.[1]

AS the history of philosophy, considered from one point of view, is the record of the development and growth of ideas and of the formation of beliefs and doctrines respecting man and the universe accomplished through the thinking of a few great *minds*, so the history of medicine is a record of the observations, thoughts, and achievements of a few great *personalities*—Hippocrates, Celsus, Galen, Paré, Harvey, and John Hunter, to name only the greatest. John Hunter is the theme which has been assigned to me.

Throughout the ages of civilisation the growth of knowledge has been slow and often irregular, but it has been continuous and it has been sure. How slow and yet how sure we may realise by comparing the dialectic notions of Aristotle respecting weight and motion with the direct appeals to the evidences of the senses afforded by the demonstrations of Galilei, whereby it was shown that, so far from there being in nature bodies possessing positive levity, all matter is equally affected by gravity, irrespective of its form, magnitude, or texture. By the simple experiment of dropping objects from the Tower of Pisa, Galilei, who began life as a medical student, laid the foundation of modern physical science, and especially of dynamics. This expedient was one of the first appeals, at least in modern times, to the use of direct experiment in physical science, and the truth thereby established became a determining factor in Newton's great discovery of the law of gravitation. From Aristotle to Galilei an interval of more than eighteen centuries had elapsed. Galilei and Harvey were contemporaries.

John Hunter was born exactly a century after the publication of Harvey's "Exercitatio De Motu Cordis." It is one hundred and eleven years since John Hunter died. Yet how modern Hunter is! Inventions and discoveries now crowd upon us so thick and fast that we are apt to forget how recently modern physical science began, and especially modern medicine. In the order of time medicine, in its rudest and simplest forms, must have been one of the first of the empirical arts, but in the order of ideas it was one of the last to enter into the hierarchy of the sciences. As a system of organised knowledge medicine presupposes and requires not only centuries of clinical observation and a complete logical apparatus, but it also requires an advanced state of all the other natural sciences. It concerns itself with the recondite problems of life in the most complex and the most highly differentiated of its manifestations, whether under the conditions of health or under those of disease. Until physics and chemistry had advanced from the conjectural and the aprioristic to the scientific stage, medicine could only be conjectural and aprioristic too, however useful it may have been as a practical art. The thoughts and labours, the experiments and discoveries of the great pioneers of modern knowledge in the physical sciences were the necessary prelude to a scientific progress in biology, which, in its turn, was a condition precedent to any real advance in the science of medicine, surgery, and pathology. Harvey, in the order of time and of thought, was the necessary antecedent of Hunter.

The starting-point of John Hunter's career as anatomist, biologist, and surgeon was in the year 1748, when he came to London with a receptive and intelligent mind, a quick and observant eye, and a well-trained hand, to collaborate with his brother William in the anatomical school which had been started two or three years before.

Considering the important part that human anatomy now plays in medical education, it is difficult to conceive that there was no systematic teaching of anatomy in England before the middle of the eighteenth century. During the many centuries which elapsed between, say, the time of Hippocrates and the middle of the sixteenth century, the dissection of the human cadaver was almost unknown. Forbidden alike by the laws and customs and religion of the ancient Greeks, and by the creed of Mohammed, the study of human anatomy was placed under a civil and religious ban until the end of the thirteenth century. In ancient Greece the laws relating to immediate burial were very stringent. Even victorious generals had been condemned to death because they neglected to bury the slain. The pathos of Sophocles' tragedy of "Antigone" turns, it will be remembered, upon the sacredness of the dead, and of the necessity, higher than imperial commands, of immediate burial.

When the tradition of Greek medicine passed—in the seventh and eighth centuries—into the hands of the Mohammedans, human anatomy was equally neglected, the practice of dissection being implicitly forbidden by the Qurân. Even after the dissection of the human cadaver received the sanction of the civil authorities in southern Europe, the teaching of anatomy was cursory and occasional, and merely descriptive. Mundino of Bologna, in the fourteenth century, who was the first in modern times to dissect the human cadaver, seems to have dissected only two bodies. So little was known of human anatomy, and so strong was the tyranny of tradition, that when Vesalius, in the middle of the sixteenth century, alleged that the anatomical descriptions of Galen could not be adapted to man, there were not a few who, in their zeal to repel the accusation that Galen had used animals in dissection, did not hesitate to maintain that the human organisation had changed since Galen's time.

In England, notwithstanding Harvey lectures on anatomy in the first quarter of the seventeenth century, there was no organised teaching of anatomy before William Hunter's time. In this matter William Hunter has not received all the credit he deserves. Had his ambition been realised, he would, nearly a century and a half ago, have solved a problem in early medical education in London which is still perplexing the minds of many thoughtful persons. He desired to establish an anatomical school in London upon an extensive scale. With this object in view, he offered to erect a building at the cost of 7000*l.* for the study and teaching of anatomy provided the Government would grant him a piece of ground to build upon. It was also his intention to give to this institution all his preparations and his books. With a lamentable lack of sympathy which British Governments have too often manifested in their dealings with science and education, William Hunter's offer was declined. Smarting under a keen sense of disappointment and full of resentment, he determined to transfer his favours to Glasgow, which now enjoys the possession of his priceless museum and his library. *Beati possidentes.*

[1] Abridged from the Hunterian oration, delivered before the Roval College of Surgeons, February 14, by Mr. John Tweedy, president of the college.

After John Hunter had worked at human anatomy for ten years, he manifested his intellectual growth by directing his thoughts to the higher and more scientific discipline of comparative anatomy and physiology. He realised that human anatomy alone was an insufficient guide to pathology and surgery. He collected all manner of animals at his house and grounds at Earl's Court in order to study their ways and habits, and from every available source he acquired animals, living or dead, for the purposes of observation, experimentation, or dissection. In his use of the lower animals for the elucidation of physiological problems he followed while amplifying the practice of Harvey, who in his turn adduced the authority of Aristotle. There was, however, a striking and characteristic difference between the use which Aristotle made of the dissection of animals with reference to human anatomy and that of Hunter. There is no trustworthy evidence that Aristotle or Hippocrates or even Galen dissected the human body, certainly not in the sense we understand by the term "dissection." They dissected the bodies of animals *instead of* those of man, and transferred their observations of animals to the corporeal organisation of man. Hunter, on the other hand, practised the dissection of lower animals *in addition to* that of man, and transferred his observations to the embryology and morphology of man and to the elucidation of the problems of human and comparative physiology and pathology.

John Hunter was a philosopher in the strict and primary sense of the word. He had a passion for knowledge. "Let no man presume to call himself wise," says Pythagoras; "God alone is wise. Man can never get beyond the passion for wisdom." John Hunter had this passion. He devoted himself to the pursuit of knowledge, searching for it in every department of the organic world, animal and vegetable. In one of his letters to Jenner he says: "I have but one order to send you, which is, to send everything you can get, either animal, vegetable, or mineral, and the compound of the two, either animal or vegetable mineralized." And, again: "Have you any large trees of different kinds that you can make free with? If you have, I will put you upon a set of experiments with regard to the heat of vegetables." With respect to the observations and experiments which he directs Jenner to make, he says, "Be as particular as you possibly can." These sentences express briefly and in epitome, as it were, Hunter's habits of mind and his attitude towards the problems of organic life.

John Hunter may have lacked the power of clear exposition, and he may have disliked routine teaching. He was, however, full and overflowing with ideas, new and original, to which he often found it difficult to give distinct shape and utterance. In contrast with William Hunter's didactic powers, John had the suggestive, the constructive, the creative faculty, the faculty of discovery, of coordinating knowledge, and he had the art of stimulating thought and calling forth effort from others. He taught by example rather than by precept.

Ottley, the first and one of the best of Hunter's biographers, remarks that in pursuing his researches Hunter strove, not like many of his more learned and less philosophical predecessors, to unravel the mysteries of nature by taking up principles *a priori* and seeking for facts to support his theory, but that, on the contrary, he followed in the strictest manner the inductive method laid down by Bacon as the only sure though arduous road to knowledge; and Babington, in his Hunterian oration, remarks of him: "He had never read Bacon, but his mode of studying nature was as strictly Baconian as if he had." Other critics and historians of Hunter's work, and not a few Hunterian orators, have written or spoken in a similar strain. In my judgment this view is entirely erroneous with respect to Hunter's method, and it is a complete misinterpretation of the Baconian system. Bacon's eloquence and influence undoubtedly did much to attract men to the observation and study of natural phenomena. He directed attention to the necessity of studying the powers and forces of the world as a means of subjecting the world to the human mind, and so far his message was appropriate and opportune. The significance of that message is probably greater now than at the time he delivered it. The future belongs to the nation which understands best the forces of nature, and which can most skilfully and economically employ them. But Bacon himself neither knew nor understood the physical sciences. His spirit was essentially mediæval, and much less modern than that of his illustrious namesake Roger Bacon, who lived three hundred years before him. Francis Bacon's aim was purely utilitarian. He had no idea of knowledge for its own sake, and he cherished the hope that by increasing our knowledge of nature the secret of the transmutation of substances would be learnt, and probably the knowledge of the making of gold. He not only had no practical acquaintance with natural science, but he lacked insight into the true methods of its investigation. He understood very imperfectly the value of experiment, and he assigned quite a subordinate position to quantitative determination, the precise quality which is the most striking characteristic of modern science, and which constituted the most original and perhaps most brilliant of the reasonings which Harvey employed in his famous induction. So far from being the founder of the modern scientific method, Bacon's writings were themselves one of the products of the intellectual awakening which began at the end of the sixteenth century. Notwithstanding his affectation of scientific knowledge and scientific methods, Bacon had an unscientific weakness for superstitions. He believed in natural and judicial astrology, though not without some hesitation and discrimination. He believed in the transmutability of elements and of the metals, in charms and signatures as remedies, and so completely did he ignore Harvey's discovery of the circulation of the blood that in one of the latest of his writings he ascribes the pulsation of the heart and arteries to the dilatation and contraction of the spirits. Well might Harvey say, in disparagement of Bacon's scientific writings: "He writes philosophy like a Lord Chancellor."

Bacon's ruling idea was the collection of masses of facts and then the employment of processes of arrangement, and separation, and exclusion, so artificially contrived that a man of common intelligence should be able to announce the truth sought for. This method has been slightingly described as a kind of scientific bookkeeping. "It is difficult," says Stanley Jevons, "to imagine a less likely way of arriving at great discoveries. The greater the array of facts the less is the probability that they will by any routine system of classification disclose the laws of nature." The answer to the claim that Bacon was the philosophic father of modern methods of scientific investigation is that none of the scientific truths established by the great masters of science can be made even to *appear* in correspondence with Bacon's methods. Whether we look to Copernicus, who preceded him, or to Kepler, Galilei, Torricelli, Pascal, Gilbert, and Harvey, or to Newton, Descartes, or Huygens, or to Thomas Young, or to the chemists Black, Priestley, Scheele, and Lavoisier, we find that discovery was achieved by a method quite different from that advocated by Bacon. So dispassionate a critic of philosophy as John Grote remarks: "I have not the smallest belief in Bacon's having reformed the method of discovery, believing rather that if he had *had* any success in that way, in the manner he wished, it would have been most calamitous for science." And even with regard to the claim of Bacon to be the founder of inductive philosophy, Ellis, one of the ablest of his editors, asserts that the nature of the act of induction is as clearly stated by Aristotle as by any later writer, while Aristotle himself ascribes the credit to Socrates. Perhaps the Baconian claim has never been more convincingly refuted than by Augustus De Morgan, at once one of the profoundest and subtlest thinkers of the nineteenth century. "Modern discoveries," he says, "have not been made by large collections of facts, with subsequent discussion, separation, and resulting deduction of a truth thus rendered perceptible. A few facts have suggested an *hypothesis* which means a *supposition* proper to explain them. The necessary results of this supposition are worked out, and then, and not till then, other facts are examined to see if these ulterior results are found in nature. . . . Wrong hypotheses rightly worked from have produced more useful results than unguided observation. But this is not the Baconian plan. . . . What are large collections of facts for? 'To make theories *from*,' says Bacon; 'To try ready-made theories *by*,' says the history of discovery."

Bacon's plan was purely mechanical. He ignored the work of the mind in the constitution of knowledge. He

imagined that he had discovered a method by which scientific truth might be determined with absolute certainty, and by a mechanical mode of procedure such that all men were capable of employing it. "Our method of discovering the sciences is," he says, "one which leaves not much to sharpness and strength of wit, but nearly levels all wits and intellects." And this opinion is endorsed by most writers of the empiricist school in complete disregard of the teaching of history. Those who imagine that science requires nothing but the registering and classification of facts forget that the facts observed can only be connected and related by the mind, and that the laws of nature are after all mental products from given data.

Not only did John Hunter not follow the mechanical methods of Francis Bacon, but it is the work of the mind which is the peculiar characteristic of his method and its chief glory. Others could do as well as he the more mechanical part of his task—indeed, much of it was done by others; but the suggesting, controlling, coordinating mind was Hunter's, which, amidst the multiplicity of phenomena and of data apparently conflicting, discovered unity amidst multiformity, which is the special function of science.

John Hunter's constant aim was to arrive at principles, and he was distrustful of so-called facts. "The principles of our art," he said, "are not less necessary to be understood than the principles of other sciences; unless, indeed, the surgeon should wish to resemble the Chinese philosopher whose knowledge consisted only in facts. In that case the science must remain unimproved until new facts arise. In Europe philosophers reason from principles, and thus account for facts before they arise."

Hunter possessed every moral and intellectual qualification necessary for useful scientific research. He had a large knowledge of facts based on an intimate acquaintance with the phenomena of organic nature. He had a fertile imagination ready to suggest possible relations of those facts. He had openness of mind, and a conscientious scientific spirit which submitted every hypothesis to the test of observation and experiment. Scepticism is the first condition of reasoned knowledge. Hunter was not only observant, but he was rationally sceptical and critical, and he himself ascribed his success as a scientific investigator to the sceptical qualities of his mind. He took nothing on trust. He was always careful to distinguish between mere conjecture and reality, and drew a sharp distinction between the actual results of an experiment physically performed and what might have been mentally anticipated. "In pursuing any subject," he says, "most things come to light as it were by accident, that is, many things arise out of investigation that were not at first conceived, and even misfortunes in experiments have brought things to our knowledge that were not, and probably could not have been, previously conceived; on the other hand, I have often devised experiments by the fireside or in my carriage, and have also conceived the result; but when I tried the experiment, the result was different, or I found that the experiment could not be attended with all the circumstances that were suggested." Here, in a sentence, we note the wide difference between the modern and the mediæval spirit in science. The alchemists performed experiments innumerable, but with them theory ranked above experiment, and if experiment gave an unexpected result, this was forced into an artificial conformity with the aprioristic theory. It was therefore, says Lange in his "History of Materialism," "essentially directed to the production of this previously anticipated result rather than to free investigation."

While Hunter was intolerant of a state of doubt in small things as in great, if by any means decision was possible, he ever held his judgment in suspense if certainty was not attainable. Like all strong characters, he cared little for systems or consistencies of opinion. He followed wherever Truth should lead, and by his very nature was always open to new and higher knowledge. To a pupil who asked with surprise whether he had not the year before stated an opinion on some point directly at variance with one he had just put forth, he boldly replied: "Very likely I did; I hope I grow wiser every year." And again: "Never ask me what I have said, or what I have written; but if you will ask me what my present opinions are I will tell you."

In attempting an appreciation of John Hunter's method I have suggested rather than explained the development and growth of the modern knowledge of physics, chemistry, and biology under the influence of the experimental method; but it has not been my purpose or intention to offer any defence of this method. To defend the use of experiment in physics and in chemistry would be manifestly absurd, and I assume that in this place and before this audience it is equally unnecessary to offer an apology for its use in physiology and pathology. I opine, however, that it is within my province as Hunterian orator to anticipate the possible censure of some who would not hesitate in the sacred name of religion to traduce the memory of Hunter because he practised experiments in physiology. John Hunter did employ the method of experiment. He employed it no less with zeal than with intelligence. He employed it not from idle curiosity, not from the promptings of vainglory, or for the purposes of worldly advancement; all that he had he gave to science. He employed it in the service of humanity and in the study of the nature and laws of life; and the knowledge which he thereby acquired he transferred to the domain of medicine and surgery, and applied to the alleviation of sickness and suffering among animals no less than among men.

I pretend not either impiously to affirm or not less impiously to deny all the purposes of infinite wisdom in giving man dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth; but we do know that throughout historic time man has not hesitated to capture, to subjugate, and to slay, beast and bird and fish, for his pleasure, his sustenance, and his service. Was the lordship over the animals given to man only for the satisfying of his physical and sensuous needs? Is not the life more than food? Was it only with reference to man's bodily well-being that the question was asked: Are ye not of much more value than the birds of the heaven? Does the mind need no aliment? And is the veto to be applied only when animals are to be used for the purposes of elucidating the kindly functions of physiology, or of disclosing the baneful secrets of disease?

The vicarious suffering and sacrifice of animals for the service and the salvation of man have obtained throughout the ages, and constituted the basis of the elaborate ceremonial system of the ancient Israelites. In anticipation of the great Passover, Moses directed the Israelites each to kill a lamb according to their families, and to sprinkle its blood upon the lintel and the two side posts. "For the Lord will pass through to smite the Egyptians; and when He seeth the blood upon the lintel, and on the two side posts, the Lord will pass over the door, and will not suffer the destroyer to come into your houses to smite you." The complete purification of *one* leper and his reception back into society involved not only the slaughter of three lambs, but the convalescent had to appear with two living clean birds, one of which was slain, while the other, still living, was baptised in the dead bird's blood, and then allowed to fly away free. The principle of substitution was actualised in the ceremony of the scapegoat. At the annual Feast of Expiation, a young bullock, two kids, and one ram were slain; and two goats were taken upon which lots were cast, one lot for Yahwè, the other for Azazel. The goat on which the lot fell for Yahwè was sacrificed for a sin offering; but the goat upon which the lot fell for Azazel was presented alive, and when the high priest had symbolically placed upon its head the sins and transgressions of all the people, the goat was led into the desert, there to become the victim of hunger and thirst, and the prey of ravenous bird and beast.

Are these hecatombs to be regarded as of Divine origin and sanction, while the inoculation of a cat or dog, or it may be a rat, is to be denounced as a desecration and a violation of the purposes and will of God? Who will say but that in our day, as the Angel of Death passes through the land, seeing upon us the sprinkling of the immunising blood, takes that for a token, and is not suffered to come into our houses to smite us? "Dipt in his fellow's blood the living bird went free"; and so we, dipped in blood, aye, the blood of our fellow-man, as the annals of medical martyrology bear witness, we enjoy a growing freedom from plague and pestilence and noisome disease, and in the fulness of knowledge the measure of our freedom will be full.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The sum of 1600*l.* has been recently contributed to the University Benefaction Fund for the endowment of a lectureship in special pathology. The collection of this fund is largely due to the activity of Prof. G. Sims Woodhead, and the lectureship will be known as the Huddersfield lectureship, in recognition of the town which has largely supplied the capital sum. The general board will proceed shortly to elect the lecturer. Applications should be sent in to the Vice-Chancellor, on or before Tuesday, March 7.

The general board has approved Mr. J. J. H. Teall, of St. John's College, Director of the Geological Survey, for the degree of Sc.D.

The Smith's prizes have been awarded to Mr. H. Bateman for his essay on "The solution of linear differential equations by means of definite integrals," and to Mr. P. E. Marrack for his essay on "Absorption by matter of Röntgen and γ rays." Both the students belong to Trinity College.

Mr. F. J. M. Stratton, of Caius College, has been elected to an Isaac Newton studentship.

LONDON.—At the South-Western Polytechnic Miss Gladys Martyn has been elected to the free studentship in the physical training department. She will devote part of her time to the scientific study of anthropometric measurements and eugenics. Mr. L. D. Coueslant, lecturer in the engineering department of the polytechnic, has been elected to be head of the mechanical and civil engineering department of the Technical Institute of Sunderland. Mr. A. J. Makower has been elected head of the electrical engineering department in succession to Mr. C. F. Smith.

The Fishmongers' Company has granted a sum of 1000*l.* toward the funds necessary for the incorporation of University College in the University of London. By this grant the amount still required to complete the funds necessary for incorporation is reduced to 17,000*l.*, a total of 183,000*l.* having now been raised for the purpose. Dr. A. R. Cushny, of the University of Michigan, U.S.A., has been appointed to the chair of pharmacology and materia medica in the college. Prof. L. F. Vernon-Harcourt has resigned the chair of civil engineering and surveying.

WE learn from *Science* that Mrs. Goldwin Smith has given 4000*l.* to Cornell University; and that by the will of the late Mr. E. A. Goodnough, of Worcester, gifts are made as follows:—5000*l.* to Mount Holyoke College, 3000*l.* to Iowa College, 5000*l.* to the Huguenot Seminary in South Africa, 1000*l.* to Washburn College in Kansas, 2000*l.* to Drury College in Missouri.

THE *Engineering and Mining Journal* of New York publishes the views of Prof. H. M. Howe, the eminent American metallurgist, on the vexed question whether technical schools serve the interests of the community better if they are parts of great universities or if they are isolated institutions. Wisely guided association, while it need not deprive the technical school of character and individuality, should, he thinks, benefit the community through the broadening interaction of the teachers of pure science and the technical teachers, with their closer contact with active life. The grand scale should effect great economy, not so much in saving salaries and in widening the use of the more expensive instruments, as in fitting work to worker, and in supplying more fully the eminent with work on their own plane.

IN a paper on "Architectural Education" read before a meeting of the Royal Institute of British Architects on Monday, Mr. R. Blomfield described the report and syllabus prepared by the Board of Architectural Education appointed by the institute. The following is the syllabus proposed by the board:—(1) Building materials; (2) construction, including (*a*) applied mechanics, strictly in practical relation to construction, and (*b*) the practical methods of the building trades; (3) architectural drawing, including working and freehand drawings, solid geometry, and measured drawings of historical examples of architecture; (4) geometrical projection and rudimentary perspective, this latter to be studied as an aid to the shaping and modelling of buildings, not as a means of elaborating architectural drawings; (5) design and the history of architecture as supplemental to and elucidatory of the study of construction. It is pointed out that these subjects should be taught by class work in the schools and by demonstration in the laboratory or lecture theatre of practical work. The laboratory or workshop for training in practical work is an essential feature of the scheme. The demonstrations given in the laboratory should be in intimate relations with the lectures given in the class-rooms of the schools, and the course must be arranged so that the training in the class-rooms and in the workshops proceed together. In moving a vote of thanks to Mr Blomfield, Sir Arthur Rücker said that, if the great movement which is taking place in technical education is to have a sound foundation, it is absolutely necessary that it should be carried out by those who are themselves the professional members of the great professions and trades which they wish to carry to a point of higher education.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 26.—"On the Drift produced in Ions by Electromagnetic Disturbances, and a Theory of Radio-activity." By George W. **Walker.** Communicated by Prof. A. Gray, F.R.S.

Electromagnetic waves produce certain mechanical forces on an electrically charged particle, and the equations of motion of such a particle can be formed. When the particle is regarded as exceedingly small and endowed with a charge e and inertia m, which includes electrical inertia, the equations take a comparatively simple form. When the small viscous term due to radiation from the particle is neglected the equations can be integrated in certain cases, and it is found that the continued propagation of waves involves an alteration of the position of the particle in space.

The case which suggested the general result was that in which the waves form an infinite simple harmonic train, and the solution showed that while the passage of a complete wave restored the initial velocities of the particle, its position in space was altered.

This alteration of position is not completely accounted for by the change due to the initial velocities had there been no waves. In particular, if the particle is initially at rest, the passage of a complete wave restores the state of rest, but the particle now occupies a new position in space. This curious result has an analogue in the case of a simple pendulum making complete revolutions, where the elapse of a complete period restores the velocity while the angle described has increased by 2π.

The continued propagation of the waves thus involves the result that the particle appears to drift through space in a manner which can be completely determined when the initial circumstances are given and the constants of the train of waves are known.

Similar results are found to hold for any kind of plane disturbances propagated in a straight line. Several cases are worked out where the disturbance is of a simple character. The disturbance is that in which the electric force is X_0, with the appropriate magnetic force X_0/V at right angles to X_0, for a time d/V succeeded by zero force for a time d/V, and this again succeeded by electric force $-X_0$ for a time d/V, and zero force for a time d/V, after which the disturbance recurs. In one case where the particle is initially at rest it appears to drift with the waves, while in another case where the particle has a certain initial velocity at right angles to the direction of propagation it drifts against the waves. If radiation from the particle is neglected, the passage of a complete pulse in which the integrated effect of electric force is zero involves a restoration of the original energy of the particle, and thus the transference of the particle is accomplished without abstraction of energy from the pulse. The expressions for the apparent velocity of drifting in the direction of propagation of the waves are found to depend on the squares of the charge, so that it is probable that an electrically neutral system will also be made to drift.

It is pointed out that if the equations held up to velocities of the charged particle equal to that of radiation, a particle

originally moving in the direction of propagation with a velocity slightly less than that of radiation may be picked up by the waves and carried forward with the velocity of radiation.

The conclusion is that the propagation of disturbances of any form in a straight line involves a sorting of free ions and molecules according to their initial circumstances, and streaming of these both with and against the waves must take place.

These results are general, and are limited only by the limits of the electrodynamic equations. They suggest, however, a possible explanation of the action of all kinds of ionising agents.

In particular, it is suggested that if a radio-active substance is an origin from which electromagnetic disturbances are radiated, these disturbances probably ionise the gas in the immediate vicinity and produce streaming of ions and molecules with their associated properties both outwards from and inwards to the substance. This view does not necessarily involve the supposition that there is a continual diminution of the substance.

The results may also throw some light on the question of the energy sent out. For, suppose that there exist a positive and a negative ion which, in the absence of the pulses, would recombine at some point A, thereby radiating a certain amount of energy, then the directive action of the pulses may make them recombine at some other point B. Thus the radiated energy will proceed from the point B instead of from the point A. The transference of a single free ion can be accomplished without the expenditure of energy, and it is possible that the transference of the positive and negative ions may take place without any abstraction of energy from the pulses. Since, however, in general the transference may involve a relative displacement of the two ions, abstraction of energy from the pulses may be involved, so that the question is one about which the greatest caution must be exercised. It cannot be decided without further investigation.

These considerations are in general agreement with the views that have been expressed by Lord Kelvin and Prof. and Madame Curie.

The question whether the apparent velocity of drifting may be of the order indicated by experiment is considered; and it is shown that in order to give velocities comparable with that of radiation, the theory leads us to expect that the frequency of vibration of the waves radiated by the particles should be of the order for visible or ultra-violet light.

The differences between ionising agents would turn to a considerable extent on the character of the disturbances radiated.

Since the propagation of waves through a region of space containing matter involves streaming of the matter, the continued propagation cannot be quite independent of any statical, electric or magnetic field present.

February 2.—"Note on the Determination of the Volume Elasticity of Elastic Solids." By Dr. C. **Chree**, F.R.S.

PARIS.

Academy of Sciences, February 13.—M. Troost in the chair.—On the existence of an ellipsoid of absorption in all translucid crystals, even when without a plane of symmetry or a principal axis: J. **Boussinesq**.—Study of the silicide of carbon from the Cañon Diablo meteorite: Henri **Moissan**. In the residue left after dissolving a block of this meteorite weighing 53 kilograms in hydrochloric acid, a hexagonal crystal of silicon carbide was noticed. It was completely identified by its appearance, density (3·2), and indifference to most chemical reagents. Fused caustic potash gave potassium silicate, and fused lead chromate, carbon dioxide. The origin of this block of iron may be terrestrial or sidereal, but the existence of silicon carbide in the midst of the metal shows that the products prepared with the electric furnace are met with in nature.—On some constants of pure methane, and on the action of solid methane on liquid fluorine: H. **Moissan** and **Chavanne** (see p. 400).—The eruptive basic rocks of French Guinea: A. **Lacroix**. Besides biotite granite, numerous basic eruptive rocks have been found in French Guinea, especially gabbros, peridotites, and diabases, a detailed account of which is given. Attention is directed to the difference in the mode of weathering in tropical and in temperate climates, as exemplified in these samples.—On the use of photography as an aid to topography: A. **Laussedat**. An account of an application of the photographic method to the survey of the region round Mount Argée, in Cappadocia, on a scale of 1/80,000. The use of photography has the advantage of reducing very considerably the time required as compared with the ordinary methods of surveying, and is especially advantageous in mountainous regions.—Observations of the Borrelly comet (1904 *e*) made with the Brunner equatorial at the Observatory of Lyons: J. **Guillaume**. The apparent position of the comet was measured on January 3, together with the positions of two comparison stars. The comet appeared as an object of the tenth magnitude, and possessed a small nucleus.—Observations of the sun made at the Observatory of Lyons with the 16-centimetre Brunner equatorial during the fourth quarter of 1904: J. **Guillaume**. The results are summarised in three tables giving the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude.—Actinometric observations made at the summit of Mont Blanc: A. **Hansky**. The observations were made in the observatory at the summit of Mont Blanc with the instruments of M. Crova. The conditions in 1900 were more favourable than in 1897 and 1898, and the results for this year are given in detail, the most probable result for the constant being between 3·0 and 3·5.—On linear partial differential equations: M. **Hadamard**.—On the deviation of falling bodies: Maurice **Fouché**. A reply to a criticism of M. de Sparre on a former paper by the author.—The thickness of transparent sheets of iron: L. **Houllevigue**. After trying unsuccessfully various methods for estimating the thickness of thin films of iron, a colorimetric estimation with sulphocyanide was found to give trustworthy results. The transparency (T) of these films was determined before dissolving in acid for the colorimetric test, and for films varying in thickness from 0·024 to 0·056 milligram per square centimetre the thickness was found to be a linear function of log T. This curve being established, the thickness of any given film could be quickly determined by the photometer.—The automatic registration of atmospheric ionisation: Charles **Nordmann**. The charge introduced by the ions is removed from the condenser plate by falling drops of water, the constancy of flow being secured by a Marriotte's bottle. The deviations of the electrometer in the arrangement described, a diagram of which is given, are proportional to the number of ions per unit volume of the gas.—On the heat given off by paraffin submitted to the action of a rotating electrostatic field of high frequency: Ch. Eug. **Guye** and P. **Denso**.—On a new reaction of aldehydes and the isomerism of their oxides: A. **Conduché**. The aldehyde is added to a dilute aqueous solution containing equimolecular proportions of hydroxylamine hydrochloride and potassium cyanate. Well crystallised compounds separate out, the melting points of which characterise the aldehyde. The discussion of the composition of these compounds throws light on the constitution of the isomeric aldoximes. No corresponding compounds are obtained when a ketone is substituted for the aldehyde in the reaction.—The action of hydrocyanic acid on epiethyline: M. **Lespieau**. The nitrile $C_2H_5.O.CH_2—CH(OH)—CH_2.CN$ is obtained in this reaction, and the preparation and properties of several substances derived from this are described.—On the non-existence of two stereoisomeric ethyl dioximidobutyrates: L. **Bouveault** and A. **Wahl**. The supposed existence of two stereoisomers indicated by Hantzsch and by Nussberger is shown to be erroneous.—On the transformation of amylocellulose into starch: Eugène **Roux**.—On the electrolysis of organic acids by means of the alternating current: André **Brochet** and Joseph **Petit**. The electrolysis of formic and oxalic acids can be easily effected with the alternating current; the results are the same as with the direct current, but the yields are much higher.—On the phosphorescence of phosphorus: E. **Jungfleisch**. It is shown that an inert gas, saturated with the vapour of phosphorus, contains an extremely small weight of phosphorus, the oxidation of which gives rise to scarcely appreciable light effects. The author regards his experiments as proving that a lower volatile oxide is first produced, and that it is the oxidation of this which gives rise to the luminous phenomena.—On isodimorphism: Frédéric **Wallerant**.—On the extension of the alkaline rocks in the basin of Aouache: H. **Arsandaux**.—Two species of Dalbergia in Madagascar produc-

ing a variety of ebony wood: Henri **Jumelle.**—On the biology of the Saprolegnia: Paul **Dop.**—The utilisation of the essential oils in the etiolated plant: Eug. **Charabot** and Alex. **Hébert.** It is shown that in the absence of light the plant is capable of consuming the essential oil which it contains, especially the terpenic compounds.—The relations between *Bougainvillia fruticosa* and *Bougainvillia ramosa*: Paul **Hallez.** The author regards these as one and the same species, the one belonging to calm water, the other to rough water, the slight difference between the two being due to this difference in the surroundings.—Experimental researches on the relations between arterial pressure and the amounts of chloroform absorbed: J. **Tissot.** In the case of subjects under chloroform the examination of the arterial pressure gives indications of approaching trouble earlier than the respiratory modifications, the latter only appearing when the dangerous condition is already set up.—A comparative study of the auto-conducting cage and the condensing couch in the treatment of arterial hypertension by d'Arsonvalisation: A. **Moutier** and A. **Challamel.** The results obtained with the solenoid are better than with the couch, the commonly accepted view that the two are equivalent being erroneous.—The action of radium on the torpedo fish: Maurice **Mendelssohn.**—On the tectonic of the region north of the Montagne Noire: Jules **Bergeron.**—The daily variation of temperature in the upper regions of the atmosphere: L. Teisserenc de **Bort.**

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 23.

ROYAL SOCIETY, at 4.30.—On some New Species of Lagenostoma; a Type of Pteridospermous Seed from the Coal-measures: E. A. Newell Arber.—On a New Rhabdosphere: G. Murray, F.R.S.—Two Cases of Trichromic Vision: Dr. F. W. Edridge-Green.—On Changes observable in the Liver Cells during Digestion, and their Relation to Hepatic Secretion: Prof. E. Wace Carlier.—The Colour-Physiology of the Higher Crustacea. Part III.: F. Keeble and Dr. F. W. Gamble.—Phosphorescence caused by the Beta and Gamma Rays of Radium. Part II.—G. T. Beilby.

ROYAL INSTITUTION, at 5.—Recent Work of the Geological Survey: Prof. J. J. H. Teall, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—*Continuation of Discussion*:—The Value of Overhead Mains for Electric Distribution in the United Kingdom: G. L. Addenbrooke.

FRIDAY, FEBRUARY 24.

ROYAL INSTITUTION, at 9.—Fungi: Prof. H. Marshall Ward, F.R.S.

PHYSICAL SOCIETY, at 5.—On the Curvature Method of teaching Geometrical Optics: Dr. C. V. Drysdale.—Exhibition of Dr. Meisling's Colour Patch Apparatus: R. J. Sowter.—A Method of illustrating the Laws of the Simple Pendulum, and an Exhibition of String Models of Optical Systems: J. Schofield.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Morecambe Sewerage: Method of laying a 15-inch Cast-iron Sewer under the London and North-Western Railway: F. D. Flint.—The Reconstruction of Bow Bridge over the River Lea: H. M. Rootham.

SATURDAY, FEBRUARY 25.

ROYAL INSTITUTION, at 3.—Archæology: D. G. Hogarth.

THE ESSEX FIELD CLUB, at 6.30 (at the Essex Museum of Natural History, Stratford).—Straw Plait; a Lost Essex Industry, I.: Chalkley Gould.—Family and Life of Gilberd, of Colchester: Prof. Silvanus P. Thompson, F.R.S.—Revised List of the Hymenomycetal Fungi of Essex: Dr. M. C. Cooke and George Massee.

MONDAY, FEBRUARY 27.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Scientific Results of the National Antarctic Expedition: Capt. R. F. Scott, C.V.O., R.N.

SOCIETY OF ARTS, at 8.—Internal Combustion Engines: Dugald Clerk.

INSTITUTE OF ACTUARIES, at 5.—Changes in Pure Premium Policy-Values consequent upon Variations in the Rate of Interest or the Rate of Mortality, or upon the Introduction of the Rate of Discontinuance: G. J. Lidstone.

TUESDAY, FEBRUARY 28.

ROYAL INSTITUTION, at 5.—Some Recent Biometric Studies: Prof. K. Pearson, F.R.S.

SOCIETY OF ARTS, at 4.30.—The Manufactures of Greater Britain. I. Canada: C. F. Just.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Surface-Condensing Plants, and the Value of the Vacuum produced: R. W. Allen.

WEDNESDAY, MARCH 1.

SOCIETY OF PUBLIC ANALYSTS, at 8.—The Estimation of Oxygen in Copper: S. Dickson.—(1) Some Conditions affecting the Ether Value of Brandies; (2) The Determination of Higher Alcohols in Spirits. I.: Dr. Philip Schidrowitz and F. Kaye.

ENTOMOLOGICAL SOCIETY, at 8.—New Species of Diurnal Lepidoptera from Northern Rhodesia: Herbert Druce and Hamilton H. Druce.—On Three Remarkable New Genera of Microlepidoptera: Sir George F. Hampson, Bart.

CRITICAL SOCIETY OF UNIVERSITY COLLEGE (Gower Street, W.C.), at 5.—Evolution and Speculation: Sir Frederick Pollock, Bart. Visitors invited.

THURSDAY, MARCH 2.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Further Researches on the Temperature Classification of Stars. No. 2: Sir Norman Lockyer, K.C.B., F.R.S.—On the Radio-active Minerals: Hon. R. J. Strutt.—Atmospheric Electricity in High Latitudes: G. C. Simpson.—On the Spectrum of Silicon, with a Note on the Spectrum of Fluorine: J. Lunt.—On the Electric Resistance to the Motion of a Charged Sphere in Free Space or in a Field of Force: G. W. Walker.

CHEMICAL SOCIETY, at 8.—The Latent Heat of Evaporation of Benzene and some other Compounds: J. Campbell Brown.—The Relation between Natural and Synthetic Glycerylphosphoric Acids: F. B. Power and F. Tutin.—The Reduction of Isophthalic Acid: W. H. Perkin, jun., and S. S. Pickles.—The Transmutation of Geometrical Isomers: A. W. Stewart.

ROYAL INSTITUTION, at 5.—Recent Astronomical Progress: Prof. H. H. Turner, F.R.S.

RÖNTGEN SOCIETY, at 8.15.—A discussion on "The Necessity of Accurate Measurement in X-ray and High Frequency Work," opened by Dr. W. D. Butcher.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY, at 8.—Engineering Expert Evidence: J. F. Reade.

LINNEAN SOCIETY, at 8.—Zoological Nomenclature; International Rules and Others (to be followed by a discussion): Rev. T. R. R. Stebbing, F.R.S.—Biscayan Plankton. Part IV. The Thaliacea: Dr. G. Herbert Fowler.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Type-setting by Telegraph: D. Murray.

FRIDAY, MARCH 3.

ROYAL INSTITUTION, at 9.—Recent Advances in Wireless Telegraphy: Chev. G. Marconi.

SATURDAY, MARCH 4.

ROYAL INSTITUTION, at 3.—Archæology: D. G. Hogarth.

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