THURSDAY, DECEMBER 22, 1910.

PROBLEMS OF CROWN COLONY ADMINISTRATION.

The Broad Stone of Empire. Problems of Crown Colony Administration, with Records of Personal Experience. By Sir Charles Bruce, G.C.M.G. Vol. i., pp. xxxiv+511+2 maps. Vol ii., pp. viii+555+4 maps. (London: Macmillan and Co., Ltd., 1910.) Price 30*s.* net, two vols.

ACCORDING to the description on the title-page, this book purports to discuss problems of Crown Colony administration, and to contain, as a subsidiary matter, records of personal experience. The first volume carries out, on the whole, the promise of the title-page, but the second is in effect a record of Sir Charles Bruce's *acta et verba* during the thirty-six years of his faithful and efficient public service in Ceylon, British Guiana, the West Indies, and Mauritius; and the discussion of problems of Crown Colony administration forms little more than a setting for the account of his experiences, and of the recognition which his valuable services deservedly received, from time to time, at the hands of his official superiors. Lengthy despatches and memoranda, much of which might with advantage have been omitted and the rest severely condensed, encumber the pages of the book, and were it not that it is provided with an excellent index, its undoubted value as a work of reference for students of colonial administration would be gravely compromised.

The book, which extends to some 1100 pages, after discussing the resources of the Crown Colonies, and British policy in connection with them, under the heads of national, colonial, and imperial, treats of the Colonial Office and the Colonial Governor; and there are chapters on law, labour, race, health, education, religion, agriculture, forestry, commerce, finance, transport, meteorology, imperial communications, fiscal system, expansion, defence, and the Crown. There are seven appendices, of which two, namely Mr. Edward Manson's memorandum on systems of law obtaining in the Crown Colonies, and a memorandum on measures to be carried out for prevention of malarial fever in Mauritius, are of special interest to students of Crown Colony administration, and, as already mentioned, there is an excellent index.

Within the limits of a short review it is not possible to discuss more than one or two of the subjects with which the author deals; it must suffice to indicate the rest, and to say that (apart from a certain discursiveness and from the other drawbacks to which we have felt bound to direct attention), the student of problems of Crown Colony administration will find much in the various chapters to reward his industry and to satisfy his curiosity. To the readers of NATURE the chapters on agriculture and on forestry, the chapter on meteorology, and the two chapters on health, will probably be of the greater interest than the others. The description of the work of the Imperial Department of Agriculture in the West Indies, which has done so much during the last ten years towards helping to restore the prosperity of the West Indian Colonies is interesting; the sketch of the progress of agriculture in Ceylon is instructive; and the chapter on forestry shows of what vital importance are conservation of forests and reafforestation, and how much remains to be done in that regard. The chapter on meteorology is practically confined to an account, interesting so far as it goes, of the work done under the auspices of Dr. Meldrum at the Mauritius Observatory. The most interesting chapters of all are the chapters on "Health." Only those who have lived in unhealthy climates can fully realise of what vital importance it is to the progress of a community that effectual means should be found for combating the diseases which in so many of the most fertile of the British Dominions beyond the seas have so hampered what Sir Charles Bruce well calls the "agencies of beneficial occupation"—industry, commerce, military and naval defence, and good government—and how dependent those agencies are on the preservation of health against tropical diseases. In this field of later years science has rendered yeoman service to the State, and to the pioneers of civilisation and progress in the tropical and subtropical dependencies of the Crown, and, indeed, throughout the world. Malaria is no longer an elusive bogey; yellow fever has lost much of its terrors; even plague and cholera, in communities which have been brought to understand the value and necessity of the precautionary measures prescribed by science, can be successfully combated and brought under control.

Yellow fever has been practically banished from its hot-bed, Havana. The isthmus of Panama, which is credited with having killed one workman for every sleeper of the Panama Railway, is no longer a particularly risky place of residence. Our garrison and fleet at Malta no longer suffer from Malta fever. Ismailia, formerly a hot-bed of malaria, has been rendered perfectly healthy. The dreaded sleeping sickness, although no absolute cure has yet been found for it, has, in Uganda, at all events, been brought under control. It is unnecessary to multiply instances. And apart from what has been done in the matter of prevention and cure of diseases which affect mankind, the labours of the bacteriologist, protozoologist, entomologist, and helminthologist have contributed in no small degree to the progress and prosperity of the tropical and subtropical colonies. This has been done by discovering and tracing the life-history and development of the lower forms of life which are the cause of many of the fatal diseases to which stock, especially in tropical and subtropical lands, are subject, in tracing out the means by which they are communicated, and the life-history of their transmitters, or intermediate hosts, in devising preventive measures, and preparing vaccines or serums, and searching for and discovering drugs which act as prophylactics or as cures.

The two branches of scientific inquiry—as regards human disease, and as regards diseases of animals—are, indeed, to a great extent interdependent. The discovery of the trypanosome of nagana in cattle and of its transmission by *Glossina morsitans* may be said to have pointed to the discovery of the transmission of the trypanosome of sleeping sickness to man by *G. palpalis.* The discovery that the trypanosome of sleeping sickness persists and grows in *G. palpalis* is akin to the discovery of the development of the malaria parasite in the anopheles. The discovery of the transmission of the piroplasma of Texas fever, of East Coast fever, and of "biliary fever" in stock, by means of ticks, pointed the way to the discovery of the transmission by ticks to man of the spirillum of relapsing fever. There may be some reason to hope that the exhaustive investigation of the causes of grouse disease which is now in progress may possibly lead to a better understanding of the causes of appendicitis in the human subject. Many similar instances might be mentioned. But this is not the place for an essay on the recent history of bacteriology.

Much yet remains to be done. The cause of and specific remedy for blackwater fever, that scourge of tropical Africa, is still to seek. An effectual remedy for sleeping sickness still makes itself desired. Leprosy still baffles the investigator. No cure for bilharzia has yet been found. Prophylaxis for horse-sickness amongst horses, hitherto baffled by hæmolysis, has still to be discovered. (For mules a fairly satisfactory prophylactic has been found.) Piroplasma, for which, in dogs, a specific cure has been discovered, in horses and cattle still presents an unsolved problem.

But the future is full of hope. Such great strides in advance have been made during the last few years that no difficulty seems, to the investigator, to be insuperable. Perhaps the most interesting of the later developments is the discovery of a series of facts which point to the probability of the terribly fatal fever, hitherto called malaria, on the west coast of Africa, being really a form of yellow fever. This matter is now, or is shortly, about to be brought under exhaustive investigation; and should the probability turn out to be a reality, the adoption on the Coast of precautions similar to those which have proved so successful on the isthmus of Panama should render the Gold Coast as healthy as Barbados. Small wonder that an influentially signed address has been sent to the Memorial Committee, suggesting that the name of our beloved Sovereign, the late King Edward the Seventh, cannot be better commemorated than by a liberal endowment of the schools of tropical medicine, which in these later years have done so much for the promotion of bacteriological research and the prophylaxis and cure of tropical diseases, both in the United Kingdom and in the British Dominions beyond the seas.

THE MICROSCOPE AS AN OPTICAL INSTRUMENT.

Microscopy. The Construction, Theory, and Use of the Microscope. By E. J. Spitta. Second edition. Pp. xxii+502+xvi plates. (London: J. Murray, 1910.) Price 12*s.* 6*d.* net.

THE views expressed in the previous notice of this work which appeared in NATURE (February 6, 1908) would appear to have been amply borne out in the welcome accorded to it by the public, since a second edition has already become necessary. Continued use of the volume as a book of reference has thoroughly confirmed the original opinion formed as to its value for the purposes of the practical microscopist. While much more limited in scope than the classical work of Carpenter and Dallinger, being restricted to the consideration of the microscope as an optical instrument, it has from this point of view already largely superseded the older work. Dr. Spitta is fortunate, too, in having obtained, in dealing with the more theoretical portions of the subject, the assistance of Mr. Conrady, whose excellent mathematical knowledge has helped to keep the book free from any of the remarkable theories in connection with the microscope which have been put forward in recent years, and have even found acceptance from some skilled practical microscopists.

One of the features of the first edition of the book was that it was well up-to-date in the account given of present-day microscopes and microscope construction and accessories. There was thus the less necessity for changes in a new edition appearing after such a comparatively short interval. Nevertheless, besides the one or two more important additions of which mention is made below, advantage has been taken of the opportunity offered to include some of the most recent work. Old illustrations of microscopes by prominent makers have been replaced by others of the newest types, and descriptions of novel accessory apparatus are given. We note that the name of the Spencer Lens Co., of Buffalo, N.Y., now appears for the first time, their stand for critical work being fully illustrated, and attention is directed to their one-sixth objective with specially long working distance (1 mm.). A new sixth by Watson and Sons, and one by Reichert, with extra long working distance, are also mentioned. Illustrations of newer models by Zeiss, Beck, and Watson take the place of those previously given, and some forms of museum microscopes, with mechanical contrivances for bringing a series of slides successively into the field of view, are now described.

Among additional accessory apparatus may be mentioned the simple form of apertometer devised by Mr. F. J. Cheshire; new illuminators, especially the convenient miniature arc lamp by Leitz; Mr. J. W. Gordon's lamp with glass-rod light collector, and Mr. J. E. Barnard's mercury-vapour lamp for microscopists—very convenient, with screens, for obtaining monochromatic light; a new auxiliary stage by Watson and Sons; forms of gauges for measuring the thicknesses of cover glasses and slips; measuring oculars or eyepiece micrometers; and a simplified apparatus and method of preparing metallurgical specimens for microscopical examination. The last would appear to be outside the limits of the work, which does not deal with the extensive subject of the preparation of specimens. We have noted also a number of changes in the text, whether by way of omission of unnecessary matter, or additions to render explanations clearer. It is interesting that Dr. Spitta appears finally to have come to the conclusion, with reference to the "black dot" and "white dot" effects in pleurosigma, that "the better the combination (objective) the better the rendering of the black dot effect, no matter the appearance, within reasonable limits, of the white one."

We would remark also that in his chapter on the "Theories of Microscopical Vision," Mr. Conrady adds a few paragraphs giving a short account of the connection between N.A. and the vision of minute objects of dimensions below the resolution limit, whether self-luminous or opaque.

The more important additions are those which deal with the extension of dark ground illumination to high powers, and the description of Siedentopf's apparatus for viewing ultra-microscopic particles. Dark ground illumination at high powers is obtained by the use of a condenser or illuminator of special type, which brings the light, usually with the aid of side reflection, to a focus on the specimen at a very oblique angle. Types of such condensers by Leitz, Zeiss, and Beck are described, and the method will no doubt be of value to the bacteriologist.

The Siedentopf method for illuminating ultra-microscopic particles is well known. The subject perhaps lies outside the range of the ordinary microscopist.

Finally, it may be mentioned that the already excellent series of photomicrographs has been extended by the introduction of four or five interesting photographs of amphipleura. Unfortunately, in the copy we have seen, the printers have made the mistake of printing the descriptive text on the wrong side of the thin paper separating the plates, with the result of making it somewhat difficult to read.

GEOMETRY OF SURFACES.

A Treatise on the Geometry of Surfaces. By A. B. Basset, F.R.S. Pp. xvi+291. (Cambridge: Deighton Bell and Co.; London: G. Bell and Sons, 1910.) Price 10*s*. 6*d*.

ACCORDING to his preface, Mr. Basset intends this book to supply a want in English works on solid geometry, namely, an adequate account of surfaces other than quadrics, the existing gap being due to the fact that Salmon's "Geometry of Three Dimensions" is now out of print.

The greater part of the book seems to be devoted to a detailed examination of the various types of singularities which can occur in surfaces of order not higher than the fourth; such a lengthy investigation cannot be properly criticised except at the cost of great labour. But, for reasons given below, it is doubtful if the method adopted for resolving higher singularities is really sufficient to do all that is claimed by the author.

It is not altogether clear, either, for what class of readers the book is intended; the greater part of the results will interest none but specialists in geometry. And one may imagine that such specialists might be tempted to ask why the analytical machinery is developed purely from metrical definitions, when the properties to be established are mainly projective (or descriptive) in character. Thus, *reciprocation* seems always to refer to a *sphere*, and *homogeneous coordinates* are defined (§3) only as *perpendiculars* on the faces of a tetrahedron. It is not quite easy to see how Mr. Basset would justify the use of coordinates such as $x+iy$, $x-iy$, on the last definition.

However, there is probably a wider circle of readers, not claiming to be geometrical specialists, who would take an intelligent interest in an account of the properties of cubic and quartic curves and surfaces, and particularly in results which are related to work in other subjects. Such readers might also find it useful to have information as to various models available for the illustration of the shapes of the figures; doubtless the expert geometer disdains these mental crutches, and relies on his powers of intuition. But those of us who confess to finding it difficult to visualise surfaces from their equations, are able to point to geometrical experts who have been led to unexpected results by the consideration of models; one need only mention Kummer's model of the surface of centres of an ellipsoid (Salmon, "Geometry of Three Dimensions," p. 273), and Henrici's models of movable hyperboloids. Even expert analysts may make slips in their work, and may find occasionally some difficulty in detecting such slips, while an examination of a diagram or model will often indicate the mistake at once. An illustration may be drawn from Mr. Basset's statement (§142) that the circles of curvature at the ends of the minor axis of an ellipse can intersect at points which lie on the circles of curvature at the ends of the major axis; a moment's glance at a figure will show that the former circles lie wholly *outside*, the latter wholly *inside* the ellipse, for all values of the eccentricity.

Those who wish for an introductory account of the simpler properties of cubic and quartic curves will find Mr. Basset's provision for them rather scanty. His theorems (and proofs) occupy but little more space than the summary (of results only) given in Pascal's "Repertorio," t. ii. (1st edition); and some of Pascal's references are omitted from the list (for cubic curves) given on p. 100. A good deal of light would be thrown on the classification of quartics of the first species by a reference to the Sylvester-Weierstrass method of invariant factors. The same method would prove useful in handling cyclides (quartic surfaces), and leading up to Darboux's pentaspherical coordinates; as Darboux's coordinates are not introduced at all, Mr. Basset is unable to prove that confocal cyclides cut orthogonally, and various other theorems given in Salmon's account of cyclides have to be omitted also.

Nor will the inquirer after the arrangement of the twenty-seven lines on a cubic surface fare much better. Mr. Basset gives half a page to proving their existence, and that of forty-five triple tangent-planes, but he has no illustration to give us of even the simplest example of a double-six. Details of the singularities of the twenty-three different types of cubic surfaces are enumerated; but we are not told that, say, the cubic with a nodal line (of the first kind) can be illustrated by the familiar *cylindroid*, models of which are amongst the commonest examples of ruled skew surfaces.

The resolution of compound singularities (chapters iv. and v.) is discussed first for the case of plane curves; the method appears in all cases to rest on the assumption (see, for instance, §165) that the most general singularity of order[1] p can be found on a curve

[1] We have not succeeded in finding a precise definition of what Mr. Basset means by this term: it would seem to be a singular point with p tangents (some or all of which may coincide).

of degree $p+1$. But, even for $p=2$, there is at least one compound singularity not to be found on a cubic curve; this is the cusp of the second kind, the first compound singularity resolved by Cayley. And readers familiar with such investigations as those of Zeuthen ("Math. Annalen," Bd. x.), or Jordan ("Cours d'Analyse," t. i., chapter v.), will recall that it is often necessary to go to terms of quite high order before we can obtain the precise equivalents of any given singularity. It is therefore open to question whether Mr. Basset's cases really include all types of singularity, even for plane curves; and, in the case of surfaces, the method adopted is similar (see, for instance, §§194, 196), so that it is apparently subject to the same kind of objection.

Readers of Mr. Basset's "Treatise on Cubic and Quartic Curves" will recollect his fertility in the invention of new terms, such as *anautotomic, aperigraphic, endodromic,* and so on. We miss the last pair of words in the present book, but *autotomic* and *anautotomic* are to be found on nearly every page, and occasionally new phrases, such as *tritactic, quintactic, nodotangential.* The question as to whether *autotomic* is a suitable term for a surface having a conical point, must be left to experts to settle; but to an ordinary reader like the present reviewer, the word rather suggests a nodal line or curve on the surface. However this may be, the addition of an index, so that the definitions could easily be looked up, would be an advantage to the general reader not specially familiar with Mr. Basset's terminology.

T. J. I'a. B.

AMERICAN MEAT INSPECTION.

American Meat and its Influence upon the Public Health. By Dr. Albert Leffingwell. Pp. xii+208. (London: George Bell and Sons, 1910.) Price 3*s*. 6*d*. net.

DURING the early period of the year 1906 the world was startled by revolting disclosures concerning the stockyards and great packing houses of Chicago, and the conditions which were then described as prevalent were certainly a menace to the public health. Since then the general public in America and England have been under the impression that permanent and satisfactory reforms have been instituted, which have led to the rectification of the abuses then disclosed. But the writer of this work, while conceding that certain improvements have been made, finds a great deal to take exception to with reference to the quality of the meat which is produced both for home consumption and export purposes. He brings forward certain facts which indicate that laws passed in 1906 for the protection of the public health have been so construed and perfunctorily administered that in some most important particulars the Federal inspection of meat leaves much to be desired.

This tendency to favour a lax construction of the law is alleged to be perceptible in many directions. Consider lard, for an example. In the regulations of 1906, which were passed immediately after the outcry in that year, it is stated that no animals dying before slaughter could be brought into any establishment for rendering. It was intended by this regulation to keep suspected carcases away from the tanks where lard is rendered; yet in barely two years' time (April, 1908) another regulation was framed which made this prohibition dependent upon the will of an official. Again, in the 1906 regulations, extracts of meat were included with other meat-food products which were subject to the examinations required by law, yet a subsequent amendment to these regulations exempts these products from meeting the general requirements.

The author produces statistics of the number of post-mortem inspections made of carcases condemned (both in part and in whole) among cattle and hogs for the years 1907 and 1908 respectively; and certainly the statistics of the latter year indicate a marked reduction of the amount of flesh condemned.

We are also informed that the Department of Agriculture has abandoned altogether the microscopic examination of pork for the detection of trichinæ; and the author observes that the American Government now throws the responsibility of contracting this disease solely upon the consumer, if the food should not be thoroughly cooked. Furthermore, a regulation of 1906 required that carcases showing generalised inflammation of the lung, pleura, intestines, peritoneum, or uterus, whether in acute or chronic form, should be condemned; but in 1908 this was amended so as to deal only with *acute* inflammatory conditions.

In a popular work with a mission of this nature one naturally seeks for evidence as to whether the writer is fair, reasonable, and broad-minded—or otherwise. The charges placed before the reader in this work are independent of personal attestation, and they rest entirely upon official documents. The writer, however, expresses somewhat exaggerated views of the necessity for the condemnation of the whole of a carcase in which there is but strictly localised evidence of tuberculosis, malignant disease, &c. In no country in the world is this the practice; and the best scientific opinion would be opposed to the necessity for the enormous waste of good flesh which would result; although one cannot but sympathise with the sentimental objection to eating the flesh of a diseased animal.

It is a well-written and readable book, and its perusal leaves the impression that the meat inspection of the United States is far from satisfactory, and that much of what the writer says in adverse criticism of it is justified. There appears to be no doubt whatever that since the passing of the Pure Food Law, regulations governing meat inspection have been issued which, in a number of instances, considerably reduced the stringency and efficiency of the 1906 regulations.

The writer looks to foreign lands, and chiefly to England, for the remedy. He points out that the English people are vast consumers of American meat and meat products; and he asks whether the meat and meat products packed in tins and exported are likely to be derived from the best of that which passes muster. He hopes and believes that by the practical expression of public sentiment which will result in the lessened demand for such meat, in England and America, the evils will eventually be remedied.

In conclusion, it should be stated that the writer is one who advocates "an emancipation from the enslavement of the slaughterhouse, with all its evils"; and that he holds the view "that the butchery of animals exists to-day solely because we demand the victims. We have inherited the custom from barbarism; there can be no doubt but that it will be discarded altogether by the higher civilisation of the future race."

THE CHEMICAL ANALYSIS OF IRON AND STEEL.

Die Untersuchungs-Methoden des Eisens und Stahls. By Dr. A. Rüdisüle. Pp. 395+xvi plates. (Bern: Max Dreschel, 1910.) Price 11 marks.

THE title of this book is somewhat misleading. It suggests a survey of the various methods used in the experimental investigation of iron and steel. In reality it is confined to one, viz., the chemical analysis of the constituents.

In his preface the author states that the analysis of iron and steel is one of the most difficult problems in analytical chemistry, and that his object has been to give a critical summary of the methods used in estimating each constituent, with a view to indicating which are the most trustworthy. His book certainly gives a singularly complete account of the details of the methods which have been employed in the last fifty years. But it is only here and there that any attempt is made to compare the limits of accuracy of comparable processes. A technical chemist wishing to estimate, say, phosphorus in a given steel to a certain degree of accuracy, would have considerable difficulty in making his choice from this book. Rapid methods are now the order of the day, and the works chemist has to adopt the quickest, consistent with the necessary degree of accuracy. It is a pity that the author has not borne this in mind more than he appears to have done.

As is only to be expected, by far the greater part of the book deals with the estimation of carbon, manganese, sulphur, phosphorus, and silicon, elements the percentage of which is demanded in all specifications where chemical analysis is included. In view of the detail in which carbon is treated it is surprising to find that no differentiation is attempted between "carbide carbon" and "hardening carbon" in the estimation of "combined carbon," although this is a point of considerable importance. Moreover, there is no reference to the so-called "missing carbon."

The "alloy" steels containing special elements, *e.g.* chromium, tungsten, molybdenum, nickel, vanadium, &c., are well treated, and complete methods are given for various combinations likely to be met in technical practice. There is, however, no mention of uranium, a modern constituent in the armour-plates of more than one navy.

It is significant of the neglect of the influence of gases in iron and steel that the survey of all the methods of estimation occupies only nine in a book of 380 pages. For oxygen only one trustworthy method appears to be known. Nitrogen has fared somewhat better. There is only a scanty reference to carbon monoxide and none to hydrogen and carbon dioxide. Modern metallographical research is insisting on the importance of the effect, particularly of oxygen and nitrogen, on the properties of iron and its alloys. For many years the pernicious influence of phosphorus has been recognised. It is now coming to be admitted that nitrogen may be anything between five and ten times as harmful. As yet no specifications require the estimation of the gaseous constituents in steel. The day is probably not far distant when this will be demanded.

The microscopic investigation of steels has led to another demand, viz., for a knowledge of *how* the various constituents exist in the metal. The present method of returning them as though they existed as such is entirely misleading. In the majority of cases they are combined. Some are segregated as special constituents; others are dissolved in the main bulk of the metal. It is just here that the present methods of chemical analysis are woefully weak; indeed, the researches of Carnot and Goutal stand almost alone as a praiseworthy attempt to obtain information on these matters. If the author, when he comes to prepare a second edition of his book, will include a chapter dealing with the methods that have thrown light on the chemical *constitution* as distinct from the *composition* of steels this will add considerably to the value of an already useful and trustworthy handbook.

H. C. H. CARPENTER.

THE PSYCHOLOGY OF SCIENTIFIC INQUIRY.

Erkenntnistheoretische Grundzüge der Naturwissenschaften und ihre Beziehungen zum Geistesleben der Gegenwart. By Paul Volkmann. Pp. xxiii+454. Second, completely revised, and enlarged edition. (Leipzig and Berlin: B. G. Teubner, 1910.) Price 6 marks.

THE second edition of this work (originally published in 1896) appears as the ninth volume of "Wissenschaft und Hypothese," a series which takes its name from its first number—a translation of Poincaré's well-known essay. The author has adopted, both in the subject-matter and the mode of exposition, numerous changes that are intended to fit the book for its new *rôle*. In particular he has sought, by avoiding unnecessary technicalities and by the multiplication of examples from the history of science, to make his work useful and interesting to the layman. There is no doubt that he has succeeded. The book in its present form, though not comparable in brilliance or charm with the name-volume of the series, gives on the whole a sound and lucid treatment of the matters with which it deals. Its chief weakness is a certain lack of architectural unity and clearness of plan.

The author's general problem is to exhibit the development of science as a psychological rather than a logical process, the result of continued reaction between objective reality and investigating minds. This reaction is conditioned by certain postulates, such as the postulate of congruence between the logical necessities of abstract thought and the phenomena which express physical "law." Also it follows universally the same general course, described by the terms induction and deduction, isolation and superposition, &c. But the details of the scientific process, and consequently its results, are a function of the mind of the investigator, as well as of the "facts" investigated. Thus there are well-defined types—especially national types—of scientific interpretation, corresponding to typical differences upon the subjective side of the epistemological relation. It follows that an inquiry into the scientific process, to be fruitful, must be based upon a study of its concrete manifestations in history.

This principle is applied in the chapters that make up the greater part of Herr Volkmann's book. The last third is devoted to an analysis of the influence of scientific thought and discovery upon the general intellectual life of our time, as represented in its philosophy, its views on education, &c. A lengthy appendix consists of a reprint of two papers, one a criticism of Newton's methods in the "Principia," the other a critical comparison between the fundamental ideas of Newton's mechanics and the alternative concepts proposed by Hertz.

OUR BOOK SHELF.

Photograms of the Year 1910. *Typical Photographic Pictures Reproduced and Criticised.* Edited by H. S. Ward. Pp. 160. (London: G. Routledge and Sons, Ltd., Dawbarn and Ward, Ltd.; New York: Tennant and Ward, 1910.) Price, paper cover, 2*s*. 6*d*. net.; cloth cover, 3*s*. 6*d*. net.

IT is very useful and helpful to the photographer to have under one cover a typical set of the photographs of the year with attendant criticisms of each. It is especially valuable to those who have not had the opportunity of studying the originals for themselves. This annual should therefore be appreciated by a great number of workers, and the one now issued is a worthy follower of the former publications. In the collection here submitted the photographs have been chosen from an enormous number, and the selection, as we are told, has been made by one "who has had exceptional opportunity of considering the world's output for a quarter of a century."

This year the book has been increased by the addition of eight pages of plates, reproduced by the three-colour process from originals by the three-colour carbon method, as well as by the newer single exposure processes on autochrome, Thames, and dioptichrome plates. While the editor points out that these processes and their reproductions are not yet at the "ideal" stage of natural colour photography, they yet afford examples of the expression of artistic individuality. The book, as usual, is of an international character exhibiting photographs by Continental, Colonial, and American workers. It contains forty-eight pages of letterpress and 161 reproductions in monochrome and eleven in colours.

The "Code" School Garden and Nature Note-Book. Edited by G. Lewis. Pp. 96. (London: H. Marshall and Son, n.d.) Price 9*d*.

THIS little note-book is intended to help the scholar and the teacher in systematising the work and the observations in the school garden. Unless a careful record is kept, the full educational value of many of the observations cannot be obtained, but there may be some difficulty in keeping the records in such a way that they shall be readily accessible. This difficulty is obviated in the present book. The main part of it is divided into twelve parts, one for each month, each consisting of five pages. On the first are a few reminders for the month, showing what should be done in the fruit, flower, and vegetable gardens, what the animals and birds are doing, and what to look for in wild plant-life. The next two pages are for a record of work done in the garden; the fourth is ruled up for meteorological observations, but as only fourteen entries can be made it is clear that daily readings are not contemplated. The last page is for nature observations. At the end of the book are pages for crop records, for temperature and rainfall charts—one for atmospheric pressure might usefully have been added—and for profit and loss account.

The mechanical labour of keeping observations is thus reduced to a minimum, and at the same time the record can always be traced back if necessary. Only those who have attempted to get together class records can realise entirely what a saving of time and trouble this means.

One or two points in the introductory pages want alteration. A loam is not "a soil composed of equal parts of clay and sand." It is not only unnecessary, but undesirable, to give the name "sulpotide" to the definite and well-known sulphide of potassium wash; if the scholar or teacher looked in the index of a standard gardening book he would hardly be likely to see the word mentioned. The author recommends the injection of carbon bisulphide into the soil to kill the larvæ of the click beetle (wireworms); this is hardly a school operation, even if it were effective, and the evidence on this point is by no means clear. But apart from these little points the book is very useful, and can be commended for class purposes.

Handbuch der vergleichenden Physiologie. Edited by Hans Winterstein. Band ii., Erste Hälfte. Neunte Leiferung. Physiologie des Stoffwechsels, Physiologie des Zeugung. Pp. 819–980. Band iii. Zweite Hälfte. Zehnte Lieferung. Physiologie der Energieproduktion. Physiologie der Form. Pp. 161–320. (Jena: Gustav Fischer, 1910.) Price per fasciculus 5 marks.

WHEN the earlier fasciculi of this ambitious work appeared, we noted the general characters and aims of the undertaking. The ninth fasciculus contains a continuation of Prof. W. Biedermann's article on nutrition in the different classes of the world of life; but the article in question is not yet concluded. Each group is considered in detail, and the outcome will be a most valuable work of reference, and contains a mine, not only of information, but of references to original researches. The bibliographical notices relating to digestion and nutrition in the insects and myriapods alone number 247.

The tenth fasciculus is a portion of the third volume, which deals with quite different subjects. No doubt it is a convenience to the editor to print the bits as they are ready, though it is a little confusing to the reader. It contains portions of two articles; the first is the conclusion of an article on the production of electricity in animals and plants, by Prof. S. Garten, and the second the commencement of an article by Prof. Ernst Mangold, on the production of light in living things, especially in animals. The two articles manifest the same thoroughness of treatment noticeable in the previous fasciculi, and we congratulate the editor on having secured the service of collaborators who are all actuated by the same high ideals.

Guide to the British Vertebrates Exhibited in the Department of Zoology, British Museum (Natural History). Pp. vii+122, with a plan and 26 illustrations. (London: Printed by order of the Trustees of the British Museum, 1910.) Price 1*s*.

THIS guide contains a concise account of the British vertebrates other than the turtles and marine fishes, which are altogether omitted, and the Cetacea, of which only a list is given. The seventy-five species of mammals are dealt with in an interesting manner, references being made to their habitat, food, care of young, change of coat, hibernation, &c. The common and Latin name of each species is given, and we are glad to note that where the Latin name has recently been changed the older and more familiar designation has also been added. The large number (442) of birds in the British list necessarily means that each can receive only comparatively short notice in the space available; nevertheless, a large amount of interesting information is packed into the twenty pages devoted to this part of the subject. The reptiles—three snakes, the blind-worm, and two lizards—and the Amphibia, seven in number, are described, with notes on their distribution and habits. The account of the fishes, which is restricted to those occurring in fresh water, also contains many interesting observations on their distribution, the distinctions between allied species, spawning, &c.

An appendix contains a full list of the species of vertebrates, other than turtles and marine fishes, which have been recorded from the British area. In the case of those birds which have occurred not more than six times notes are added or references given to the records of capture. The illustrations, about half of which are reproduced from photographs, are good, and several are of special excellence. The volume forms a thoroughly serviceable guide to the collection.

The Sea-Kings of Crete. By the Rev. James Baikie. Pp. xiv+274. (London: A. and C. Black, 1910.) Price 7*s.* 6*d.* net.

As a compilation this work shows great diligence; it has evidently been written *con amore*, and its aim is most praiseworthy; but it has no scientific value. We prefer to see *œuvres de vulgarisation* of this kind written, when possible, by the excavators themselves. This is no doubt a counsel of perfection; they have usually too much to do to write popular books. But in any case, such books should only be written by trained archæologists with a first-hand knowledge of the subject and a personal acquaintance with Crete itself. Of these qualifications we do not see much evidence in Mr. Baikie's work, which, after the publication of the books of Mrs. Hawes (a Cretan excavator) and Prof. Burrows, seems scarcely needed.

Pinro. (Brook's patent.) (W. J. Brooks and Co., Letchworth, Herts.) Price 1*s.* per twelve yards.

THIS device consists of a thin metal tape, from which fine steel points project at intervals of about four inches. It is intended to be used by draughtsmen as a substitute for drawing-pins, and also for attaching canvas, posters, fabrics, &c., continuously along the edges. The contrivance does not seem to us likely to be generally adopted, but there are special circumstances under which it might be found very serviceable.

Teachers' Notes on Nature-Study: Plants and Animals. Pp. viii+232. (London: Blackie and Son, Ltd., n.d.) Price 1*s.* 6*d.* net.

THIS re-issue of an old work will not commend itself to teachers who desire to make the school study of science a training in accurate observation, simple reasoning, and precise expression. The method of teaching, the haphazard arrangement of subjects, and the general absence of scientific treatment, all remind the reader of the discredited style of "object-lesson" common ten or fifteen years ago. The compiler, whose name is withheld, does not appear to realise the necessity in the case of young pupils for basing every lesson on plants upon specimens in the hands of each child, and encouraging the children to draw from the specimen rather than from the teacher's blackboard sketches.

The Scientists' Reference Book and Pocket Diary for 1911. (Manchester: J. Woolley, Sons and Co., Ltd.) Price 1*s.* 6*d.*; bound in morocco, 2*s.* 6*d.*

IN addition to a handy diary in which provision is made also for memoranda and addresses, this publication provides a very useful book of tables and facts likely to be of use to workers in science, as well as to students. In view of its small price the combination is likely to secure a wide popularity.

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.*]

Historical Note on Recalescence.

THE interesting *résumé* of Prof. Arnold's British Association paper on recalescence, which appeared in NATURE for December 1, contains the following statement in the opening paragraph:—

"In 1868 the late Dr. Geo. Gore, F.R.S., discovered the recalescent points now known as Ar_3 and Ar_2, and in 1872 Prof. W. F. Barrett, F.R.S., discovered the recalescent point Ar_1, which is now known as the carbon change point. Prof. Barrett gave the phenomena the generic title of 'recalescence,' by which they have been known ever since."

As no little misapprehension exists on this subject, it is desirable, as a matter of historical accuracy, to state that Dr. Gore did not discover the phenomenon of *recalescence*, but he was the first to observe the remarkable momentary elongation of an iron wire during cooling from bright incandescence, which important observation subsequently led to the discovery of recalescence.

Owing to the great practical importance which recalescence has assumed in the hardening and heat treatment of steel, it may perhaps be of interest if I briefly state the early history of this discovery.

The Proceedings of the Royal Society for January 28, 1869, contains a paper by Dr. Gore which records the anomalous behaviour of cooling iron above referred to—its sudden transient expansion at a dull red heat. This anomalous behaviour Dr. Gore found was not shared by other metals, and he states that no reverse effect was noticed upon heating iron wire to incandescence.[1]

Some two years later, having to deliver a lecture before the Royal Dublin Society on the "Molecular Changes that accompany the Act of Magnetisation," I was anxious to show Mr. Gore's interesting discovery, as it appeared likely to be connected with the resumption of the magnetic state in iron when cooling from a white heat. In answer to my inquiry Mr. Gore kindly furnished me with his apparatus, and as he said he had no further use for it I purchased it from him, and it is still in my possession. To make the effect visible to a large audience a mirror was attached to the spindle which moved the index, and from it a ray of light was reflected to a distant scale. This device revealed the fact, overlooked by Dr. Gore, that a small momentary *contraction* of the iron wire took place during its heating to incandescence, approximately at the same temperature at which the momentary elongation occurred in cooling.[2]

Dr. Gore having informed me, in a letter dated May, 1872, that he was not pursuing his original observation and that the subject was quite open to anyone, I felt at liberty to continue the inquiry. Accordingly, the following year, Dr. Guthrie having kindly placed his laboratory

[1] In fact some eighteen months after his original observation Dr. Gore states in a paper published in the *Phil. Mag.* for September, 1870 (the italics are his):—"The iron during cooling . . . . suddenly elongated by diminution of cohesion . . . a corresponding but reverse phenomenon did *not* occur during the process of *heating* the wire."

[2] This lecture was repeated at the London Institution a year later, and a full report of it is published in the Journal of that Institution.

at South Kensington at my disposal, an investigation was begun, which led to the discovery of recalescence on September 12, 1873. On that date I noticed that accompanying the Gore effect in cooling iron, and at the same critical temperature, a sudden reheating or *after glow* occurred. It was more difficult to detect the reverse effect on heating, but a momentary arrest of the heating appeared to occur at the critical temperature. The Chatelier thermo-electric pyrometer was unknown at that time, and I had to have recourse to an air thermometer, which showed that the after glow was not an optical illusion, but a real, though transient, accession of temperature, due to a liberation of latent heat and not to surface oxidation of the iron, as was shown by the recalescence occurring as strongly in an atmosphere of nitrogen or other inert gas as in air. Furthermore, this effect appeared to synchronise with the critical temperature at which iron lost on heating and regained on cooling its magnetic power, and with the remarkable thermo-electric inversion in iron which Prof. Tait had then recently discovered. I noticed, also, that a crepitation occurred in the iron at this temperature resembling the Page effect on magnetising iron.

These and other observations were described, and the experiments exhibited at the British Association meeting at Bradford a few weeks later, September, 1873, and the paper was published in the *Philosophical Magazine* for December, 1873.[1] An interesting discussion on recalescence followed the reading of my paper, in which Prof. Clerk Maxwell, Mr. Herbert Spencer, Prof. Carey Foster, and others took part. This was reported in the local papers at the time, and happily is preserved in a number of the now defunct *Quarterly Journal of Science*.[2]

Later on a British Association Committee was appointed to report on the whole subject, Prof. Geo. Fitzgerald being chairman and myself secretary. Unfortunately, a long delay occurred in the publication of the report, partly owing to my removal to Dublin and the pressure of work in the chair to which I was appointed; meanwhile, the subject was greatly enriched by the researches of others, especially by M. Osmond, who in 1886 made it the starting point of his classical investigations. An interim report by the British Association Committee was, it is true, published, but I would specially refer to the final lengthy report published in the Proceedings of the British Association for 1890, which had the advantage of Prof. Geo. Fitzgerald's cooperation, he having witnessed and corroborated some of the earlier experiments described therein. It is there shown that in 1875 two recalescent points were found, most markedly in steel wire, "the second and far stronger after glow being exactly coincident with the sudden elongation of steel wire during cooling" (the Gore effect). As that report is easily accessible, I will not refer to the other observations it contains. Amid the large literature on this subject which has grown up attention should be directed to an excellent investigation by a Swede, Dr. G. E. Svedalius, on the "Measurement of the Anomalous Changes in the Length and Temperature of Iron and Steel during Recalescence"; this was communicated by Prof. Geo. Fitzgerald to the *Philosophical Magazine* for August, 1898.

With regard to the allotropic form of iron which appears to be produced at high temperatures—Osmund's β iron—and the liberation of the latent heat of allotropy during cooling causing recalescence, I may point out that Prof. Tait, from his thermoelectric researches, had been led to the conclusion, as stated in his Rede lecture in 1873, "that iron becomes a different metal on being raised above a red heat." But I believe Prof. Geo. Forbes was the first to suggest and publish the fact that recalescence might be due to the liberation of the latent heat of an allotropic form of iron. Writing to me upon my experiments on April 18, 1874, he remarks:—"It would follow that iron heated to an intense white heat assumes an allotropic form, and that at this temperature [of recalescence] when cooling it changes to the other form and gives off latent heat."

In conclusion, let me congratulate Prof. Arnold upon his investigations, extending over so many years, and the light he has thrown on the causes of the different phases of recalescence and the importance of the carbon change point. No doubt he is aware that M. Svedelius, in the paper referred to above, also experimented with electrolytic iron. Referring to the expansion at the critical temperature, Svedelius says:—"In a rod of electrolytic iron the magnitude of the expansion at D_1 decreased very rapidly with every renewed heating, and after the fiftieth heating no trace either of the critical point D or D_1 could be discovered"; and he adds in a footnote:—"This confirms the statement made long ago by Prof. Barrett that in very pure iron the anomalous contraction and expansion could be 'washed out,' as it were, by repeated heating and cooling." I do not know whether Prof. Arnold has experimented with a very low carbon "burnt iron" to ascertain whether any recalescent points remain in such iron.

W. F. BARRETT.

Kingstown, co. Dublin, December.

1 "On Certain remarkable Molecular Changes occurring in Iron Wire at a Low Red Heat. *Phil. Mag.*, December, 1873, p. 472; see also my paper in the following number of the *Phil. Mag.*

2 Upon the publication of my paper in the *Phil. Mag.*, Dr. Gore wrote to me as follows, in a letter dated Edgbaston, December 22, 1873:—"Your new discoveries respecting the molecular changes in iron, described in the *Phil. Mag.* for this month, have greatly pleased me; especially the sudden development of heat attending the elongation during cooling, and the sudden shortening during heating." Furthermore, when Sir Roberts-Austen in a lecture before the British Association in 1889 made much the same error as that quoted at the beginning of this note, Dr. Gore at once wrote to me and expressed his great surprise that the discovery of recalescence should be attributed to him.

Captain Cook Memorial.

UNDER the auspices of the British Empire League, a very representative and influential committee has been formed to carry out the proposal made by Sir Joseph Carruthers, K.C.M.G., ex-Premier of New South Wales, that a monument should be erected in London to the memory of Captain Cook; but I venture to ask, is this the best way to honour the memory of the illustrious navigator? Captain Cook was a great seaman, geographer, and ethnologist; indeed, he was one of the foremost of the men of science of his day. As his life was devoted to discovery of various kinds, surely the best memorial to him would be to establish a fund, associated with his name, the interest of which should be devoted to the prosecution of investigations analogous to those in which he spent his life and met his death.

Cambridge, December 13.

A. C. HADDON.

Accuracy of Time on Magnetograms.

I AM greatly interested by Dr. Krogness's letter in NATURE of December 8 directing attention to this matter. We have been investigating this point for some time by interrupting both trace and base line in our Adie magnetographs.

We find that, in general, if the times are taken from the base line we should actually get declination for about two minutes later, but horizontal force and vertical force for two minutes earlier. The error is probably not constant, and so we have decided to interrupt the trace. It may be of interest to say that we have been able to reduce the interruption to one minute, which corresponds to ¼ mm. on the paper.

GEORGE W. WALKER.

The Observatory, Eskdalemuir, Langholm,
Dumfriesshire, December 19.

The Quadrantid Meteor Shower.

IF the maximum of this meteor shower should occur when the earth is in the same position with regard to the sun as was formerly the case, it would take place in the daytime of January 3, 1911, but this shower does not seem to have been sufficiently watched of late years to ascertain when the maximum now occurs. There is, however, some reason to believe that it will not be until the evening of January 3, in which case, as there is no moonlight, it would be a very favourable opportunity for its observation in this country. As the maximum is of short duration it ought to be more extensively watched for annually than appears usually to be the case.

T. W. BACKHOUSE.

West Hendon House, Sunderland, December 13.

ORIENTAL OR BUBONIC PLAGUE.

PLAGUE is an acute infective disease, an infectious fever, attacking man and some of the lower animals, and attended with a considerable mortality. The symptoms in man develop within a few days of infection, and consist of fever, headache, giddiness, weakness, with staggering gait, great prostration, and delirium. In 75 per cent. of the cases the lymphatic glands in the groin, armpit, and other regions are inflamed, infiltrated, and much enlarged, constituting the "buboes," hence the name "bubonic plague" frequently given to the disease.[1] In the remaining cases, the lungs may be primarily attacked, the "pneumonic" form, or a severe blood infection may develop, the "septicæmic" variety; in both of these buboes are absent, or are a late development if the patient lives. Occasionally an eruption of pustules or carbuncles appears on the skin, a phenomenon frequently mentioned by the older writers, and abscesses may form in the buboes. The bubonic form is hardly infectious or even contagious, but the pneumonic variety is highly infectious, owing to the presence of large numbers of the infective agent, the plague bacillus, in the expectoration from which it is readily disseminated in the air. In some instances the patients do not appear particularly ill, and are able to go about, though such cases are liable to sudden death from heart failure.

The micro-organism of plague was discovered independently by Kitasato and by Yersin in 1894. It is a stumpy, rod-shaped organism or "bacillus," having rounded ends, and measuring as a rule about 1/8000 inch in length, and 1/16000 inch in breadth, but longer forms occur. In smears made at an early stage of the disease from the buboes, expectoration or blood respectively in the three varieties, the bacillus is present in enormous numbers, and if the films are stained with an aniline dye, such as fuchsia, it tends to stain deeply at the ends ("polar staining"), the centre being hardly stained at all (see Figs. 1 and 2); this is a very characteristic appearance. In older lesions peculiar, large, rounded or ovoid "involution" forms of the bacillus are met with. The organism can be readily cultivated in various media in the laboratory; it is non-motile, and does not spore, and is readily destroyed by heat (60° to 65° C. for ten to fifteen minutes), and by disinfectants. The plague bacillus is pathogenic for a number of animals, in addition to man—the rat, mouse, guinea-pig, rabbit, hare, ferret, cat, monkey, &c. In the United States the ground squirrels are attacked.

A remarkable feature which has characterised plague from the earliest times is the alternation of periods of widespread prevalence, "pandemics," with periods of quiescence and complete intermission. Thus, in the fourteenth century, in the course of three years, plague decimated the whole of Europe, with an estimated destruction of one-fourth of the population, appearing in England as the black death.[2] In the fifteenth, sixteenth, and seventeenth centuries there were frequent outbreaks in Europe, Asia, and Africa, more or less limited in extent, culminating in England in the great plague of London, with 97,306 burials in 1665, of which 68,596 were attributed to plague, whereas in the five years preceding and succeeding this terrible visitation the normal number of burials in London ranged from about 15,000 to 20,000. Plague then rapidly disappeared from western Europe, so that by the end of the seventeenth century it was practically extinct, and save for isolated outbreaks (*e.g.* at Marseilles and Toulon in 1720) occurred only in Turkey, the Levant, Egypt, and Asia Minor. Thus plague was practically unknown to the present generation until 1894, when it reappeared in epidemic form, this time in Hong Kong. There have always been localities in which plague has been "endemic," *i.e.* continuously prevalent, for example, on the Persian Gulf, in Asia Minor, and in Yunnan, a province of China bordering on Burmah and Tibet. According to Prof. Simpson, plague travelled from Yunnan by the overland trade routes to Canton, thence by river to Hong Kong; from Hong Kong the disease was sea-

FIG. 1.—Smear from bubo showing large numbers of plague bacilli. ×1200.

borne to India, where it certainly appeared in 1896, and since then has similarly been carried all over the world. The agent by which the disease has been so widely disseminated is the rat, infection from man to man being almost negligible, the rat fleas being the intermediaries between the rat and man, and mechanically conveying the infection—the plague bacilli—from rat to rat, and from rat to man (*vide* an article by Dr. Petrie in NATURE, November 3, p. 15). For combating the spread of plague, the destruction

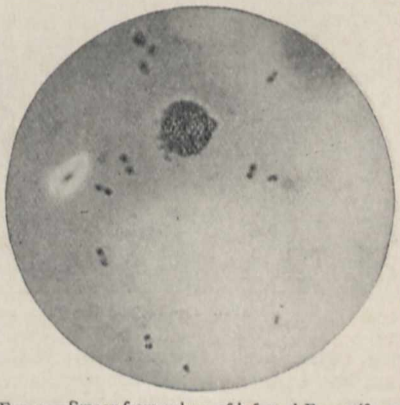

FIG. 2.—Smear from spleen of infected Ferret (from Suffolk), showing typical bi-polar staining plague bacilli. ×1200.

of rats is therefore an important measure. While it seems hopeless to effect complete destruction of these rodents, a great deal can be done to lessen their numbers, and the survivors will probably be less likely to be infected. The destruction of rats may be carried out by systematic trapping, ferreting, and poisoning, but anyone who has had to deal with rats is aware how "cute" they are, and the most tempting morsels will often fail to attract them to trap or poison. Handling the material or trap is sufficient to rouse their suspicion, and the "taint" of man, if present, must be destroyed by flaming or disguised by the use of

[1] Although this is the rule, Prof. Simpson points out that in Accra, West Africa, 50 per cent. of the cases were of the pneumonic variety.

[2] I am indebted to Prof. Simpson's "Treatise on Plague" for these and other historical details.

some strong-smelling substance, such as aniseed. Moreover, after a few rats have been caught or poisoned in a locality, the survivors will frequently migrate elsewhere, hence the need for concerted and systematic action in and around a district in which plague has occurred.

Although plague cases may occur at any time of the year, the disease usually exhibits a marked seasonal prevalence. In Poona plague is epidemic only from July to February, August, September, and October being the months of maximum prevalence. This period corresponds closely with the extent of flea prevalence on the rats. An epidemic terminates naturally, owing to a combination of adverse factors, *e.g.* decrease in the number of fleas, decrease in the number of rats, and an increase in the proportion of immune to susceptible rats.[1] In some instances plague cases may be completely absent between the seasons of prevalence, but by what means the infection is kept alive in the intervals has not yet been determined. Rats are occasionally met with suffering from what has been regarded as chronic plague, but the latest investigations of the Indian Plague Committee indicate that the condition is one of recovery from plague infection, and the condition is stated to possess no significance in the seasonal recurrence of the disease among the rats.[2]

The recent outbreak of plague in Suffolk, though in itself insignificant, is disquieting owing to the fact that plague-infected animals—rats, rabbits, hares, a ferret (see Fig. 2), and a cat—have been met with in five districts in Suffolk, in one district in Essex, and in the London Docks, indicating a somewhat wide distribution of infected localities. This may be of no moment, but, on the other hand, it may in the future lead to scattered outbreaks of human plague, probably not in themselves very serious, but possibly causing great injury to commerce. Thus, if, say, half a dozen cases of plague occurred in the neighbourhood of the docks, the Port of London would be placed in quarantine,[1] and the home and foreign trade of the port amounts nearly to *one million pounds per day!* It behoves the authorities therefore to prosecute a vigorous, concerted, and systematic campaign against the rats with a view to the detection and the limitation of infected areas; now is the time for action, for when infection becomes widespread it is too late.

For the photo-micrographs I am indebted to Mr. J. E. Barnard. R. T. HEWLETT.

1 See "Reports on Plague Investigation in India," Nos. xxxvi and xxxvii, *Journal of Hygiene*, x. No. 3.
2 *Ibid.*, Report No. xxxiv.

1 Plague and cholera are the two diseases now quarantinable under the Paris Convention.

EXPLORATION IN THE NEARER EAST.

IN his latest book,[2] Mr. Hogarth has given us a series of brilliant sketches, each of which centres round some episode in a life of very varied archæological adventure. It is a delightful form of autobiography, for we find no dull pages to skip, no laboured accounts of worthy but uninteresting achievement. Each chapter is a separate picture in itself, and, as we read, we find ourselves transported, with somewhat startling rapidity, throughout the lands of the Nearer East. We see the author at work as an archæologist on the coasts of Asia Minor, in Crete, among the Nile fens of the Delta, in Upper Egypt, on the North African coast at Cyrene, and by the banks of the Euphrates and Sajur, to say nothing of the time when he served as the *Times* correspondent in Thessaly during the Græco-Turkish war. Few archæologists, if any, have accomplished work of so

FIG 1.—Rigging the great Pump at Ephesus. From "Accidents of an Antiquary's Life."

2 "Accidents of an Antiquary's Life." By D. G. Hogarth. Pp. x+176. (London: Macmillan and Co., Ltd., 1910.) Price 7s. 6d. net.

varied a character, and certainly none has Mr. Hogarth's gift of vivid narrative. Many readers will doubtless be surprised that the study of archæology should prove so attractive and picturesque an occupation, but it is not without its hardships, as Mr. Hogarth's pages bear witness. Saddle-sores, poor food, the necessity to keep going even when half-dead with malaria, and the absence of skilled advice when suffering from other ailments, have to be faced by anyone who would take part in the exploration of the less accessible countries of the Nearer East. But Mr. Hogarth lays no undue stress on what he has undergone, and in his introductory chapter, which he entitles an "Apology of an Apprentice," he examines the basis of the faith that has sustained him.

FIG. 2.—Half Buried Palm-forest, Baltim. From "Accidents of an Antiquary's Life."

We do not pretend to an opinion as to whether an antiquary, like a poet, is born, not made, but there can be little doubt that careful training may do much to mould an original, though perhaps latent, inclination. Apart from the fact that he is more curious of the past than the present, Mr. Hogarth well describes the antiquary as loving detail for its own sake and as caring less for ends than means. His ideals are, in fact, rather different from those of the purely scientific mind. The severe man of science may extol the pursuit of knowledge for its own sake, but at the back of his mind there is always an idea of benefiting somebody or something. The true antiquary has no such obsession. The results of his labours, when set out and labelled in public museums, may perhaps have an educational value—archæology may after all be the handmaid of history—but to him the pursuit is an end in itself apart from its results.

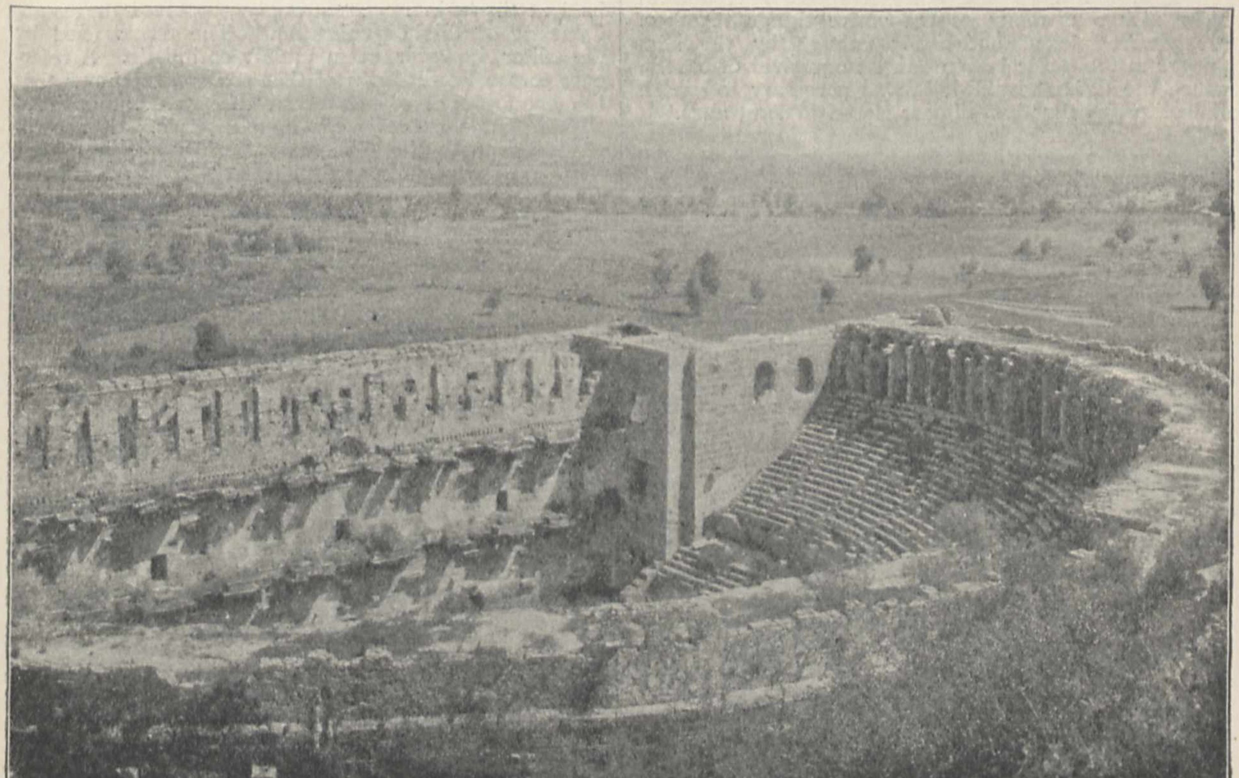

FIG. 3.—The Theatre of Aspendus. From "Accidents of an Antiquary's Life."

Though such may be the philosophy of "the antiquarian trade," Mr. Hogarth does not fail to recognise that plunder is a real incentive, even to the most philosophical of inquirers; and the material results of his own explorations give them a satisfying completeness, like the buried gold which should always reward the treasure-seeking hero of romance. One of the most exciting episodes in the volume, the exploration of the limestone cave on Dicte, the legendary birthplace of Zeus, affords an instance in point, and shows how unexpected may be the treasure that sometimes awaits the fortunate explorer. Having blasted a way into the cave through the fallen rock and boulders that blocked its entrance, a fortnight's careful search of the soil in the upper cave was rewarded by a certain number of votive offerings around an altar of burnt sacrifice. But it was at the end of the excavation, when it only remained to search the lower cave for objects that might have slipped down during the secret digging of the past few years, that the element of luck came in. The floor of the lower cave is covered with an icy pool which runs far into the hill about the bases of fantastic stalactite columns. Here, Mr. Hogarth tells us, he did not expect to find much spoil, since no native had ever found anything in the pool among the columns, except a few scraps of water-borne pottery from above. But with the true archæologist's instinct of seeing for himself, Mr. Hogarth ordered a thorough search. Not much was found in the pool itself, but a zealous worker, wanting to put both hands to his work, happened to wedge his candle-end in the fluting of one of the stalactite columns, and by its light he perceived the green edge of a bronze blade in the slit. A further search was at once ordered:—

"Men and girls dispersed themselves along the dark aisles, and perching above the black waters on natural crockets of the pillars, peered into the flutings. They found at once—found blades, pins, tweezers, brooches, and here and there a votive axe, and in some niches as many as ten votive things together. Most were picked out easily enough by the slim fingers of the girls; but to possess ourselves of others, which the lights revealed, it was necessary to smash stalactite lips that had almost closed in long ages."

These were all votive objects, placed on the columns of that silent pool that formed the shrine of the god of Dicte. "As we saw those pillared aisles," Mr. Hogarth remarks, "so with little change had the last worshipper who offered a token to Zeus seen them three thousand years ago."

Another venture that was crowned with unexpected spoil was the excavation of the great Artemisium at Ephesus, when the resources of modern engineering had to be invoked to pump out the flooded excavation around the base of the "Great Altar" and the foundation-deposit. The illustrations to the volume, unlike those in so many modern works, really illustrate the text, and each fits naturally into the narrative. Of those we have chosen for reproduction, one shows the rigging of the great pump at Ephesus; another, representing a half-buried palm-forest at Baltim, well illustrates the constant eastward progression of the shifting sand-dunes which fringe the great flats of the Nile delta; the other, taken in the theatre of Aspendus in Pamphylia, forms a striking contrast to the Ephesus photograph, and shows the remarkable state of completeness in which a building of classical antiquity may be preserved. Of all Roman theatres this is perhaps the most perfectly preserved example.

The book contains several good stories, such as that of the young British subaltern who knew no word of Greek, but arrived on a polo pony "to be a father to some twenty Cretan villages," and whose judgments, delivered in knickerbockers and a cricket shirt, were worthy, in their practical aspects, of a Solomon. But we have already trangressed the space allotted to us, and in any case we would not quote or summarise the many passages we have marked. We prefer to leave them unspoiled for the reader, to whom, whether he be of an archæological bent or not, we warmly recommend the volume as excellent reading.

L. W. K.

ANTI-MALARIAL MEASURES IN INDIA.

A PERMANENT committee dealing with anti-malarial measures in India has been appointed by the Government of India. Its members are Lieut.-Col. Leslie (Sanitary Commissioner with the Government of India), Major James, I.M.S., Captain Christophers, I.M.S., and Lieut.-Col. Semple. Excluding the last-named, whose views on the matter have not yet been made public, the members of the committee, previous to their embodiment, allowed it to be understood that, in the light of the reputed failure of the Mean Mir "mosquito reduction" experiments of 1901–3, they hold any effort beyond quinine prophylaxis as rarely applicable to India. Indeed, they claim that conditions in that country are so different from those found in other parts of the world that further investigations—and not application of elsewhere approved anti-malarial measures—is the necessary *rôle*.

An earnest of this attitude is exhibited in the publication by it, under the auspices of the Government of India, of a brochure entitled "Paludism," which it is announced will appear at irregular intervals—as results from its labours become available. The editor (Major James) in describing the functions of the committee and its relation to Sanitary Departments and local bodies under provincial Governments, states that the conference on anti-malarial measures in India, held at Simla in 1909, "strongly supported the establishment of this organisation." The terms used by the editor, however, seem unduly optimistic. A reference to the Proceedings of that conference shows that the appointment of this committee was not open to option, but was definitely announced as an accomplished fact by the Government of India; and that there are recorded marked objections by members, not to the existence of the committee as a scientific body, but to its possessing the extraordinary administrative power to "direct (*sic*) and coordinate investigations" throughout India, which, in the presence of Indian official methods and the huge area involved, cannot fail not only to trammel the initiative of local Governments and their Sanitary Commissioners, but must hopelessly delay the execution of practical measures.

Although, doubtless, having regard to the excellent *personnel* of the committee, the publication will from time to time furnish scientific matter of value, in the absence of insistence by the Government of India that practical anti-malarial measures be undertaken, public opinion will be apt to hold that its primary function is that of a convenient financial scapegoat. The first number of *Paludism*, after referring to the functions of the committee, affords an original paper by Captain Christophers on the use of statistics in investigating the epidemiology of malaria, and gives abstracts of papers relative to paludism *in countries other than India*.

In the meantime, sanitarians with no lack of local experience have failed to see that there is in the environment of the mosquito in India more startling conditions than have been met with and overcome elsewhere. Major Ross, C.B., especially, has from time to time called in question the correctness of the Mean Mir experiments; and, in person, he challenged the methods and conclusions of the officers concerned at the Indian Medical Congress held at Bombay in 1908. It was therefore a wise decision on the part of the Government of India, on the termination of the Simla anti-malarial Conference of 1909, to depute a special committee of inquiry on this subject. The officers selected were the Hon. Mr. Nathan, I.C.S., Colonel Thornhill, I.A., and Major Leonard Rogers, I.M.S. Whilst all its deductions cannot be accepted, this committee has produced a report which, though omitting important details, is a remarkable product of a single month's work. The experimenting officers, Major James and Captain Christophers, apparently elected to test statements made by Major Ross, and regarded Mean Mir as a suitable locality for this object. Of several typical extracts from his publication and speeches quoted in the report as justifying their methods, the following is selected as of the most definite nature:—

"It is now a matter of the general experience of many investigators that where mosquitoes abound in a house their larvæ can easily be found at a short distance, say within a few hundred yards of the house. Occasionally, where the house is isolated and no stagnant water is in its immediate vicinity, mosquitoes may attack it from a greater distance; but this is exceptional, and in the great majority of cases, especially in towns, almost every house breeds its own mosquitoes in its backyards or in puddles or drains in the streets close by."

To meet the necessities of a test experiment guided by such very general data, it would have been well, whilst relying upon the importance of the observation as to pools in the vicinity of houses, also to have ascertained from the authority concerned what he implied by a "few hundred yards" of the house and even "a greater distance"; especially as by making pools unfit for the reception of larvæ by "oiling" in the neighbourhood of houses, there was fulfilled—so far as the mosquito is concerned—the condition that "no stagnant water" be available in that position.

The area selected by Major James was an oblong—and not an isolated—portion of two square miles of the total of eight square miles of the cantonment of Mean Mir, whilst the line defining its limit, except on the west, was "drawn close round the residential quarters, no attempt being made to deal with the outlying uninhabited areas." The map furnished with the report proves that the distance of dwellings from untreated portions of the cantonment varied from 40 to 260 yards, and that the limiting line abruptly excluded numerous pits and rain-fed depressions. It is a curious commentary upon this haphazard method of conducting an important experiment that Dr. Balfour, in his successful work at Khartoum, did not similarly interpret Ross's dicta with which he professed agreement.[1]

More reasonable measures were, however, employed by Captain Christophers when operations fell under his charge. He found that the flight of the mosquito could be estimated at 1320 yards, and, thereupon, he reports, he extended the area maintained by Major James three-quarters of a mile "in every direction."[2] Unfortunately, however, action was not taken by him on this basis until the end of August, 1903, which, having regard to the duration of life of the mosquito, was perilously close to the ensuing three months known locally as the "fever season." Moreover, on comparing the map accompanying his own report with that furnished by the committee, it will be seen that confusion exists as to the essential point of measurement being made from the most external of the houses of groups of dwellings protected, and not, for example, "from the centre of the inhabited area"—a method which seems to have been erroneously adhered to by the reporting committee. Comparative measurements show that, in reality, he extended Major James's area 220 yards in the north, 465 yards on the west, 500 yards in the east, and a little more than three-quarters of a mile on the south. Yet, had the same solicitude been afforded in other directions as to the south, so as to secure a uniform extension of three-quarters of a mile "in every direction," there would have been included the native cavalry lines, the west infantry lines, the east native infantry lines, the lowlying dhobies' ground, and part of the pits of the east rifle range.

The map showing present conditions, and the accompanying description by the committee of work done in the filling of pits, subsequent to abandonment of the experiments by Captain Christophers, prove that under this arrangement there must have remained untreated very numerous and favourable spots for larvæ. The committee, in summing up its evidence, has recorded its opinion that mosquito reduction, under conditions prevailing in Lahore, was impossible; but it seems to us clear that the experiments were based upon an erroneous interpretation of data said to have been adopted for guidance, and, in execution, so lacking uniformity of method as to be of no sanitary value.

On completion of the "mosquito reduction" experiments at Mean Mir, the Government of India left the cantonment to its fate until Surgeon-General Hamilton, C.B., urged the employment not only of "mosquito reduction" methods, but the systematic improvement of surface drainage, the abolition of canals, and irrigation within a definite (but we think insufficient) radius of dwellings, and the employment of quinine prophylaxis. This highly practical advice met with warm support from General Kitchener, who was in charge of the division, and operations were accordingly carried on from 1904 to 1909. Nevertheless, those who would support a *laissez-faire* policy in India have declared that these efforts have also proved inapplicable. But, it is evident from the committee's report that in no detail has the advice of Surgeon-General Hamilton, up to date, been acted upon in so complete a manner or with such a grade of efficiency as would warrant final conclusions as to possible benefits.

In its conclusion, the committee holds that the "general prosecution" of major schemes, such as conducted in Panama, Lagos, and Sweetenham, is financially impracticable; it regards anti-larval measures combined with quinine prophylaxis as offering "great possibilities," and advises action by Government on this system, but would defer this pending investigations by the committee referred to above, in our notice of *Paludism*. For the rest, it would trust to education of the people, which they state "thus lies at the root of the problem." There is here therefore a diminution of hope as to practical measures by a process of whittling, and a suggestion of the Greek Kalends as to consummation. In using the term "general prosecution" of schemes, the committee has presumably laboured under the common misapprehension that sanitarians would desire the sudden expenditure of crores of rupees on anti-malarial "major works" throughout India. What, however, is pleaded for is that the Government of India should no longer be guided by results of experiments conducted at Mean Mir by haphazard methods, and thus fail, as it has for several years—apparently in

[1] Second Report Wellcome Research Laboratories (Khartoum), p. 21.
[2] Scientific Memoirs by Officers of the Medical and Sanitary Departments of the Government of India, No. 9, p. 8.

consequence of advice founded on such results—to insist that local governments and local bodies serving under it shall no longer fail to class anti-malarial measures as practicable, but shall estimate for and finance them when feasible.

As to the combined anti-larval measures and quinine prophylaxis, of the "great possibilities" of which the committee is hopeful, obviously they could be conducted continuously, at the least feasible cost, by the Government of India insisting that a correctly organised and well-educated executive sanitary service should be available in each province, as, if the still incomplete service in the Madras Presidency be excepted, not even the skeleton of such an organisation yet exists in India.

As for "education," the only form that will appeal to the average Indian villager for the next century is practical demonstration of what correctly conceived anti-malarial works can accomplish. His acquiescence in Western *theories* would be but a polite fiction, although no race can more quickly, or more gratefully, appreciate sanitary works demonstrably decreasing sickness and death; nor, in the face of his conviction as to their utility after their completion, would he grudge his contribution towards them.

Municipalities do at the present time undertake large sanitary works (other than anti-malarial) at a cost from Rs.4 to Rs.12 per head of the population served. But it is apparently the typical "small town" under district board jurisdiction that presents to the committee the insuperable difficulty of financing "major schemes." But in this is involved an erroneous method of regarding the matter. In severe cases of malaria justifying major schemes, when a town is impoverished by sickness and mortality, and, moreover—as such places must be—is a danger to the surrounding inhabited areas of the district in which it is situated, by reason of its wandering human malaria germ-bearers, it is sound political economy to require not solely the already impoverished locality but the district board, and, in exaggerated cases, the provincial government concerned, to afford financial aid, in part or whole. Nor need such a distribution of responsibility be regarded as financially impracticable if these principles be recognised. The borrowing powers of district boards remain practically unexploited, whilst the expenditure of funds in their charge is so erratic, and in such ill-considered proportions to the various requirements of the Acts they administer, that the best value is not obtained.

Average taxation for district board purposes does not exceed three half-pence per head *per annum*; but a single attack of fever (against several possible) *per annum* in the case of an adult, if the standard treatment by quinine approved by the Simla Conference be resorted to, would cause an unproductive expenditure of 10*d*. for this single drug, besides that due to extra luxuries during sickness, adjuvant medicines, and ceremonies, &c., irrespective of loss of labour. Yet, in the Punjab, where, during 1908, in round figures, there occurred 700,000 deaths from malarial fevers (giving a rate from this cause alone of 34·6 per mille of the population), the district boards concerned thought it proper to spend 24 per cent. of their incomes for education, against 1·5 per cent. for sanitation, including nothing for new water supplies. In connection with malarial fevers and "the drain upon the resources of India" they bring about, it is worth remembering that, during 1908, there were treated in the civil hospitals of India (where necessarily but a fraction of the population resort) a total of 5,211,851 cases of malarial fevers.

W. G. KING.

THE VOLUME OF THE KILOGRAMME OF WATER.

THE volume referred to below [1] contains three important memoirs relative to determinations which have been made during recent years by the Bureau International des Poids et Mesures, or under its auspices, on the volume of the kilogramme of water.

Since the fundamental work of Lefèvre-Gineau and Fabbroni, made towards the end of the eighteenth century, on which the prototype standard kilogramme was based, the question of the specific mass of water has been the subject of a number of inquiries in various countries. In spite of the critical and detailed examination to which these inquiries have been subjected, it is not easy to institute an exact comparison between the results, partly because the measures have been made and expressed in units of which the relation to the metric units is more or less uncertain, and partly because certain elements in the reductions and calculations have not been set out in sufficient detail.

A *résumé* of this work is given by M. Guillaume in the first of the three memoirs above referred to. From this account, in which the previous work has been carefully revised, and all corrections introduced, so far as known data would permit, it appears that the most probable values for the mass of a cubic decimetre of water deducible from the most important of the determinations subsequent to those of Lefèvre-Gineau and Fabbroni, are as follows:—

		kg.
1821.	Shuckburgh and Kater	1·000475
1825.	Svanberg, Berzelius, Akerman, and Cronstrand	1·000290
1831.	Stampfer	0·999750
1841.	Kupffer	0·999931
1893.	Chaney	0·999850

The original work on which Lefèvre-Gineau and Fabbroni established the first standard kilogramme has also been minutely examined and discussed by several authorities, and M. Guillaume has subjected these revisions to a further scrutiny, from which it would appear that the following are the most probable values of the mass of the cubic decimetre of water:—

		kg.
According to the revision of	Broch (minimum)	0·999880
,, ,, ,,	Mendeléeff	0·999966
,, ,, ,,	Guillaume	0·999970

These numbers, it will be seen, differ notably among themselves, and even after due weight has been given to their relative probable value, it still remains uncertain in which direction the difference between the kilogramme as defined and as it actually is really lies.

The exactitude of these values ultimately depends upon the precision with which the linear and hence the cubical dimensions of bodies can be ascertained. Within recent years great increase in accuracy has been secured in such measurements by the application of the phenomena of optical interference as worked out by Fizeau and Michelson. In 1897 the late M. Macé de Lépinay ascertained the precise dimensions of a cube of quartz by this method and by means of it made a series of determinations of the mass of a kilogramme of water, and obtained the value 0·999959. In 1899, MM. Fabry and Perot made similar determinations by a modification of the method on the same cube of quartz, and found the value 0·999979.

These methods, with all the improvements which experience has suggested, have formed the basis of the series of determinations made by M. Chappuis, on

[1] "Travaux et Mémoires du Bureau International des Poids et Mesures." Tome xiv. (Paris: Gauthier-Villars, 1910.)

one hand, and by MM. Macé de Lépinay, Buisson, and René Benoît, on the other. That made use of by M. Guillaume consisted in ascertaining the measurements by mechanical contact—the old method, in fact, of Lefèvre-Gineau, modified by the refinements of modern metrology. In each of the methods the general problem was the same, namely, to determine by lineal measures referred to the prototype metre, the dimensions, and consequently the volume of a solid of definite geometrical form, say a cylinder or cube of brass, or glass, or quartz, of as perfect a form as possible, and then to ascertain the weight, referred to the prototype kilogramme, apparently lost by the solid when immersed in water. The two parts of this operation are of very unequal difficulty: that of ascertaining the dimensions is by far the more difficult. Thanks to the admirable equipment of the bureau, the hydrostatic weighings could be made with a very high degree of accuracy.

It is impossible within the space at disposal to enter into the details of manipulation or to explain the manner in which the experimental methods were carried out. For information on these points the memoirs themselves must be consulted. The final results, obtained after a careful revision of all the calculations, may be thus summarised :—

Method of Contact.

	cm.	Mass of a cubic decimetre of water (kg.)	Volume of a kilogramme of water (dm^3)	Weighted Mean
Bronze cylinder of	14	0·9999749	1·0000251	1·000029
,, ,,	12	0·9999655	1·0000245	
,, ,,	10	0·9999672	1·0000328	

Interferential Method by Reflexion.

	cm.		kg.	dm^3	
Cube of glass	4		0·9999713	1·0000287	1·000026
,,	5	1st measure	0·9999789	1·0000211	
,,	5	2nd ,,	0·9999784	1·0000216	
,,	5	reworked	0·9999731	1·0000269	
,,	6		0·9999696	1·0000304	
,,	5		0·9999731	1·0000269	

Interferential Method by Transmission.

	cm.	kg.	dm^3	
Cube of quartz	4	0·9999741	1·0000259	1·000027
,,	5	0·9999729	1·0000271	

With respect to the relative value of the methods of measurement, there can be little or no doubt in M. Benoît's opinion that those obtained by the method of optical interference are to be preferred to the mechanical method of contact. On the other hand, the older method has the advantage that bodies of larger volume can be employed with a corresponding diminution of error in other directions. The three results are, it will be seen, very close together. The final mean falls between 1·00027 and 1·00028, and is rather nearer the first than the second number.

Accepting the sixth decimal as the limit of accuracy, the ultimate result is that 1 *kilogramme of pure water, free from air, at* 4°, *and under normal pressure, measures* 1·000027 *cubic decimetre; or that the mass of* 1 *cubic decimetre of this water is* 0·999973 *kilogramme.*

The uncertainty of these numbers probably does not exceed 1 in the last figure, or about a milligramme on the kilogramme.

M. René Benoît, the director of the bureau, concludes the *résumé* of the three important memoirs which have led to this result which some general observations on its bearing upon the question of the relation of the actual value of the kilogramme to its original theoretical definition. He justly points out that the original standard kilogramme of Lefèvre-Gineau and Fabbroni was constructed with a perfection truly admirable, and altogether extraordinary when one considers the general state of science and the means at command in their epoch. Their kilogramme was in effect represented by the mass of a cube of water, the side of which measured not exactly 1 decimetre, but 1·000009 decimetre. Even if it be admitted that such a result could only have been obtained by a fortunate compensation of errors, it is certain that a like perfection can only be secured to-day by observers equipped with all the resources of modern metrology, working with the most scrupulous care, joined to a critical faculty of the highest order in the sifting and discussion of results.

He points out that whilst it might be possible to construct a new standard kilogramme in closer conformity with its definition, there would be little practical gain in so doing. The litre, the volume of a kilogramme of water, is in practical conformity with the cubic decimetre, not only for the needs of ordinary life but for by far the greater number of the requirements of science. Should any case need a higher degree of precision, there would be no difficulty in the application of a correction based upon the conclusions of the present work of the bureau. M. Benoît sees in the general result a proof of the wisdom of the decision of the International Metric Commission of 1872, not to disturb the original standards, but in constituting the international kilogramme as fundamental prototype simply to copy the old kilogramme of Lefèvre-Gineau and Fabbroni.

T. E. THORPE.

NOTES.

PROF. J. H. POYNTING, F.R.S., has been elected a foreign Fellow of the Reale Accademia dei Lincei.

BY the will of Mr. Thomas Lupton, solicitor to the Royal Institution, the institution will receive 10,000*l.* for general purposes.

M. ARMAND GAUTIER will be president of the Paris Academy of Sciences for 1911. M. Lippmann has been elected vice-president.

IT has been decided to establish a laboratory for researches in the chemistry of therapeutics in the Pasteur Institute in Paris. The laboratory will be directed by M. Ernest Fourneau.

ON Thursday next, December 29, Prof. Silvanus P. Thompson will commence the Christmas course of six juvenile lectures at the Royal Institution on "Sound, Musical and Non-musical."

THE Paris correspondent of the *Times* reports that Prof. Guignard, who has acted as director of the Paris School of Pharmacy for the last fifteen years, has resigned his appointment, and is succeeded by M. Henry Gautier, professor of mineral chemistry at the school.

THE Institution of Naval Architects, which was founded in 1860, has received an intimation from the Lord President of the Privy Council to the effect that the King has been pleased to approve of the grant to the institution of a Royal Charter of Incorporation.

A CORRESPONDENT of the *Daily Chronicle* states that a brilliant display of aurora borealis was witnessed at Hampstead on Monday, December 19, between 10.30 p.m. and 11 p.m. The display started in the north-north-west, and the streamers spread across the sky so far as the constellation of Orion.

WE learn from *Science* that the Nichols gold medal of the American Chemical Society for the year 1909–10 has been awarded to Prof. M. A. Rosanoff, of Clark University, and his pupil, Mr. C. W. Easley, for their joint study of the partial vapour pressures of binary mixtures. The formal award will take place at the meeting of the New York Section on January 6, 1911.

REFERRING to the letter from Prof. W. A. Douglas Ridge on the tribo luminescence of uranium in NATURE of December 15, Mr. H. A. Kent (The Poplars, Maidstone Road, Bounds Green, N.) writes to say that he noticed similar effects in 1904. He found by filling the tube containing metallic uranium with oxygen the brilliancy was much exhalted.

IN continuation of the index volume printed twenty years ago, the Royal Society of Edinburgh has completed an index to the Transactions of the society issued during the years 1889–1908. The volume includes also an address by Sir Wm. Turner, K.C.B., F.R.S., president of the society, delivered at the opening of the new rooms on November 8, 1909.

A PRIZE of 100,000 francs is to be awarded to the inventor of a practical apparatus which will make it possible to save the crews of wrecked submarines, enabling them to regain the surface uninjured. The French Minister of Marine is able to offer the prize, as he has received an anonymous gift from a French lady for the purpose. The conditions under which the prize will be awarded have been officially announced.

A MEMORIAL has been erected, says *Science*, at the National Bacteriological Institute in the City of Mexico to the late Prof. H. T. Ricketts, who at the time of his death was assistant professor of pathology in the University of Chicago and professor-elect of pathology in the University of Pennsylvania. His death was caused by typhus fever, which he contracted while conducting researches in this disease.

AMONG the many curious investigations carried out by means of instantaneous photography, not the least curious are those which Prof. A. M. Worthington, F.R.S., has devoted to the study of the effects produced by the fall of drops or solid spheres into water and other fluid. These investigations will be described and illustrated in this year's Christmas lectures at the Royal Society of Arts by Prof. Worthington.

IN his recent annual report the Secretary of the United States points out that the attainment of the North Pole by Commander Peary has added to the honour and credit of the United States. The Secretary of State therefore recommends that Commander Peary should be given a commission by legislation as rear-admiral of the Corps of Civil Engineers of the U.S. Navy, to date from the day of his discovery, and that he be retired as from that date with the highest retired pay of that grade.

THE death is reported, at the age of sixty-eight, of Dr. Charles Otis Whitman, for the last eighteen years head of the department of zoology and curator of the zoological museum at the University of Chicago. He had previously held appointments at the Imperial University of Japan, the Naples Zoological Station, Harvard University, the Allis Lake Laboratory, and Clark University. From 1888 to 1908 Dr. Whitman was director of the Marine Biological Laboratory at Woods Hole. He was editor of the *Journal of Morphology* and of the *Biological Bulletin*.

ONE of the most promising of American pathologists, Dr. Christian Archibald Herter, has died recently at the early age of forty-five. In 1890 he followed up his studies at Johns Hopkins University and Zurich by publishing a text-book on "The Diagnosis of Nervous Diseases." He then devoted himself especially to pathological chemistry, and held for several years the chair of that subject at the Bellevue Hospital Medical School, New York. Since 1903 he had been professor of pharmacology and therapeutics at the New York College of Physicians and Surgeons. Dr. Herter had carried out several scientific investigations for U.S. Government departments. He was treasurer to the Rockefeller Institute for Medical Research, and had himself created two lectureship foundations, one at Johns Hopkins University and the other at the Bellevue Medical School.

AT the annual meeting of the Yorkshire Naturalists' Union, held at Middlesbrough on Saturday, December 17, a vigorous protest was made against the action of H.M. Stationery Office in reference to the increased prices which have now to be paid for hand-coloured editions of the maps of the geological department. It was pointed out that in withholding from the public cheap and easy access to the results of the Geological Survey, the objects of the Survey were in large measure defeated, and the cost of this department of the public service deprived of much of its justification. At the same meeting Dr. Alfred Harker was elected president for 1911, Mr. H. Culpin the hon. treasurer, and Mr. T. Sheppard hon. secretary.

THE Eastern Telegraph Company report that an earthquake was felt at Zanzibar on December 14 at 11.40 a.m. Greenwich mean time. The shock must have been of great intensity over a wide area, for four of the company's cables between Zanzibar and Durban were broken at about the same time. The first tremors were recorded by the seismograph at Cardiff at about noon, the total duration of the movement there being about two hours.

Two slight earthquakes were felt throughout Glasgow on Wednesday evening, December 14, the first at 8.54 p.m. and the second shortly after ten. The first shock, which was strong enough to make windows rattle and to throw down some ornaments, lasted four or five seconds, and was accompanied by a loud rumbling noise. The area affected by it extends at least twenty-one miles east and west from Glasgow to Greenock, and ten miles north and south from Milngavie to Johnstone. The seismograph record at Paisley Observatory shows a disturbance, one-tenth of a millimetre in amplitude, at 8·54 p.m., and others of larger amplitude, but not connected with the Glasgow earthquakes, at 9.26 and 9.29 p.m., while a slight movement about 10 p.m. may have been caused by the second shock. The record obtained at the Royal Observatory, Blackford, Edinburgh, at about 10.30 p.m. had, of course, no connection with the Glasgow shocks.

IN a communication published in the *Morning Post* of December 20 Prof. J. Milne, F.R.S., records the following series of earthquakes:—After a long period of rest we have had a succession of large earthquakes. On December 13 there was one on the West Coast of Africa, which broke several cables, and on December 14 one in Scotland. On December 16 one occurred so far off as New Guinea. On December 17, at 7.30 a.m., one reached us from a place so far distant as the West Indies. Next day, at 4 a.m., one came from Java, and in less than two hours, namely, at 5.49 a.m., there was another disturbance in the West Indies. There was a third at 4.50 p.m. With the exception of the disturbance in Scotland they were all very large, and shook quite half the world.

THE subject of the Neolithic age culture in Malta has been dealt with by Dr. Ashby and by Mr. Peek in the last issue of Papers of the British School at Rome. It has often been remarked that up to the present no cemetery of this race has been discovered. In a letter addressed to the *Times* of December 13 Mr. T. Zammit, curator of the Valetta Museum, announces that he has found on the road between Attard and Nobile an undoubted Neolithic interment. No flint implements were discovered with the remains, but the characteristic pottery and the iron ochre pigment in which the bones were soaked leave no doubt regarding the date of the interment. The discovery is most important, because on this evidence Malta falls into line with Sicily and Italy so far as the Neolithic culture is concerned.

AT a meeting of the executive committee of the British Science Guild, held on December 14, it was reported that a deputation on behalf of the Guild waited on December 2 upon the private secretary to the Prime Minister to represent the undesirability that Government should part with the site at Fosterdown which had been selected by the Solar Physics Committee three years ago as most desirable for the future site of the Solar Physics Observatory about to be vacated at South Kensington. This site, for some unexplained reason, had been put up by Government to be sold on December 13. The memorial protesting against this sale was signed by the surviving members of the Duke of Devonshire's Commission, past-presidents, and a large numbers of Fellows of the Royal Society, and of the British Science Guild. The Prime Minister was pleased to comply with great alacrity with the prayer of the memorial.

THE Franklin Institute recently awarded the Elliot Cresson gold medal, the highest in the gift of the institute, to several men of science. The secretary of the institute has favoured us with a detailed statement of the grounds of the award in each case "for distinguished leading and directive work," from which we extract the following particulars. The award was made to Dr. Edward Weston, Newark, N.J., for "electrical discovery and in the advancement of electrical application"; to Prof. Ernest Rutherford, F.R.S., for "the advancement of our knowledge of electrical theory"; to Sir Joseph J. Thomson, F.R.S., for "the advancement of our knowledge of the physical sciences"; to Sir Robert A. Hadfield, for "the advancement of our knowledge of metallurgical science"; to Dr. Harvey W. Wiley, chief chemist to the Department of Agriculture, Washington, D.C., for "work in the fields of agricultural and physiological chemistry"; to Mr. John Fritz, Bethlehem, Pa., for "work in the development of the iron and steel industries"; and to Dr. John A. Brashear, of Pittsburg, Pa., for "work in the production and perfection of instruments for astronomical research."

THE late Sir George S. Mackenzie, formerly Administrator of the Imperial British East African Company's Territories, left estate of the gross value of 104,004*l.* 19*s.* 6*d.*, of which the net personalty has been sworn at 99,647*l.* 17*s.* 9*d.* The residue of his property is bequeathed to his children in equal shares, and in the event of his leaving no children the following bequests are made:—(1) To the Ross and Cromarty County Committee 2000*l.* on trust to found two bursaries each of the value of 30*l.* per annum, to be known as the "Sir William Mackenzie and the Jessie Mackenzie Inchvannie Bursaries," to be tenable at the Scottish universities for students from Ross and Cromarty, and preferably from the National Schools, for the study of medicine, chemistry, engineering, or agriculture, or other branch of applied science. (2) To the Royal Geographical Society 1000*l.* to found a prize to take such form as the council of the society may see fit, and to be in commemoration of the great work done by the British East Africa Company in saving British East Africa for the British Empire. (3) To the president and council of the Royal College of Physicians and the Royal College of Surgeons, England, 30,000*l.* (subject to life interest of his two brothers), for the endowment of scientific research by students of ability and of registrable medical qualification, who may thus be able to devote their whole energies to such work, and be independent of ordinary practice. This bequest is made in the hope that the combined results of the systematic work of so many trained workers may prepare the way for a genius to come who will make great discoveries.

THE International Exhibition of Hygiene is to be held at Dresden in 1911. The object of this exhibition is in no sense commercial; it is being promoted for purely educational purposes, and it is intended to give hygienists of all nationalities an opportunity of learning what is being done in other countries in the direction of guarding the individual from the many dangers to health which exist, more particularly in our large industrial communities. It will bring home to the public what has been achieved by scientific research in the cause of hygiene, and it cannot fail to offer an impressive object-lesson to a large number of visitors from different countries of the importance, not only from the personal, but from the social and national point of view, of a due regard to the physical welfare of man. There is no doubt that the exhibition will be international in its widest sense, the Governments of far distant countries having already voted considerable sums of money for the proper display of what they have done and what they are doing in the domain of hygiene. To ensure this, the German Government has issued invitations to all the principal nations of the world to take an active part in this philanthropic scheme, and the invitation has been accepted by the very large majority of those to which it was extended. The only great country which stands aloof is Great Britain, a country which is universally regarded as occupying a foremost place among the nations in its appreciation and practical application of the requirements of sanitation. Although our Government, with its characteristic lack of appreciation of scientific work, does not seem disposed to take an official part in this international exhibition, it is to be hoped that money will be obtained from other sources in order to allow Great Britain to be represented adequately.

A CORRESPONDENT, Mr. George Boaq, writing from Aguilas, Murcia, Spain, directs attention to a method devised by Drs. Nasmith and Graham, of the Provincial Board of Health, Ottawa, for destroying typhoid and dysentery bacilli in water, and rendering it safe for drinking purposes. A level teaspoonful of chloride of lime is rubbed up in a cupful of water, the water being added little by little, so as to obtain a uniform emulsion. This is then diluted with three more cupfuls of water, and one teaspoonful of the dilution is added to two gallons of the water to be purified, mixing thoroughly, and the mixture is allowed to stand for at least ten minutes. The directions are somewhat rough and ready, but if the water tastes distinctly of chlorine sufficient chloride of lime has probably been added. A water containing much organic matter will require more chloride of lime than one containing little organic matter. For a water containing little organic matter one part of chloride of lime per million parts of water suffices, but for an impure water four or five parts may be required. If an excess of chloride of lime be added the water becomes unpalatable, but the taste disappears on standing, particularly in bright sunshine, or may be destroyed by the addition of a dechlorinising agent such as bisulphite of soda. The efficiency of chlorine and chloride of lime for sterilising water has been amply demonstrated by many observers—Nesfield, Rideal, Thresh, Woodhead, and others.

IN view of the recent scare of plague in the Eastern Counties, considerable interest attaches to a paper by Captain W. D. H. Stevenson (Scientific Memoirs by Officers of the Medical and Sanitary Departments, India, No. 38) giving a preliminary account of experiments on the killing of rats and rat-fleas by means of hydrocyanic acid, generated by the action of sulphuric acid on potassium cyanide. Fleas were killed very rapidly by the gas. In one experiment a mixture of 1 ounce of potassium cyanide, 2 ounces of sulphuric acid, and 4 ounces of water was placed in a small room of the capacity of about 346 cubic feet, and the door was then closed. After forty minutes the door was opened, and fifteen minutes later the room was entered; all the fleas left in different parts of the room were killed, even those placed inside four bags, three of blanket and one of cotton, but some of the fleas placed inside a box of clothes survived. Rats were found to require more gas and a longer exposure than fleas. On the other hand, plant-life appears to be uninjured by the gas, and cultures of bacteria were also unaffected by it. Dried grain is not made poisonous for food by the gas, nor are its powers of germination impaired in any way. Moist food-stuffs, however, such as water, milk, butter, and flesh, are said to absorb the poison, and should therefore be removed from a building during fumigation. The gas has no action on metals or fabrics.

THAT dorbeetles and their kindred are generally infested with mites in this country is a well-known fact, but it appears to be a comparatively new discovery that in Ceylon beetles of this group are likewise infested by minute species of flies. In the December number of the *Entomologist's Monthly Magazine* Mr. J. E. Collin describes a new species of small hairy flies of the genus Limosina taken from a coprophagous beetle in Ceylon. The flies were found clinging to the under surface of the beetle, and, instead of attempting to fly away, allowed themselves to be dropped into a collecting tube without change of position.

IN *British Birds* for December it is stated that about 7900 birds were ringed in this country during the year, Messrs. Smalley and Robinson having marked no fewer than 2313 out of this number. In the editor's opinion it is at present too early to decide whether the results will repay the trouble and expense involved in marking. Its chief results will relate to the movements of individual birds, and it is urged that special attention should be paid to the recapture of the smaller marked birds by the editor's correspondents, most of those which have been taken having fallen into the hands of persons unacquainted with the scheme. The costs of the inquiry during last year considerably exceeded the funds at the disposal of its promoter, and if the scheme is to be continued next season it can only be by the aid of special subscriptions.

IN the Proceedings of the United States National Museum (vol. xxxix., 1910, pp. 37–91) Mr. R. E. Snodgrass, whose treatise on the structure of the honey-bee was noticed in NATURE of December 8 (p. 169), publishes an important memoir on the thorax of the Hymenoptera. In this paper the modification and elaboration of the thoracic skeleton in the various families of the order are described in detail, and illustrated by nineteen text-figures and fifteen plates. The author finds no support for Verhoeff's theory that each thoracic segment is a complex of three primitive somites, but prefers to regard the serially arranged sclerites of the mesonotum and metanotum—so fully shown by many Hymenoptera—as evidence of specialisation.

IN vol. v., No. 3, of the *Philippine Journal of Science* Mr. L. E. Griffin publishes additional information with regard to the pearl-fishery, dealing in this instance with the products obtained off Bantayan, an island lying between the northern ends of Negros and Cebu, at the head of the Tañon channel. In May and June, and again in November and December, the water is usually so still and clear that the bottom can be seen to a depth of eight fathoms, and it is at these seasons that the natives look for oysters. In place of forming banks, these occur sporadically, and were it not for the shortness of the season there is little doubt they would long ago have been exterminated. The shells, although of relatively small size, are of excellent quality, but they are chiefly valuable on account of the large percentage of pearls they yield and their fine quality. During the present year one pearl of the value of 80*l*. was collected, while others worth from 20*l*. to 40*l*. each were obtained. The total annual value of the fishery is about 900*l*.

A SURVEY of the vegetation on the Kasatzkisch steppe, near Kursk, is contributed by Mr. V. Alechin to the botanical section (part ii.) of *Travaux de la Société des Naturalistes de St. Pétersbourg* (vol. xli.). The main feature is the great predominance of dicotyledons, although *Carex humilis* takes an important part in the ground cover. The author concludes that the steppes existed previously to the wooded areas, and that they have been but little modified by human agency.

THE suitability of bamboos and lalang, or cogon grass, for making paper pulp is considered by Mr. G. F. Richmond in an article on Philippine fibres published in the *Philippine Journal of Science* (Section A, vol. v., No. 4). Proceeding upon evidence furnished by other investigators and by laboratory experiments, the author takes a favourable view of the prospects of a local soda pulp mill for treating bamboos, and supplies an estimate of the probable cost. Also it is stated that a supply of raw material and the necessary fresh water could be obtained in several localities.

BUD-ROT disease of palms has been notified within recent years from the West Indies, Ceylon, India, and the Philippine Islands, but in most cases the cause of the disease has not been definitely established. Dr. E. J. Butler, who has conducted the investigations in India, where palmyra palms are chiefly attacked, attributes the disease there to a Pythium, deriving his conclusions from the inoculation of healthy palms. The source of the disease in the other countries, where cocoanut palms are infested, is probably different. Dr. Butler has embodied his latest researches, together with a general account of the distribution and remedial measures adopted, in the botanical series (vol. iii., No. 5) of the Memoirs of the Department of Agriculture in India. Two spore forms are recognised; in the ordinary case the contents of a sporangium break up into zoospores, but in hot, dry weather a resting variety of conidium is more commonly found.

THE Journal of the Royal Society of Arts for December 9 contains a paper delivered to the society by Mr. A. Montgomery, State Mining Engineer of Western Australia, on the progress and prospects of mining in Western Australia. Mr. Montgomery states that the metallic minerals occur in very old igneous and sedimentary rocks, which are almost certainly pre-Cambrian. His conclusion is that Western Australia owes the present shape of its surface largely to submergence beneath the sea within post-Tertiary times. The paper was accompanied by an exhaustive statistical appendix, from which we find that for the quinquennium 1903–7 the world's production of gold was 76,000,000*l.*, of which the Commonwealth of Australia contributed 20 per cent. and Western Australia 10½ per cent. For the same quinquennium the gold produced has been more than 96 per cent. of the total mineral production, and the mineral export from Western Australia has been 80 per cent. of the total for all the exports from the colony. The value of gold produced per man employed has been more than 400*l.* during the years 1908–9. In regard to the help afforded by the Government to the mining industry, attention is directed to the extensive development of the railway lines and of the systems of water supply; water is sold to the mines at from 4*s.* 9*d.* to 8*s.* 6*d.* per 1000 gallons.

THE November number of *Petermann's Mitteilungen* contains an interesting map of Siberia taken from one published by the Russian Academy of Sciences, which shows the distribution of places where remains of the mammoth and rhinoceros have been found. Most of them lie within the Arctic circle, but one of the former and three of the latter sites lie further to the south.

AN event of much interest in cartography is the completion, after about thirty years' work, of the 1 : 100,000 map of Germany in 675 sheets. A full account of these maps and the various stages in their development and their production is given by Colonel v. Zglinicki, chief of the cartographic section of the Prussian Survey, in a recent number (No. 9) of the *Zeitschrift der Gesellschaft für Erdkunde*.

THE determination of the international boundaries in Africa proceeds apace, and in Heft 4 of the current volume of *Mitteilungen aus den deutschen Schutzgebieten* are published the latitudes and longitudes which were determined in 1905–7 along the boundary which divides the Cameroons from the French Congo. Neither the time available nor the funds at disposal sufficed to carry out a chain of geodetic triangulation along the boundary, so that it was necessary to rely on astronomical observations alone. Latitudes were determined by circummeridian altitudes of north and south stars, and longitudes by lunar observations, and in three cases only by star occultations. Observations made at the observatories of Greenwich, Paris, and Göttingen were utilised to furnish the final corrections, the uncertainty of the results being ±2 to ±5 seconds.

UNDER the title of "The Burial of Olympia," Prof. Ellsworth Huntington in the *Geographical Journal* for December applies the theories advocated in his work "The Pulse of Asia" to the problem of the decadence of Greek civilisation. This is often attributed to deforestation; but from evidence collected in America by Prof. Moore, chief of the United States Weather Bureau, he denies that this can have played an important part in the ruin of the natural resources of Greece. He assumes that pulsatory changes of climate, such as the rapid desiccation of parts of Asia, may have occurred in Greece in the millenium preceding 600 A.D. To these he attributes many of the world's greatest movements of population, such as the attacks of the barbarians on southern Europe, the invasions of Genghis Khan and Tamerlane, and he connects with these the spread of malaria due to the introduction of the mosquito, for which Greece now became a fitting habitat. In the instructive discussion which followed, these views were criticised by Prof. Myres, Dr. Hogarth, Dr. Stein, Prof. Gregory, and others, most of whom, while admitting the novelty and interest of Prof. Huntington's suggestions, desired further evidence. This may perhaps be gained from Prof. Huntington's recent work in the American deserts; but until the question of North Africa is settled the general problem cannot be finally decided.

IN the *Popular Science Monthly* for December Prof. S. W. Williston discusses the birthplace of man in the light of the palæontological record. The evidence, he suggests, points to the conclusion that it was in India and its borderlands that the chief domesticated animals were specialised—the genus Bos in the Indian Lower Pliocene, the swine, horse, elephant, and the cat tribe; among birds, the ostrich, jungle-fowl, peacock, and grey goose. Man may have been developed in this region during the Late Miocene or Early Pliocene periods. He believes that within a very few years the discovery of indubitable links in man's ancestry will be made in Central Asia, China, or North India, there being no other region to which the palæontologist looks with more eager expectation for the solution of many profound problems in the phylogenetics and migrations of mammalian life.

THE Transactions of the Leicester Literary and Philosophical Society for 1910 contain two geological papers of interest. Mr. F. Cresswell deals with the frequently discussed question of the origin of the English Triassic strata, with special reference to the Keuper marls. He suggests that the grey bands represent periods of moister climate, when minute organisms reduced the peroxide of iron to protoxide. While regarding the floor on which the English Trias was deposited as a rocky tableland, he falls into a very common error by stating that the Libyan Desert differs from this, being "a uniform sandy plain." Mr. Cresswell fully supports the view that desert conditions prevailed in Triassic times in England, and urges that the Keuper marls are formed of particles worn from igneous and metamorphic rocks by "weathering with a very limited amount of water." Mr. J. McKenzie Newton contributes an essay on the crystallisation of igneous rocks.

IN the Bulletin of the Central Meteorological Observatory of Japan (No. 5, 1910) Mr. T. Okada discusses in great detail the rainy season in Japan, which usually extends from about the middle of June to the middle of July, and is the most important period for the cultivation of rice. To make the investigation more complete, five-day means are given for the whole year for a large number of stations in Japan and adjacent districts, with charts and a short discussion of each of the principal elements. The figures show that in Japan proper the rainfall reaches a maximum at the end of June or in the first decade of July; it then falls to a minimum in August, and again increases to a maximum in September or October. The rainfall of the season in question is chiefly caused by cyclonic disturbances from the Yangtse Valley and Formosa, and is not a simple monsoon rainfall. The period is characterised by continued cloudy weather, large relative humidity, comparatively high temperature, small wind-velocity, and more or less rainfall every day. The discussion extends to eighty-two quarto pages.

THE use of the Clark and Weston cells as standards of electromotive force has necessitated a close study of the properties of cadmium and zinc amalgams, and numerous valuable papers on this subject have issued from the van 't Hoff laboratory at Utrecht. In the current number of the *Zeitschrift für physikalische Chemie* (December 2) is a further contribution from this laboratory by Ernst Cohen and P. J. H. van Ginneken, dealing with the properties of zinc amalgam as affecting the Clark cell. The authors conclude that the formula in current use representing the relation between the E.M.F. and the temperature of the Clark cell is not trustworthy, and should not be employed in accurate measurements. It is further shown that for exact work the Clark cell must be used at temperatures between 20° C. and 38° C.

THE Department of Mines, Canada, has sent us a copy of the report of analyses of ores, fuels, &c., made in the chemical laboratories of the Geological Survey during 1906 and 1907, and of the Mines Branch of the Department of Mines in 1906, 1907, and 1908. With the exception of twenty-seven rock analyses, the work done is chiefly of practical interest, analyses being given of numerous coals, lignites, peats, and ores of iron, copper, and chromium. The results of seventy-seven gold and silver assays show the wide distribution of the precious metals in Canada. In an appendix a description is given of the commercial methods and apparatus used for the analysis of oil-shales.

MESSRS. WHITCOMBE AND TOMBS, LTD., will publish shortly a fully illustrated work on "Australian Plants" suitable for gardens, parks, timber reserves, &c., by Mr. W. B. Guilfoyle.

OUR ASTRONOMICAL COLUMN.

A PROJECTION ON SATURN'S OUTER RING.—During the total eclipse of the moon on November 16 M. Jonckheere directed the 35-cm. equatorial of the Hem Observatory to Saturn, and found a bright projection extending outwards from the eastern extremity of the exterior ring. The projection was best seen with low powers (100 and 200), and its intensity decreased gradually, going from the outer edge of ring A on to the background of the sky. On November 20 and 24 the same projection was seen with difficulty (*Astronomische Nachrichten*, No. 4461).

DISCOVERY OF ANOTHER NOVA, SAGITTARII NO. 3.—In a note appearing in No. 4459 of the *Astronomische Nachrichten* Prof. E. C. Pickering states that Miss Cannon has found that a new star appeared in the constellation Sagittarius on August 10, 1899. A photograph taken on August 9, although showing stars of magnitude 11·5 in the immediate neighbourhood of the nova, shows no trace of it, yet on August 10 it is a conspicuous object of magnitude 8·5. While the outburst was so sudden, the decline, as is common with such objects, was very rapid, for the light faded from 8·6 on August 25 to 10·5 on October 13, 1899; the decrease after that date was more gradual. The nova is not shown on any photograph taken after October, 1901, when its magnitude was about 13·0. The position of this object was R.A. = 18h. 12·2m., dec. = −25° 14′ (1875·0); this is about 10m. west of λ Sagittarii and 20m. east of Nova Sagittarii No. 2.

FAYE'S COMET.—Having identified Cerulli's comet with Faye's short-period comet, M. G. Fayet has investigated the orbit with the idea of obtaining closer agreement with Dr. Strömgren's elements. Employing three observations, made between November 10 and 22, he calculated the value for the mean motion and obtained two sets of elements, which, however, were not altogether satisfactory. Then on November 30 he secured a further observation, and this enabled him to apply the method of the variation of geocentric distances and to calculate other systems, the fifth of which agrees very nearly with Dr. Strömgren's elements for 1903, except that the mean motion is 486·792″ instead of 480·16″; they also give a close agreement with the observations. From the best system obtained, which may, however, yet be improved, M. Fayet has calculated an ephemeris giving daily positions up to January 30, 1911 (*Astronomische Nachrichten*, No. 4461).

NEW EXPERIMENTAL DEMONSTRATION OF THE EARTH'S ROTATION.—An interesting description of an experiment devised by Father Hagen to demonstrate the rotation of the earth is described by M. B. Latour in No. 1346 of *Cosmos* (November 12). Father Hagen's apparatus consists of a balanced beam of wood, 9 metres long, which has a bifilar suspension, and to which is attached heavy masses movable in the horizontal plane towards and away from the suspension. In the modified experiment these masses each consist of 80 kilograms of lead mounted in small waggons, which can be automatically released by the fusion of a leaden wire. When released the waggons run towards the centre, the moment of inertia of the beam is modified, and it swings relatively to the earth; the motion is shown by a mirror attached to the suspension and reflecting a beam of light on to a scale fixed on the wall of the circular room wherein the apparatus is installed. When the chariots are made to run from the centre to the extremities the swing of the beam is in the opposite direction and about half the amount. With Father Hagen's apparatus, mounted in the massive tower which carries the astrographic equatorial at the Vatican Observatory, the mean of twenty experiments gave a value for the earth's rotation very near the theoretical value at Rome.

INVESTIGATION OF THE ORBIT OF WOLF'S COMET, 1898–1911.—In No. 4460 of the *Astronomische Nachrichten* M. M. Kamensky gives in brief the results of an elaborate investigation he has made of the movements of Wolf's comet during the period 1898–1911. This is the well-known short-period (6·7 years) comet discovered by Wolf at Heidelberg on September 17, 1884, and independently by Copeland with the spectroscope on September 22; it was reobserved in 1891 and 1898, but was not seen in 1904–5. The orbit was completely transformed by Jupiter in 1875, but the slight differences between the observed and calculated places in 1898 indicate that it is now a permanent member of our system.

M. Kamensky first investigated the motion during the period 1898 August 22 to 1904 June 12, taking into account the perturbations of the earth, Mars, Jupiter, Saturn, and these are published in full in No. 15 (1910) of the *Bulletin de l'Academie Impériale des Sciences de St. Pétersbourg*. He then carried the investigation forward to March 28, 1911, and publishes the full tables in No. 16 of the Bulletin; he also gives elements showing the severe perturbation by Jupiter in 1875, and states that extraordinary changes may again take place at a near approach in the latter part of 1922.

According to the final elements, the next perihelion passage should occur on February 24, 1912, and in Bulletin No. 16 M. Kamensky gives an ephemeris for the period 1911 January 3 to October 14; for the latter date the estimated magnitude is 12·2.

THE LIGHT CHANGES OF FORTY-NINE VARIABLE STARS.—In the fourteenth issue of the *Bulletin International*, published by the Cracow Academy of Sciences, Dr. L. Pračka discusses the light changes of forty-nine variable stars. The observations were made at the Bamberg Observatory during 1905–9, and each star is discussed at length. A summary of the results is given in handy tabular form at the end of the paper showing the elements, the magnitudes and colour, and the form of the light-curve for each object.

THE PHYSICAL SOCIETY'S EXHIBITION.

ON Tuesday, December 20, the Physical Society of London held its annual exhibition of physical apparatus, and the occasion was marked by some interesting experimental lectures. Prof. J. A. Fleming, F.R.S., chose for his subject some improvements in transmitters and receivers for wireless telegraphy, and referred first to his well-known oscillation valve, consisting of a glow lamp in which a metal plate of some convenient form is fixed. When the filament (which in the latest form is of tungsten) is glowing, a current will flow if an E.M.F. is applied between the negative terminal of the filament and the metal plate; the current can flow from the filament to the plate, but not in the reverse direction, and thus rectification results. Owing to the upward trend of the conductivity curve a much higher sensibility is obtained by applying a certain constant E.M.F. on which that due to the oscillations is superimposed. Passing to the question of the spark, the lecturer reproduced some interesting records showing how greatly the secondary current is increased when the spark gap is subjected to an air blast. Finally, Prof. Fleming showed his new form of spark discharger. This is of the Wien "quenched-spark" type, and consists of two heavy steel circular discs, one above the other, very perfectly surfaced and with an air gap of ¼ mm. between them. The lower disc is stationary and the upper one is rotated. The discs are placed in oil, and as there is a hole in the lower disc there is a continual circulation of oil. The discharger is found to give very satisfactory and uniform results, and has been used for measuring losses in condensers.

Mr. R. W. Paul gave several demonstrations of kinematograph diagrams. One series, due to Prof. R. W. Wood, illustrated sound waves; but certainly the most effective films were those due to Prof. S. P. Thompson, F.R.S., showing the movement of lines of force as a keeper approaches a magnet, the starting of a current in a solenoid, the rotation of a dynamo armature (in section), and other similar phenomena. These must have appealed strongly to teachers of magnetism.

As regards the apparatus exhibited, it may be said that there were many interesting new instruments, though perhaps nothing very striking, and there was much excellence in many exhibits that were not essentially novel. Thus in optical work A. Hilger, Ltd., gave an excellent display of spectroscopic instruments and a beautiful demonstration of anomalous dispersion. R. and J. Beck showed a small spectroscope giving large dispersion and with a sine motion so as to give wave-lengths direct. Carl Zeiss, as usual, gave an interesting exhibit, including the movement of gold particles (stated to be about 6 $\mu\mu$ in size) in colloidal solution, a special "cardioid" condenser being used, consisting of two lenses combined, and so shaped that a top illumination is secured for a dark ground, although the beam of light comes from below the centre of the stage. Messrs. E. Leitz showed a large projection apparatus giving excellent definition.

Photometric apparatus was not so much in evidence as on former occasions, but R. and J. Beck, and also Everett, Edgcumbe and Co., showed very small portable photometers for measuring surface brightness and illumination. As an exhibit of general interest may be mentioned that of Strange and Graham illustrating flapping flight. Two wings are worked by "Vilcar" mechanism, and a distinct upward pull is noticeable, apparently due to the upward path of the wing differing from that on the downward stroke.

The largest number of exhibits, as usual, were electrical. Several interesting thermo-electric exhibits were shown by the Cambridge Scientific Instrument Co., among which may be mentioned an arrangement for keeping the cold junction of a clinical recording thermometer at a constant temperature. This junction is covered by a small Dewar vacuum vessel, and is surrounded by a heating coil, which comes into action as soon as the temperature falls below a certain value; by this means the temperature of this junction is maintained constant to 0·1° C. This firm also showed compensating leads consisting of copper and copper-nickel alloy; these are run in series with the pyrometer, and, being thermo-electrically equal to the platinum/platinum-iridium couple, they transfer the cold junction of the pyrometer to the galvanometer, thus securing less variation in temperature of the cold junction. An arrangement whereby a constant E.M.F. is obtained for applying to a pyrometer so as to secure a false zero was also shown, and we noticed a convenient piece of apparatus for tracing recalescence curves; also an improved form of C. T. R. Wilson's tilting gold-leaf electroscope. A new form of radiation pyrometer which does not require focussing was shown by the Foster Instrument Co., who also exhibited some special thermo-junction alloys. H. Tinsley and Co. showed a set of instruments largely due to Dr. C. V. Drysdale, and some interesting vector diagrams of alternating magnetic flux in an iron wire, obtained by Drysdale's alternate-current potentiometer. This firm also showed a simple and strong form of vibration galvanometer based on the familiar Kelvin galvanometer; a heavy permanent magnet is provided for the control, and the tuning is effected (without affecting the zero) by magnetically shunting this magnet to the desired extent. The alternating current traverses a small coil, which can be easily changed, and the makers state that the instrument can be used for alternating pressures down to 1/100th micro-volt. R. W. Paul exhibited a well-designed new type of decade standard resistance box with switch contacts, the case being filled with oil, and we noticed some new transforming apparatus by Leslie Miller and by Muirhead and Co. Since there were thirty-five exhibitors, we need scarcely say that there was a good deal to be seen, but in the above notes we have only been able to refer very briefly to a few of the more interesting items.

INVESTIGATIONS ON WHEAT IN INDIA.[1]

THE importance of the wheat crop in India is not always realised at home. Until the last few years we received more wheat from India than from Canada or Australia—sometimes more than from both countries put together. At the present time wheat represents some 7 per cent. of the total value of merchandise exported from India, but the amount exported is only about one-tenth of the total production, the remaining nine-tenths being consumed in the country itself. When an industry has reached such great dimensions without excessive nursing it is clear that those engaged in it have consciously or unconsciously adopted tolerably satisfactory methods of working, and any attempt on the part of an outsider to effect improvements must be developed cautiously. When in 1906 the Indian Board of Agriculture decided to take up the matter seriously, they entrusted the work to Mr. and Mrs. Howard, and subsequent events have amply justified the wisdom of their choice. Several important papers have been issued, and finally a volume, "Wheat in India," in which the authors summarise the present position of the problem and indicate the lines on which advancement may be hoped for.

Mr. and Mrs. Howard devote the first half-dozen chapters of their volume to a general sketch of wheat-growing in India. Wheat is fairly widely distributed over the country, but the areas where it is really important all lie to the north or on the Central Plateau above the Ghats. In the north-west a great deal of the wheat is irrigated; the Punjab is especially well suited to canal irrigation by reason of its never-failing snow-fed rivers and its level tracts of land, but recourse is also had to irrigation by wells. On the other hand, in the Central Provinces, Bengal, and Bombay, only a small area is artificially watered.

In general, the soil is thoroughly well ploughed or scarified during the monsoon and previous to sowing, as many as fourteen ploughings being sometimes given. A good deal of manure is applied in the northern districts, but usually to the maize crop preceding the wheat; in the Central Provinces the monsoon (*kharif*) crop of rice, which precedes wheat, is slightly manured, but in Bombay the irrigated wheat itself is manured. Harvest begins in the Central Provinces in March, elsewhere in April, May, and even the end of June in the frontier districts. The wheat for export has to be got to Karachi for shipment as soon as possible, or it rapidly deteriorates, and is attacked by moths and weevils. In the rush the railway resources are heavily taxed, just as they are in Canada; the Indian case is, indeed, the worse, as there is no elevator system.

These preliminary chapters are illustrated by maps,

[1] "The Milling and Baking Qualities of Indian Wheat." No. 2. By Albert Howard and Gabrielle L. C. Howard.

"The Influence of Environment on the Milling and Baking Qualities of Wheat in India." By Albert Howard, H. M. Leake and Gabrielle L. C. Howard. (Pusa: Agricultural Research Institute.)

"Wheat in India, its Production, Varieties and Improvements." By Albert Howard and Gabrielle L. C. Howard. Pp. ix+288. (Calcutta: Thacker, Spink and Co. London: W. Thacker and Co., n.d.)

quotations and statistics, and give an illuminating account of wheat-growing in India.

Passing on to a discussion of experimental work, the authors point out that manurial trials on orthodox lines are of purely academic interest in India. It was no doubt an excellent thing to make them, but their value is limited by the fact that the cultivator cannot usually buy the necessary manures. It is much more to the point to make cultivation trials, seeing that labour is very cheap and the labourer realises the necessity for working the land. But here again intelligent planning is necessary; if the trials are to serve as demonstrations for the native they must be made with implements he can afford to buy and learn to handle, and which the village blacksmith can repair. A summary is given of the well-known Cawnpore experiments, which show that the nitrogen supply is the limiting factor in normal conditions of moisture and temperature obtaining there. At Nagpur nitrogen was also the most important factor, but the water supply was in this case near the limit. The Punjab irrigation experiments, said to be the best of their kind in India, were made to ascertain the best quantity of water and the best number of waterings. It was found that the native was, like many other irrigation farmers, taking too much water, so that the area under treatment was needlessly curtailed, and the revenue suffered loss. But the authors further point out that over-watering gives rise to mottled grain and to samples uneven in texture, and therefore of low value. This loss in value, of course, falls on the cultivator himself, and if it could be brought home to him would, no doubt, induce him to take less water.

The authors then discuss the factors adversely affecting the production of wheat in India. In order of merit these are climatic extremes, fungi, insects, and vermin. Of the diseases, rusts are the most important, transcending in effect all other diseases put together. The only trustworthy remedy at present known is to grow rust-resisting varieties. Introduction of such wheats of high repute from abroad proved to be useless; wheats resistant in Australia succumbed badly in India, and, indeed, were more susceptible than the indigenous kinds, besides ripening too late. It therefore became necessary to raise new varieties from Indian wheats, and this work was begun by the authors in 1905. The first step was to take stock of the native sorts. An ordinary Indian wheat-field contains a mixture of several sub-varieties, which had to be isolated. These in turn comprise several types, agriculturally distinct, though botanically identical, and within each type individual variations occur. Selection was carried on, not on the old mass-selection lines, but by isolating single plants and studying their progeny in succeeding generations. The separation of forms and of pure lines has been successfully accomplished, and already several wheats have been obtained which are of much greater value than the mixtures at present in cultivation. Indeed, five of the Pusa selections have been shown by milling and baking tests to be in the same class with the Canadian spring wheats, the strongest and most valuable on the market. When the botanical survey was well on to completion it was possible to hybridise. This work is now in hand, and it is to be hoped that Mr. and Mrs. Howard will be able to carry the hybridisation on for the necessary length of time, so that the full benefit of their survey and selection work may be obtained.

A list of the botanical varieties of wheat found in India is then given, and for certain provinces the agricultural varieties as well. This survey is still in progress.

Throughout the book and the papers which the authors have issued the various wheat problems of India are handled in a masterly way. The record of work done reflects the highest credit on the authors, and is full of promise for the future of Indian agriculture.

THE REDUCTION OF ROLLING IN SHIPS.

REFERENCE is made in *Engineering* for December 16 to a paper by Mr. H. Frahm at the November meeting of the Schiffbautechnische Gesellschaft, in which the author describes his apparatus for reduction of rolling in ships. In this apparatus two water tanks are disposed on opposite sides of the centre line of the ship near the shell, and are connected below by a water conduit and above by an air conduit; a throttle valve is inserted in the latter. The water tanks are filled partly with water, which may oscillate in the closed circuit formed by the conduits. If the throttle valve is closed oscillation is practically prevented; with the valve full open the oscillations are unobstructed, excepting that free waves cannot arise.

The principle on which the device is based is that a series of wave-impulses will cause the ship to oscillate about its longitudinal axis; these oscillations will become pronounced when the period of the waves agrees with that of the natural vibration of the ship. These differ in phase by 90°, *i.e.* the maximum deflection of the ship from the vertical will occur a quarter period after the wave has been at its maximum inclination to the ship. The same applies to the oscillations of the ship and to those of the water column in the tanks, which rises and falls so that the two oscillation periods are equal, provided the water has the proper mass. In this case the oscillations of the water column will lag a quarter period behind those of the ship, and hence half a period behind the period of the waves, and the two turning moments acting on the ship will therefore oppose one another. This is an application of the principle of resonance.

Mr. Frahm's apparatus is beyond the mere experimental stage. The oil-tank boat W83 of the German Navy, 446 tons displacement, is a very stiff boat, with a high natural vibration period of 10·75 per minute. In dock the deflections from the perpendicular were reduced from 10° to 2° by twelve oscillations when the tanks were cut out, and by two oscillations with the tanks in action. At sea the amplitude of rolling was diminished to one-third. Two steamers of the Hamburg-America Line—the *Ypirango* and *Corcovado*—of 12,600 tons displacement, have been fitted with the anti-rolling tanks. The former was a notorious roller. Both are now regarded as steady boats; the tanks reduce rolling 11° (on either side) to 2½° maximum. Messrs. Blohm and Voss are designing anti-rolling tanks for the new passenger steamer of 55,000 tons which they are now building for the Hamburg-America Line. The paper in itself is very interesting, and is doubly so in view of statements made recently in the case of the loss of the British steamer *Waratah*.

ARGENTINE METEOROLOGICAL RESEARCH.[1]

THE services rendered to meteorology by Dr. W. S. Bruce in founding the meteorological observatory at Scotia Bay, South Orkneys, in 1903, are brought into forcible evidence by the publication of successive years' observations. Through the exertions of Dr. Escalante, Minister of Agriculture, and the enthusiasm of Mr. W. G. Davis, the Argentine Meteorological Office was enabled to take over the observatory from the Scottish National Antarctic Expedition, and has maintained it ever since. It must be remembered that this is the only permanent meteorological observatory in Antarctic regions. The observations for 1904, with an introduction by Mr. R. C. Mossman, are now published, though the title-page is dated 1905. The observations of following years seem not yet to have appeared, but they are briefly summarised in a most interesting and useful outline by Mr. W. G. Davis on the climate of the Argentine Republic. It may be mentioned, also, that a discussion by Mr. Mossman of each successive year's observations has appeared year by year in the *Scottish Geographical Magazine*. The tardy appearance of the 1904 volume detracts somewhat from its interest in view of our knowledge of the six later years, but we understand that circumstances beyond the control of the Meteorological Office alone delayed the publication.

Previous to the expedition of the *Scotia* it was supposed that, from their latitude, the South Orkneys would enjoy an oceanic climate. Actually, however, these conditions only obtain for four months, while for the rest of the year the conditions are continental. In exceptional years either of these states of climate may be prolonged at the expense of the other. The climate largely depends on the distribution of ice in the Weddell Sea. The average mean

[1] Anales de la Oficina Meteorológica Argentina. Tomo xvi., Observaciones de las Islas Orcadas en el Año 1904. Text in both Spanish and English. (Buenos Aires, 1905.)
"Climate of the Argentine Republic." By W. G. Davis. (Buenos Aires: Department of Agriculture, 1910.)

monthly temperature for five years (1903–8) varies from 9·68° F. in July to 32·54° in January, while the absolute range in the same period was 88°. The temperature variability of the seasons brings out the tendency to a winter continental and a summer oceanic climate. These values are (1904):—spring, 5·1°; summer, 1·3°; autumn, 5·4°; winter, 9·1°. The year 1904 had a mean annual temperature of 22·4°, which is 0·96° below the average mean of the five years 1903–8.

The wind directions, which were taken from the movements of the lower clouds, since the high land to the west of the observatory tended to deflect many winds, show a prevalence of north-westerly winds. Subsequent years' observations give west and south-west winds as the most frequent, which seems to show that the readings of 1904 give too high a value to north-west winds. Undoubtedly the position of Omond House is such that west and south-west winds would tend to be below what would be recorded in an unexceptional situation. In fact, on further consideration, Mr. Mossman has, we understand, come to the conclusion that the wind directions of 1904 are not wholly trustworthy. East, and especially north-east, winds are conspicuously rare, and the percentage wind frequency for each season does not materially differ from that of the year. The temperatures associated with these winds are of great interest, but unfortunately in Mr. Davis's five years' summary no thermal wind-roses are given. Very probably the high temperatures associated with some of these apparent westerly winds is partly due to Föhn effects, since in May, 1903, that is, in midwinter, an undoubted Föhn wind raised the temperature at the site of the observatory to 46°, which was only 1° lower than the absolute maximum of the year.

Associated with these prevailing west and south-west winds, which were also experienced by Dr. Nordenskjöld at Snow Hill in 1902–3, there exists a low-pressure area in the Weddell Sea, furthest south in autumn and most northerly in winter, but with a centre normally about 66° S. and 30° to 35° W. The continental origin of these prevailing winds accounts largely for the low temperatures of the South Orkneys compared with their latitude. The thermal gradient on the east of Graham Land is steep, and this fact, in relation to the southward bending of the isotherms about 40° W., is strong evidence for the existence of the northward projection of Antarctica south of the South Orkneys to about the Circle. Moreover, on no other grounds is it possible to account for the very low temperatures that occur from time to time at Scotia Bay with southerly and south-easterly winds.

NATIVE WORKING OF COAL AND IRON IN CHINA.

AN interesting illustrated article on the native working of coal and iron in the province of Shansi, China, appears in *Engineering* for December 2. In the Ping Ting Chau districts the iron ore is of excellent quality. The methods of extraction are decidedly primitive; in the old workings the ground is often found honeycombed with small shafts, seldom more than 14 inches in diameter, and usually just large enough to allow a man to go down. The tools used consist of a native pick, a cast-iron hammer, a wedge, and a sort of basket-shovel, the ore being raised in the basket by a small wooden winch. The climate is healthy, but work under such conditions is sure to produce disease, and consumption is very prevalent. During the summer the mines are shut down, and all the men become farmers until the close of the harvest season. The southern district specialises in wrought-iron goods, for example, spades, picks, nails, wrought-iron bars, and general ironwork; the northern district produces the larger and rougher classes of goods, such as cast-iron pans and sections of tyres for cart-wheels. Reduction of the ore is conducted in roasting-kilns; the broken-up ore is mixed with anthracite and charged into clay crucibles, which are heated in the kilns for about four days. The iron residue is then treated in a foundry, where it is broken up and remelted in crucibles for the production of cast iron, or, if wrought iron is being produced, by melting in a crude furnace, hammering, and puddling.

The Ping Ting Chau district is one of the largest anthracite coal beds of which there is any knowledge. The natives get at the coal by adit or by shaft, as may best suit the nature of the ground. Shafts vary from 6 to 8 feet in diameter, and from 60 to 300 feet in depth; the thickness of the seam of coal varies from 4 to 18 feet. During late years native mechanics have been giving advice, with the result that collieries are coming into existence in which the coal is hoisted in baskets, and cow-hide bags are used for hauling out accumulations of water. A Canton Chinaman attempted to apply up-to-date methods to a mine just outside the Ping Ting Chau area, and sank a shaft beside the adit. He proposed to use a winch for winding up the coal, but before this could be done water was struck and the mine flooded. Boilers and pumps were erected by Chinese workmen, and the water was successfully cleared out of the first level. Shortly after starting work an explosion took place, and practically closed the shaft. At present the men are carrying the coal up the steps in bags in an excessively high temperature due to the steam-pipes, and the Cantonese has retired from the field. Pick, hammer, and wedge are the only tools used.

THE DYNAMICS OF A GOLF BALL.[1]

THERE are so many dynamical problems connected with golf that a discussion of the whole of them would occupy far more time than is at my disposal this evening. I shall not attempt to deal with the many important questions which arise when we consider the impact of the club with the ball, but confine myself to the consideration of the flight of the ball after it has left the club. This problem is in any case a very interesting one; it would be even more interesting if we could accept the explanations of the behaviour of the ball given by many contributors to the very voluminous literature which has collected round the game; if these were correct, I should have to bring before you this evening a new dynamics, and announce that matter, when made up into golf balls, obeys laws of an entirely different character from those governing its action when in any other condition.

If we could send off the ball from the club, as we might from a catapult, without spin, its behaviour would be regular, but uninteresting; in the absence of wind its path would keep in a vertical plane; it would not deviate

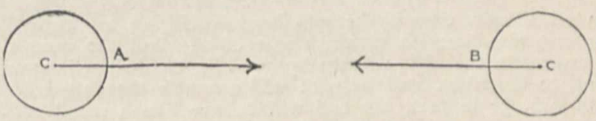

FIG. 1.

either to the right or to the left, and would fall to the ground after a comparatively short carry.

But a golf ball when it leaves the club is only in rare cases devoid of spin, and it is spin which gives the interest, variety, and vivacity to the flight of the ball. It is spin which accounts for the behaviour of a sliced or pulled ball, it is spin which makes the ball soar or "douk," or execute those wild flourishes which give the impression that the ball is endowed with an artistic temperament, and performs these eccentricities as an acrobat might throw in an extra somersault or two for the fun of the thing. This view, however, gives an entirely wrong impression of the temperament of a golf ball, which is, in reality, the most prosaic of things, knowing while in the air only one rule of conduct, which it obeys with unintelligent conscientiousness, that of always following its nose. This rule is the key to the behaviour of all balls when in the air, whether they are golf balls, base balls, cricket balls, or tennis balls. Let us, before entering into the reason for this rule, trace out some of its consequences. By the nose of the ball we mean the point on the ball furthest in front. Thus if, as in Fig. 1, C the centre of the ball is moving horizontally to the right, A will be the nose of the ball; if it is moving horizontally to the left, B will

[1] Discourse delivered at the Royal Institution on Friday, March 18, by Sir J. J. Thomson, F.R.S.

be the nose. If it is moving in an inclined direction CP, as in Fig. 2, then A will be the nose.

Now let the ball have a spin on it about a horizontal axis, and suppose the ball is travelling horizontally as in Fig. 3, and that the direction of the spin is as in the

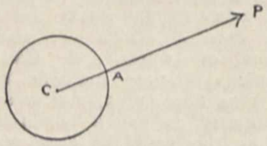

FIG. 2.

figure, then the nose A of the ball is moving upwards, and since by our rule the ball tries to follow its nose, the ball will rise and the path of the ball will be curved as in the dotted line. If the spin on the ball, still about a horizontal axis, were in the opposite direction, as in

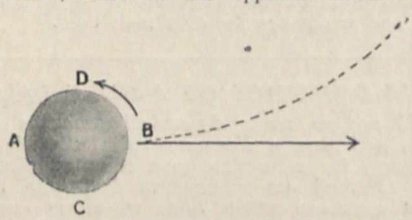

FIG. 3.

Fig. 4, then the nose A of the ball would be moving downwards, and as the ball tries to follow its nose it will duck downwards, and its path will be like the dotted line in Fig. 4.

Let us now suppose that the ball is spinning about a

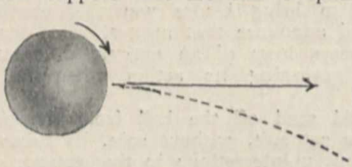

FIG. 4.

vertical axis, then if the spin is as in Fig. 5, as we look along the direction of the flight of the ball the nose is moving to the right; hence by our rule the ball will move off to the right, and its path will resemble the dotted line in Fig. 5; in fact, the ball will behave like a sliced ball.

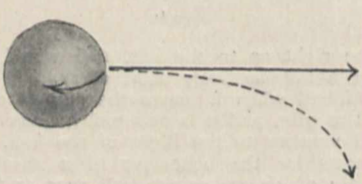

FIG. 5.

Such a ball, as a matter of fact, has spin of this kind about a vertical axis.

If the ball spins about a vertical axis in the opposite direction, as in Fig. 6, then, looking along the line of flight, the nose is moving to the left, hence the ball moves

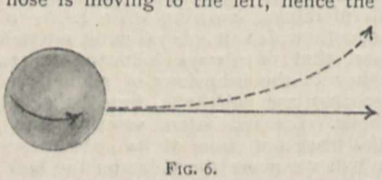

FIG. 6.

off to the left, describing the path indicated by the dotted line; this is the spin possessed by a "pulled" ball.

If the ball were spinning about an axis along the line of flight, the axis of spin would pass through the nose of the ball, and the spin would not affect the motion of the nose; the ball, following its nose, would thus move on without deviation.

Thus, if a cricket ball were spinning about an axis parallel to the line joining the wickets, it would not swerve in the air; it would, however, break in one way or the other after striking the ground; if, on the other hand, the ball were spinning about a vertical axis, it would swerve while in the air, but would not break on hitting the ground. If the ball were spinning about an axis intermediate between these directions it would both swerve and break.

Excellent examples of the effect of spin on the flight of a ball in the air are afforded in the game of base ball; an expert pitcher, by putting on the appropriate spins, can make the ball curve either to the right or to the left, upwards or downwards; for the sideway curves the spin must be about a vertical axis, for the upward or downward ones about a horizontal axis.

A lawn-tennis player avails himself of the effect of spin when he puts "top spin" on his drives, *i.e.* hits the ball on the top so as to make it spin about a horizontal axis, the nose of the ball travelling downwards, as in Fig. 4; this makes the ball fall more quickly than it otherwise would, and thus tends to prevent it going out of the court.

Before proceeding to the explanation of this effect of spin, I will show some experiments which illustrate the point we are considering. As the forces acting on the ball depend on the *relative* motion of the ball and the air, they will not be altered by superposing the same velocity on the air and the ball; thus, suppose the ball is rushing forward through the air with the velocity V, the forces will be the same if we superpose on both air and ball a velocity equal and opposite to that of the ball; the effect of this is to reduce the centre of the ball to rest, but to

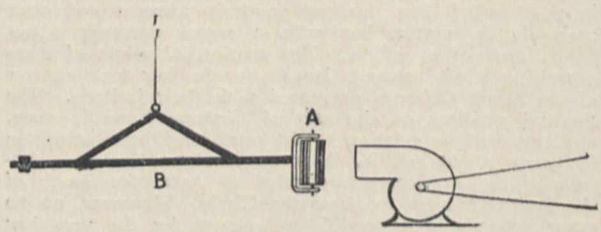

FIG. 7.

make the air rush past the ball as a wind moving with the velocity V. Thus the forces are the same when the ball is moving and the air at rest, or when the ball is at rest and the air moving. In lecture experiments it is not convenient to have the ball flying about the room; it is much more convenient to keep the ball still and make the air move.

The first experiment I shall try is one made by Magnus in 1852; its object is to show that a rotating body moving relatively to the air is acted on by a force in the direction in which the nose of the body is moving relatively to its centre; the direction of this force is thus at right angles both to the direction in which the centre of the body is moving and also to the axis about which the body is spinning. For this purpose a cylinder A (Fig. 7) is mounted on bearings so that it can be spun rapidly about a vertical axis; the cylinder is attached to one end of the beam B, which is weighted at the other end, so that when the beam is suspended by a wire it takes up a horizontal position. The beam yields readily to any horizontal force, so that if the cylinder is acted on by such a force this will be indicated by the motion of the beam. In front of the cylinder there is a pipe D, through which a rotating fan driven by an electric motor sends a blast of air which can be directed against the cylinder. I adjust the beam and the beam carrying the cylinder so that the blast of air strikes the cylinder symmetrically; in this case, when the cylinder is not rotating the impact against it of the stream of air does not give rise to any motion of the beam. I now spin the cylinder, and you see that when the blast strikes against it the beam moves off sideways. It goes off one way when the spin is in one direction, and in the opposite way when the direction of spin is reversed.

The beam, as you will see, rotates in the same direction as the cylinder, which an inspection of Fig. 8 will show you is just what it would do if the cylinder were acted upon by a force in the direction in which its nose (which, in this case, is the point on the cylinder first struck by the blast) is moving. If I stop the blast the beam does not move, even though I spin the cylinder, nor does it move when the blast is in action if the rotation of the cylinder is stopped; thus both spin of the cylinder and

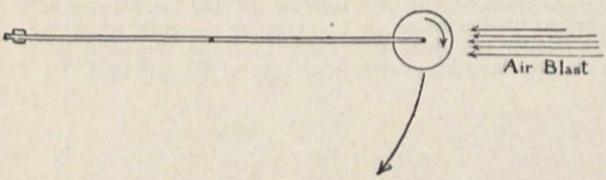

FIG. 8.

movement of it through the air are required to develop the force on the cylinder.

Another way of showing the existence of this force is to take a pendulum the bob of which is a cylinder, or some other symmetrical body, mounted so that it can be set in rapid rotation about a vertical axis. When the bob of the pendulum is not spinning the pendulum keeps swinging in one plane, but when the bob is set spinning the plane in which the pendulum swings no longer remains stationary, but rotates slowly in the same sense as the bob is spinning (Fig. 9).

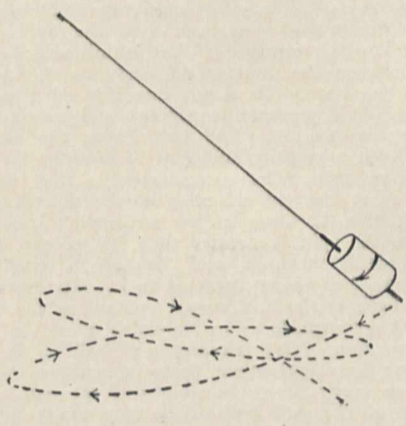

FIG. 9.

We shall now pass on to the consideration of how these forces arise. They arise because when a rotating body is moving through the air the pressure of the air on one side of the body is not the same as that on the other; the pressures on the two sides do not balance, and thus the body is pushed away from the side where the pressure is greatest.

Thus, when a golf ball is moving through the air, spinning in the direction shown in Fig. 10, the pressure

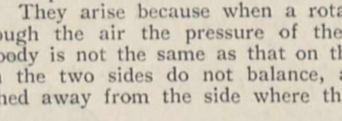

FIG. 10.

on the side ABC, where the velocity due to the spin conspires with that of translation, is greater than that on the side ADB, where the velocity due to the spin is in the opposite direction to that due to the translatory motion of the ball through the air.

I will now try to show you an experiment which proves that this is the case, and also that the difference between the pressure on the two sides of the golf ball depends upon the roughness of the ball.

In this instrument, Fig. 11, two golf balls, one smooth and the other having the ordinary bramble markings, are mounted on an axis, and can be set in rapid rotation by an electric motor. An air-blast produced by a fan comes through the pipe B, and can be directed against the balls; the instrument is provided with an arrangement by which the supports of the axis carrying the balls can be raised or lowered so as to bring either the smooth or the bramble-marked ball opposite to the blast. The pressure is measured in the following way:—LM are two tubes connected with the pressure-gauge PQ; L and M are placed so that the golf balls can just fit in between them; if the pressure of the air on the side M of the balls is greater than that of the side L, the liquid on the right-hand side Q of the pressure-gauge will be depressed; if, on the other hand, the pressure at L is greater than that at M, the left-hand side P of the gauge will be depressed.

I first show that when the golf balls are not rotating there is no difference in the pressure on the two sides when the blast is directed against the balls; you see there is no motion of the liquid in the gauge. Next I stop the blast and make the golf balls rotate; again there is no motion in the gauge. Now when the golf balls are spinning in the direction indicated in Fig. 11 I turn on the blast, the liquid falls on the side Q of the gauge, rises on the other side. Now I reverse the direction of rotation of the balls, and you see the motion of the liquid in the gauge is reversed, indicating that the high pressure has gone from one side to the other. You see that the pressure is higher on the side M, where the spin carries this side of the ball into the blast, than on L, where the spin tends to carry the ball away from the blast. If we could

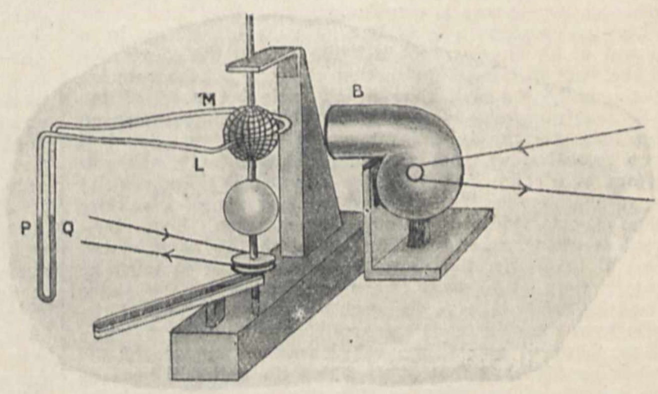

FIG. 11.

imagine ourselves on the golf ball, the wind would be stronger on the side M than on L, and it is on the side of the strong wind that the pressure is greatest. The case when the ball is still and the air moving from right to left is the same from the dynamical point of view as when the air is still and the ball moves from left to right; hence we see that the pressure is greatest on the side where the spin makes the velocity through the air greater than it would be without spin.

Thus, if the golf ball is moving as in Fig. 12, the spin increases the pressure on the right of the ball and diminishes the pressure on the left.

To show the difference between the smooth ball and the rough one, I bring the smooth ball opposite the blast; you observe the difference between the levels of the liquid in the two arms of the gauge. I now move the rough ball into the place previously occupied by the smooth one, and you see that the difference of the levels is more than doubled, showing that with the same spin and speed of air blast the difference of pressure for the rough ball is more than twice that for the smooth.

We must now go on to consider why the pressure of the air on the two sides of the rotating ball should be different. The gist of the explanation was given by Newton nearly 250 years ago. Writing to Oldenburg in 1671 about the dispersion of light, he says, in the course of his letter:—"I remembered that I had often seen a tennis ball struck with an oblique racket describe such a curved line. For a circular as well as progressive motion being communicated to it by that stroke, its parts on that side where the motions conspire must press and beat the contiguous air more violently, and there excite a reluctancy and reaction of the air proportionately greater." This letter has more than a scientific interest—it shows that Newton set an excellent precedent to succeeding mathematicians and physicists by taking an interest in games. The same explanation was given by Magnus, and the mathematical theory of the effect is given by Lord Rayleigh in his paper on "The Irregular Flight of a Tennis Ball," published in the *Messenger of Mathematics*, vol. vi., p. 14, 1877. Lord Rayleigh shows that the force on the ball resulting from this pressure difference is at right angles to the direction of motion of the ball, and also to the axis of spin, and that the magnitude of the force is proportional to the velocity of the ball multiplied by the velocity of spin, multiplied by the sine of the angle between the direction of motion of the ball and the axis of spin. The analytical investigation of the effects which a force of this type would produce on the movement of a golf ball has been discussed very fully by Prof. Tait, who also made a very interesting series of experiments on the velocities and spin of golf balls when driven from the tee, and the resistance they experience when moving through the air.

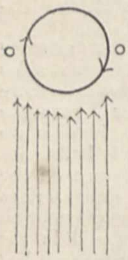

FIG. 12.

As I am afraid I cannot assume that all my hearers are expert mathematicians, I must endeavour to give a general explanation, without using symbols, of how this difference of pressure is established.

Let us consider a golf ball (Fig. 13) rotating in a current of air flowing past it. The air on the lower side of the ball will have its motion checked by the rotation of the ball, and will thus in the neighbourhood of the ball move more slowly than it would do if there were no golf ball present, or than it would do if the golf ball were there but was not spinning. Thus if we consider a stream of air flowing along the channel PQ, its velocity when near the ball at Q must be less than its velocity when it started at P; there must, then, have been pressure acting against the motion of the air as it moved from P to Q, *i.e.* the pressure of the air at Q must be greater than at a place like P, which is some distance from the ball. Now let us consider the other side of the ball; here the spin tends to carry the ball in the direction of the blast of air; if the velocity of the surface of the ball is greater than that of the blast, the ball will increase the velocity of the blast on this side, and if the velocity of the ball is less than that of the blast, though it will diminish the velocity of the air, it will not do so to so great an extent as on the other side of the ball. Thus the increase in pressure of the air at the top of the ball over that at P, if it exists at all, will be less than the increase in pressure at the bottom of the ball. Thus the pressure at the bottom of the ball will be greater than that at the top, so that the ball will be acted on by a force tending to make it move upwards.

side of the boat they have to face the wind, on the other side they have the wind at their backs. Now when they face the wind, the pressure of the wind against them is greater than if they were at rest, and this increased pressure is exerted in all directions, and so acts against the part of the ship adjacent to the deck; when they are moving with their backs to the wind the pressure against their backs is not so great as when they were still, so the pressure acting against this side of the ship will not be so great. Thus the rotation of the passengers will increase the pressure on the side of the ship when they are facing the wind and diminish it on the other side. This case is quite analogous to that of the golf ball.

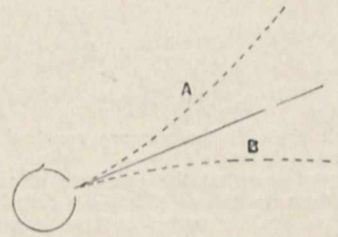

FIG. 14.

The difference between the pressures on the two sides of the golf ball is proportional to the velocity of the ball multiplied by the velocity of the spin. As the spin imparted to the ball by a club with a given loft is proportional to the velocity with which the ball leaves the club, the difference of pressure when the ball starts is proportional to the square of its initial velocity. The difference between the average pressures on the two sides of the ball need only be about one-fifth of 1 per cent. of the atmospheric pressure to produce a force on the ball greater than its weight. The ball leaves the club in a good drive with a velocity sufficient to produce far greater pressures than this. The consequence is that when the ball starts from the tee spinning in the direction shown in Fig. 14, this is often called underspin; the upward force due to the spin is greater than its weight, thus the resultant force is upwards, and the ball is repelled from the earth instead of being attracted to it. The consequence is that the path of the ball curves upward as in the curve A instead of downwards as in B, which would be its path if it had no spin. The spinning golf ball is, in fact, a very efficient heavier-than-air flying machine; the lifting force may be many times the weight of the ball.

The path of the golf ball takes very many interesting forms as the amount of spin changes. We can trace all these changes in the arrangement which I have here, and which I might call an electric golf links. With this apparatus I can subject small particles to forces of exactly the same type as those which act on a spinning golf ball.

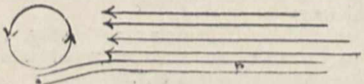

FIG. 13.

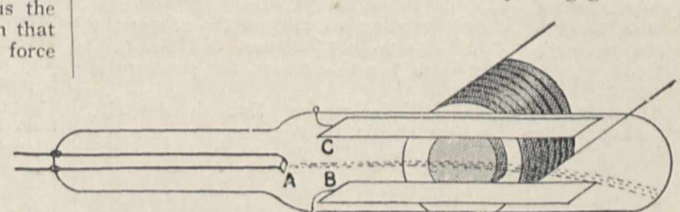

FIG. 15.

We have supposed here that the golf ball is at rest, and the air rushing past it from right to left; the forces are just the same as if the air were at rest, and the golf ball rushing through it from left to right. As in Fig. 13, such a ball rotating in the direction shown in the figure will move upwards, *i.e.* it will follow its nose.

It may perhaps make the explanation of this difference of pressure easier if we take a somewhat commonplace example of a similar effect. Instead of a golf ball, let us consider the case of an Atlantic liner, and, to imitate the rotation of the ball, let us suppose that the passengers are taking their morning walk on the promenade deck, all circulating round the same way. When they are on one

These particles start from what may be called the tee A (Fig. 15). This is a red-hot piece of platinum with a spot of barium oxide upon it; the platinum is connected with an electric battery which causes negatively electrified particles to fly off the barium and travel down the glass tube in which the platinum strip is contained; nearly all the air has been exhausted from this tube. These particles are luminous, so that the path they take is very easily observed. We have now got our golf balls off from the tee; we must now introduce a vertical force to act upon them to correspond to the force of gravity on the golf ball. This is easily done by the horizontal plates BC, which are electrified by connecting them with an electric battery; the upper one is electrified negatively, hence when one of these particles moves between the plates it is exposed to a constant downwards force, quite analogous to the weight of the ball. You see now when the particles pass between the plates their path has the shape shown in Fig. 16; this is the path of a ball without spin. I can imitate the effect of spin by exposing the particles while they are moving to magnetic force, for the theory of these particles shows that when a magnetic force acts upon them it produces a mechanical force which is at right angles

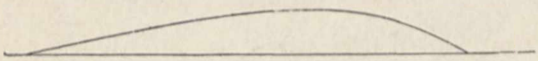

FIG. 16.

to the direction of motion of the particles, at right angles also to the magnetic force, and proportional to the product of the velocity of the particles, the magnetic force, and the sine of the angle between them. We have seen that the force acting on the golf ball is at right angles to the direction in which it is moving at right angles to the axis of spin, and proportional to the product of the velocity of the ball, the velocity of spin, and the sine of

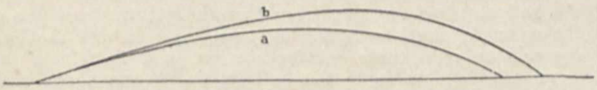

FIG. 17.

the angle between the velocity and the axis of spin. Comparing these statements, you will see that the force on the particle is of the same type as that on the golf ball if the direction of the magnetic force is along the axis of spin and the magnitude of the force proportional to the velocity of spin, and thus if we watch the behaviour of these particles when under the magnetic force we shall get an indication of the behaviour of the spinning golf

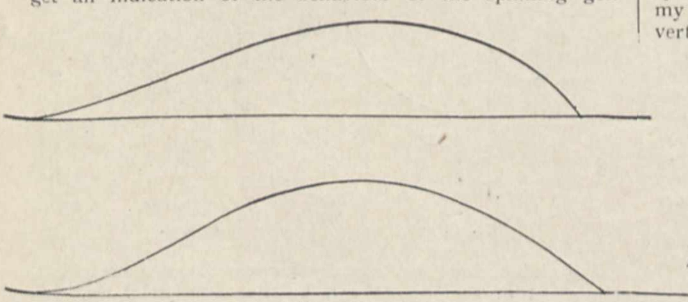

FIG. 18.

ball. Let us first consider the effect of underspin on the flight of the ball; in this case the ball is spinning, as in Fig. 3, about a horizontal axis at right angles to the direction of flight. To imitate this spin I must apply a horizontal magnetic force at right angles to the direction

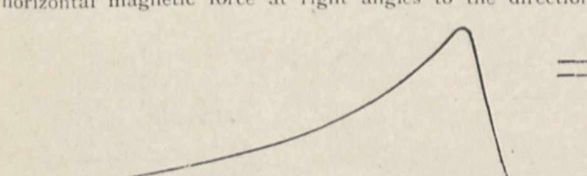

FIG. 19.

of flight of the particles. I can do this by means of the electromagnet. I will begin with a weak magnetic force, representing a small spin. You see how the path differs from the one when there was no magnetic force; the path, to begin with, is flatter, though still concave, and the carry is greater than before—see Fig. 17, *a*. I now increase the strength of the magnetic field, and you will see that the carry is still further increased, Fig. 17, *b*. I increase the spin still further, and the initial path becomes convex instead of concave, with a still further increase in carry, Fig. 18. Increasing the force still more, you see the particle soars to a great height, then comes suddenly down, the carry now being less than in the previous case (Fig. 19). This is still a familiar type of the path of the golf ball. I now increase the magnetic force still further, and now we get a type of flight not to my knowledge ever observed in a golf ball, but which would be produced if we could put on more spin than

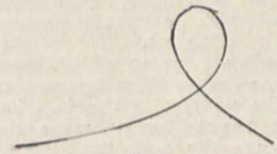

FIG. 20.

we are able to do at present. You see there is a kink in the curve, and at one part of the path the particle is actually travelling backwards (Fig. 20). Increasing the magnetic force I get more kinks, and we have a type of drive which we have to leave to future generations of golfers to realise (Fig 21).

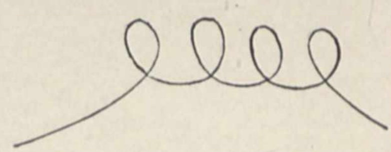

FIG. 21.

By increasing the strength of the magnetic field I can make the curvature so great that the particles fly back behind the tee, as in Fig. 22.

So far I have been considering underspin. Let us now illustrate slicing and pulling; in these cases the ball is spinning about a vertical axis. I must therefore move my electromagnet, and place it so that it produces a vertical magnetic force (Fig. 23). I make the force act

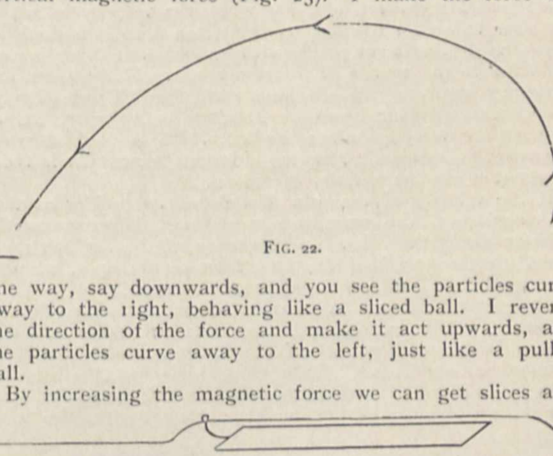

FIG. 22.

one way, say downwards, and you see the particles curve away to the right, behaving like a sliced ball. I reverse the direction of the force and make it act upwards, and the particles curve away to the left, just like a pulled ball.

By increasing the magnetic force we can get slices and

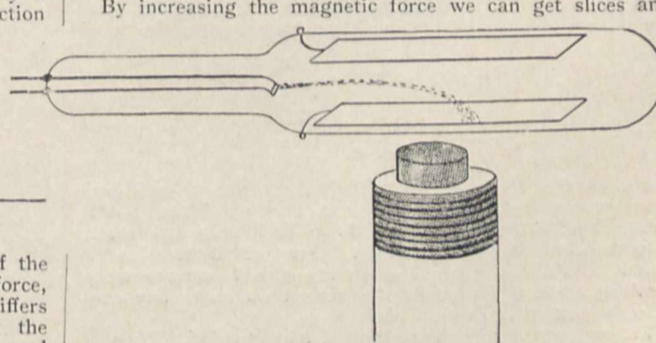

FIG. 23.

pulls much more exuberant than even the worst we perpetrate on the links.

Though the kinks shown in Fig. 20 have never, so far as I am aware, been observed on a golf links, it is quite easy to produce them if we use very light balls. I have here a ball A made of very thin indiarubber of the kind used for toy balloons, filled with air, and weighing very little more than the air it displaces; on striking this with the hand, so as to put underspin upon it, you see that it describes a loop, as in Fig. 24.

Striking the ball so as to make it spin about a vertical axis, you see that it moves off with a most exaggerated slice when its nose is moving to the right looking at it from the tee, and with an equally pronounced pull when its nose is moving to the left.

One very familiar property of slicing and pulling is that the curvature due to them becomes much more pronounced when the velocity of the ball has been reduced than it was at the beginning when the velocity was greatest. We can easily understand why this should be so if we consider the effect on the sideways motion of reducing the velocity to one half. Suppose a ball is pro-

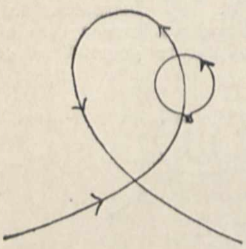

FIG. 24.

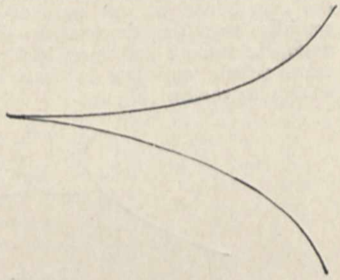

FIG. 25.

jected from A in the direction AB, but is sliced; let us find the sideways motion BC due to slice. The sideways force is, as we have seen, proportional to the product of the velocity of the ball and the velocity of spin, or, if we keep the spin the same in the two cases, to the velocity of the ball; hence, if we halve the velocity we halve the sideways force, hence, in the same time, the displacement would be halved too, but when the velocity is halved the time taken for the ball to pass from A to B is doubled. Now the displacement produced by a constant force is proportional to the square of the time; hence, if the force had remained constant, the sideways deflection BC would have been increased four times by halving the velocity, but as halving the velocity halves the force, BC is doubled when the velocity is halved; thus the sideways movement is twice as great when the velocity is halved.

If the velocity of the spin diminished as rapidly as that of translation, the curvature would not increase as the velocity diminished, but the resistance of the air has more effect on the speed of the ball than on its spin, so that the speed falls the more rapidly of the two.

The general effect of wind upon the motion of a spinning ball can easily be deduced from the principles we discussed in the earlier part of the lecture. Take, first, the case of a head-wind. This wind increases the relative velocity of the ball with respect to the air; since the force due to the spin is proportional to this velocity, the wind

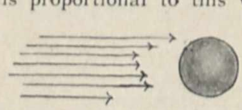

FIG. 26.

increases this force, so that the effects due to spin are more pronounced when there is a head-wind than on a calm day. All golfers must have had only too many opportunities of noticing this. Another illustration is found in cricket; many bowlers are able to swerve when bowling against the wind who cannot do so to any considerable extent on a calm day.

Let us now consider the effect of a cross-wind. Suppose the wind is blowing from left to right, then, if the ball is pulled, it will be rotating in the direction shown in Fig. 26; the rules we found for the effect of rotation on the difference of pressure on the two sides of a ball in a blast of air show that in this case the pressure on the front half of the ball will be greater than that on the rear half, and thus tend to stop the flight of the ball. If, however, the spin was that for a slice, the pressure on the rear half would be greater than the pressure in front, so that the difference in pressure would tend to push on the ball and make it travel further than it otherwise would. The moral of this is that if the wind is coming from the left we should play up into the wind and slice the ball, while if it is coming from the right we should play up into it and pull the ball.

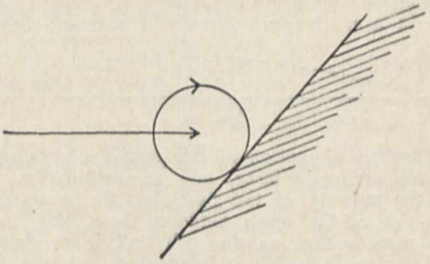

FIG. 27.

I have not time for more than a few words as to how the ball acquires the spin from the club. But if you grasp the principle that the action between the club and the ball depends only on their *relative* motion, and that it is the same whether we have the ball fixed and move the club or have the club fixed and project the ball against it, the main features are very easily understood.

Suppose Fig. 27 represents the section of the head of a

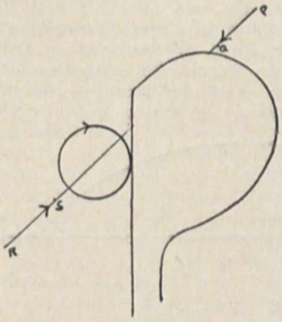

FIG. 28.

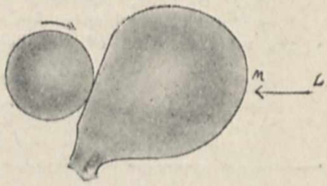

FIG. 29.

lofted club moving horizontally forward from right to left, the effect of the impact will be the same as if the club were at rest and the ball were shot against it horizontally from left to right. Evidently, however, in this case the ball would tend to roll up the face, and would thus get spin about a horizontal axis in the direction shown in the figure; this is underspin, and produces the upward force which tends to increase the carry of the ball.

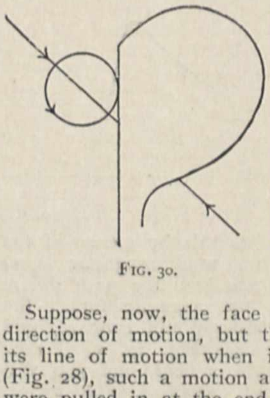

FIG. 30.

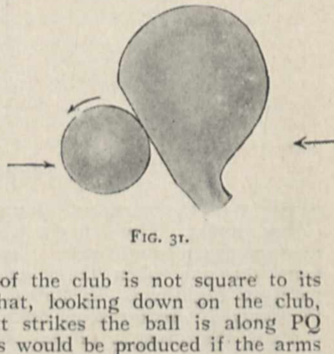

FIG. 31.

Suppose, now, the face of the club is not square to its direction of motion, but that, looking down on the club, its line of motion when it strikes the ball is along PQ (Fig. 28), such a motion as would be produced if the arms were pulled in at the end of the stroke, the effect of the impact now will be the same as if the club were at rest and the ball projected along RS, the ball will endeavour to roll along the face away from the striker; it will spin in the direction shown in the figure about a vertical axis. This, as we have seen, is the spin which produces a slice. The same spin would be produced if the motion of the club was along LM and the face turned so as to be in the position shown in Fig. 29, *i.e.* with the heel in front of the toe.

If the motion and position of the club were as in Figs. 30 and 31, instead of as in Figs. 28 and 29, the same consideration would show that the spin would be that possessed by a pulled ball.

THE SECOND FRENCH ANTARCTIC EXPEDITION.[1]

THE Antarctic is so vast as to admit of many expeditions working together with good results, and Dr. Charcot therefore resolved to return to the region which he had explored to some extent in 1903–5. His precise object was to investigate from every point of view as great an extent of the Antarctic as possible, without any considerations as to latitude. He desired to enter the region where the ice drifted furthest to the north, and he had no hope whatever of reaching the Pole. He had a three-masted vessel constructed at St. Malo, with auxiliary engine, which he named *Le Pourquoi Pas?* It was equipped with every care, and supplied with the most modern instruments for observation. The crew consisted of twenty-two men, most of whom had already accompanied Dr. Charcot on his previous expedition. The staff consisted of seven, who were experts in different departments of science. The expedition started from Havre on August 15, 1909, and on December 16 left Punta Arenas for the Antarctic.

After passing Deception Island Dr. Charcot made for Port Lockroy, in Gerlache Strait, where the work of the expedition began. Some days later the expedition arrived at Wandell, which was found to be a very unsatisfactory harbour, and therefore the expedition moved on to Petermann Island. Dr. Charcot with two of his companions set out to discover if it was possible to pass between the Biscoe Islands and the coast. As they expected to return the same day they did not take any provisions or change of garments. Their return was blocked by the ice, and it was four days before they were able to reach the ship, narrowly escaping death from hunger and cold. From Petermann Island a journey was made towards the south along the coast, the mapping of which, begun during the previous expedition, was completed. A hydrographical survey was made of Adelaide Island, which was found to be seventy miles long instead of eight, as had previously been stated. To the south of Adelaide, in a region which had not previously been visited, a great gulf was discovered which was entitled Marguerite Bay. Here the greatest difficulties were met with from the ice and from icebergs, but these were successfully overcome. In spite of all the difficulties the expedition discovered and studied the hydrography of 120 miles of unknown coast to the south.

At last, after two attempts, the expedition succeeded in traversing the ice and reaching Alexander Land, which was mapped, and the hydrography of which was investigated. It was found absolutely impossible to winter here, however, and the expedition was compelled to return to Petermann Island. Observations, however, were carried on with great perseverance, numerous soundings and dredgings were made, and many photographs taken. The house which had been constructed here on the previous expedition was still available, and after three days' work was put into condition for being able to be used during the winter. In the autumn numerous and long excursions were made on the glaciers. The winter, though mild, was almost continuously stormy, a formidable north-east wind blowing during nine months. An immense quantity of snow fell. The terrible season was very trying to the members of the expedition, some of whom had been attacked with scurvy.

An attempt was made to traverse Graham Land. The members of the expedition who carried out the work returned with many interesting observations, but without having been able to overcome the impassable perpendicular wall of granite and of ice which lines the whole of the coast where a landing was attempted to be made. Many other excursions were made in the neighbourhood. With great difficulty, owing to the state of the ice, Deception Island was reached at the end of November, and the expedition received the greatest hospitality from the whalers who are settled on the island. Many observations were here made in seismography, on the tides, on hydrography, in natural history and geology, and many soundings and dredgings were carried out.

After the expedition had been refitted it visited Bridgman Island, Admiralty Bay, the south coast of the South Shetlands, at all of which places good work was done. After this another attempt was made to penetrate southwards. In spite of the unfavourable condition of the ice and the weather, the expedition succeeded in passing beyond all the latitudes previously reached to the south-west of Alexander Land. It was hoped that the expedition would be able to make further discoveries to the south and the west of Alexander Land, but the formidable condition of the pack rendered this extremely difficult. The route, however, was continued along the edge of the pack, when Peter 1st Island was discovered in the place at which it is usually charted. After this the icebergs became so numerous as to be embarrassing and dangerous. Dr. Charcot reckons that they counted something like 5000 of these in one day. However, they succeeded in reaching 126 degrees west longitude, and so reached two or three degrees further south than the route followed by Cook and Bellingshausen. As the supply of coal was now almost exhausted, and the health of the expedition had become alarming, it was decided to make for the north. The icebergs gradually diminished, and at last disappeared, and, thanks to an uninterrupted series of strong winds, varying from south-west to N.N.W., rapid progress was made. In ten days the Straits of Magellan were reached, and on February 12 the expedition anchored at Punta Arenas. The *Pourquoi Pas?* behaved admirably in spite of the many trials to which it was subjected, and the crew was all that could be desired, while the scientific staff worked incessantly, and from the scientific point of view the programme was scrupulously carried out. It will take many months to work out the observations which have been made during the expedition, to study and arrange the rich collections obtained, and therefore it is somewhat difficult to give more than a brief *résumé* of the results obtained.

From the geographical point of view the expedition has proved that the west coast of what may be called the South American Antarctic is cut up by deep fjords, and the coast studded with islands and reefs. Graham Land is continued to the south by a land to which Dr. Charcot has given the name Terre Loubet; this is continued by the Terre Fallières. Alexander Land, which has only been seen by Bellingshausen, is a large island, but the lands discovered by the expedition to the south and west of that very probably join on Terre Fallières. Outside of Peter 1st Island the expedition did not obtain sight of any other land, but their soundings in continuation of those of the Belgian expedition, the configuration of the icebergs and their movements, seem to indicate that there exists a continual line, which most probably joints the Graham Land section of the Antarctic to King Edward VII. Land. Dr. Charcot considers that the further exploration of this land is very desirable, although the difficulties from the state of the weather and the formidable nature of the ice here will render such an enterprise extremely difficult.

In spite of the difficulties which had to be faced, the observations made in the various departments of science are extremely rich. Careful mapping of the lands visited was carried out throughout; numerous gravity observations were made; earthquake phenomena recorded; an eclipse of the sun on December 23, 1908, was observed; important geological observations carried out, proving that the same dioritic and granitic forms which are to be found in Graham Land are continued further to the south. Of the existence of a continental plateau there can be little doubt from the observations that were made. Numerous excursions were made on the glaciers into the interior; careful continuous meteorological observations were re-

[1] Summary of a paper by Dr. J. B. Charcot read before the Royal Geographical Society on December 19.

corded; 100 soundings were made; 200 specimens of the water collected; twenty dredgings were carried out; observations of interest in magnetism, in solar radiation, zoological and botanical collections, and additions to our knowledge in other directions, rendering the expedition from the scientific point of view completely successful.

COMPARISONS OF JURASSIC FLORAS.

AT the forty-ninth annual meeting of the Yorkshire Naturalists' Union, held at Middlesbrough on Saturday, December 17, Prof. A. C. Seward, F.R.S., delivered his presidential address, entitled "The Jurassic Flora of the East of Yorkshire in Relation to the Jurassic Floras of the World." It was pointed out that the estuarine beds of east Yorkshire were among the most famous and important strata of the world from the point of view of their fossil contents. Since the publication in 1822 of Young and Bird's "Geological Survey of the Yorkshire Coast" much attention has been paid to the fossil plants of Yorkshire by British and foreign students. During the first half of the nineteenth century a considerable amount of work was done by such pioneers as William Bean, John Williamson, W. Crawford Williamson, John Phillips, and others. Prof. Seward gave a general sketch of the flora which the labours of Yorkshire naturalists have enabled students to investigate. Prof. Nathorst, of Stockholm, who has more than once invaded our shores, recently transported a portion of our island to his country. By establishing a department devoted to the floras of the past, the Swedish Academy has set an example which the trustees of our national collections would do well to imitate. Palæobotany is still without a representative in the British Museum!

Prof. Seward then reviewed the various fossil remains of Algæ and Fungi, Hepophyta, Equisetales, Lycopodiales, Filicales, Gymnospermæ, Ginkgoales, and Coniferales, being some of the types which occur in the Yorkshire strata. The Yorkshire coast flora is characterised by the abundance of ferns and cycads and certain types of conifers, though as yet it is not possible to make any statement as to the relative abundance of these different groups. It is also probable that the Ginkgoales played a fairly prominent part in the composition of the vegetation. The most interesting fact in regard to the Jurassic ferns is that they afford strong presumptive evidence in support of the view that their nearest living allies are to be sought in the southern hemisphere. As regards the cycads, comparison with recent genera is rendered more difficult because of the greater gulf between recent members of the group and those which flourished in the Jurassic era. There can, however, be no reasonable doubt that the cycads of to-day are derived from an ancient stock which produced also Williamsonia and other Jurassic genera. Here, again, the recent plants most nearly akin to those of the Mesozoic floras are chiefly characteristic of southern and warmer regions. The same general statement is applicable to the relation of some of the Jurassic conifers to recent types. Finally, in the genus Ginkgo of the Jurassic flora we have a member of a group which would probably have ceased to be represented among living plants were it not for the fact that the recent species has been long held in veneration in the Far East as a sacred tree. With these southern forms there grew in profusion stalwart Equisetums, which afforded one of the few instances of a genus still represented by several species in the British flora which can claim a Jurassic ancestry.

At first sight one might be tempted to infer that there is clear evidence of a tropical, or at least subtropical, climate in Jurassic Europe. This would, perhaps, be a correct conclusion, but it is one which cannot be confidently made, so far, at least, as the botanical evidence is concerned. The fact must be borne in mind that among living plants very closely allied types, or even one of the same species, may flourish under widely different climatic conditions, as in the case of our own familiar bracken fern, which appears to be equally at home on the Yorkshire moors, in Tasmania, Abyssinia, and elsewhere. The comparison of a past with a recent flora is bound up with numerous considerations in addition to those connected with the comparison of existing and extinct species. During the Rhætic and Jurassic eras, and in the succeeding Cretaceous and Tertiary epochs, the genus Ginkgo was very widely distributed in Europe. So recently as the Lower Tertiary period it existed in what is now the west of Scotland in a form hardly distinguishable from the maiden-hair tree. Are we justified in assuming that the living species is a safe criterion as regards power of resistance or capabilities of life with which the family was endowed at the zenith of its vigour? Were it possible to learn from the maiden-hair tree what vicissitudes its ancestors passed through since the days of the Jurassic period, we might hear of unequal competition and gradual migration from northern to southern latitudes.

In dealing with the relation of the Yorkshire Jurassic flora with that of other parts of the world, it is remarkable to find that almost precisely similar plants to those occurring in the local rocks also are found embedded in strata of about the same age at places so far distant as Bornholm, Poland, Turkestan, Siberia, Korea, Japan, Franz Josef Land, Spitsbergen, Greenland, America, India, and Australia. This extraordinary distribution would certainly seem to indicate that the climate in Jurassic times must have been much more uniform the world over than obtains to-day.

As a result of Prof. Seward's address and his interest in the union's work, a committee was formed for the investigation of the Jurassic plants of Yorkshire, with Prof. Seward as first chairman.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

SHEFFIELD.—Mr. R. J. Pye-Smith has resigned the professorship of surgery. The council has adopted the following resolution:—"That the resignation of Mr. Pye-Smith as professor of surgery in the University be accepted with great regret. Mr. Pye-Smith, who is the senior member of the teaching staff, has been a teacher of surgery for thirty-four years, first in the old Medical School, next in the University College, and finally in the University, and the council desire to place on record their appreciation of the distinguished services which he has rendered to the cause of medical education in Sheffield."

Dr. E. W. Adams has been appointed to the post of lecturer in materia medica and assistant to the professor of materia medica, pharmacology, and therapeutics.

DR. W. GOODWIN, head of the chemical department at the South-Eastern Agricultural College, Wye, has been appointed principal of the Midland Agricultural College, Kingston, Derbyshire.

A REUTER message from Chicago announces that Mr. John D. Rockefeller has made a final donation of 2,000,000*l*. to Chicago University, making a total of approximately 7,000,000*l*. given by him to that institution.

THE annual meeting of the Geographical Association will be held on Saturday, January 14, 1911, in the Lecture Hall, London School of Economics. The following short papers will be read:—Geography at seven years, Miss C. von Wyss; map-making as a school subject, F. Beames; practical contouring round a London school, J. Fairgrieve; the training of teachers in geography, J. F. Unstead. An address will be delivered by the president, Mr. Douglas W. Freshfield, and a lecture on "The Highways of England and Wales, Past and Present, and their Relationship to Geographical Conditions," by Mr. G. Montagu.

LIVERPOOL.—The Liverpool School of Tropical Medicine (Incorporated) at the time of the death of the late Dr. J. E. Dutton in the Congo Free State, whilst investigating sleeping sickness and other tropical diseases there, started a fund to establish a chair in the University in his memory. The necessary amount has now been raised, mainly through the generosity of the late Sir Alfred Jones, Mr. W. H. Lever, Sir William Hartley, and many others. The Liverpool School has at present a lectureship in tropical entomology, and the committee decided, therefore, that the best form the memorial could take would be the foundation in the University of a Dutton professorship in tropical entomology. The value of close investigation into the habits and life-cycles of disease-bearing biting insects, not only in the tropics, but also at home, is daily becoming more evident. Dr. Dutton was one who realised this intensely, and it is fitting that his memorial should take the form of a chair of medical entomology. The appointment to the chair has not yet been made by the University, but will be announced in due course.

AN agreement has been arrived at between the Senate of the Queen's University of Belfast and the Corporation of Belfast by which the work of the University and of the Belfast Municipal Technical Institute will be coordinated. As the Vice-Chancellor of the University said at the meeting of the Senate on December 15, when the agreement was made, this will afford an opportunity to young men in Belfast of obtaining a complete education in such subjects as mechanical engineering, electrical engineering, chemical technology, textile technology, and naval architecture, and of securing the degree of B.Sc. at the conclusion of their course of work. The advantages of this arrangement to the Technical Institute, on one hand, and to the University on the other, will be very great. By the proposed arrangement means will be provided for obtaining trained captains of industry for the various great enterprises for which Belfast is famous. The coordination forges another link between the University and the city. The technical subjects mentioned will be studied at the institute, which becomes an integral part of the University in a manner analogous to several cases in England. We learn, too, that a public textile testing and conditioning house has been started in connection with the institute at Belfast. The functions of the testing house are to be similar to those of other public textile testing and conditioning houses, namely, the examination of textile materials with the view of ascertaining and certifying their true weight, length, condition, and strength, and, in addition, the carrying out of such other tests and investigations as may be required in order that spinners, manufacturers, merchants, and others desirous of having tests conducted and an official certificate issued may effect their object through the medium of an independent public authority.

As the result of representations made by the Old Students Association of the Royal College of Science, London, of which Sir Thomas H. Holland, K.C.I.E., F.R.S., is president, the governing body of the Imperial College of Science and Technology has granted the privilege of wearing academic costume to associates of the Royal College of Science, London, a like privilege being also granted to associates of the Royal School of Mines, of the City and Guilds of London Institute, and to diplomate students of the Imperial College. Patterns for academic costume have been approved by the governing body. In each case the gown is as for the University of London B.A., of black silk or stuff, but with the forearm seam open, and without button, cord, or pleats. The hoods are differentiated for the several colleges as regards the colour of the neckband, which for A.R.C.S.'s will be white, for A.R.S.M.'s gold, for A.C.G.I.'s red (as in the Arms of the City of London), and black for diplomate students of the Imperial College, the hood in each case being as the Oxford University M.A. hood in size and shape, of black silk or stuff, partly lined with white watered silk to a depth of 6 inches, with an edging, 1 inch in width, of royal purple velvet, ½ inch from the outer edge, and with a neckband 1¼ inches in width, lined with white watered silk and edged with white watered silk ¼ inch in width. As regards the Associates of the Royal College of Science, the decision of the governing body removes a grievance of long standing, which was felt more especially by teachers in secondary and technical schools. It is generally recognised that the A.R.C.S. diploma represents a course of training in no sense inferior to that represented by a university degree and there is therefore no reason why an invidious distinction should be made between university graduates and associates of the college in respect of academic costume. The claim of associates to the privilege is strengthened by the fact that it has been granted to associates of various London colleges, such as the Royal College of Art, King's College, the Royal College of Organists, and the College of Preceptors. Several London firms of robe-makers have undertaken to supply academic costume of the approved patterns.

SIR ALFRED KEOGH, Rector of the Imperial College of Science and Technology, delivered an address at the Woolwich Polytechnic on Saturday, December 17, on the occasion of the nineteenth annual prize distribution. In the course of his remarks he said:—There are certain subjects engaging our attention at the present moment which are of enormous importance to the future of the country. We have been told that we are losing our supremacy because we do not keep science and industry in close touch with one another; we are told that the manufacturers have not an appreciation of science, and as a consequence are being ousted in various directions by other people. However it may shock you to hear me say so, I have the greatest sympathy with the manufacturers. As a matter of fact, I know in this country there are manufacturers who have the greatest appreciation for scientific education, and are employing foreigners in their workshops because they have the required knowledge. The reason is this, that we are not providing the class of men this country needs, and until we do provide them the manufacturer will turn aside and get people from abroad. We have been told all this, we have been told that our industries are failing in consequence, and an effort was made—which has been passed unnoticed—to bring science and industries together and to coordinate general scientific education in London. Three of the great colleges at South Kensington —the City and Guilds College, the Royal College of Science, and the Royal School of Mines—were combined for the purpose of coordinating knowledge, and that incident passed almost unnoticed. The Imperial College was intended to coordinate the whole scientific education in London, and we have in London (I include, of course, Woolwich) a number of polytechnic institutions doing technical work, and we are not coordinated one with the other. If something could be done to coordinate the polytechnics with the Imperial College, I for one have no fear of the foreigner. This I earnestly hope will come about soon. Perhaps it may be possible to get the teachers in the polytechnics of London to recognise that there is one great need at the present moment, that professors and teachers should come together and devise a scheme to work for one solid purpose and one object, and that is the correlation of science and industrial work. I do not know what the opinion here is on this point, but we think at the Imperial College that there should be a great imperial college in London including this institution, including every other polytechnic, in which we shall be able to give our own degrees. The principals of the polytechnics have been called upon to express their opinion. I earnestly hope that they will not forget that upon their shoulders will rest the responsibility of saying whether these young men who are here to-night are simply to become B.Sc.'s and then to be thrown aside, or whether they are to become learned Britons to help forward the industries of our Empire; unless the polytechnics do come forward with their solution of the difficulty, then I can only tell you that some other authority will have to start other institutions.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 8.—Mr. A. B. Kempe, treasurer and vice-president, in the chair.—Sir W. de W. **Abney**: Colour-blindness and the trichromatic theory of colour-vision. Part ii.: Incomplete red or green blindness. In this paper the author continues the subject of the trichromatic theory of colour-vision and colour-blindness. In part i. he treated of complete colour-blindness, and in this paper, part ii., he treats of incomplete colour-blindness. He shows how the amount of incompleteness can be accurately determined from the luminosity curve of a colour-blind person both red and green blind. He also shows that the amount of incompleteness can be determined from observations made by the red- or green-blind at any part of the spectrum if someone with normal vision makes observations at the same place, using unchanged white light for the comparison. Incidentally, he shows that the three sensation components of the different colours of the spectrum, as determined by himself, are verified by the results, and that the trichromatic theory fully accounts for all cases of incomplete colour-blindness which he has measured.—Lord **Rayleigh**: The sensibility of the eye to variations of wave-length in the yellow region of the spectrum.—Sir D. **Bruce** and others: Trypanosome diseases of domestic animals in Uganda. IV.: *Trypanosoma uniforme*, sp. nov.—Sir D. **Bruce** and others: Trypanosome diseases of domestic animals in Uganda. V.: *Trypanosoma nanum* (Laveran).—Major Ronald **Ross** and D. **Thomson**: Some enumerative studies on malarial fever. The object of these researches was to make a minute coordinated study of cases of malarial infection occurring in the Tropical Ward of the Royal Southern Hospital at Liverpool. The first care of the authors was to elaborate a method by which the number of parasites could be correctly counted, and the one which they adopted was to make a measured quantity of blood into a dehæmoglobinised thick-film, and then to count the organisms contained in it. Almost daily estimates of the number of parasites, with frequent estimates of the leucocytes, the hæmoglobin, and the excreted urobilin, were made since the beginning of this year in twenty-four cases of *Plasmodium falciparum*, eight cases of *P. vivax*, and one case of *P. malariae* and *P. falciparum*. Correlation with minor deviations was found between the number of asexual parasites present and the degree of fever. If the asexual forms did not number more than several hundreds per cm. they were not numerous enough in these cases to produce fever. The asexual forms do not disappear between relapses, as usually thought, but tend to diminish. It is roughly estimated from these cases that quinine reduces the asexual forms by 50 to 80 per cent.—G. C. E. **Simpson**: Hæmoglobin metabolism in malarial fever. (Preliminary note.) In the pyrexia of malaria there is a marked fall in the hæmoglobin of the blood, and further investigation of this question was undertaken in the hope that it might throw light on the relationship of malaria and blackwater fever. In benign tertian malaria a slightly increased output of urinary urobilin occurs, in malignant tertian malaria a greater increase, and in the malignant form mrked urobilinuria was sometimes found.—Major Ronald **Ross** and D. **Thomson**: A case of sleeping sickness studied by precise enumerative methods; further observations. *Conclusions.*—(1) The increase of trypanosomes is due to their active multiplication, depending on the following conditions:—(*a*) the liberation of a reproductive stimulant from the dead trypanosomes of the previous fall; (*b*) the small number of leucocytes, especially mononuclears; (*c*) the habituation of the trypanosomes to their antibodies; (*d*) the absence or diminution of antibodies. (2) The decrease of trypanosomes is due to their rapid death, and to a cessation of multiplication depending on the following conditions:—(*a*) the large increase of leucocytes, especially of mononuclears; (*b*) the formation of antibodies in the serum. (3) The trypanosomes remaining between the rises are resistent forms. (4) Extracts of dead cells would appear to stimulate the corresponding live cells to multiply or divide.—Dr. H. B. **Fantham** and J. G. **Thomson**: Enumerative studies on *Trypanosoma gambiense* and *Trypanosoma rhodesiense* in rats, guinea-pigs, and rabbits; periodic variations disclosed. (1) The strains of trypanosomes used in these investigations were:—(*a*) *T. gambiense*, old laboratory strain; (*b*) *T. rhodesiense* (Stephens and Fantham), from a patient suffering from sleeping sickness in Rhodesia. (2) Rats, guinea-pigs, and rabbits were inoculated with a definite number of trypanosomes, and daily counts were made of the parasites in the peripheral blood of the animals. (3) Periodic variation was found in all these animals comparable to that discovered by R. Ross and D. Thomson in the blood of the sleeping sickness patient. (4) Rats inoculated with each strain showed either a periodic increase or a continuous rise in the numbers of parasites. (5) The average life of rats inoculated with *T. rhodesiense* was 11·3 days, with *T. gambiense* 13·8 days. (6) The average incubation period in rats in the case of *T. rhodesiense* was 2·9 days, in *T. gambiense* 4·4 days. The average weights of the animals and the average number of parasites inoculated were approximately the same in the two strains. (7) In rats infected with *T. rhodesiense* the period between the crests of the graph was 3 to 4 days, while in *T. gambiense* this period was 4 to 6 days. (8) In guinea-pigs the trypanosomiasis tended to run a chronic course, but the life of animals infected with *T. rhodesiense* was shorter. The period between the crests of the graph in both strains was longer than in rats, namely, 5 to 8 days. (9) Rabbits inoculated with *T. rhodesiense* also exhibit periodic variation. (10) The periodicity is explained by (*a*) variations in resistance on the part of the host, accompanied by (*b*) the formation of latent bodies by the trypanosomes in the internal organs of the host during fall in numbers of the parasites in the peripheral blood.—Dr. H. B. **Fantham**: The life-history of *Trypanosoma gambiense* and *Trypanosoma rhodesiense* as seen in rats and guinea-pigs. (1) The researches were undertaken to investigate the parasitological aspect of the numerical cyclical development found by R. Ross and D. Thomson in the trypanosome of a patient suffering from sleeping sickness contracted in Rhodesia. Rats and guinea-pigs inoculated with *T. rhodesiense* and with *T. gambiense* were killed at various stages of infection and their internal organs examined, controls being used. (2) The formation of a non-flagellate, latent or rounded body from a trypanosome was observed in life, much of the cytoplasm and the flagellum of the flagellate being cast off. (3) Non-flagellate bodies were seen to grow into flagellate trypanosomes when placed in fresh, warm, uninfected blood. (4) The latent or non-flagellate stages are formed at or near the time when the trypanosomes are most numerous in the peripheral blood. (5) The latent bodies are relatively numerous in the internal organs when the flagellates are few in the peripheral blood of the host. (6) The formation of latent bodies takes place especially in the lungs. The latent bodies collect in the spleen and bone-marrow, as stated by Salvin-Moore and Breinl. (7) Latent bodies from the spleen of an infected rat inoculated into another rat produced trypanosomiasis. (8) The latent bodies are the post-flagellate stages of one generation of trypanosomes and the pre-flagellate stages of the succeeding generation. (9) There is a life-cycle of *T. gambiense* and of *T. rhodesiense* in vertebrate hosts. (Compare Crithidia and Herpetomonas in invertebrates.) (10) The occurrence of latent bodies explains the recurrence of trypanosomiasis in hosts when it has apparently died out. (11) Mutual action and reaction of the host and the parasite lead to the formation of rounded bodies, which are relatively resistant. (12) Some flagellate trypanosomes do not form latent bodies, but degenerate. Some latent bodies die, and do not flagellate.—Major R. **Ross** and J. G. **Thomson**: Experiments on the treatment of animals infected with trypanosomes by means of atoxyl, vaccines, cold, X-rays, and leucocytic extract; enumerative methods employed. In all the animals used in these experiments regular daily counts were made of the parasites in the peripheral blood by means of thick-film method. (1) Small repeated doses of atoxyl prolonged the lives of rats infected with the Rhodesian strain of trypanosomes, but failed to have any trypanocidal action, as was demonstrated by the fact that the parasites increased rapidly and showed very active division. (2) We venture to suggest that small doses of atoxyl actually stimulated the trypanosomes of this strain to divide, and that the drug is also a tonic to the body cells of the host. (3) Large doses of atoxyl are trypanocidal, but the parasites form resistant bodies, and cure is only temporary. The dose required to approach as near lethal as possible, and even then a cure was not obtained in the Rhodesian strain. (4) Vaccine treatment gave indefinite results, and insufficient experiments prevent definite conclusions being formed. The life of one rat seemed to be prolonged when the vaccine was administered in doses of 10,000,000 trypanosomes, with an interval between the doses. We suggest that the time of administration, the amount given, and the interval between the doses are all of importance, and further work is being carried out. (5) Animals suffering from trypanosomiasis had the incubation period delayed and their lives prolonged in the cold. (6) X-rays had no trypanocidal action, but the life of the animal may have been prolonged. (7) Leucocytic extract gave indefinite results.—A. **Campbell** and D. W. **Dye**: Sound vibrations of very high frequency produced by electric sparks.

Geological Society, December 7.—Prof. W. W. Watts, F.R.S., president, in the chair.—Dr. A. S. **Woodward**: Recent excavations in the cavern of La Cotte, St. Brelade's Bay (Jersey), made during the present year by the Jersey Society of Antiquaries. According to the report of Mr. E. T. Nicolle and Mr. J. Sinel, shortly to be published by the Jersey Society, the cave has yielded evidence of human habitation and traces of Pleistocene Mammalia. About a hundred flint implements of the Mousterian type have been obtained, besides part of a molar of *Rhinoceros antiquitatis*, and both teeth and antlers of *Rangifer tarandus*. Human remains and teeth of Bos have also been examined and determined by Dr. C. W. Andrews and Dr. A. S. Woodward, to whom the whole of the collection of mammalian remains was referred. This being the first discovery of typical Pleistocene Mammalia in the Channel Islands, the Jersey Society hopes to proceed with the excavations as soon as possible. —Dr. A. **Strahan**: The occurrence of recent shelly Boulder-clay and other glacial phenomena in Spitsbergen.

CAMBRIDGE.

Philosophical Society, November 28. — Sir George Darwin, president, in the chair.—Prof. **Pope**: Demonstration of natural colour photography of interference figures. —Dr. **Fenton** and W. A. R. **Wilks**: (1) Colloidal form of Nastvogel's osazone; (2) a method of characterising certain ureides.—H. O. **Jones** and D. I. **James**: The racemisation of malic and tartaric acids by heat.—Miss A. **Homer**: A note on the action of aluminium chloride on benzene.—Dr. **Forsyth**: Some theorems concerning uniform functions of two complex variables, together with some simple properties of such functions.—Dr. **Young**: Note on the fundamental theorem of integration.—H. C. **Pocklington**: (1) The determination of the exponent to which a number belongs, the practical solution of certain congruences, and the law of quadratic reciprocity; (2) the divisors of certain arithmetical forms, the primes of certain forms, and the arrangement of quadratic and some other residues.—L. **Doncaster**: Note on spermatogenesis of *Abraxas grossulariata*.—F. **Horton**: The discharge of positive electricity from sodium phosphate heated in different gases. A strip of platinum foil was covered with sodium phosphate and heated in a partial vacuum by means of an electric current. The positive leak from the heated strip to two parallel platinum plates, one on either side of it, was measured, when the following gases were, in turn, contained by the apparatus:—air, oxygen, carbon monoxide, hydrogen. It was found that the positive leak in oxygen was about the same magnitude as the leak in air. In carbon monoxide gas the leak was several times greater than the leak with the strip at the same temperature in oxygen or air at the same pressure. In hydrogen the leak was irregular, being when first tested about ten times as great as in carbon monoxide, but after heating for some hours it had diminished to less than the value in carbon monoxide under the same conditions. The fact that the positive leak is increased by admitting carbon monoxide into the apparatus is in accordance with the view that the positive ions from heated solids consist of molecules of this gas.—J. A. **Crowther**: The distribution of secondary Röntgen radiation round a radiator. The distribution of the secondary rays round a radiator under the action of a beam of primary Röntgen rays has been measured both for the "scattered" and for the "homogeneous" secondary rays. The scattered radiation rises to a maximum on both sides of the radiator in the line of the incident beam, and falls to a minimum at right angles to that direction. The maximum in the forward direction of the primary beam is considerably greater than that in the reverse direction. The homogeneous secondary rays are uniformly distributed round the radiator.—J. **Satterly**: The radium content of salts of potassium. Three years ago Campbell and Wood discovered that the salts of potassium were radio-active, giving off β rays. They tested the salts for radium and found none. In the opinion of the author their test was not as accurate as the occasion demanded, and he has performed some experiments in which the presence of radium in potassium salts is decisively proved. The amount, however, is extremely small (3×10^{-14} gm. radium per gm. of potassium salt), and does not interfere with Campbell and Wood's deductions.

EDINBURGH.

Royal Society, December 5.—Dr. Burgess, vice-president, in the chair.—E. M. **Wedderburn**: Temperature observations in the Madüsee (Pomerania), with mathematical discussion of temperature oscillations. A joint expedition with Prof. Halbfass, of Jena, was made in August to the Madüsee, a lake 17 km. long and 43 metres deep. About 3000 observations were made, and a temperature oscillation (or seiche) with a period of about twenty-five hours was observed, the oscillations at the two ends of the lake being in opposite phase. In the mathematical discussion of the oscillations of the bottom water in a lake of varying depth and breadth, the assumption was made that at a certain depth there was a sudden change of temperature, and therefore of density, and that the temperature was constant throughout each of the layers separated by this surface of temperature discontinuity. The period of the temperature oscillations depends on the differential equation

$$\frac{d^2P}{dv^2}+\frac{n^2}{g(\rho-\rho')\Sigma(v)}P=0,$$

where $v=\int b(x)dx$, $b(x)$ being the breadth of the surface of temperature discontinuity at a distance x from the origin taken in that surface; P is a function of v alone; ρ' and ρ are the densities of the upper and lower layers; and

$$\Sigma v=b(x)\Big/\left\{\frac{\rho}{A(x)}+\frac{\rho'}{A'(x)}\right\},$$

where $A'(x)$ and $A(x)$ are the areas of cross-section of the upper and lower layers. The equation is of exactly the same form as that used by Chrystal in his discussion of ordinary seiches. The period of temperature oscillation in the Madüsee, calculated according to this formula, is 24·9.—E. M. **Wedderburn** and A. M. **Williams**: Experimental verification of the hydrodynamical theory of temperature seiches. To verify the theory given in the last paper, laboratory experiments were made with a small trough of rectangular cross-section and parabolic longitudinal section. Paraffin oil represented the upper layer of warm water, and water the lower layer of cold water. The observed periods of oscillation in the lower liquid agreed well with calculation from theory. In some experiments the ends of the trough were truncated just above the surface of separation. As was anticipated by theory, this caused no appreciable alteration in the period of oscillation of the lower liquid.—Dr. Sutherland **Simpson**: Observations on the body temperature of the domestic fowl during incubation. The rectal temperature of the brooding hen was compared with the corresponding temperatures of a non-brooding or control hen. The modifications which were observed to occur during the brooding until a few days after the hatching were such as might be expected to occur because of the altered habits of the hen, apart altogether from the brooding condition.

PARIS.

Academy of Sciences, December 12.—M. Émile Picard in the chair.—W. **Kilian** and M. **Gignoux**: The fluvio-glacial terraces of Bièvre and Basse-Isère. In a previous paper an account has been given of the pebble beds and terraces in the neighbourhood of La Valloire and Saint-Rambert-d'Albon. The present paper deals with the continuation of these beds towards the east, and leads to conclusions differing from the views now held as regards the relations of the external moraines with the terraces. —M. **Amann** and Cl. **Rozet**: The total eclipse of the moon of November 16, 1910, observed at Aosta, Italy. The contacts were observed under good conditions, the times of the two observers being concordant.—M. **Borrelly**: Observation of the Faye-Cerulli comet made at the Observatory of Marseilles with the comet finder. Positions of the comet and comparison stars are given for November 22, 23, and 26, and December 1 and 2. The comet appeared to be between the eleventh and twelfth magnitude.—M. **Esmiol**: Observations of the comet 1910*e* (Faye-Cerulli) made at the Observatory of Marseilles with the Eichens equatorial of 26-cm. aperture. Positions given for December 1 and 2.—Maurice **Servant**: Transformations of surfaces applicable to surfaces of the second degree.—E. **Blutel**: The application of Newton's method of approximation to the approximate resolution of equations with several unknowns.—Léon **Autonne**: Commutative groups of hypercomplex quantities.—M. **Galbrun**: The asymptotic representation of the solutions of an equation of finite differences for large values of the variable.—W. **Stekloff**: The conditions of closing of systems of orthogonal functions.—H. **Violette**, E. **Lacour**, and Ch. **Florian**: Telescopic sights for marine guns of small calibre.—Georges **Claude**: Luminescent tubes containing neon. Photometric measurements have been made with a tube containing neon, 6 metres in length and 45 mm. diameter. Traces of impurities in the neon were found to be very prejudicial, and details of the method of purification found to be necessary are given. The efficiency was found to be 0·8 watt per candle, but this efficiency can be raised by increasing the length of the tubes, and reasons are given for hoping that about 0·5 watt per candle can be ultimately obtained.—G. **Massol**: The chemical composition of the gases spontaneously given off by the thermo-mineral spring of Uriage, Isère. The gas contains 1·87 per cent. by volume of rare gases, about one half of which is helium. From an estimate of the total gas evolved from the spring, it is concluded that not less than 20 litres of helium per day could be obtained from this spring.—Léon **Guillet**: The softening of metals after wire-drawing. Specimens of nickel and steel drawn into wires have been studied from the point of view of the annealing temperature.—E. **Léger**: The action of nitric acid upon the aloins: the production of tetranitroaloemodine and trinitro-2:4:6-meta-oxybenzoic acid.—Marcel **Godchot**: Hexahydroacetophenone and hexahydrobenzoylacetone. Hexahydroacetophenone on oxidation with alkaline permanganate gives adipic acid; the preparation of the oxime of this ketone and of hexahydroacetanilide are also described.—Paul **Gaubert**: The influence of foreign substances dissolved in the mother liquor on the facies of crystals of meconic acid and on their pseudopolychroism.—Louis **Duparc** and Georges **Pamphil**: Issite, a new rock in dunite. Issites are holocrystalline amphibole rocks of variable grain. Five complete analyses are given.—J. **Couyat**: Sodium rocks of the Arabian desert.—Ch. **Mauguin**: Doubly refracting liquids of helicoidal structure.—V. **Vermorel** and E. **Dantony**: General principles which ought to be followed in establishing formulæ for insecticides. It is shown that the quantities of soap used in insecticidal preparations can be reduced from 5 per cent. to 1 in 1000 without the moistening powers of the solution being adversely affected. Methods have been worked out for the employment of sulphur in such solutions.—L. **Moreau** and E. **Vinet**: Lead arsenate in viticulture and its distribution on the fresh and dried grapes. If the treatment is applied before flowering there is no danger of contamination by arsenic; if the application is delayed until after flowering, traces of lead arsenate are present on the grape.—MM. **Griffon** and **Maublanc**: A parasitic disease of the chestnut.—A. **Brissemoret** and A. **Joanin**: Contribution to the study of the physiological action of the organic bases. The sleep which is produced in the dog by the administration of conicine is due to the hydrocarbon residue in the base. Phenomena of narcosis analogous to those produced in the rabbit by morphine can be obtained by the action of hexahydrophenanthrene.—J. Künckel **d'Herculais**: The relation between the insects (Lepidoptera) and the flowers of the Zingiberaceæ, and in particular with those of Hedychium. Their capture, its mechanism, and its consequences.—M. **Roubaud**: Details concerning the morphological phenomena of the development of trypanosomes in Glossina.—E. **Sollaud**: The affinities of the genera Urocaris and Palæmonella.—Gabriel **Bertrand**: Observations on a note relating to the action of the Bulgarian ferment on proteid materials. Criticisms of a recent note by M. Effront.—Jean **Boussac**: The phenomena of folding in the Italian maritime Alps and at Castelvecchio.

VICTORIA.

Royal Society, November 10.—Prof. E. W. Skeats in the chair.—H. R. **Hamley** and A. L. **Rossiter**: The magnetic properties of "Stalloy." As the result of a research by (*a*) direct current, (*b*) alternating currents of different frequency, the authors conclude that, previous to annealing, "Stalloy" is of very little use, but that when annealed it furnishes an almost ideal material for the construction of electric machinery.—W. **Stapley**: The morphology of the vermiform appendix. The formation of a true appendix is shown to be due, not to the presence of lymphoid tissue, but to an atrophy of a larger cæcum, the peculiar shape and position being due to the disposition of the longitudinal bands.—William **MacKenzie**: Some observations on the comparative anatomy of the fibula. The fibula is held to be undergoing recession among the higher mammals, its future complete loss being indicated by the occurrence of congenital cases of absence of fibula in man. This loss is considered to be due to the assumption of the erect position.—Hilda **Kincaid**: The biochemical significance of phosphorus. Imported grasses and cereals have a lower phosphorus content than the same species grown in Europe, but a higher phosphorus content than native Australian plants. Victorian soils are poor in phosphorus. Animal tissues, eggs, and milk in Australia have a phosphorus percentage equal to the European. The export of phosphorus in the form of animal carcases is considerable.

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