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CONTENTS.

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Fossils and Strata.[1]

FOR a little more than a hundred years, geologists, following the lead of William Smith, have utilised fossils to identify strata, to arrange them in the order of their formation, and to divide them into larger groups. At first they merely recognised certain fossils as characteristic; thus, Micraster indicated the Chalk, Paradoxides the Cambrian, Nummulites the Tertiary; even this century introduced an attempt to zone the British Carboniferous by species of unrelated brachiopod and coral genera; and the idea culminates in the lengthy list of characteristic fossils that a committee of the British Association has been trying to produce for more than thirteen years. It was high time for a president to point out to the Geological Section that this method leads to the burdening of stratigraphy with an enormous number of local subdivisions, and (she might have added) the burdening of our memories with innumerable specific names subject to perpetual change.

The remedy prescribed by Dr. Elles is twofold. First of all we are to pay more attention to the evolution of selected groups, not worrying over-much about nomenclature, but concentrating on the change of structures, and noting the horizons at which important stages of development are attained. To keep ourselves on the right lines in this study, we are to distinguish the faunas of shallow water from those of deeper water, because in the former, as so well illustrated by the work of C. G. J. Petersen and his colleagues, there is great variation from place to place in correspondence with the diverse physical and biological conditions; while in the latter, under more uniform conditions, evolution (it is assumed) progresses more regularly and continuously. These are principles that it is always well to urge on stratigraphers, but one is glad to think that they are not so foreign to palæontological literature as might be inferred by a reader of Dr. Elles' address. Let us look at them more closely.

The groups of animals suitable for the construction of an evolutionary scale are those which run with the requisite continuity through a considerable series of strata and have, at the same time, a wide distribution in space. Dr. Elles calls these "stable or successful types," and implies that they are found in the deeper waters. Put thus crudely, her thesis may appear open to some objection. By "stable" can scarcely be meant "persistent," for it is "the so-called long-ranged species" of brachiopoda that are said to appal the heart of the palæontologist; and clearly the change of form must be readily appreciable in rate and in amount. The stability needed is that not of a house

[1] "Evolutional Palæontology in Relation to the Lower Palæozoic Rocks." Presidential Address by Dr. Gertrude L. Elles to Section C (Geology) of the British Association at Liverpool, 1923.

but of a bicycle, and the epithet must therefore apply to a series of forms or a trend of evolution. "Successful," again, seems to imply no secure station, but the highway of progress as opposed to blind alleys. As for deep water, one pictures it rather as a retreat from the evolutionary stress of the more changeful littoral, and one hesitates to accept the idea of a progressive trend pursuing the even tenor of its way through the night of the abyss. A gloss is needed, and is given. The Graptolite Shales form the instance, and "the factors controlling their accumulation" are "not depth as such," but those "associated with depth, especially quietness of water and absence of coarse sediment." Now, since it is admitted that the graptolites did not live on the bottom but were probably "pseudoplanktonic," one concludes that they appear to characterise the black shales mainly because they were more readily preserved therein and were not there confounded with the shelly fragments frequent in rocks formed under other conditions. It may, in fact, be suggested that the graptolites of the Lower Palæozoic, like the ammonite shells of the Mesozoic, meet the want of the stratigrapher simply because they present rapidly evolving series, the successive forms of which were swiftly borne throughout the sea waters of the world.

Turning from the deep-water rocks to those formed in shallow waters, we find that the latter have their special advantages and disadvantages for the palæontologist and stratigrapher. Not only do the faunas change with the conditions of each locality, but even fossils of identical species may present a variety of appearances due to mode of preservation, diverse deformation of the rocks, or differences of food-supply affecting size. Here Dr. Elles emphasises the need for work in the field to illuminate that in the laboratory. But these rocks yield an advantage from their diversity and their thickness, in the clearer separation of variants in space and time: the successive steps of evolution are more spread out. In them we cannot hope so often to have long continuous series within a single group of animals; but it is often possible to study briefer successions within species-groups. Such work, Dr. Elles reminds us, has been done on Carboniferous corals by several British workers, and on the Silurian Pentamerids of Christiania by Kiaer; she proceeds to illustrate her point by original observations on the changes of the glabella lobes and the increasing fusion of tail-segments in two species-groups of Ordovician trilobites, observations which could be made only by one familiar with the occurrence of the fossils in the field.

Some day, perhaps, the authorities of national museums in Great Britain will realise, as already is understood in America, that those who are to study and catalogue the specimens in the cabinets must be sent to collect and observe them in the cliffs and quarries. If stratigraphy depends on palæontology, palæontology no less depends on stratigraphy. It is the merit of this address that it presents the carefully considered views of one who has earned high distinction in both branches of the science. F. A. BATHER.

Early Astronomy in Oxford.

Early Science in Oxford. By R. T. Gunther. Vol. 2: Astronomy. Pp. xv+408+66 plates. (Oxford: Printed for the Subscribers, 1923.) n.p.

SOME six or seven years ago Mr. Gunther began to examine the old instruments of various kinds, most of which had until then been utterly neglected or forgotten, preserved in the Colleges and Museums at Oxford. The present volume is the outcome of his studies of the astronomical instruments, not only of those found in Oxford, but also of the magnificent collection of portable instruments, chiefly astrolabes and sun-dials, formed by Mr. Lewis Evans during the past thirty years. This collection is at present exhibited in the portrait gallery of the Bodleian Library, and has been offered as a free gift to the University, on the sole condition that it shall be properly housed and exhibited. Owing to the rarity of examples of the work of many of the makers, it is a collection which it would be difficult or impossible to bring together again. It is very much to be hoped that the gift may be accepted, and that it may form the nucleus of a museum illustrating the progress of science since the Middle Ages.

While studying these and other instruments Mr. Gunther has made good use of many of the medieval manuscripts in the Bodleian bearing on the subject, giving in an appendix lengthy extracts from some of them in the original Latin, and in the text full references to all he has seen, quoting the Library numbers, so that any one wishing to look them up himself can do so without a tiresome search. The book is most beautifully and most profusely illustrated by plates and figures in the text, which make it a positive pleasure to turn over the pages, while they contribute very much to make the descriptions of the instruments intelligible.

The author begins by giving a rapid summary of what has been preserved at Oxford in the way of old instruments. No instrument associated with the name of Roger Bacon or of his time has survived, and even the building on the Folly Bridge supposed to have been his observatory was pulled down long ago. The Oxford collections begin with astrolabes (Fig. 1) dating from the middle of the fourteenth century and associated with a number of men who studied astronomy and

were nearly all connected with Merton College. Next, there is in the library of Christ Church a collection of "orreries" and similar articles of English manufacture, mostly dating from the end of the seventeenth century. While all these instruments were only intended for instruction or for obtaining approximate places of the

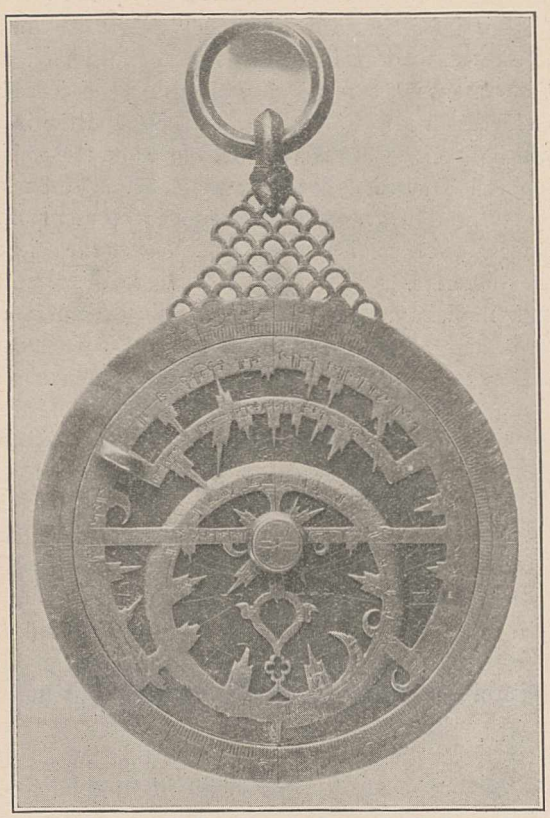

FIG. 1.—Persian Astrolabe (A.D. 984). Reduced from "Early Science in Oxford."

planets or determining the time, there are in the Radcliffe Observatory all the fine instruments with which it was equipped at the time it was founded (in 1771), whereby Oxford at last got the means of advancing astronomy through observations. After this preliminary notice, a short account is next given of the principal astronomical instruments of antiquity and the Middle Ages. Speaking of the triquetrum of Ptolemy, Mr. Gunther says that with this instrument "Copernicus made those measurements with which he overthrew the Ptolemaic system." In reality Copernicus took very few observations, and if he had taken ten times as many with his poor instrument (on which the division lines were marked with ink) it would have made no difference. His system was produced by a careful study of Ptolemy's book and not of the heavens, and by changing the origin of co-ordinates from the earth to the sun, while keeping as closely as possible to Ptolemy's methods.

At Oxford the study of astronomy was much cultivated in the fourteenth century, especially at Merton College, by John Maudith, Richard Wallingford, Simon Bredon, William Reede, Walter Bryte, and others. Wallingford designed an instrument of a novel and peculiar form, the Rectangulus, which is explained in three Oxford manuscripts but has never been described in print before. Probably it never became known outside Oxford. Mr. Gunther reproduces the detailed description and illustration (Fig. 2) from a Corpus Christi MS. The principal idea is to substitute measures of chords for measures of arcs in observing altitude and azimuth of a star. The instrument consisted of four brass rules hinged to one another and mounted by a swivel joint on the top of a pillar. The lowest rule (I.) had a scale engraved on it. It was kept in the meridian, while the uppermost one was pointed to the star by means of two sights. The plumb-lines attached to the rules III. and IV. must have been long enough to reach the lowest one, which alone was graduated.

Whether this instrument was ever used is not

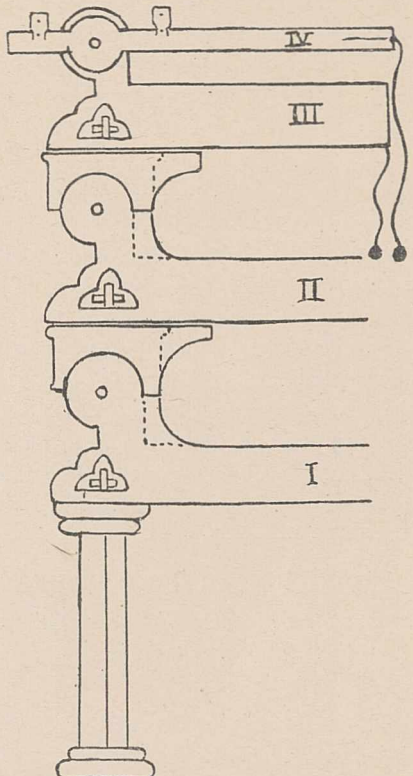

FIG. 2.—Wallingford's Rectangulus. From "Early Science in Oxford."

known; it is certain, however, that those students of astronomy at Merton left astronomical science exactly as they found it. But they did good work all the same by teaching, by reducing the Alfonsine tables of the planets to the meridian of Oxford and explaining the use of them, and by the construction of various auxiliary

tables. In this way they helped (as Jean de Lignières did in Paris) to spread knowledge of the astronomy of the Alexandrian school, thereby paving the way for the revival of astronomy in the second half of the fifteenth century. Their activity is very fully described and illustrated by Mr. Gunther, and his detailed account of the "Merton School" will be of permanent value and is one of the most interesting parts of his book. Curiously enough he has very little to say about Walter Bryte, and yet the "Theorica planetarum" of Bryte was the only product of the Merton school which reached the Continent. It exists in two redactions, a shorter one, often printed but falsely ascribed to Gherardo of Cremona, and a longer one, never printed but existing at Oxford in at least four MSS. But there is nothing original in either text.

That the belief in astrology did a good deal to encourage the study of astronomy is an undoubted fact, but whether the decline of that belief had anything to do with the disappearance of astronomy from Oxford after the year 1400 it is hard to say. But no prominent name appeared for two hundred and fifty years, after which a new period was ushered in by Seth Ward and Wren, immediately followed by Halley and Bradley, both stars of the first magnitude.

It is quite impossible to give a fair idea of the wealth of information contained in Mr. Gunther's book about sun-dials, astrolabes (oriental and European), volvelles, or æquatoria (systems of graduated discs used for finding roughly the places of sun, moon, or planets), models, globes, and old telescopes, ending with descriptions of the old instruments at the Radcliffe Observatory. Though the scientific value of astrolabes and similar contrivances must not be exaggerated, they played an important part in the Middle Ages and much later, and this detailed account of so many of them is therefore a very valuable contribution to the history of science. J. L. E. DREYER.

The History of Technology.

Transactions of the Newcomen Society. Vol. 2. Published for the Society. (Leamington Spa: The *Courier* Press, 1923.) 20*s*.

ONE of the most striking features of the age on its intellectual side is the invasion of the historical spirit into all departments of thought. It is a new thing—new, that is, since the early part of the last century. Coincidently with the French Revolution, which was to give us a new world, came the growing inclination to see in all new things only a reforming of the old, a growth from the past. This becomes the leading line of approach to all studies in the nineteenth century: it dominates all lines of thought and fills our encyclopædias. History, which was until that time mainly the record of states and of the lives of the men who have made or marred them, became by this process of thought the account of how all things that we see, and especially all things that man has made, have come to be what they are.

On no other aspect of man's achievement has the historical spirit thrown more light than on the growth of science, for in this the steps are unmistakable and the progress is secure. Hence the history of science has attracted an increasing host of workers, and the books which describe it, from Whewell's first and most philosophical exposition down to the labours of Sarton, Sudhof, and Singer (to take three typical contemporary names), are becoming as multitudinous as the sciences they describe. It is no doubt owing to this vastness and complexity that no one society or institute has been formed for the history of science, although in the 'forties, under the stimulus of Augustus de Morgan, an association did for a time exist. This gap makes the existence of the "Newcomen Society for the study of the History of Engineering and Technology" all the more welcome. We have before us the second volume of its Transactions, together with the presidential address of Mr. Loughnan Pendred on "The Value of Technological History."

To those who recognise the real nature and the necessity of history for all valid life and thought, the work of the Society needs no justification. But its members have succeeded in devising a very telling emblem for their title-page. They thought at first of a picture of Newcomen's engine itself, but rejected this as seeming to restrict their studies to one aspect of its activities. They have therefore devised an heraldic dragon, which, while prancing vigorously to the front, keeps its head steadily turned to the rear. A dangerous attitude in real life, yet fitly explained by the motto beneath: "Actorum memores simul affectamus agenda," or, in the words of the Danish philosopher Kierkegaard, "Let us think backward and live forward."

The contents of this second volume deal mainly with engineering, and largely with the history of the locomotive and the railway. This is a just proportion, as transport by sea and land, due to the use of steam, was as clearly the second most vital stage in the industrial revolution as the factory system due to Watt's engine was the first. But there are other articles which keep to the front the more general aspect of the Society's work. There is a very instructive account of Greek and Roman engineering instruments by Mr. Skyring Walters, with illustrations representing many reconstructed instruments, especially of Hero and Vitruvius. A more generalising article by Mr. T. East Lones, on

mechanics and engineering from the time of Aristotle to that of Archimedes, suggests that an outburst of practical skill naturally accompanies, or soon follows, a period of intense scientific activity. The whole volume is interesting and well done, and should attract fresh members to the Society.

Mr. Pendred's presidential address to the second annual conference of the Society rises to the full height of his subject, and deserves careful study by the students of any branch of history. He begins by examining various definitions of history and the reasons that have been advanced for its study. He rejects, with well-merited contempt, the idea that it should be studied by technologists—or any one else—for any utilitarian object narrowly conceived. Even Frederic Harrison's contention that the past of civilisation is the most important subject, because it dominates the present, scarcely satisfies him. He would have history studied because it admits the student to the fullness of life: only thus can he live with a full understanding of life. "The real importance of history resides in its evolutionary characteristics." Just as in the hands of Darwin natural history was raised to a higher plane because a general purpose and consistent movement was revealed in it, so, by the study of man's inventions, we become conscious of his continued rise in the scale of existence beyond the biological stage. His tools, from the most primitive to the most highly perfected machines, are an extension of his mental powers, by contact with, and for the conquest of, the external world. There is a close analogy, as Mason has pointed out in his "History of Invention," between the natural history of the kingdom of Nature and the unfolding of the arts of life, and the latter study is at least as worthy of honour and pursuit as the former. Within the realm of history, as usually conceived, it could be easily shown—so Mr. Pendred holds—that "technological progress has made far more difference to the world than philosophies have made."

Mr. Pendred wisely does not attempt to justify this claim, which would depend for its truth upon the meaning we attached in the first place to the word "philosophies" and in the second to making "difference to the world." But he concludes with excellent practical reasons for the increased study of technology. It teaches us that everything in the history of man proceeds *per gradum* and not *per saltum*, and that germs of all our most elaborate modern inventions may be found in the earlier and simpler efforts of our forefathers. Above all, perhaps, should be placed the intellectual stimulus in education derived from following the footsteps of some great inventor in the past. What man has done, man can do. The lesson derived from the work of Smeaton or of Watt is equally applicable to other lines of human endeavour, and we are grateful to Mr. Pendred and the Newcomen Society for directing our attention so forcibly to it.

It is to be hoped that this presidential address may be published in full, and, if possible, enlarged by some of the examples which Mr. Pendred had in mind, but was prevented by pressure of time from giving to his audience.

F. S. MARVIN

Belgian Biology.

Recueil d'œuvres de Léo Errera. Pédagogie: Biographies. Pp. iii+336. (Bruxelles: M. Lamertin; London: Williams and Norgate; Milan: U. Hoepli; Paris: J. Hermann, 1922.) n.p.

WITH the publication of this volume is completed the task of publishing in collected form the less technical papers of the Belgian biologist and plant physiologist, Léo Errera. Four earlier volumes were published during 1906–10, while other scientific papers have been collected in the volumes issued from the Botanical Institute that now bears his name. Errera has made a lasting impression, not only upon Belgian scientific development, but also upon the progress of biology; his share in establishing the laws of development in plant and animal upon a framework of physics and chemistry may not always be in the minds of later workers, but a reference to his papers will show that his work is enduringly embodied in the groundwork of a still young science. A perusal of his more general writings is still a very congenial task; his style is clear and animated, instinct with humour and inspired with passionate devotion to science, and in these pages will be found both good stories and wise counsel.

The first address of Errera in this volume, given to his students for the doctorate in 1884, is an interesting reminder of the comparatively short history of the teaching laboratory, then being introduced on a modest scale into the biological courses at Brussels. It is, however, somewhat disconcerting to realise, as a description follows of the provision made at that date for experimental work in the Plant Physiological Institute at Göttingen, that such facilities are available at few, if any, botanical laboratories in Great Britain nearly forty years later! It is little consolation to think that we are at least safely past the days, amusingly delineated by Errera, when, upon the complaint from his auditors that they might just as well send their servants to take notes from his dictation, the professor finds the suggestion a good one, and on his part proposes to send his servant to dictate the necessary passages from his manuscript! And are we yet safely past that era? The address upon the necessity for the pursuit of the "études superflues" is a forceful example of the

presentation of a case that every biologist seems to have to argue, or to have argued, on his behalf.

The biographies fall into two categories. Some are appreciations, sympathetic and yet critical, of botanists of international repute, such as Schleiden and Nägeli; others are intimately told stories of Errera's colleagues in the scientific world of Belgium. These form at one and the same time valuable contributions to the history of science and human portraits, the sincerity and inward vision of which give them a quality of universal appeal, whether their subjects be little-known Belgian botanists or chemists of international repute such as Stas, who was sufficiently a prophet in his own country to be entertained by the Bishop of Namur, though he insisted upon bringing a Jesuit father with him and in eating "bifsteak" upon a Friday.

Medical History of the War.

History of the Great War: Based on Official Documents. Medical Services: Pathology. Edited by Major-General Sir W. G. Macpherson, Major-General Sir W. B. Leishman, and Colonel S. L. Cummins. Pp. vi+600. (London: H.M. Stationery Office, 1923.) 21*s*. net.

THIS volume is the final one of the purely medical series dealing with the diseases and hygiene of the great War. It may appear to be a matter of doubt whether it was desirable to separate in different volumes the symptoms and treatment of individual diseases from their pathology, but that is the course which the editors have pursued. The result is that every subject is disjointed, and it will not always be a simple task for those who consult these volumes in future to fit the pieces into their proper places.

The present volume deals with the pathological side of many conditions, such as wounds, tetanus, enteric fevers, dysentery, cerebro-spinal fever, influenza, tuberculosis, trench fever, spirochætal jaundice, polyneuritis, nephritis, gingivitis, and encephalitis lethargica. As in works with many contributors, there is a lack of unity which the editors have not succeeded in dispelling. After the prolonged period which has elapsed since the termination of the War, and as the work is stated to be "based on official documents," one would have expected greater harmony and detail, which would have gone to make this a standard work. Instead, it is really a collection of individual essays by twenty-three contributors, mostly civilian, who had been called together to complete the work.

In a heterogeneous collection of papers such as this is, it is perhaps invidious to single out individual contributors, but after a careful study the reviewer considers that the essay on the physiology of wounds by Sir Almroth Wright and that on amœbic dysentery by Mr. Clifford Dobell are of outstanding merit. In that of Wright we have one of the great researches of the War, full of ingenuity and rich in idea, which characterises all his work; whereas Mr. Dobell's essay is a model for other workers by a master of his subject.

One of the editors, Sir W. B. Leishman, contributes an introductory chapter on the organisation of the pathological service. He also writes a general paper on the enteric fevers, which suffers from having lost its bibliography during the composition of the book. This hiatus is, however, supplied in a special leaflet, but with a separate pagination. The other bibliographies are short but accurate, and in some cases the authors have dispensed with the trouble of compilation and have adopted the easier method of referring to the work of some one else in a foreign language. W. B.

Anthropology and Colonial Administration.

The Lango: a Nilotic Tribe of Uganda. By J. H. Driberg. Pp. 468+12 plates. (London: T. Fisher Unwin, Ltd., 1923.) 63*s*. net.

THE work before us is an excellent example of a happily increasing class of literature which bears great tribute to the value of anthropological studies in colonial administration. In the old days, young men went out to administer primitive peoples with no more experience than that afforded by the public school. Fortunately for England, the mode of thought, ideas of justice, and general social propriety current in the public school are so near to that of primitive man that the new administrator made far fewer mistakes than might have been expected. But there is no denying that the advance of anthropological science has assisted the colonial administrator, and this fact has been recognised by the British Colonial Office in its inclusion, in the Tropical African Services course, of a series of lectures on social anthropology.

Mr. Driberg's book is just that response to an elementary anthropological training which justifies anthropology. Indeed, it goes further than that, for Mr. Driberg *is* an anthropologist, and is gifted with two rare qualities: the sympathetic understanding, and the faculty of clear expression.

The Lango are an important tribe of Nilotic negroes inhabiting the Nile province of Uganda. Mr. Driberg deals with them faithfully: their history, environment, physical characters, occupations and daily life, social organisation, religion and magic, and language. The linguistic section consists of a grammar, Lango-English and English-Lango vocabularies, and a very interesting series of fables, reproduced in double columns in both languages. Of the form of the book, and the method of

presentment of the material, there can be no criticism; but the home anthropologist is always insatiable and wants to know more. The social side of Lango life is treated at great length and very adequately; and it is clear that the author's interests were concentrated on this aspect. From the technological point of view many questions remain unanswered. For example, the author gives an account of the various kinds of flute used by the Lango, their uses and names, but gives no description, so that the technologist is left wondering whether they are side- or end-blown; while the types of drum in use can only be gathered from a photograph.

From the social side, Mr. Driberg's detailed account makes it plain that the relationship system of the Lango is based on the classificatory, and that, though father-right prevails, there are traces of an earlier maternal system, and also evidences of a broken-down totemism.

The section on religion is good, and shows much careful research and thought, but the account of the native belief in the nature of a man's "soul" (or "souls") seems to require a little further consideration. Inquiries on such a subject invariably produce results which do not tally. Mr. Driberg's account is a little confused, and it seems possible to the reviewer that further research might show that the Lango hold the belief, so common among African tribes, that man has two souls, one of which is the life (usually identified with the heart or liver), the other being the "dream-soul" or "double," which leaves the body during sleep without material hurt, and at death is "explained away" variously, according to tribal tradition.

In one respect Mr. Driberg's book may meet with criticism, and he almost disarms this by admitting the fact. For the tribes Masai, Nandi, Turkana, etc., to which he applies the term "Hamitic," Prof. Seligman's description "Half-Hamites" is far preferable. Mr. Driberg has a perfect right to use any term as he likes provided he defines it, and this he has done; but if he wishes to class the Masai as "Hamitic," what word is left for the Beja, Galla, Somali, and Dankali?

Yet these criticisms relate only to matters of detail. Mr. Driberg has produced a book which is admirable in both form and matter, invaluable to both the scientific anthropologist and the administrator. It is regrettable, from the point of view of both, neither of them being moneyed men, that the publishers did not find it possible to produce it at a lower price. Books of such paramount importance, not only to science, but also to Colonial administration, should be nearer the reach of the average individual; and if this, as a commercial proposition, is impossible, the Government, local or Imperial, might consider whether it could not provide assistance.

Our Bookshelf.

Études élémentaires de météorologie pratique. Par Albert Baldit. Deuxième édition. Pp. xiii+428. (Paris: Gauthier-Villars et Cie., 1923.) 24 francs.

M. BALDIT'S work is divided into three parts: the first dealing with the organisation of a meteorological service; the second giving a brief outline of meteorological theory; and the third dealing with methods of weather forecasting.

In the first part the author discusses the question of organisation and equipment from a wide viewpoint, going into some detail as to the choice of location of stations, their equipment and their maintenance in good running order. A welcome novelty in a meteorological text-book is the advocacy of the wider use of the kite balloon and aeroplane for meteorological purposes. The equipment of stations for kite balloon and aeroplane is discussed in detail. In the discussion of observations of the upper winds we note that no reference is made to the use of a tail on the pilot balloon, a method which has been found to provide a very useful check on the assumed rate of ascent.

The second part of the book discusses such questions as reduction to mean sea-level, calculation of the density of air allowing for the observed relative humidity, the derivation of the general equations of motion and their simplification for horizontal motion over the surface of the earth. The author's advocacy of the use of the gradient wind estimated from the isobars is a new departure among French writers, though the method has long been in use in the British Meteorological Service. There follows a very brief discussion of turbulence.

The third part of the book is interesting and useful. It gives a large number of rules for forecasting, prefixed by a description of the phenomena. To most readers this part will be more useful for its description of the observed phenomena than for the rules given. A clear and concise description of what is now called the "polar front" theory of cyclones is given.

The book can be recommended to English readers. Apart from the absence of an index, which should be remedied in future editions, the book is well arranged, clearly written, and gives a fair number of references to original sources. D. B.

Penrose's Annual: the Process Year-book and Review of the Graphic Arts. Edited by Wm. Gamble. Vol. 26, 1924. Pp. xvi+136+64+74 plates. (London: Percy Lund, Humphries and Co., Ltd., 1923.) 8*s.* net.

MR. GAMBLE always succeeds in making an interesting volume, even when there is very little progress to record. He tells us that half-tone blocks give results that can scarcely be improved, that there is no new achievement in colour-block making—the same plates, colour-filters, and inks still hold the field, though the shortcomings of this process are well known. In rotary photogravure, the use of thin sheets of copper with which the cylinders are faced, instead of working upon the solid cylinders, has been a commercial process for some months, and is regularly yielding excellent results.

Mr. Price's method of dry lithography is now in daily use, and considerable quantities of work have been printed in black and in colours by this process. It is not merely that the trouble of damping the stone or zinc plate is saved, but the printing surface lasts longer, less ink is required, the paper is less liable to stretch in register work, and there are other advantages. The contributed articles are of much interest. We may mention specially that by Prof. Namias on colour-sensitising gelatino-bromide paper; one on metallic inks to supersede the use of dry dusting powders, by Mr. E. S. Hanes; Mr. G. C. Laws' article on an enamel for zinc half-tone blocks that needs no heating, and thus obviates the many troubles that the use of fish-glue gives rise to; and Mr. Bawtree's description of his photographic type-composing machine. Increasing attention is paid to typography, which has many illustrations. The text of the book is composed in a new monotype face which is a faithful reproduction of the historic type designed by John Baskerville (born 1706); and the article on the work of the private presses, a feature of recent annuals, is on the Ashendene Press. All kinds of modern methods of reproduction are well illustrated by the numerous plates.

The British Journal Photographic Almanac and Photographer's Daily Companion: with which is incorporated "The Year-Book of Photography and Amateur's Guide" and "The Photographic Annual," 1924. Edited by George E. Brown. Pp. 812. (London: H. Greenwood and Co., Ltd., 1923.) Paper, 2*s*. net; cloth, 3*s*. net.

THIS well-known publication preserves its characteristic features. The list of photographic societies, camera clubs, and the like, gives the names and addresses of the acting officers of well over 500 of such bodies, all except 50 or so belonging to Great Britain. There are also a few professional societies in a separate list. The article by the editor, which takes the place of the multitude of contributions from a great many workers that characterised the Almanac years ago, is "On Using a Hand-Camera." He exposes the fallacy that a focal plane-shutter is of necessity very efficient, and gives the practical efficiency as varying between 50 and 99 per cent., according to circumstances. He says that the picture given by a finder that consists of a small lens and a ground-glass screen is dim, but he does not add that this practical difficulty may be quite overcome by putting the 45° mirror outside instead of inside the finder. The tables and formulæ are probably the most used part of the book, and some of them have been revised and improved. May we point out (p. 451) that "a 2*d*. tin of Globe polish" has not been obtainable for some years, and that the contents of the present small tins are not what they were? We are glad to see such firms as Zeiss, Goerz, and Hauff represented again among the advertisements.

The Medical Year Book, 1924. Edited by Charles R. Hewitt. Pp. 592+vi. (London: William Heinemann (Medical Books), Ltd., n.d.) 12*s*. 6*d*. net.

THIS new annual is described by its editor as an unofficial guide to the current activities of the medical profession in the United Kingdom. More than half of the book is devoted to the medical schools, opportunities for clinical work, and (134 pages) lists of consultants and specialists. These lists are conveniently arranged geographically and by subjects, and constitute, perhaps, the chief justification for the appearance of a new year-book. The criterion adopted for admission to them—"present or past official connexion with a hospital or similar institution"—is perhaps no more objectionable than any other that could have been used. Among other items are a diary of forthcoming meetings, original articles on insulin, cancer, and chemotherapy, particulars of the Metropolitan Asylums Board, etc., notices and regulations of the G.M.C., the Examining Board in England, etc., medical members of Parliament, nursing homes, obituary list, wills of medical men, charitable bequests, medical periodicals, and books and pamphlets of 1922–23. We miss the D.L.O. in the list of diplomas of the Royal Colleges, and we notice what seems a misleading description of the Royal Institute of Public Health as "a public educational institution of the University of London."

Equatoria: The Lado Enclave. By Major C. H. Stigand. Pp. lv+253. (London, Bombay and Sydney: Constable and Co., Ltd., 1923.) 21*s*. net.

ON December 8, 1919, the author of this book, then Governor of the Mongalla Province of the Sudan, was killed while operating against rebel Dinkas. Well known as an authority on the geography and history of parts of Central and East Africa, in this book, which was unfinished at the time of his death, he had put together the results of his personal observation and study of the Lado Enclave, which he was chosen by Sir Reginald Wingate to take over when it reverted to the Sudan in 1910 after the death of the King of the Belgians. Although the Enclave is about the size of England, it includes nine main tribes with one composite tribe, the Alurr, and a number of sub-tribes, which Major Stigand considered also to be of mixed origin. Their languages include at least five groups. The bulk of the tribes are Nilotic, though some show Negro or Bantu affinities. Had the author lived to complete his work, some sections might possibly have been expanded; but as it stands, it shows a detailed knowledge of the geography of the country and of the customs of the people, which goes far to explain his success as an administrator.

The Psychology of Reasoning. By Prof. Eugenio Rignano. Authorised translation by Winifred A. Holl. (International Library of Psychology, Philosophy, and Scientific Method.) Pp. viii+395. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1923.) 14*s*. net.

PROF. RIGNANO'S "Psychologie du Raisonnement" was reviewed in NATURE, July 14, 1921, p. 612. Our review closed with the expression of a hope that the book would soon appear in an English translation in order that it might be available for students of logic. This hope has been fulfilled. The author knows our language, and appears to have taken special pains to assure himself that the translation is accurate and adequate.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Eyes of Spiders.

AT various times, as occasion offered, I have examined the optical construction of the eyes of most of the orders of animals, and in the present note some recent observations on the eyes of spiders are recorded, giving details which may not perhaps be generally known.

Most spiders have eight eyes placed symmetrically

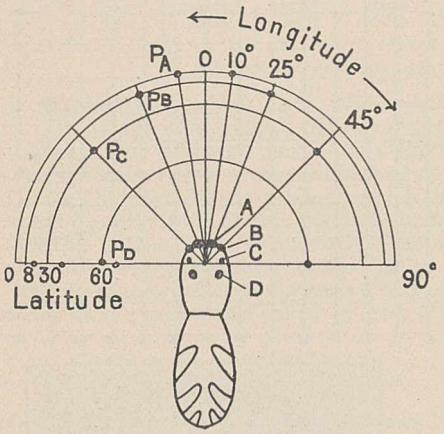

FIG. 1.—Upper surface of body and head of *Salticus scenicus*, showing the position of the eyes.

on the head, and the disposition of these four pairs has been largely used as a means of generic classification. In some genera the eight eyes are reduced to six either by the coalescence of the contiguous elements of two, or the non-development of one pair.

FIG. 2.—*Salticus scenicus*. Full face. ×27.

In books on spiders the pairs are termed anterior, median, etc., but for my own convenience I denote them as A, B, C, and D, the A pair being those in front and nearest to the vertical plane bisecting the length of the head, and I define their position by the latitude and longitude of the points in which the optic axes of the eyes meet a large sphere described about the head, taking the vertical through the head as the polar axis, and the plane through this bisecting the length of the head as the zero meridian. For example, an eye looking directly ahead would be in latitude 0° and longitude 0°.

In the greater number of genera the size of the eight eyes in any individual, though not identical, is not greatly different, but in the group known as hunting spiders (genus Salticus) the A pair is enormously developed. *Salticus scenicus*, to which

FIG. 3.—Horizontal section through the A and B eyes. ×60.

the present notes refer, is a black-and-white spider, often found on old walls and dry stumps of wood. Hunting spiders spin no regular web, but catch small flies, etc., by leaping on them from a distance. They are, however, provided with spinarets, and wherever they go they pay out, leave behind, a single thread, by which they can recover their position after a leap.

Fig. 1 gives a general view of the body and head, showing the position of the eyes and the latitude and longitude of their optic axes. Fig. 2 is a full-

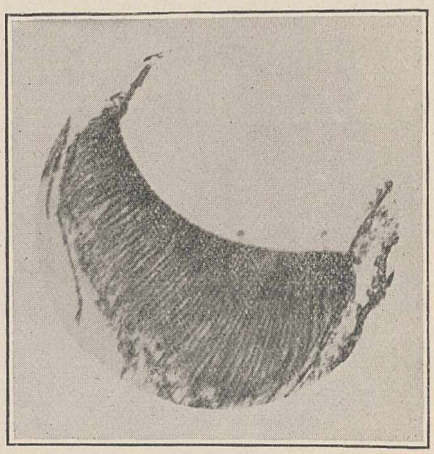

FIG. 4.—Normal section through the retina of the B eye. ×134.

face picture showing the A and B eyes. The pose is a natural one, and it is interesting to observe how the A eyes just clear the palpi which in this position hide the jaws. Fig. 3 is a nearly horizontal section through the A and B eyes. This section passes underneath C and D. Figs. 4 and 5 are more highly enlarged sections of the retinal parts of A and B.

Fig. 6 is a similarly enlarged section of D. The C eye is very small (see Table) and no section suitable for reproduction was obtained, but its retina was of the same type as that of D.

It may fairly be assumed that the effective parts of the retina are those which are in the focus of their lenses, but to determine the focal length of the combination would require a knowledge of the refractive indices of all the parts and the radii of curvature of the lens surfaces.

The curvature of the external surface of the cornea can be found with considerable accuracy by measuring the size of the reflected virtual image of an object of known size and at a known distance, but the refractive index of such small parts as the internal lenses and the vitreous humour present a much

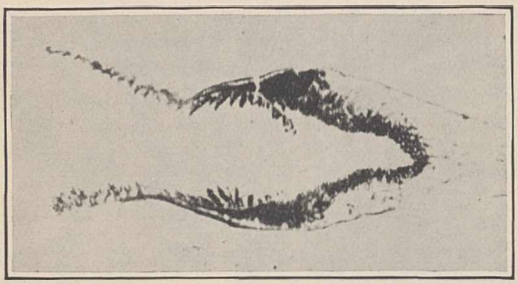

FIG. 5.—Normal section through the retina of the A eye. ×134.

more difficult problem. It is improbable, however, that the refractive index in any part can exceed 1·6, and from the appearance of the parts when immersed in such fluids as xylol, etc., it may be guessed to average 1·5 or rather less. The combination may be considered as a biconvex lens the back surface of which is in contact with a medium of slightly less refractive power.

If s_1 and s_2 are the radii of the front and back surfaces of a lens, and μ_1 and μ_2 the refractive indices of the lens and the medium behind it, it can

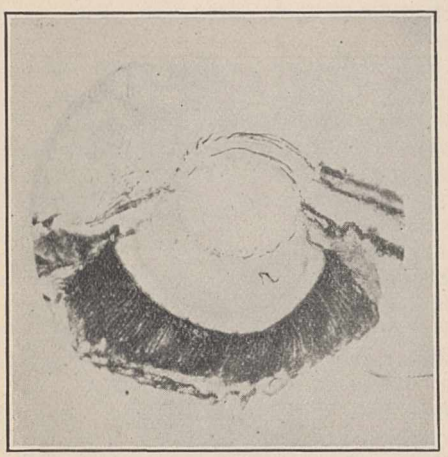

FIG. 6.—Normal section through the retina of the D eye. ×134.

be shown that (putting $\mu_2 = \kappa\mu_1$, $s_2 = ps_1$, and qs_1 for the thickness of the lens) for axial pencils the distance of the principal focus from the front surface is

$$s_1\left[\frac{\kappa p\{\mu_1 - q(\mu_1 - 1)\}}{p(\mu_1 - 1) + (1 - \kappa)\{\mu_1 - q(\mu_1 - 1)\}} + q\right].$$

Assuming, for trial, that the combination can be represented by a sphere of refractive index 1·5, partly immersed in a fluid for which $\mu = 1{\cdot}35$ (*i.e.* $\kappa = 0{\cdot}9$, $p = 1$, $q = 2$), the focal distance from the front surface is 2·8 times the radius of the sphere, and these are the distances given in Col. V. of the Table.

These computed[1] distances agree fairly with the actual distances of the retinal surface from the front of the cornea, and are of interest chiefly in connexion with the A eyes, indicating, as they do, that only the extreme end of the curiously formed chamber which contains the vitreous humour (see Fig. 5) can be in focus.

The angle of view embraced by each eye is determined by the (width of the retina)/(focal length of its lens) and measurements show that, approximately,

for A the field covers 2·5°
,, B ,, ,, 20°
,, C rather more than 60°
,, D about 120°.

With regard to resolving power it may be re-

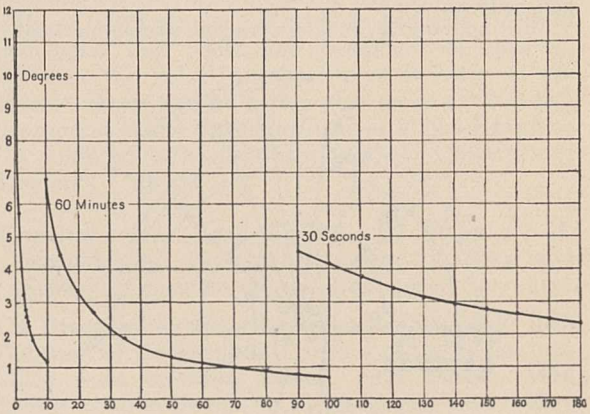

FIG. 7.—Relation between lens diameter and angle of distinct vision.

marked that all eyes, whether simple or compound, exhibit certain similarities of structure.

In all cases the pictures which the eyes transmit to the consciousness are not continuous but made up of a finite number of parts, like the patterns in a tessellated pavement. Every eye also consists of a lens, or lenses, of some sort the foci of which are at the retinal surface. The retinal surfaces themselves expose to the action of the light a finite number of sensitive nerve-ends, each of which, it may be presumed, contributes a single impression to the number out of which the picture is formed.

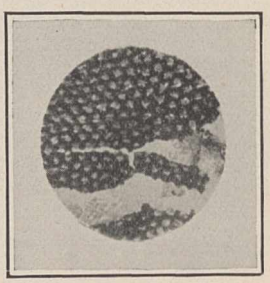

FIG. 8.—Tangential section of part of the retina of the B eye. ×270.

In every eye also the nerve-ends are set in intensely opaque tubes or cells which are open in the direction from which the light reaches them. If it is really the case that each such cell supplies only one element of the mosaic picture, then two points could not appear separate if they were not far enough apart for their images to stimulate at least two adjacent cells, or in other words the resolving power is limited to angles

[1] They indicate that the mean refractive index is less than 1·5.

not less than the (distance between adjacent nerve-ends)/(focal length of the lens). There is, however, another limit to resolving power depending on the diameter of the lens. The resolving power of a lens of diameter D is of the order λ/D, λ being the wave-length of light, and the diagram in Fig. 7 gives the least angular distances which can be distinguished by

TABLE OF MEASUREMENTS RELATING TO THE EYES OF *SALTICUS SCENICUS*.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
	Direction of Axes.		Cornea.		Distance from Cornea to Retina.		Separation of Elements of Retina.	Resolving Power.	Field of View.
Eyes.	Latitude.	Longitude.	Diameter.	Radius of Curvature.					
A	0°	±10°	·0126	·0088	·0245	·0270	·00030	1°·08	>2° <3°
B	8°	±25°	·0063	·0044	·0123	·0148	·00035	2°·5	20°
C	30° ?	±45° ?	·0024 ?	·0015 ?	·0040 ?	·0050 ?	·0003 ?	4°·2 ?	>60°
D	60°	±50°	·0063	·0032	·0070	·0077	·0003	2°·1	120°

The linear dimensions are given in inches.

lenses the diameters of which vary from 0·0001 to 0·018 inch. In all the eyes which I have examined the distance between the adjacent nerve ends has never been much less than about one three-thousandth of an inch, and it may be that the materials of which the eye is constructed do not admit of this distance being decreased. If this is true, no eye can distinguish angles less than about one three-thousandth of its focal length. The distances between the nerve ends in the retinæ of *Salticus scenicus* are given in Col. VII. of

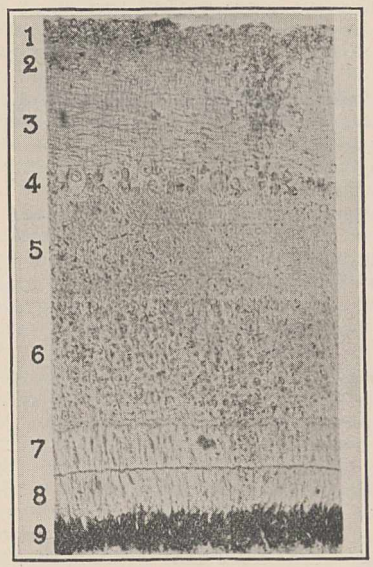

FIG. 9.—Normal section of retina of robin. × 270.

the Table, and are not very different for any of the four pairs of eyes. Hence the resolving power must be nearly proportional to the focal length of each. It is sometimes difficult to measure the separation of the nerve-ends in sections cut normal to the retinal surface, and the figures given in the Table are taken from tangential sections such as are shown in Fig. 8.

It will be seen that the diameter of the lenses indicates a resolving power much in excess of that found from the "grain" of the retina, so that it would appear illumination rather than sharp definition is the most important object.

The enormous lenses of the A pair of eyes and the very small area of the retina which can be in focus (an area which only contains twenty or thirty nerve-ends) is a most curious development. It may be that these eyes are used by the spiders as "sights" in adjusting their position for a leap.

Figs. 3-6 and 8-12 are intended to illustrate some of the similarities of eyes in general. Fig. 9 is a normal section through the eye of a bird (robin). Nine distinct layers are visible, of which all except the ninth in the natural state appear perfectly transparent. Fig. 10 is a tangential section of the ninth layer, which consists of closely packed and extremely opaque hexagonal cells. (This may be compared with Fig. 8.) The distance separating the cells is about 0·0004 inch, and, since the focal length of the lens is 0·25 inch, the resolving power should be $5\frac{1}{2}$ minutes of arc.

Fig. 11 shows a section of a Molluscan eye (*Helix aspersa*), and Fig. 12 of one of the three simple eyes

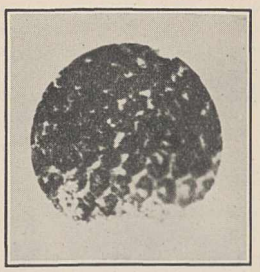

FIG. 10.—Tangential through layer No. 9 of robin. × 270.

of a fly (Eristalis). The pictures formed by both of these must be very crude.

Fig. 13 is a section of a small part of the composite eye of the same fly. In composite eyes each nerve-

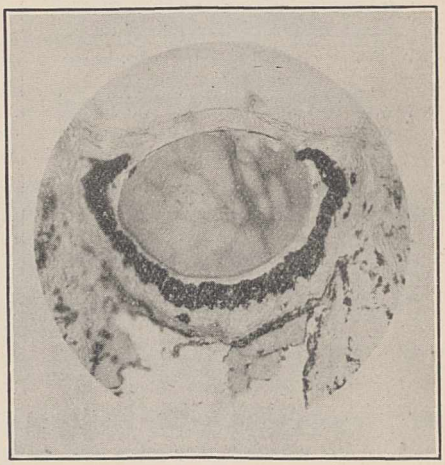

FIG. 11.—Normal section of eye of *Helix aspersa*. × 134.

end is capped by a separate lens, and in estimating the resolving powers of such eyes the radius of curvature of the surface on which the lenses are set must be substituted for the focal length of the simple eye; *e.g.* the resolving power is measured by the angle between the axes of any two adjacent lenses.

The mechanism which intervenes between the exciting cause and the nerves which convey the impression to the seat of consciousness is better known

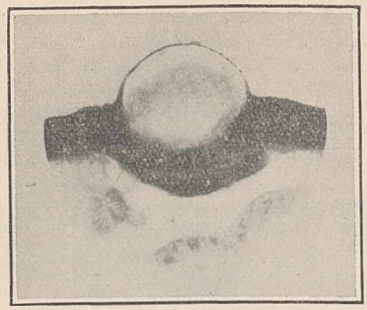

FIG. 12.—Normal section of simple eye of Eristalis. ×134.

for sight than for any of the other senses, but knowledge is altogether wanting as to the action which takes place in the nerves themselves.

For sight, the stimuli are applied at the rate of millions of millions per second, and for hearing at

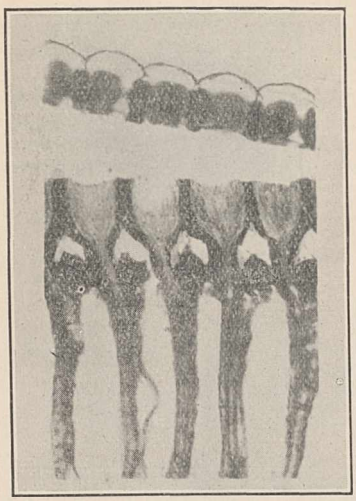

FIG. 13.—Normal section of composite eye of Eristalis. ×270.

The cornea and lenses have separated from the cups containing the vitreous humour in the process of mounting the section.

hundreds or thousands in the same time. Smell and taste depend on contact with certain molecules, and touch on the variations of mechanical pressure; but there is nothing in the appearance of any nerve, so far as the microscope can distinguish, to indicate which form of stimulus will produce a response.

A. MALLOCK.

9 Baring Crescent, Exeter.

Mrs. Ayrton's Work on the Electric Arc.

WHEN a negro servant lighted a fire with Prof. Ayrton's paper on "Variation of Potential Difference of the Electric Arc with Current, Size of Carbons, and Distance Apart," at Chicago in 1893, he little knew that he was rendering a service to science and to electrical engineering. The paper, the result of three years' work, had not been read in full at the Electrical Congress, and no rough copy, or even an abstract, remained. The research had not been conclusive, and had not been finished when Prof. Ayrton left for America, and was continued under the superintendence of Mrs. Ayrton, who sent him results twice a week by post. Prof. Ayrton had no inclination to rewrite the paper, and Mrs. Ayrton took up the research and published some of the results in the *Electrician* in 1895, and her book in 1902.

The book was the only complete history of the electric arc, fully documented, from the time of Sir Humphry Davy. It dealt with what may be called the behaviour of the arc. One of the difficulties of the research was unintentionally exemplified by Prof. Silvanus Thompson in his Cantor Lectures on the electric arc in 1895. An arc had been arranged for projection, and left in good order, but when struck at the lecture, misbehaved, declined to burn steadily, and not until the last of the audience were leaving the room did it work satisfactorily. Many of the phenomena of a normal arc, especially with small current, do not appear until it has been burning for a considerable period, sometimes more than an hour. There had been a long discussion about the "back E.M.F." or apparent negative resistance of the arc since the time of Schwendler in 1878. Many of Prof. Ayrton's experiments occupied the greater part of a day, as the current, which was made to vary slowly backwards and forwards between two limits, was never stopped nor the arc allowed to go out for many hours at a time. In these circumstances the unhappy arc never had a chance of settling down to adjust itself to any particular current. Looped curves resulted, and it was not until Mrs. Ayrton kept an arc by hand control under a steady current for more than an hour that she arrived at a constant potential difference definitely related to that current. Having access to the laboratory note-books, she began the whole research afresh, and not only obtained consistent results, expressed in curves and equations, but also interpreted the work of previous investigators, and, in those sections with which I am most familiar, presenting them more lucidly and correctly than the original author had done.

An attempt to illustrate the normal arc appeared long ago as a woodcut in a French work, and has become familiar by being borrowed and copied into dozens of text-books. Mrs. Ayrton made many tracings of arcs projected with a magnification of ten times, in her study of the shapes of carbons, and this study led to important results.

There was little or nothing of fundamental scientific consequence in this work; rather it was technological, and the outcome was more practical than theoretical. From 1905 to 1910, at first with Prof. Ayrton, and afterwards by herself, she worked for the War Office or Admiralty on standardising types and sizes of carbons for searchlights. She urged the necessity for shaping the ends of the carbons, particularly the positive one, to the form that it would assume during steady burning, and her recommendation was adopted, with the result that the arc quickly settled down to steady burning after re-carboning. Col. Crompton long ago suggested the use of small negative carbons, and on Mrs. Ayrton's advice small negatives, coppered to carry the current, were adopted both by the War Office and the Admiralty.

In 1912 Mrs. Ayrton was consulted by a kinematograph company about the improvement of their projectors, and introduced considerable improvements not only in the types of carbons, but also in the design of lamp houses. Her investigations into the humming condition of the arc was the starting-point of Duddell's discovery of the musical arc, which is of such importance in radio-telephony.

Enthusiastic as she was about her experiments with

the electric arc and in her later scientific work, there was no impulsive jumping to conclusions, but patient observation and well-considered reasoning.

A. P. TROTTER.

Teffont, Salisbury,
December 22.

Is the Gulf of Suez a Rift Valley?

I WAS somewhat surprised when reading Prof. J. W. Gregory's interesting article on "The Structure of the Great Rift Valley" in NATURE of October 6, p. 514, to learn that in my lecture to the Royal Geographical Society in 1921 I had thrown doubt on the fault origin of the Gulf of Suez. Fortunately, Prof. Gregory has mentioned the pages in which my views on this subject have been set forth, namely, the *Geographical Journal*, Vol. 58, pp. 267-271.

In my paper I considered three areas: (1) the northern portion of the Red Sea proper; (2) the Clysmic Area; (3) the depressions within the Sinai Peninsula parallel to the well-known major one outside it, which includes the Gulf of Aqaba, Dead Sea, and Jordan Valley.

The Clysmic Area is the one which is involved in the discussion. I have defined it as the expanse of lower confused hills and plains which, with the shallow Gulf of Suez, lies between the northern Red Sea Hills, the two Galalas, Ataqa, and Geneffe ranges on the west, and the marked scarps of western Sinai on the east. I have suggested the name "Clysmic" (derived from Clysma, the Roman name for Suez) in order to avoid constantly referring to this wider region (which is really the area under consideration) as the larger Gulf of Suez. In the discussion on this area this statement is made on p. 269. "In this region the more detailed study undertaken over wide portions of the area suggests to me that these surface differences, while emphasised by erosion, are *nevertheless based on fault movements*." It is true that in the following lines I mention that deeper-seated granitic masses undergoing uplift would produce the effects observed, and that, as in the Red Sea, the minute nature of the elevations in relation to the breadth of the areas makes it difficult to explain the features observed as resulting from tension. But surely this sentence on p. 269 is clear enough: "While the Red Sea might be more purely derived by erosion, there seems no doubt that the Clysmic Area (in which the boundaries with the igneous hill ranges are marked by the most striking faults) *is of a fault-controlled type*." The italics are mine, added to emphasise the statement.

May I in conclusion give the summary of my views as set forth on p. 271 of my *Geographical Journal* article:

"We broadly conclude, in connexion with the present controversy on the rift question, that

"(*a*) The northern portion of the Red Sea shows no evidence of large faulting, and can be easily explained by erosion of a fold.

"(*b*) The narrower Clysmic Area is both folded and faulted to a remarkable extent, differing most markedly from the Red Sea region. The boundary between them is marked by a line which prolongs that of the Dead Sea and Gulf of Aqaba depression, on the northern side of which lie the land surfaces of the Clysmic Area and the shallow waters of the Gulf of Suez (25 to 40 fathoms deep), while to the south are the several hundred fathom depths of the Red Sea. To this line I specially call attention, though not professing to explain its reason.

"(*c*) The very narrow valleys in south-east Sinai and presumably the Dead Sea–Jordan depression are obviously fault-controlled in origin, and close study is required to indicate what part tension or compression have played in determining them. Erosion is the cause of the actual valley character."

My impression is that readers of my own remarks will draw quite a different conclusion as to the views I hold from those arrived at by Prof. Gregory.

Prof. Gregory also refers to a reversed fault recorded by me in my "Report on the Oilfields Region of Egypt, 1916" (see p. 515). On this point I shall bring comfort to Prof. Gregory and unburden my own conscience. I have long felt that to have one reversed fault in the midst of an area where all are of normal type was extremely unlikely, and I consequently take this opportunity of stating that in the interesting case where the Um Murer Anticline abuts against the ancient metamorphic rocks (see Plate II. of my "Report on the Oilfields Region of Egypt," 1916) a different explanation will have to be sought.

The locality is somewhat off the beaten tracks, but should one of my colleagues be in the neighbourhood, I would ask him to re-examine the section and give his opinion as to its nature.

It would be a great gratification to me if the International Geographical Congress of 1925 enabled those interested in these subjects to see some of the type sections in the region under discussion. I have unfortunately missed Prof. Gregory on those occasions when there has been formal consideration of these subjects, and I hope the time may be not long delayed ere I meet him in England or Egypt, giving us the opportunity of discussing these questions in that atmosphere of cordial friendship which has so long existed between us.

W. F. HUME.

Geological Survey of Egypt,
November 17.

I AM delighted to learn that Dr. Hume's views and my own are in even closer agreement than I thought, and that I have misunderstood his conclusion as to the relative effects of fold and fault in the formation of the Gulf of Suez. I was unfortunately not able to attend either his lecture to the Royal Geographical Society or his address to the Geological Society. I was influenced by the interpretation of his views by speakers in the discussions, where one of them stated that after the researches of Dr. Hume and his colleagues "we must look elsewhere than in Egypt" for support to the rift valley conception.

The illustrations from the publications of the Egyptian Survey were therefore included in my recent article to correct such misconceptions of the facts. Dr. Hume described that gulf as "one of complicated fold-and-fracture effects," and I was under the impression that he regarded the folds as the main factor, and the gulf as "fault-controlled" but not as fault-made, especially as in the report of his Geological Society address he remarked on the difficulty of "rift formation as defined" by me in a paragraph which seemed to apply mainly to the Clysmic Gulf. The passages quoted in his letter seemed to me, therefore, restricted by some qualifications. But on re-reading both Dr. Hume's paper and address I see that I had read into some sentences more criticism than was intended. Our views as to the Gulf of Suez are therefore in agreement, especially as the representation of the fault at Um Murer as a reversed fault is now placed in suspense as improbable.

I have so often scanned the alluring fault-scarred cliffs on the western shore of the Gulf of Suez through glasses from the sea, that it would be a great joy if the International Geographical Congress of 1925 enabled me to examine them ashore under the guidance of Dr. Hume.

J. W. GREGORY.

Colour Vision and Colour Vision Theories.

WITHOUT interfering in any current controversy, an experiment suggests itself, from the concluding sentence of Dr. Edridge-Green in NATURE of December 22, p. 900, which if carefully tried might be instructive.

I presume that no one, whatever his theory, will deny the bare fact that a spot or rectangle of yellow can be projected on a screen by the superposition of red and green. A similar spot of pure spectrum yellow can be projected alongside. The two spots can be made indistinguishable by the normal eye; though a prism discriminates at once. So far, I know.

Let these two similar-looking spots be studied for positive after-image. Will one turn into green, because of red-fatigue, while the other will not? I do not know the answer. OLIVER LODGE.

SURELY it might have been better had Dr. Edridge-Green omitted the remark in his letter (NATURE, December 22) regarding the attitude of certain physicists towards physiology. But that is a small matter. I should be quite prepared, if it stood in need of defence by a physicist, which I am quite certain it does not, to defend physiology against Dr. Edridge-Green's assertion that it limits us to one set of fundamentals for normal vision for one person, unless he alludes explicitly to the *absolute* fundamentals. In that case physics and physiology are at one. But he refers explicitly to the special fundamentals, chosen for various reasons by various workers; and of these there may be within certain limits a triply infinite choice, each framed legitimately from the single absolute set. If the existence of four fundamentals were admitted, the choice would similarly be quadruply infinite.

Dr. Troland's results, like those of Prof. Frank Allen, are of the type which will gradually pave the way towards knowledge of the variables which essentially affect the threshold values of stimuli, and towards an understanding of the corresponding relations amongst these quantities.

In the second last sentence of his letter, Dr. Edridge-Green makes statements, regarding my explanations, which puzzle me as to their origin; and, in the last sentence, he merely repeats the error of postulation to which I objected, and pointed fully out in my last letter (NATURE, November 24).

I agree with him as to the simplicity of the trichromatic theory. That, apart from sufficiency, is its most outstanding merit. Nevertheless, for the complete elucidation of its higher developments, especially in the matter of the absolute fundamentals alluded to above, it requires some knowledge of what I may term elementary advanced mathematical physics. It is well in this connexion to remember the words of another who, like Helmholtz, stood amongst the giants, "I have no faith in speculations of these kinds unless they can be reduced to exact analysis."

Finally, I would say that, in our discussion, I have only attacked Dr. Edridge-Green's attacks upon the trichromatic theory; for these, in my view, have been entirely undeserved. W. PEDDIE.

University of St. Andrews,
December 22.

Deferred Annuities (Two Rates of Interest).

SIR RICHARD REDMAYNE in NATURE of December 22, p. 893, gives, as the value of a deferred annuity in which two rates of interest are involved, $a/(1+AR/100)$ or $a/(1+Aj)$ where the remunerative rate of interest is R per cent. or j per unit, a is the amount of 1*l.* per annum accumulated at r per cent. or i per unit for the period of enjoyment (e), and A the amount of 1*l.* per annum at the same rate for the total period, *i.e.* period of deferment (d) *plus* period of enjoyment. The underlying idea of the two rates of interest according to Mr. George King, who is cited by Sir Richard Redmayne, is that "a lender grants an advance at a higher rate of interest than he can secure from other investments and that he wishes to realise the higher rate on the whole of the capital during the entire term of the annuity," and the formula quoted above is given in all modern text-books on interest for the limiting case, $d=0$, that is, for an immediate annuity. The value in such cases is always lower than that obtained by using the remunerative rate throughout, which is naturally the object of the assumptions made by the lender. When however we come to a deferred annuity, we find that the values by the formula are in some cases higher than those found by using the remunerative rate alone—see Table, cols. (3) and (4), where $i=0{\cdot}025$ and $j=0{\cdot}05$. Similar results will be found with other rates of interest if i and j differ considerably.

TABLE SHOWING VALUES OF ANNUITIES.

e. (1)	d. (2)	$a/(1+Aj)$. (3)	At j throughout. (4)	$a/\{(1+aj)(1+j)^d\}$. (5)
5	0	4·16	4·33	4·16
5	5	3·37	3·40	3·26
5	10	2·77	2·66	2·56
10	0	7·18	7·72	7·18
10	5	5·91	6·05	5·63
10	10	4·92	4·74	4·41
15	0	9·45	10·38	9·45
15	5	7·87	8·13	7·41
15	10	6·62	6·37	5·80

I think the formula advocated by Sir Richard Redmayne and Prof. Louis is open to objection when used for deferred annuities because, while a lender will accumulate at the low accumulative rate any sums available to repay his capital, he would never agree to accumulate additions to the debt at such a rate; yet this is what the formula seems to assume. I suggest that if P be the value required we might reach a better formula as follows:

$$P(1+j)^d = a/(1+aj)$$

or

$$P = a/\{(1+aj)(1+j)^d\}.$$

This assumes that the lender will require interest on his original investment at the remunerative rate to be added to and become part of his capital each year (or interval) and will only use the accumulative rate when he has a sum available for accumulation. The values resulting from the formula last given are shown in the Table, col. (5).

Sir Richard Redmayne is no doubt aware of objections to the formula he mentions, and it is his reference to the "vexed question of the proper formula to apply" that is my excuse for writing.

W. PALIN ELDERTON.

December 24.

Mendelism and Evolution.

MAY I be allowed to direct the attention of readers of NATURE to an article by W. Johannsen, the distinguished Danish geneticist, entitled "Some Remarks about Units in Heredity" (*Hereditas*, vol. iv., 1923, p. 133)? Johannsen maintains that the term unit-character should be "exterminated": the following extracts will show the nature of his conclusions.

"Certainly by far the most comprehensive and most decisive part of the whole genotype does not

seem to be able to segregate in units, and as yet we are mostly operating with 'characters' which are rather superficial in comparison with the fundamental Specific or Generic nature of the organism. When we regard Mendelian 'pairs,' *Aa*, *Bb*, and so on, it is in most cases a *normal* reaction (character) that is the 'allel' to an *abnormal*. Yellow in ripe peas is normal, the green is an expression for imperfect ripeness as can easily be proven experimentally, *e.g.* by etherisation. 'No starch' in maize is evidently an abnormality.—Is the whole of Mendelism perhaps nothing but an establishment of very many chromosomical irregularities, disturbances or diseases of enormous practical and theoretical importance, but without deeper value for an understanding of the normal constitution of natural biotypes?—The problem of Species, Evolution, does not seem to be approached seriously through Mendelism nor through the related modern experiences in mutations."

Those biologists who have maintained that Mendelian research does not help to solve the problems of the origin of species and the evolution of adaptations, will welcome this exposition of Dr. Johannsen's views.

C. TATE REGAN.

41 Warwick Rd., Ealing, W.

Bessemer Steel.

YOUR reviewer (NATURE, December 8, p. 831) asks me to give "the date of construction of the last new Bessemer plant erected in Great Britain for steel manufacture." I am indebted to Mr. Lloyd, the secretary of the Iron and Steel Institute, for the information that new plants were erected in Great Britain last year (1922). Moreover, I learn that all the steel works in the devastated areas in France, which have been reconstructed since the War, have installed Bessemer converters, and that these are larger than those previously in use. Thus far twenty converters, each of thirty tons capacity, have been constructed, and put into operation. Finally, may I say that large quantities of steel are now made by a process in which the metal is first refined in Bessemer converters, and afterwards, at still higher temperatures, in electric furnaces which permit the reduction of phosphorus and sulphur to very small quantities, and the manufacture of high quality steels. The Bessemer process is still very much alive.

H. C. H. CARPENTER.

Royal School of Mines,
South Kensington, London, S.W.7,
December 13.

Standardisation of Scientific and Technical Publications.

IN his letter in NATURE of December 1, p. 794, Mr. J. F. Pownall suggests a system for standardising the publication of scientific and technical literature. He expressly states that he gives only the roughest idea of his system, but, even so, its very basis seems so unsound that further consideration would appear needless.

1. A standard page size would be very convenient but would have its drawbacks; it would be rather futile unless *every* publication—or, at any rate, every standard publication—adopted this chosen size, which I should say is a most unlikely happening.

2. The basis of the encyclopædia scheme appears to be a loose-leaf system, so that any paper can be removed from a volume to be made up into a separate volume of papers on a special subject, or "in alphabetical order, or order of classification as desired."

As few private libraries have more than one or two periodicals, the chief use of this system would be made in libraries attached to laboratories, institutions, etc. Every one knows the great difficulty of preventing bound volumes going astray, so what would happen could every paper be separated from its fellows passes description—as would the language of the librarian. Moreover, if the various papers of publications are removed for any of the three mentioned objects, it simply means that the publications cease to exist, as such, from the very beginning, while as to the order of arrangement adopted, everybody would probably have a different system—although certainly fifty per cent. would have no system at all.

These considerations alone seem to show that there would be such confusion that any inherent advantages would be soon quite lost sight of.

As one should not give destructive criticism without at the same time offering some constructive considerations, I should like to suggest that one way in which Mr. Pownall's system is to be "of great service" can be obtained at once without changes to existing publications, and with very little, if any, expense. Most scientific publications, at any rate, reprint each paper as a pamphlet or leaflet, copies of which are supplied to the author to dispose of as he pleases. Could not a few more than are required by the author be prepared at very little extra cost and kept by the publisher of the particular periodical? Any one, then, interested in a certain subject or line of research, could obtain any paper bearing on the subject simply by applying to the publisher, who would thus be able to supply at a small charge.

W. P. WIDDOWSON.

Dr. Lee's Laboratory,
Christ Church, Oxford,
December 15.

Scientific Names of Greek Derivation.

MY attention has just been directed to the letter by Dr. Bather in NATURE of December 22, p. 901, in which he inquires concerning the derivation of the name Dinocochlea employed by me to designate "the giant corkscrew shell from the Hastings Sand." It was derived, of course, from the Greek "deino-" transliterated in accordance with the prevailing custom as in Dinotherium, Dinornis, and the parallel cases of Pliosaurus, Chiroptera (inconsistently Cheirotherium has retained its "e"), etc. A classical friend promptly directed my attention to the e-less "dino-," and had I only been aware of it at the time the Hastings fossil might have blossomed forth as Deinodinos.

It is too late, as Dr. J. W. Evans fears, to restore Meiokaine and Pleiokaine, but it is worthy of note that in Pleistocene we have a compromise. It is to be hoped, however, that we shall never descend to the enormities committed by the Germans just before the War, when I was startled to encounter "Zefalopoden."

As regards diphthongs, since they are single sounds surely they should be represented if possible by single symbols. The fanciful method of "spelling them out" was, if my memory serves me, of Transatlantic origin. It seems to have attracted Dr. Bather and hence probably was introduced into the Geological Department of the British Museum. The trifling trouble of looking out for misprints is more than counterbalanced by ease in reading, as for example Nymphæaceæ in lieu of Nymphaeaceae. The fault lies with the printers, who will, especially in italic type, use a badly designed font. Here, as usual, a compromise might be found by linking the vowels of diphthongs, as often done in manuscript, and printing as "a͡e" and "o͡e."

B. B. WOODWARD.

4 Longfield Road,
Ealing, W.5

Bird Migration in Relation to Foot-and-Mouth Disease.

By A. LANDSBOROUGH THOMSON, O.B.E., D.Sc.

A PAPER with the title "Bird Migration and the Introduction of Foot-and-Mouth Disease" appears in *The Journal of the Ministry of Agriculture* for November 1923 (vol. xxx., No. 8, p. 681). The authors are Sir Stewart Stockman, Chief Veterinary Officer of the Ministry, and Miss Marjory Garnett, the former being responsible mainly for the veterinary information and the latter for the ornithology. Their purpose is to discuss whether migratory birds may possibly be the means of introducing fresh infections of foot-and-mouth disease into Great Britain. The available evidence is admittedly circumstantial, and the authors start with the assumption that it is impossible to prove a positive case, but that it is practicable to inquire whether the question can be disposed of by establishing a negative. Having thus disavowed any intention of engaging in special pleading, they proceed to state the arguments in favour of the theory that birds may be the responsible agents.

Throughout the paper the question is confined to "initial outbreaks of invasion," as distinct from "outbreaks of ramification from the former," and of these there are said to have been eighty in twenty-two years. Mystery enshrouds the origin of these original outbreaks, which may occur months or years after the country has been free from infection, and commonly arise at places which had not previously harboured cases of the disease. The entry of ruminants and swine was totally forbidden during the period, as also the importation of straw and hay from infected countries. All outbreaks were dealt with by slaughter, so that the possibility of recovered "carriers" is excluded, and all infected premises were disinfected and then kept isolated for a time. Inquiries made in every case usually failed to reveal any obviously possible source of infection.

For these reasons it is assumed that the initial outbreaks are due to the importation of the virus from abroad by some unknown means, and it is noted that they occur during waves of prevalence of the disease on the Continent. It is then argued that birds constitute a possible means of introduction. Three ways are suggested: the birds might themselves contract some form of the disease, although this is not actually known to occur, and birds have usually proved highly insusceptible in experiments; the birds might infect pastures with virus carried on their feet or plumage, which is not inherently impossible in view of the known carriage of the virus in straw, hay, clothing, and the like; or the birds might swallow the virus and excrete it uninjured, although the viability of the virus under these conditions is not discussed.

The main theme of the paper is the connexion, if any, between the seasonal and geographical incidence of initial outbreaks of disease and the known immigratory movements of birds from the Continent. This is simplified by the fact that foot-and-mouth disease is rare in countries north of Denmark, and that the autumn and winter immigrations of birds from the north-west, north, and north-east may therefore be disregarded. The question thus resolves itself into that of a possible correlation between the introduction of disease and (*a*) autumn and winter immigration and passage from the east on the southern portion of the east coast of England, and (*b*) spring and summer immigration and passage from the south.

The authors argue that there is indeed good evidence of a correspondence between the epidemiological and ornithological phenomena. Their conclusions are as follows: "There would appear to be most remarkable relations, both as regards seasons and localities, between the movements of birds and the initial outbreaks of invasion in foot-and-mouth disease in Great Britain. Some of these outbreaks, however, do not correspond with what are believed to be the known facts as regards bird movement. On the other hand, these facts are admittedly incomplete, and the circumstantial evidence as a whole is very far short of being able to establish a negative."

That a negative case is not established may be freely admitted, but we wish to examine, from an ornithological point of view, whether the indications in favour of a positive case are in fact so remarkable as the authors suggest. They themselves point to some serious discrepancies in the available evidence, and it does not seem helpful to suggest that these may be explicable, consistently with a positive case, by ornithological factors as yet unknown. The ornithologist is indeed tempted to retort that his present knowledge of bird migration rests on at least as sure a basis as the existing knowledge of the pathology of foot-and-mouth disease, and that unknown factors in the latter may equally well contain the clue to an explanation of quite another kind. Such speculation, however, is outside the scope of the present article.

Is the seasonal correspondence between migration and disease invasion indeed remarkable? The numbers of initial outbreaks in each month from January to December are as follows: 14, 5, 4, 4, 2, 2, 9, 3, 8, 8, 8, 12. The numbers of years in which these outbreaks have occurred in each month are: 4, 4, 4, 4, 1 (or 2), 2, 5, 3, 6, 5, 6, 6. From these figures the authors conclude that "by far the greater number of initial outbreaks have occurred in the months from September to January," the season of the principal immigrations from the east, and that from February to May "there are fewer initial outbreaks, and they are of less regular occurrence."

The available figures seem to be rather small to serve as a basis for such emphatic statistical deductions as those quoted, but taking them at the authors' valuation we find that several questions arise. There is, as they point out, a high incidence of initial outbreaks in the month of July, when migration is at its lowest ebb; there is a little immigration during the month, perhaps rather more than we know of, but certainly none on a scale in the least comparable with that of the autumn. There follows a period of low incidence of initial outbreaks in August, and then a period of higher incidence during September, October, and November, the chief months of autumn immigration from the Continent. But in December and January, as the authors themselves say, there is a still higher incidence. During these months there are

"weather movements" similar in direction to the true autumn migrations, but they are on a much smaller scale. So far as autumn and winter invasions of disease are concerned, therefore, we may remark that, while corresponding migratory movements do exist, the incidence of outbreaks is not proportional to the magnitude of the movements, but is actually highest during the less important migration months of December and January, and at least as high during the relatively stagnant month of July as during the height of the autumn immigration in September, October, and November.

February is a difficult month—a period of cross-currents at the turn of the migratory tide; it is a period of moderate incidence of initial outbreaks of disease. From March to June, however, we have the straightforward phenomenon of spring and summer immigration and passage from the south. In these four months the incidence of disease invasion remains relatively low. The ornithologist naturally asks why this great movement should be less important than the autumn and winter movements along the east-to-west route. It seems difficult to give any convincing ornithological reason, although a few possibilities suggest themselves, and the authors have not given us any other. To appreciate the point we should need to have information as to the seasonal incidence of the disease on the Continent, and of its frequency in France as compared with Belgium, Holland, Northern Germany, and Denmark. We are not, however, given this opportunity of envisaging the problem as a whole, and on the evidence before us we feel unconvinced that a close relationship is discernible between the seasonal phenomena of migration and the incidence of outbreaks of the disease. Certainly no quantitative correspondence is apparent between the numbers of initial outbreaks at different seasons and the magnitude of the appropriate bird movements.

Is the geographical correspondence between migration and disease invasion indeed remarkable? It is pointed out that the September, October, and November initial outbreaks occurred mainly in the part of England lying south of a line from the Bristol Channel to the Humber, the area chiefly affected by immigration at that season from countries to the east where the disease exists. It may be noted, however, that of 19 outbreaks in this area (against 5 outside) only 1 was in Suffolk and none in either Norfolk or Essex, although on the coasts of these counties a great part of the immigration from the east takes place. Nine were in Kent, Surrey, or Sussex, and 5 others further west but still near the south coast. A more detailed examination therefore tends to destroy some of the effect of the broad statement.

In December, January, and February, 20 out of 31 initial outbreaks—not an overwhelming preponderance—fell south of a line from the Severn to the Wash, *i.e.* in the area chiefly affected by immigration from the east at that season. Of these 1 was in Norfolk, 1 in Suffolk, 2 in Essex, 3 in Kent, and 6 in the south coast counties from Sussex to Devon. Of those outside the area, all but two were in the eastern half of the north of England, and certain northward movements of gulls up the east coast are suggested as the explanation. The case here is obviously not a strong one.

Of the initial outbreaks in March, April, and May, 3 were in Norfolk, 1 in Essex, 2 in Kent, 1 in Surrey, and the other 3 towards the north-west. There is nothing in this which at all strongly suggests the lines of migration at that season, although perhaps also nothing inconsistent therewith.

Of the initial outbreaks in June, July, and August, 6 were in Kent, Surrey, Sussex, or Hampshire, 1 in Somerset, 4 in the Midlands, 1 in Lincolnshire, 1 in central Yorkshire, and 1 in Cumberland. There is again nothing altogether inconsistent with the directions of migration at this season, but there is no indication of a distribution closely related to the principal movements either of the late summer or of the early autumn. The 5 July outbreaks in the Midlands and in the north—as against 3 in Kent or Surrey, and 1 in Somerset—are indeed difficult to explain on any theory of the kind, as the authors admit. During all three months there was a complete absence of outbreaks in an area of a dozen counties lying between the Wash and the Thames; yet this region is one which is particularly affected by late summer passage to the north and would be affected by any early autumn movements from the east.

The figures for the numbers of initial outbreaks in different areas are, of course, very small for statistical purposes and for the elimination of the effect of mere chance in the geographical incidence, but we have, again, taken them at the value which the authors appear to place upon them. Even so, we do not agree that the correspondence is remarkable. For although it may be possible to assign most of the apparent routes of disease invasion to the general directions of appropriate migratory movements, there is little indication of a quantitative relationship between the distribution of initial outbreaks and the importance of the different paths of bird immigration. Taking the distribution of initial outbreaks as a whole, it indeed seems difficult to find ground for saying much more than that they occurred most frequently in the extreme south-east of England, the part nearest the Continent, and decreased in frequency westwards and northwards.

Throughout this article we have taken the validity of the veterinary data for granted as being a matter outside the ornithologist's sphere of criticism, but there is one point on which we may at least raise a question. In the definition of "initial outbreaks of invasion" the authors include not only outbreaks occurring after an interval during which the country was free from the disease, but also "those arising simultaneously in parts of the country very remote from each other and having no possible connexion, except perhaps through the same agency, whatever it may be, whereby the virus is carried long distances and in certain directions." This seems to come perilously near begging the question, and our misgivings are aroused when we see from the illustrative charts how many of these nearly simultaneous outbreaks are in fact classed as separate invasions. Unconnected in any obvious way they doubtless were, but it seems scarcely permissible to select the data for an inquiry such as this on an assumed principle the validity of which depends

in some part on the subsequent argument. Nor are the charts altogether in accord with even the extended definition. We note, for example, the inclusion of outbreaks side by side in Kent with a difference of four days, and of two outbreaks in Devon with a fortnight's difference. For December 1919 and January 1920 no fewer than sixteen "initial" invasions are recorded, most of them in the south of England, and in the next ten months the total is brought up to twenty-nine. The elimination of such cases as these by a more rigid definition would materially alter the aspect of the data. Nor is it any answer to this objection to say that if these cases are connected it can only be by the same agency as connects original British outbreaks with foreign outbreaks. The possible carriage of the virus by birds moving within the country is a different ornithological question from that of carriage from abroad, and it is the latter for which the data are presented and which is discussed in the paper.

We are interested to learn from an editorial note in the *Journal* that Sir Stewart Stockman is now experimentally investigating the possibility of the infection being carried by birds. The question remains open, and further research may well be useful. Here we can only express the opinion that the evidence put before us does very little towards establishing a *prima facie* positive case.

The Utilisation of Volcanic Steam in Italy.

THE increased desire for economic independence that accompanied the growth of national sentiment during the War has been shown very clearly in the intensified study and exploitation of natural resources; and the welkin is still ringing with cries of "increase production," "back to the land," and "keep the home-fires burning." Examples of this world-tendency are apparent everywhere: in Central Europe, particularly, brown coal, water-power, and minerals have been greatly developed; in tropical countries, useful vegetable products have been increasingly exploited; and in many lands the rush for petroleum has gathered momentum. Very little, however, has been heard as yet of attempts to utilise the interior heat of the earth, which many believe to be one of the most important potential sources of energy. Only in Italy has a definite and successful effort been made in this direction, namely, by utilising the natural steam which emerges from the earth in volcanic districts. The jets of steam ("soffioni") and the pools of water, formed in small craters and maintained at boiling temperature by natural steam ("lagoni"), have been known for centuries, but for long were regarded by the peasants as manifestations of unseen and unfriendly powers. The discovery in them of boric acid in 1790, the extraction of this acid on a commercial scale since 1818, and, in particular, the recent pioneer work of Prince Ginori Conti, in association with the Società Boracifera di Larderello, have completely transformed the picture, and revealed a source of wealth which may play an important part, not only in the future industrial development of Italy, but also in that of other countries that are blessed—and at times cursed—with volcanic activity.

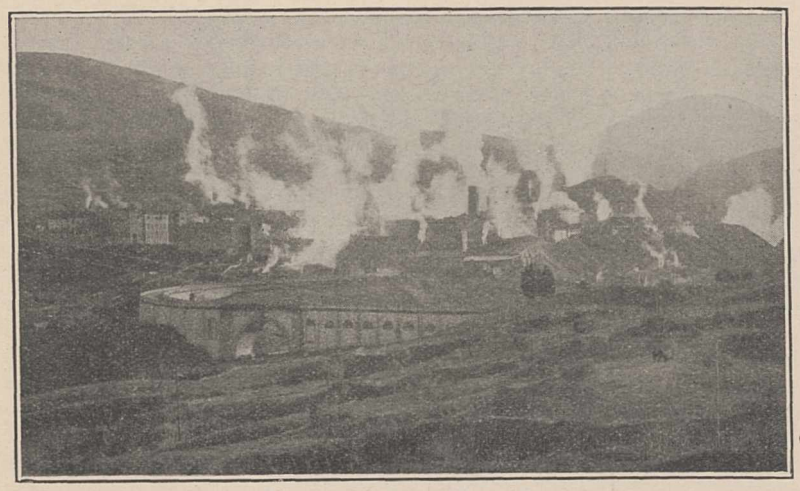

FIG. 1.—General view of Larderello.

The district which has been selected for study and exploitation forms, roughly, an elliptical area of about 2·5 sq. miles, lying south of Volterra and from 40 to 50 miles south-south-west of Florence. In this part of Tuscany, works for generating electrical power and for producing boric acid and other chemicals have been erected at Larderello, Castelnuovo, Sasso, Monterotundo, Lago, Lustignano, Sarrazzano, and, to the eastward, at Travale. The works are situated at the bases of hills dividing the valleys of the rivers Cecina and Cornia, and the roads are good, though winding. The volcanic nature of this district is shown by stretches of arid soil, the presence of many "soffioni" and "lagoni," and by the occurrence in their vicinity of sulphur, crystals of calcium carbonate with pseudomorphous growths of gypsum, larderellite (ammonium borate), and sassolinite (orthoboric acid).

For industrial utilisation the supply of steam from "soffioni" is not sufficient, and hence bore-holes, 16 in. diameter and from 200 to 500 ft. deep, are sunk and protected from caving by iron tubing. The steam issues at an average pressure of two absolute atmospheres, and at a temperature varying from 100° to 190° C., friction against the walls of the bore causing much of the super-heat. Recent drillings have released steam at a considerably higher pressure, and in quantities up to 60,000 kg. (59 tons) per hour. At Larderello the actual available output is above 150,000 kg. per hour from 135 bore-holes, and generally there is abundant evidence of enormous untapped supplies. The steam, which Prof. R. Nasini has shown to be radioactive, contains an average of 0·06 per cent. of boric

acid, with a maximum of 0·1 per cent., and about 4 to 6 per cent. by weight of gases, mainly carbon dioxide (over 90 per cent.), but also hydrogen sulphide, hydrogen, methane, oxygen, nitrogen, ammonia, argon and helium.

The first attempt to produce power from natural steam was made in 1897 by using it to heat water in a boiler and feeding a reciprocating engine with the pure steam. In 1905, Prince Conti fed steam direct from a "soffione" into a piston engine, and the result was so successful that in the following year a larger engine was used, and the steam generated was made to drive a dynamo for lighting the works. In 1912 it was decided to erect a 250 kw. turbo-generator to be worked with natural steam, but owing to fear of corrosion of the turbine blades, and the difficulty of obtaining a good vacuum in the condensers, on account of the presence of the gases mentioned above, this intention was abandoned. Intermediate boilers or evaporators were therefore constructed and used.

The present large power-plant at Larderello was first operated in 1916, and comprises evaporators, turbo-generators, condensers, and transformers. The evaporators employed, until recently, consisted of vertical aluminium tubes enclosed in a shell of sheet-iron; natural steam circulated round them and the water to be evaporated through them, this water being taken from the

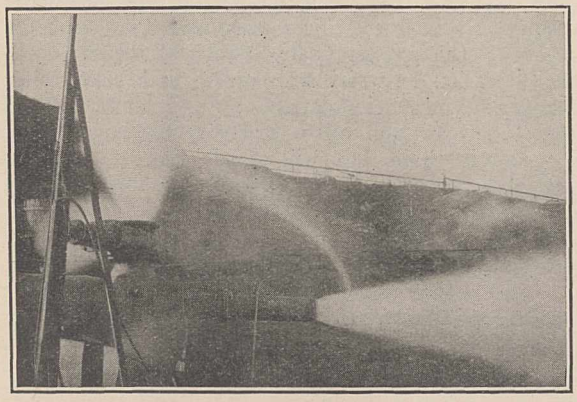

FIG. 3.—A powerful jet of natural steam ("soffione").

condensers or from that formed by condensation of the natural steam.

According to a paper which was read by Prince Conti at the Catania meeting on April 5-11, 1923 of the Italian Association for the Advancement of Science, this type of evaporator has been replaced by another, invented by Signor P. Bringhenti, in which the dissolved gases (*v.s.*) are separated from the natural steam, thus increasing the efficiency of the condensers. The pure steam, superheated with the aid of natural steam, is fed at a pressure of 1·25 atm. abs. into 3000-kw. turbo-generators of the Parsons type, of which two are in use and one is kept in reserve. Each unit has a net efficiency of 2500 kw., and generates a 3-phase current at 4000 volts, 50 periods. Step-up transformers of the self-cooling oil type raise this voltage to 16,000 for distribution to the various works, and to 32,000-38,000 for transmission to Siena and Florence, Leghorn, Piombino, for use in iron and steel works, and to the pyrites mines at Massa.

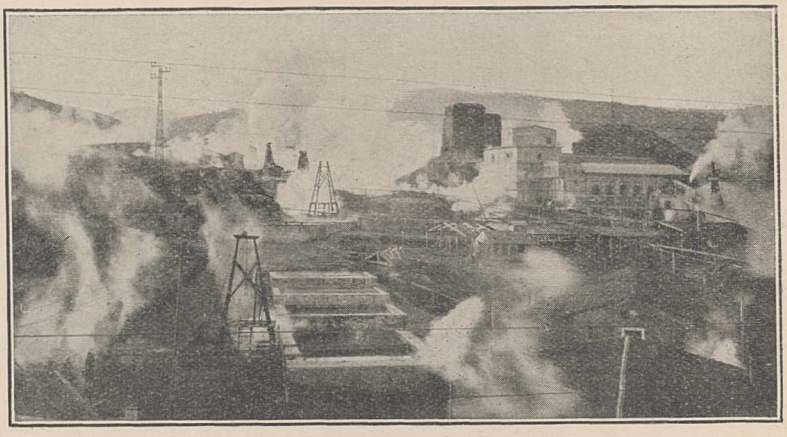

FIG. 2.—Works at Larderello: power station and collecting tanks.

The condensers, each with a cooling area of 11,300 sq. ft., are placed below the turbines; the cooling water is driven through the tubes by centrifugal pumps and thence to the refrigerating towers. Two hydraulic ejectors are fitted to each condenser, and the condensate is removed by centrifugal pumps. A second power station has recently been erected, at the Lago works, for experimental purposes, including work on the new type of evaporator.

The water containing boric acid is evaporated by natural steam in shallow lead-lined basins arranged on a slightly inclined plane and operated on the counter-current principle. When the boric-acid content has increased to about 8 per cent., the liquid is cooled and the crude acid, up to 99 per cent. purity, is crystallised out. This acid is then purified by re-crystallisation. At Larderello there is a small production of borax from boric acid and sodium carbonate, and at the Castelnuovo works an output of about 10 tons per day of ammonium carbonate.

Looking to the future, it appears more than probable that the production of power and chemicals with the aid of natural steam will not long be confined to Tuscany. Already the volcanic districts of Vesuvius, Etna, and the islands of Eolie (Lipari) are being studied. Outside Italy, like investigations are being pursued in America on the steam springs of California, Chile, and Bolivia; and attention will doubtless be given to similar fields in Alaska, New Zealand, and especially Japan, where such volcanic manifestations are numerous. To Italy, however, will belong the credit of having initiated this method of tapping a supply of energy which, in spite of the attention it has attracted, has been running to waste for centuries, and thus providing yet another method of "utilising the forces of Nature for the benefit of mankind."

The Meridian of France.

THE well-known French journal, *Revue Scientifique*, has published in the issues of September 8 and 22 two admirable articles on the meridian of France by a very competent authority, Col. Perrier.

As an introduction, Col. Perrier passes briefly in review some of the larger geodetic operations, including those of the Survey of India. "Aux Indes c'est à la ténacité et à la science des premiers directeurs du 'Trigonometrical Survey,' le Colonel Lambton . . . le Colonel Everest et de tous leurs successeurs que l'on doit le bel arc de 21° d'amplitude." It may be noted that Lambton's proposal for the measurement of this arc took shape in 1802; he died in 1823, "worn out by incessant toil under a tropical sun."

The meridian of France has a history that goes back more than a century earlier. It is associated with the names of Picard (1669), the Cassinis, La Caille, Laplace, Legendre, Delambre, Méchain, Biot, Arago, and others, who have permanent niches in the temple of geodesy. But "la méridienne de France, si souvent remaniée et remesurée," perhaps the most famous of arcs, is also the most unfortunate.

After more than 250 years of effort one might expect that this arc, which passes through Paris and traverses France from north to south, would consist of permanently marked and accurately fixed points, and that the reductions of the geodetic and astronomical calculations would have been published in a definitive form. "Par une singulière infortune aucune de ces conditions n'est réalisée," and Col. Perrier explains why. The principal cause of this state of affairs is the extreme slowness with which the operations were carried out, a slowness due to want of funds. The second cause of the present imperfect state of the triangulation, and of its records, is the effect of successive wars in damaging the northern portion of the chain.

In the seventeenth and eighteenth centuries the operations were not only undertaken on the initiative of the Académie des Sciences, but were also carried out by the Academicians themselves. But from early in the nineteenth century the arc was rightly made to serve the purposes of cartography, and the direction of the work passed to the Dépôt de la Guerre and, in 1887, to that efficient body, the Service Géographique de l'Armée.

Picard's arc of 1669–70, between Amiens and Paris, was about 150 kilometres long; its great interest consists in the fact that the value of the degree derived from it was used by Newton in 1682. The Cassinis prolonged the chain to Dunkerque and Collioure and, misled by faulty observations, propounded the notion of a prolate spheroid. In 1739–40 Cassini de Thury and La Caille revised the arc; and in 1792–98 Delambre and Méchain again revised it and extended it to Barcelona. In 1817 a commission under Laplace reported upon the triangulation and the construction of a cadastral and topographical system to be based upon it, and made recommendations which, unfortunately for France, have never been carried out.

The meridian of Delambre and Méchain was recognised as obsolete and inaccurate a hundred years ago; but, from that time until 1870, geodesy in France underwent a gradual eclipse. In 1845 the Dépôt de la Guerre was of opinion that geodesy had said its last word. In 1860 Great Britain proposed to France to re-observe the cross-Channel connexion between the triangulations of the two countries. It appears that, on the French side, officers were employed on the work who were totally new to it, and Col. Perrier states that the comparison between British and French methods and instruments was greatly in favour of the British.

The subject began to revive about 1870, the authorities having decided that another revision of the arc should commence in the spring of that year. But then came the Franco-Prussian war. The re-measurement was taken up again in July 1871 and was finished in 1892.

This "new meridian" of France, finished in the field thirty years ago, has suffered from many of the misfortunes that attended its predecessors. Its execution and its reduction were always much hindered by want of money. The Service Géographique had always more on hand than its resources enabled it to carry through effectively. Apart from work in Algeria and Tunis, and elsewhere abroad, the re-measurement of the "arc of Peru" in 1899–1906 caused much interference with the work at home; so the reduction of the meridian of France went to the wall. Various volumes have been published, by the late General Perrier, by Defforges, and by Bourgeois, but the publication is far from complete. The final reduction of the triangulation was in hand in 1913–14, and on August 2, 1914 was about two-thirds finished. "Bien entendu, à l'armistice, on en était toujours au même point."

But, by this time, a great part of the northern section of the chain had been destroyed, as a result of the War; the greater part, that is, of the trigonometrical stations between Laon, Amiens, and Dunkerque. This work is now being carried out again for the fifth time. The operation will not only serve to complete the geodetic chain, but will enable the second and third order triangulations required for the detailed mapping to be extended over the devastated area.

Here we touch the question of the "cadastre," which appropriately enough is discussed by M. Ch. Lallemand in another article in the same journal (September 22). In spite of the great eminence of those Frenchmen who have dealt with the matter, from the days of Delambre and Laplace to the present time, the cadastre and large-scale maps of France are in a worse state than the geodesy; and, from various causes, chiefly the perpetual want of funds, the state of the surveys of France will not bear comparison with those of the British Isles.

The history of the meridian of France serves to point the moral that, in geodesy, provisional measures undertaken for the immediate utilisation of results, with the object of saving money, inevitably lead to confusion and disorder, and finally to the expenditure of a larger sum than the sound and methodical execution of the work would have originally entailed.

C. F. CLOSE.

Obituary.

DR. FRANK CLOWES.

DR. FRANK CLOWES, emeritus professor of chemistry, University College, Nottingham, who passed away on December 18, 1923, was a man of many parts. He was educated at the City of London School, and afterwards studied at the Royal College of Science, Dublin, the Royal School of Mines, London, and the University of Würzburg. After leaving College he became research assistant to the late Prof. Edward Frankland. He then became science master in Ashby-under-Lyme and at Queenwood College. During this time he published his first work on "Qualitative Analysis," which is still a standard text-book.

In 1881 Dr. Clowes was appointed as the first professor of chemistry at University College, Nottingham, a position which he held for sixteen years. For a considerable portion of this time the writer of this notice had the privilege of working with him. He practically founded the school of chemistry at Nottingham. From a small beginning it gradually grew until it became one of the most vigorous departments of the College and is now recognised as a centre for advanced work and research.

During his tenure of office at Nottingham, Dr. Clowes founded the East Midland section of the Society of Chemical Industry, and so linked up the chemical industries of the town and neighbourhood with the College. He instituted technical classes, notably in connexion with dyeing and bleaching, soap manufacture, brewing, and the coal industry. In connexion with the latter industry he published a work entitled "The Detection of Inflammable Gases," embodying a considerable amount of research and investigation on the presence of explosive gases, and the causes of explosion, in coal mines. He also published a number of papers in the journals of various scientific societies. He maintained his early interest in analytical chemistry, and, in conjunction with another, he published several text-books on this subject.

In 1897 Dr. Clowes was appointed chief chemist to the London County Council, and retired from this appointment in 1913 on reaching the age limit of sixty-five. During this time the chemical staff was increased and the work reorganised. The experiments on the biological treatment of sewage initiated by his predecessor, Mr. W. J. Dibdin, were continued and extended in various directions. Useful work was also done on the bacteriology of sewage, the bacterial content of sea-water, and the effect of the dissolved salts in sea-water on the solubility of oxygen.

Other work undertaken by Dr. Clowes and his staff dealt with the ventilation of the London tube-railways, and the examination of the London water-supply, the latter work being done prior to the institution of the Metropolitan Water Board. A considerable amount of work was done in connexion with the many enactments and departmental committees on gas-supply.

Probably the most important investigation on gas-supply was that undertaken conjointly with Mr. J. H. Coste (the present chemist), which led to the epoch-making introduction of a calorific standard for gas. In spite of his busy professional life, Dr. Clowes found time to investigate various problems of, and publish papers on, industrial chemistry.

Dr. Clowes was a valued member of many scientific societies. He served as president of the Society of Chemical Industry, vice-president of the Institute of Chemistry, member of the senate of the University of London, and in many other high positions in the scientific world. He was especially interested in the Society of Chemical Industry and the Institute of Chemistry, and he largely helped to increase their usefulness and power.

Those of us that knew Dr. Clowes intimately feel that we have lost in him a friend of uniform kindness, and a man possessing in a high degree the qualities of sound insight, integrity, and steadfastness of purpose. J. B. COLEMAN.

MR. WILLIAM MORFITT.

MR. WILLIAM MORFITT of Goole, who died on December 28 at the age of ninety-two, retired forty years ago from his business as a baker and took a small cottage on the Holderness Coast at Atwick, near Hornsea, where he passed the remainder of his long life, accompanied by his two sons. Besides devoting attention to gardening, Mr. Morfitt discovered a fine pair of antlers of the red deer in the peat near his house, which gave him an interest in antiquarian matters; and the father and two sons have spent much of their time during the past forty years in scouring the cliffs and fields for geological and archæological specimens. In this way they have gathered together a large collection of derived fossils from the beach, remains of red deer and other mammals from the peat, implements of the Stone Age, and a number of examples of pottery of the Bronze Age and of Roman and later dates.

The collection was exhibited in a shed adjoining the cottage, which was always a welcome resort for visitors to the village, to whom the objects were described by Messrs. Morfitt. Teeth and portions of tusks of mammoth particularly were sought for, and according to the Press reports the weight of these alone is more than 700 pounds. Sir William Boyd Dawkins, the late Canon Greenwell, the late J. R. Mortimer, and other well-known antiquaries visited the "Museum" at Atwick, and were in regular correspondence with Mr. William Morfitt. It was one of the sons who produced the harpoons which some authorities consider to represent the Maglemose culture, the authenticity of which was challenged at the Hull Meeting of the British Association.

WE regret to announce the following deaths:

Prof. H. J. Hamburger, professor of physiology, histology, and physiological chemistry in the University of Groningen since 1901, aged sixty-four.

Dr. F. Omori, professor of seismology in the Tokyo Imperial University and president of the Japanese Imperial Earthquake Investigation Committee, on November 8, aged fifty-five.

Mr. W. M. Pybus, a well-known north of England ornithologist, on January 4, aged seventy-two.

Sir John Tweedy, past president of the Royal College of Surgeons, a distinguished ophthalmic surgeon, on January 4, aged seventy-four.

Current Topics and Events.

IN our issue of March 10, 1923, p. 336, we referred to a number of telegrams which had appeared in the daily Press reporting the discovery of a so-called fossilised human skull of Tertiary age in Patagonia. At the time, we urged the need of caution in accepting such reports. Dr. Imbelloni has contributed to the *Revista de la Universidad de Buenos Aires*, t. li., under the title "Nota sobre los supuestos descubrimentos del Doctor J. G. Wolff en Patagonia," what may be regarded as the final chapter in the history of the alleged discovery. His object is to place the facts on record and at the same time to clear Argentine men of science of any suspicion of having lent support to the view that the find was genuine and of a high antiquity. Dr. Imbelloni's account, which is written with an acid humour, makes it clear that the report was received from the first with scepticism. As soon as Dr. Eric Boman and others had had an opportunity of cross-examining Dr. Wolff, they arrived at the opinion that the specimen was not a skull at all. It was not, however, available for examination. When it reached Buenos Aires in May, it was immediately examined by a commission consisting of Dr. Boman, Dr. S. R. Dabbene, Dr. R. Lehmann-Nitsche, Prof. F. F. Outes, Dr. V. Vidakovitch, and the author, and it was at once pronounced to be a block of sandstone.

AN article in the *Times* of December 29 directs attention to the movements in Afghanistan of M. Foucher, the distinguished French authority on Buddhism, which may give rise to difficulties in the prosecution of archæological research in that country owing to the exclusive right to excavate granted by the Afghanistan Government to France at the beginning of last year for thirty years. As a result of protests made at the time, an amicable arrangement was reached by negotiation between the French and British Governments. It was stated that the French monopoly was intended to facilitate M. Foucher's work near Kabul and would not preclude the Afghan Government from allowing concessions, with French consent, to other nationalities in areas where the French were neither working nor intending to work. It was M. Foucher's intention, after the summer and autumn excavations at Kabul, to excavate during this winter at Jelalabad, which is only 30 miles from Peshawar. Under instructions from Paris he has, however, proceeded to Balkh, 375 miles north-west of Kabul, an area in which, it may be noted, climatic conditions are unfavourable for excavation in winter. The writer of the *Times* article points out that his presence here technically debars Sir Aurel Stein, the distinguished Central Asian explorer and antiquarian, from carrying out his contemplated excavations in Northern Afghanistan. It is scarcely necessary to emphasise the unfortunate character of a concession which might thus, on a technical point, preclude a scientific worker of the highest international reputation from continuing his researches in an area in which his discoveries have already added enormously to our knowledge.

THE Council of the Institution of Civil Engineers has for some time past felt that, owing to an increase in recent years in the number of engineering societies and the unregulated employment of the term "Civil Engineer," uncertainty was likely to be created in the public mind as to the status of the members of the engineering profession who possess qualifications of a high order. The Council is naturally desirous that no erroneous impression or confusion may exist on the subject, so far as it concerns its corporate members. The opinion at one time prevailed that the ends which the Council had in view could best be attained by means of a Registration Act similar to that by which members of the medical profession are governed. The matter of promoting a bill in Parliament for this purpose was carefully examined a few years ago by the Council, but this idea was abandoned; the conclusion having been arrived at that, at the time, the Institution could not, with any degree of confidence, anticipate the successful outcome of an attempt to secure, by means of a Registration Act, the legal limitation of the assumption of the title "Civil Engineer" by those alone who held the appropriate qualifications. Accordingly, the Council turned its attention to other means for obtaining for its corporate members authoritative recognition in the nature of a distinctive description, and it has recently attained its object by means of a supplemental charter (dated February 24, 1922) and the by-laws approved by the Privy Council in connexion therewith. Under these by-laws, it is provided, *inter alia*, that: "Every member and associate member is, and is entitled to describe himself as, a 'Chartered Civil Engineer.'" It is further laid down that this description, when used, shall be placed after the designation of the class in the Institution to which a corporate member belongs.

AN appeal has been issued with the view of purchasing the Farne Islands, off the Northumbrian coast, and preserving them as a bird sanctuary under the National Trust. The principal islands of the group are about fifteen in number, and have a surface area of some eighty acres in all: they vary in character from flat shingly mounds to sheer basalt pillars. As a breeding resort for sea-fowl they have no equal on the English coasts, and even the great bird stations among the Scottish Isles lack one or two of the species represented here. The regular breeding population includes gulls of three species, terns of four, auks of three, cormorants of two, waders of two, and one species of duck. Most interesting of these, perhaps, is the roseate tern, now found in only a few British localities. The Sandwich tern has also one of its chief colonies on the Farnes, and they are one of the most southerly stations in the breeding range of the eider duck. The present owners are anxious to sell, and it is feared that the islands might thus fall into less scrupulous hands and come to be exploited to the detriment of this interesting avifauna. Sir George Noble, who signs the appeal, indicates that 1500*l.* is still required to complete the purchase price.

A SLIGHT earthquake is reported to have been felt about 7.40 P.M. on December 25 in South Devon. The shock was a tremor of intensity 4 (Rossi-Forel scale); that is, it was strong enough to make windows, etc., rattle, and it was accompanied by the usual rumbling sound. The disturbed area is an elongated ellipse, 14 miles long and 7½ miles wide, and contains about 82 square miles. Its centre lies about one mile north-east of the village of South Brent, and the longer axis is directed about east-north-east. One or two of the accounts seem to imply that the disturbance was transmitted through the air, and are suggestive of a meteoritic origin, but the evidence seems on the whole in favour of its seismic nature. Earthquakes are rare in the south of Devon and are invariably slight. Since the year 974, however, not one can be assigned to the same centre as the recent shock. On the north side of Dartmoor, in the neighbourhood of Okehampton, a similar earthquake occurred on September 28, 1858, and disturbed an area 15 miles long and 8 miles wide containing 95 square miles. Also, on January 4, 1886, another occurred in the country round Dartmouth, disturbing an area 16 miles long and 8 miles wide and including about 100 square miles.

PROF. E. C. WILLIAMS will deliver a public inaugural lecture at University College on "The Aims and Future Work of the Ramsay Laboratory of Chemical Engineering," on Thursday, January 17, at 5.30 P.M., in connexion with the establishment of the Ramsay Memorial Laboratory of Chemical Engineering. The chair will be taken by Sir Robert Robertson. Tickets can be obtained from the Secretary of University College. The establishment of the Laboratory was one of the two main objects of the fund raised in memory of the late Sir William Ramsay. The Committee of the Ramsay Fund found it possible to hand over to the University of London for University College a sum of approximately 27,000*l.* The Laboratory has been instituted in the first instance for an experimental period of five years, and a suitable building in Gordon Street, close to the Chemistry Laboratories, has been reconstructed and equipped so as to be available for the work of the new Laboratory. A number of firms interested in the chemical and chemical engineering industries have promised annual subscriptions for a period of five years totalling 1540*l.* a year.

THE Model Engineers' Exhibition was held at the Royal Horticultural Hall on January 4-11. A considerable amount of the space was taken up by manufacturers' stands, some showing trade models and others hand and machine tools suitable for the construction of models. There was, however, a large and interesting collection of models, most of which had been made by amateurs. A London surgeon, a clerk, a country postmaster, and many others engaged in occupations not connected with engineering showed working models which evidenced not only manual skill, but also understanding of many of the principles underlying engineering. The smallest working internal combustion motor in the world can be covered by an ordinary tea-cup, and showed extremely fine workmanship both as regards accuracy of the fits and appearance; this model was constructed by a chauffeur. Another piece of work which attracted attention was a scale model of an antique carved oak bedstead, made by a lady. The charge has been sometimes made regarding the present craze for constructing wireless apparatus that the results can be obtained too easily. A few wires are twisted up, and a crystal receiving set is available. This charge cannot be applied to the models in this exhibition, nearly all of which gave evidence of the time and patience which must be devoted in order to acquire dexterity in handling tools, and to obtain a knowledge of the working properties of the materials used in engineering. Working models are of interest to many people, and most of all to their makers, who not only enjoy the behaviour of the finished machine, but also find in its making an outlet for the imagination often stifled in their uncongenial daily occupations.

A SHORT account of Hassanein Bey's latest journey in the Libyan desert is contributed by him to the *Times* of January 3. Starting from Sollum in the end of December 1922, he made for the Siwa oasis and Jalo. At Jalo, a great trade centre of Cyrenaica, a caravan was organised for the Sudan. Faring better than on his journey in 1921, he reached Zieghen without serious mishap, and five days later was at Kufra. Theodolite readings show that Rohlf's position of Zieghen was 100 kilometres too far to the east-north-east, and that of Kufra 40 kilometres too far west. Hassanein Bey left Kufra in April for the oases of Arkenu and Ouenat. These oases do not depend on underground water, but on rainfall collected in natural rock basins in a mountainous region. Arkenu is inhabited only fitfully for grazing, but Ouenat has permanent dwellers. On neighbouring rocks, drawings of giraffes, ostriches, lions, gazelles, and other animals were discovered, but not the camel. Nowadays it is only by the camel that this oasis can be reached. South of Ouenat difficult country was crossed, and for about 280 miles there were no wells. Then the scenery changed as the caravan ascended the slopes of the Erdi and Erdibah hills and reached a grass-covered country. In this part of Wadai, population is not numerous, and consists of negro tribes with some Arab civilisation. Hassanein Bey reached the railway at El Obeïd in June after a camel trek of 2200 miles, of which a considerable distance was over unmapped ground.

THE Secretary of the British Association, Mr. O. J. R. Howarth, is leaving for Toronto on January 16, in connexion with arrangements for the meeting to be held there on August 6-13. He will be returning about February 9.

THE Colonial Research Committee has made a special grant to the Imperial College of Tropical Agriculture, Trinidad, towards the expenses of carrying out, at the College, investigations into the Panama disease of bananas.

APPLICATIONS are invited for a Grocers' Company's research scholarship for original research in sanitary science. The scholarship will be of the annual value of 300*l.*, tenable for one year but renewable for a

second or a third year conditionally. The award will be made in May next, and applications must be sent before April 1 to the Clerk of the Grocers' Company, Grocers' Hall, E.C.2, upon a prescribed form.

SINCE the illness and death of the late Sir William de W. Abney, the annual course of lectures on "Colour Vision" at the Imperial College of Science and Technology, South Kensington, has been perforce suspended. It is of interest, therefore, to note that a course of ten evening lectures on "Colour Vision and Colour Measurement" is announced by the department of Optical Engineering and Applied Optics at that college. These lectures will be delivered at 6.30 P.M. on Tuesday evenings, beginning on January 15, by Dr. L. C. Martin. The subject is one which has developed considerably in recent years, and the review of the present situation allowed in such a course should prove by no means inopportune.

THE December issue of the *Decimal Educator* contains a report of the annual meeting of the Decimal Association, from which we learn that the metric system is to be adopted in Latvia and in Soviet Russia. The address of the president, Sir Richard Gregory, dealt with the necessity, if trade with foreign countries is to be fostered, of adopting the international language of quantity which has now become almost universal—that is, the metric system. While the gallon of 277·25 cubic inches is used in British Dominions, the United States use one of 231 cubic inches, and parts of South America one of 4 litres, which lies between them. We use the long ton of 2240 pounds, the United States and Canada use the short ton of 2000 pounds, and the rest of the world a ton of 1000 kilograms or 2205 pounds, which again lies between them. What is most urgently needed is that the use of metric measures, so indispensable during the War, shall be more encouraged by Government departments, and this can be done without further legislation.

THE general courses of lectures to be given at the Royal Institution before Easter include a wide range of topics. Among them are the following:—"Drug Addictions," by Dr. W. E. Dixon (January 15, 22); "What is Heredity?" by Prof. A. Dendy (January 29, February 5); "The Respiratory Pigments in Animal Life and their Significance," by Prof. Joseph Barcroft (February 12, 19, 26, March 4); "Recent Investigation concerning the Safety of Railway Bridges," by Prof. C. E. Inglis (March 11, 18); "The Crystalline Structure of Organic Substances," by Sir William Bragg (February 7, 14, 21, 28); "Modes of Volcanic Action" and "Types of Volcanic Structures," by Dr. John S. Flett (March 6, 13); "Evolution To-day," by Prof. D. S. M. Watson (March 20, 27); "Scientific Research on Sea Fisheries," by Dr. E. J. Allen (April 3, 10); "Properties of Gases in High and Low Vacua," by Sir Ernest Rutherford (March 8, 15, 22, 29); "Aristotle as a Biologist" and "Leonardo da Vinci as a Man of Science," by Dr. C. Singer (April 5, 12). The lecture hour for the Tuesday and Thursday courses is now 5.15 P.M. Saturday lectures are at 3 P.M. Full particulars of lectures can be obtained from the assistant secretary of the Royal Institution, 21 Albemarle Street, W.1.

Our Astronomical Column.

THE JANUARY METEORIC SHOWER.—Mr. W. F. Denning writes: "The sky was cloudy over a considerable part of England during the night of January 3, and no meteors could be observed. At Stowmarket, however, there was a favourable sky, and it was watched up to $11^h\ 15^m$ G.M.T. by Miss Cook, and a fair number of meteors was counted, but the display was not of an exceptionally rich character. Some brilliant Quadrantids were recorded. At the same place Mr. Prentice watched the sky for $10\frac{1}{2}$ hours before 17^h G.M.T. when clouds interfered. He saw 158 meteors, including about 120 directed from the usual radiant point at about 233° +53°. The maximum appeared to be attained from 14^h to $14^h\ 30^m$, but at no time did the hourly rate exceed 25. There were several contemporary radiants feebly active. The maximum of the display was expected between about 17^h and 19^h Jan. 3, but the accuracy of this prediction could not be tested owing to clouds. In 1900 Prof. A. S. Herschel watched this shower on Jan. 2 and saw 130 meteors in $5\frac{1}{2}$ hours; and in 1918 and 1922 also meteors were more plentiful than during the recent display. Possibly further observations will come to hand and provide more evidence on which to judge fairly of the character of the 1924 shower."

DIFFERENTIAL LATITUDE OBSERVATIONS AT HELWAN.—Bulletin No. 27 of Helwan Observatory describes an interesting series of observations of the altitude of Polaris at two neighbouring stations, in order to see whether the astronomical difference of latitude accords with the geodetic difference. A notable disagreement is an indication that the density of the local strata differs considerably from the mean value, and hence the method may be employed to detect the presence of minerals, oil, etc. Similar tripod stands were erected at the two stations, and a small telescope that could be clamped at a fixed angle was carried from one to the other. It had two parallel horizontal threads, the transit of Polaris being observed over one at each station. It was found advisable when the star approached a thread to extinguish the lamp and observe the transit in a dark field, as small differences of illumination had an appreciable effect.

The results are compared with those obtained from the Eötvös torsion balance. This instrument is stated to be the best for detecting small mineral deposits near the surface; the former method is preferable for large deposits at a greater depth.

STATUS OF THE SPIRAL NEBULÆ.—*Scientia* for January contains a discussion on the spirals by Prof. H. D. Curtis. He contends for a distance of the globular clusters much smaller than that adopted by Prof. H. Shapley, but he supports the view that the spirals are external galaxies, with distances from half a million light years upwards. He gives the arguments that tend in this direction, but scarcely gives enough weight to those that oppose it, notably the evidence of sensible proper motion and rotation deduced by Van Maanen, combined with the spectroscopic evidence of rapid rotational movement. But in a problem of such difficulty it is a help to have all possible points of view exhaustively discussed.

Presumably the printers, not the author, are responsible for the reprehensible mode of marking off the digits of large numbers by decimal points instead of commas. Thus the distance of the Andromeda nebula is given as 500·000 light years. This legitimately means "five hundred," but "half a million" is intended.

Research Items.

THE ICE AGE AND MAN.—An important contribution to the discussion of the Ice Age problem by Prof. A. P. Pavlow appears in the Geological Section of the *Bull. de la Société des Naturalistes de Moscou*, 1922, under the title "Époques glaciaires et interglaciaires de l'Europe et leur rapport à l'histoire de l'homme fossile." He divides Europe into three longitudinal sections: East (Russia), Central (Central Europe), and West (Great Britain). After a closely reasoned analysis of the geological and palæontological evidence, he concludes that there are three glaciations in each area which can be equated with three of the glaciations of Penck's classification, Gunz being regarded as purely local and confined to the Alpine region. His correlation of glaciation and culture places the Mousterian in the Riss-Würm interglaciation; but it is possible that it extends into the Würm. The Aurignacian, however, coincides with the period of maximum cold in the Würm. He thus holds a view which many geologists, at any rate in Great Britain, are discarding in favour of the view that the Mousterian "straddles" the Würm. As regards Great Britain, he suggests that the moraine which extended to the Thames represents the first and maximum glaciation of the three, equating with Mindel, while the Riss, he holds, did not extend beyond Norfolk. Prof. Pavlow would then assign the brick-earths of Hoxne to the Mindel-Riss interglaciation, regarding the occurrence of Acheulean implements in these deposits as corroborative evidence.

THE PALÆOLITHIC PERIOD IN HUNGARY.—L'Abbé Breuil in a first instalment of "Notes de Voyage palæolithique en Europe Centrale," which appears in a recent number of *L'Anthropologie* (t. xxxiii. No. 4), discusses the remains of palæolithic age found in Hungary which he has had an opportunity of examining while on a visit recently to that country. It should be noted, however, that the term Hungary is used in a geographical, and not in the present political, sense, and comprises the area between the Carpathians and the Danube. The author describes the chief features of the principal sites, and discusses the types of the implements found therein. As regards the objects attributed to the Acheulean, the implements found at Mickolcz, about which authorities differ, some regarding them as Acheulean, others as Solutrean, while others even assign them to the Neolithic, he is inclined to class as Solutrean, comparing two of them to types occurring sporadically in Scandinavia in deposits of the Reindeer Period. In discussing the Aurignacian specimens, he points out that finds of this period have been made in Serbia and Bulgaria and in caves near Belgrade, and suggests that the geographical conditions indicate the probability of further Aurignacian discoveries in the Balkan area. An interesting point which he brings out in describing the sites on which Solutrean implements occur is the much higher percentage of implements of this type in the strata of occupation taken as a whole as compared with sites of Western Europe.

NEW FLOWERING PLANTS.—Among the plants figured and described in the last number of *Curtis's Botanical Magazine* (Vol. 149, Part I., 1923) by Dr. O. Stapf, may be mentioned two rhododendrons, *R. Thayerianum* Rehder and Wilson and *R. lacteum* Franch., the latter, in spite of its specific name, having sulphur-yellow flowers. Two interesting succulents are *Caralluma pseudo-N.E. Brownii* Dinter, an Asclepiad of striking habit from South-west Africa, and *Sempervivella alba* Stapf, a little Crassulaceous plant long grown in gardens in Great Britain, but of doubtful origin, probably from the neighbourhood of Simla. This little plant is put into a new genus by Dr. Stapf, in view of the need for smaller and more natural genera in the Crassulaceæ. A new genus is also represented by *Candidea stenostegia* Stapf, the find of Capt. D. W. Robbins, an engineering officer in Northern Nigeria, advantage being taken of an opportunity to split a natural group away from the heterogeneous assembly of species grouped under Vernonia. In all, twelve species are described in this number, including *Primula calciphila* Hutchinson, a species distinguished by its author from *P. sinensis*, with which it has long been confused, in a paper in the *Kew Bulletin* (pp. 97-102, 1923). Dr. Stapf. however, evidently thinks that this species has still to make good its distinctive claim to specific difference from *P. rupestris*. Evidently the origin of the Chinese primula of our garden is a problem of which we may still expect to hear more.

SEISMIC SEA-WAVES IN HAWAII.—The Monthly Bulletin of the Hawaiian Volcano Observatory for February 1923 contains a brief but interesting account of a series of seismic sea-waves that reached north-western Oahu on February 3, 1923, at 12.2 P.M., Hawaiian time (2.32 A.M. on February 4, G.M.T.), and Hilo about 12.30 P.M. Four hours earlier, the seismographs at the Volcano Observatory had given warning of the coming waves by registering a large earthquake, the centre of which was probably under the sea off the Aleutian Islands. The waves, as shown by the tide-gauge at Honolulu, consisted first of a recession of the waters followed by a series of movements that lasted for many hours. In the greatest wave the water rose more than 20 feet, wrecking boats and railway bridges in Wailoa River (Hilo) and killing one man. Elsewhere frame houses were demolished, embankments were washed away, and boats and wharves were injured.

IS SNOWFALL DECREASING?—The *Monthly Weather Review* for July, published by the U.S. Department of Agriculture, has an article entitled "Are we having less Snowfall?" by Mr. C. J. Root, of the Weather Bureau at Springfield, Ill. Snowfall in the State of Illinois is chiefly considered, but for completeness the author has discussed what has happened in other States. The inquiry is suggested by such remarks as, "We do not have the big snows that we did when I was a boy, and I do not think we will ever have them again." At Springfield the snowfall has been rather light during several recent winters, although the greatest fall on record, 43 inches, occurred in the winter of 1913–14. The winter totals averaged for periods of 10 years from 1884 are 20·3, 19·6, 21·9, and 20·3 inches. In New England the snowfall was unusually heavy in the winter of 1922–23; at Portland the January fall was 53 inches, and in the winter the total exceeded 10 feet. All highways are said to have been absolutely impassable for automobiles from the first week in January until the last week in March. At Albany and New York the snowiest winter occurred some 30 years ago, while at New Haven, with a record from 1873, the heaviest snow occurred in the winter of 1915–16, and in 1922–23 the total was 19 inches above the normal. At Boston, with a record from 1871, the greatest snowfall, 96 inches, occurred in 1873–74, but the winter with the least snow was only two years later. Many more facts are given, and the author sums up with the conclusion that in years to come the snowfall will be as heavy as in the past.

HISTORY OF PETROLEUM.—An article on this subject from the pen of Prof. Marshall Haney, of the Shenandoah Institute, U.S.A., appears in the December number of the *Scientific Monthly*. The gist of his treatment is that "petroleum is absolutely necessary to the age in which we live and one of the most important substances used by society to-day," and consequently some broad knowledge of the nature, origin, mode of occurrence, production, refining, transport, and uses, including a brief account of the history of the industry, is essential from every human point of view. He proceeds, therefore, to trace the history of the industry in America from the early 'forties to the present time, giving a brief summary of the principal oilfields developed in the United States. Considerable space is devoted to the theoretical aspects of the subject, and here we notice one of the few cases where an author has cited climatic conditions of past ages as being directly contributory to the formation of oil by rendering an environment suitable to the support of abundant life. Also the significance that most of the great oilfields of the world lie between parallels 20° and 50° north latitude is commented upon. Altogether the article is a curious mixture of novel observation and orthodox description of petroleum, and, though it is for the most part disjointed in the extreme, it gives the non-technical reader a good general impression of the subject with which it is concerned.

RAILWAY SURVEYING BY PHOTOGRAPHY.—Mr. J. W. Gordon, who has devoted much time to the investigation of the application of photography to surveying, read a paper on this subject, on December 3, before the Society of Engineers. The object is to make a large-scale contoured survey of a zone of land about a hundred feet wide, in which the detailed location of a railway line is to be determined. The method proposed is to take a series of photographs from camera stations about three hundred feet apart, the camera in each case to be mounted on a tower ladder, or otherwise raised above the ground. By permission of Sir J. Colman, an experiment was made in Gatton Park on October 20. Unfortunately, the tower ladder went astray, and the experiment had, perforce, to be made without it. In general, the optical axis of the camera would be horizontal, or inclined at a small angle to the horizontal, and this angle would be ascertained from the photograph. The positions of visible objects on plan and in contouring would be fixed by a comparison of photographs taken from successive camera stations. Mr. Gordon uses a special comparator, devised by himself, for the determination of contours, and a special plotting board for the construction of the plan. So far as can be seen at present, the chief merit of the system lies in the fact that the photographs constitute a trustworthy record of the operation. More experiments are required, especially experiments in competition, for cost, speed, and accuracy, with the normal methods of the railway engineer, over open featureless country, as well as over country well provided with visible marks.

PULVERISED FUEL.—At the Institution of Electrical Engineers, London, on December 13, Mr. David Brownlie read a paper on "Pulverised Fuel and Efficient Steam Generation." He dealt mainly with the superiority over steam-raising plant using mechanical stokers, even of the most modern design, which is displayed by coal-dust-fired boilers—especially those using the Lopulco system. In this the coal is dried by the heat of the flue gas and burned with preheated secondary air. Complete combustion is attained though the excess air is reduced to 10 per cent., and accordingly very high carbon dioxide contents (17-18 per cent.) are attained in the flue gases. There circumstances make possible the attainment of high thermal efficiencies of steam production. At the Lakeside electrical power station, Milwaukee, efficiencies reaching 85-86 per cent. are claimed as being regularly maintained in normal working. This is to be set against an excellent long-duty performance of 76·6 per cent. in the boilers with mechanical stokers at the Dalmarnock power station, Glasgow. In addition to high thermal efficiency, dust firing has other advantages, such as reduction of boiler-house labour, flexibility as to fuel and load—overloads of 100 per cent. being possible. Smoke is easily avoided, but as much as 25 per cent. of the ash of the coal is ejected at the chimney top—an undesirable feature in urban installations. Soon there will be 3,500,000 tons of pulverised coal burned annually in boiler plants. What is, however, most significant is the fact that the newest and the largest plants projected are to be so operated, especially in America, where the most ample practical experience has been accumulated. Mr. Brownlie pleads for a serious investigation of the question of pulverised fuel in Great Britain, especially for large power station plant.

DEFINITIONS AND NOMENCLATURE.—In the *School Science Review* for December Mr. V. T. Saunders raises the question of the best way of defining the fundamental concepts of geometry and physics in introducing them into school work, and Mr. G. H. Benham asks how much longer teachers are to put up with the existing confusion in the nomenclature of chemistry? The former, after discussing some of the current definitions, concludes that the best definition of a straight line is "a line all in one direction," and of an angle "the difference in direction between two straight lines." Force he defines as a push or a pull, and a machine as a means of transmitting pushes and pulls. Mass he would replace by weight in defining density and specific heat, and for temperature he takes Preston's definition-degree of hotness. Mr. Benham directs attention to the two standards of atomic weight, the use of univalent and monovalent, of pyro- and di-sulphate, of bi- and di-chromate, of sulphocyanide and thiocyanate, of strong and concentrated acid, of water of crystallisation and of hydration, as alternatives which are unnecessary and confusing to teacher and taught.

MEASUREMENT OF THE INTENSITY OF X-RAY SPECTRAL LINES.—In order to measure the relative intensity of different lines it is found advisable to make use of some device which will enable the effect produced on the measuring photometer to be made nearly equal in the two cases. Messrs. M. Siegbahn and A. Láček, in the *Annalen der Physik*, 71. 1-4, pp. 187-198, 1923, describe a method in which a disk, with sectors of variable aperture, is rotated in front of the photographic plate while it is being measured, so that the intensity due to a strong line is reduced, at least approximately, to that of the weaker line with which it is being compared. Herr G. Kettmann varied the time of exposure, in a given series of experiments, so that approximately equal blackening is produced; the blackening was measured by a Koch Goos microphotometer, and the intensity of the X-rays was calculated by dividing the blackening by the product of the current and the time of exposure. Curves giving the relation between intensity and voltage have been obtained for the K series of chromium, copper, and silver, and the L lines of lanthanum and lead; the results are in agreement with former measurements of Webster

and of Wooten on other materials, in a more limited region. With very high voltages, the intensity reaches a maximum which depends on the absorption of the X-rays in the anticathode. The theory of Bergen Davis was found to agree with the results; with small absorption of the X-rays in the anticathode the intensity increases linearly with V^2. A simple method is given, assuming the correctness of the Davis theory, for finding the braking power of the anticathode for cathode rays.

ELECTRON EMISSION FROM INCANDESCENT SUBSTANCES.—Herr A. Goetz describes the apparatus used by him in an investigation of the emission of electrons at different temperatures, with special relation to points of physical discontinuity, in the *Physikalische Zeitschrift*, September 15, 1923. An electrical furnace was employed consisting of a cylindrical cup of carbon, mounted on a long vertical carbon rod, inside the cylindrical, glass vacuum globe. This was made in two portions, the upper one being joined to the lower with a mercury seal. To obtain vacuum-tight joints for the two thick iron rods used to supply current to the furnace was very difficult; but a special water-cooled joint of cement and mercury was evolved. The carbon furnace was turned down to a thickness of 1/10 mm., thick rings being left at the ends to attach the connecting wires; the inside was lined with magnesia or zirconia. The temperature of the heated metal was measured with an optical pyrometer, and the saturation current due to the electronic emission was observed, over a long range of temperature, for copper, iron, and manganese. According to Richardson's theory, $\log i - \frac{1}{2} \log T$ should be proportional to T^{-1}, where i is the saturation current and T the absolute temperature. Graphs of these quantities gave straight lines of different slopes between the different points where physical change in the metal takes place. According to the kinetic gas theory of the conduction electrons, this would be explained by a change in the number of these electrons. The difficulties in the way of this theory are such that Goetz considers the conduction theories of Benedick and Borelius, the latter of which is in some ways more satisfactory; he does not notice the recently published suggestion of Schottky, that the conduction electrons inside the metal are moving in special quantum orbits; this appears to have the advantage of the Borelius theory, and to be superior in that the conducting electrons possess a certain amount of kinetic energy.

NEW INSULATION TESTER.—Messrs. Evershed and Vignoles of Acton Lane Works, Chiswick, are placing on the market a "constant pressure 'meg' insulation tester," which should prove of great use to electrical engineers. The instrument comprises a 500-volt generator, a moving coil ohmmeter unit, totally enclosed driving gear, and a constant pressure clutch which enables the armature to run at a practically constant speed of 4500 revolutions per minute. In order to secure a long life at this high speed, the roller bearings have been specially constructed. The instrument only weighs $7\frac{1}{4}$ lb., and its overall measurements when open and ready for use are only $5\frac{1}{2} \times 6\frac{1}{4} \times 8\frac{1}{2}$ inches. When a testing voltage is applied between two insulated conductors, a current flows until the voltage gets constant, as the conductors act like a condenser. If the voltage is varying, therefore, when the reading is taken, there may be an error introduced by the condenser current. It is therefore advisable to use a constant pressure instrument. The manufacturers are to be congratulated on the many great improvements they have introduced into this testing set.

EXHAUST-VALVE AND CYLINDER-HEAD TEMPERATURES IN HIGH-SPEED PETROL ENGINES.—A paper on this subject was read on December 14 by Prof. A. H. Gibson and Mr. H. Wright Baker before the Institution of Mechanical Engineers, which gives an account of experiments made on a number of cylinders during the past five years. The earlier tests were carried out on aero-engines, and these have been greatly extended by investigations on a single-cylinder water-cooled unit presented to the University of Manchester by Messrs. Armstrong Siddeley Motors, Ltd. Thermocouples were employed for measuring the temperatures. The investigations go to show that, in a well-designed and well-cooled overhead-valve petrol engine, either air-cooled or water-cooled, under normal conditions, the temperature of the exhaust valve may be between 600° C. and 750° C. The temperature is affected by a large number of factors, the most important, in an engine operating without detonation, being the timing of the ignition, the temperature of the cooling water, and the strength of the working mixture. The highest temperatures under such conditions are attained at full throttle with the weakest mixture capable of maintaining maximum load, with the highest jacket-water temperature, and with a retarded ignition. If the conditions are such as to set up pre-ignition, the temperature of the exhaust valve may exceed 800° C. At such temperatures, valves of chromium or tungsten steel rapidly burn out. Generally speaking, the conditions tending to give a hot valve also tend to give a hot cylinder head. Retarding the ignition is exceptional, and gives a hot valve but a cool head. By water-cooling exhaust-valves the temperature can be reduced to about 300° C., and such valves enable the output and efficiency of an engine to be appreciably increased, and also permit of higher compression ratios. Such valves are only suitable for use on an air-cooled engine, and if water is used as the cooling fluid, unless carefully designed, are likely to prove a source of danger.

SEPARATION OF ZIRCONIUM AND HAFNIUM.—In the issue of the *Chemical News* for December 7, Messrs. Hevesy and Jantzen describe the method adopted in separating hafnium—an account of the discovery of which was first communicated to NATURE of January 20, 1923, p. 79—from zirconium. The new element occurs in appreciable amounts in certain zirconium minerals, particularly the mineral alvite, a variety of zircon. The separation from zirconium is effected by fractional crystallisation of the double ammonium zirconium fluoride. The crystallisation may be carried out in porcelain dishes. The authors describe the process in detail, and show by analyses the enrichment of the fractions at the various stages. The final fraction contained not more than 1 per cent. of zirconium, traces of titanium, niobium, and manganese, and very minute traces of vanadium and germanium. Further communications in the same journal are promised.

ELECTROLYTIC METHODS IN ORGANIC CHEMISTRY.—The *Chemical Trade Journal* for December 7 contains an article on this subject. Among the more recent applications are the following: oxidation of *o*-toluene sulphonamide to saccharin (1922); acetaldehyde from acetylene (1920); reduction of acetaldehyde to alcohol (1919); oxidation of acetaldehyde to acetic acid (1920). The use of electrolytic methods in preparing azo-dyestuffs dates from 1904; among the dyes which have been thus prepared are congo red, dianisidine blue, and Ponceau 2G; *p*-rosaniline has also been obtained electrolytically.

The Bloemfontein Meeting of the South African Association for the Advancement of Science.

THE twenty-first annual meeting of the South African Association for the Advancement of Science was held at Bloemfontein on July 10-14, under the presidency of Prof. J. D. F. Gilchrist. The meeting was well attended, and some 60 papers were presented, including a symposium on the drought problem and a discussion on Mendelism. There were various visits to places of scientific and historic interest in the vicinity, and after the close of the meeting some of the members went on a short excursion into Basutoland that was of considerable scientific interest. Two popular lectures were given in Bloemfontein, one by Sir G. Cory on the Piet Retief-Dingaan Treaty, and one by the Rev. Noel Roberts on South African birds. A scientific conversazione arranged by Profs. Logeman and Potts was held at the Grey University College. Opportunity was taken to identify the Association with the celebrations in honour of the centenary of the birth of Louis Pasteur, and Dr. Annie Porter gave a short illustrated account of Pasteur's life and researches.

The president of the Association chose the subject of "The South African Seas" for his address, first treating the matter historically. South Africa originally was intended merely as a victualling station by the Dutch and settlement was not encouraged. Gradually migration inwards began and the sea-instinct was lost. The history of exploration of these seas was reviewed, and the marine fauna was briefly described. Need for full investigation of currents and their periodicity is fundamental. The Agulhas current and circumpolar West Wind Drift current differ in temperature, salinity, and nitrogen content, three factors which determine the environment of the forms of life they contain. Life in the sea on the Natal coast is more active and strenuous than in the Cape seas; acidity is more marked in west coast waters. The future possible developments of South African seas were discussed, and the influence of marine biological surveys, of expansion due to new universities, and to the Association during the last twenty years was outlined. Need for continuous advancement was emphasised.

"The Structure of the Atom" was the subject of Prof. W. H. Logeman's presidential address to Section A. An historical résumé was given from the time of Dalton. Prout's hypothesis was discussed and the far-reaching results of Crookes's statement that there was no evidence that all atoms of an element were of exactly the same weight were outlined. The properties of the electron with reference to Thomson's work, the discovery of radio-activity, the properties of radio-active substances, and the α-, β-, and γ-rays were discussed in some detail. The work of Thomson, Rutherford, and Aston was briefly described. The strength and weakness of the present theory of the structure of the atom were indicated.

The presidential address to Section B was delivered by Mr. A. Stead, and dealt with "Twenty Years of Chemical Progress in South Africa." It also served as an introduction to the symposium on the Drought Problem in South Africa. The speaker first dealt with the rise of chemical industry, increase in employment of trained chemists, the rise of chemical societies, the development of a Government Division of Chemistry, and the institution of a Government Soil Survey. Animal nutrition was discussed. The interrelation of rainfall and plant growth, the various methods of increasing rainfall, as well as those whereby water could be conserved, were considered. Attention was directed to the superiority of the paddocking system over the kraaling system for sheep, and comparative figures were given for the metabolism costs in the two cases. Preservation of soil sponges, natural manuring of the veld, prevention of veld destruction, and search for new sources of chemical fertilisers within the Union were urged.

Dr. Bertha Stoneman took as the subject of her presidential address to Section C, "The Search for Crucial Instances in Botanical Procedure." The various conflicting views especially in relation to the philosophical and physiological aspects of botany were indicated. Work on mutations, Mendelian experiments, and hormones was cited, the latter indicating that many adaptations may have been produced in a Lamarckian manner by stimulation and functional response under the influence of such secretions. The age and area theory was outlined. Geotropism in relation to the hydrogen-ion concentration in the cells of the region of gravity perception was discussed, as were current views on translocation of water, organic and inorganic compounds within plant tissues, routes of translocation of food materials, and work on rhythmic pulsation of tissues leading to the ascent of sap. The wealth of conflicting evidence on the various problems was held to afford stimulus for investigation.

"Remarks on the Distribution of Animals in South Africa" was the title of Mr. J. Hewitt's presidential address to Section D. The probable source of the African mammalian fauna was considered to be in the Northern Hemisphere, the earliest forms being found farthest away from the centre of dispersal. The African continent is a comparatively passive region, receiving successive invasions of refugees. Warthogs, duikers, and steinbok, however, are peculiar to Africa. The Western Province of the Cape has characteristic species of Amphibia and Reptilia. Primitive genera have a comparatively limited range of distribution, as illustrated by lacertids, snakes, and geckos. The Drakensberg serves to divide northern waves of invasion into two streams. Groups that have entered from the north have their primitive members chiefly in the south and south-west, and their highest forms more or less concentrated in the tropics. The few groups that seem to have radiated from the south have their greatest specialisation in South Africa and their more generalised forms in the tropics. A plea was made for a more intensive study of animal distribution.

The presidential address to Section E was delivered by Prof. A. Radcliffe-Brown, who spoke on "The Methods of Ethnology and Social Anthropology." The need for agreement as to the proper aims and methods to be followed in the study of the customs and institutions of uncivilised peoples was emphasised, and the limitations of the respective fields were set forth. An outline was given of the building up of the historical and the inductive branches, of the evolutionary theories, and of the diffusion of culture hypotheses. The distinction between the aims of psychology and social anthropology was illustrated, and totemism and totemistic hypotheses considered. The immediate applications of the study of social anthropology must be passed on to all social workers. The present is a critical time for the subject, for just as it has established itself, its subject-matter is disappearing or becoming radically changed by contact with other civilisations; hence there is urgent need for immediate study of the native peoples of Africa.

The presidential address to Section F was given by Dr. J. T. Dunston, his subject being "Retarded

and Defective Children: Native Mentality: Mental Testing." It was pointed out that the future of the state depends on the children. The proportion of children in South Africa retarded for three years or more is larger than in the United States, and is greater in country than in town schools. The cases can be classified as restoration cases, backward cases, doubtful cases, the feeble-minded and the psychopathic group. Feeble-mindedness, much of which is inherited, is of the greatest importance. Measures for combating this condition were outlined. The estimation of the mentality of natives is difficult, no standard of normal intelligence having been established. From numerous considerations, both of the African Bantu and of the American negro, it was suggested that in natives there is such a deficiency of brain cells that neither education nor environment, nor any other factor except a mutation, can lead to their rising to the level of advancement of higher races. Mental tests were considered to be more useful for pedagogic or industrial purposes than for diagnosis.

It is only possible to notice some of the interesting papers read before the various Sections.

In Section A, Dr. J. Lunt gave a well-illustrated paper on a spectrographic analysis of the germanium-gallium mineral germanite, from a new and valuable deposit at Tsumeb, while Mr. G. W. Cox contributed an interesting paper on seasonal weather forecasting.

In Section B, Dr. P. A. Wagner described the chromite from two new belts in the Bushveld igneous complex. The grade of the mineral is considered to be too low for export. Mr. T. D. Hall gave an account of the comparative determination of the lime requirements of soils by different methods. The Veitch method is preferred for South African conditions. Mr. I. P. J. du Plessis described the mode of extraction of oils, alkaloids, and other chemical products from the plants *Dodonea thunbergi*, *Eriocephalus umbellata*, and *Sphenogyne abrotanifolia*, of reputed therapeutic value. Mr. W. Torrance gave an account of the disaggregation of certain rock- and soil-forming minerals. Dr. J. P. van Zyl contributed a note on the effect of varying the quantity of nitric acid in determining P_2O_5 by the molybdate method. Messrs. A. J. Pelling and J. B. Robertson discussed the reciprocal salt-pair formed by sodium chloride and calcium nitrate. Profs. H. H. Green and W. H. Andrews described the isolation by them of the toxic principles of *Adenia digitata*, these being a cyanophoric glucoside and a new toxalbumen named modeccin. Prof. H. H. Green and Miss I. Lonstein described a bacterium that decomposes nicotine.

The drought symposium was attended by all sections. Mr. Stead's presidential address to Section B served to open it. Then Mr. R. J. van Reenen gave a comprehensive review of the problem in South Africa. Remedial measures suggested included artificial rain-making, induced increase of rainfall, and the more efficient use of natural rainfall. Overstocking and overgrazing causes veld deterioration, exaggerates soil erosion, and aggravates drought. Bad agricultural methods contributing to the conversion of former permanent streams into dry or occasional watercourses were indicated. Prof. R. H. Compton discussed drought in the South-west Cape, pointing out that in summer the native vegetation is xerophilous; in winter and spring, annuals and bulbous plants abound. The influence of the south-east cloud, which precipitates moisture on mountain-side vegetation, and the need for increasing natural vegetation for moisture precipitation were emphasised. Prof. G. Potts discussed the plant succession in the Orange Free State. Little or no soil erosion occurs on natural Anthistiria veld. Prof. J. W. Bews pointed out that plant communities in a district are not wholly determined by environmental factors, and the use of indicator plants was discussed. Prof. E. H. L. Schwarz presented a paper on his suggested Kalahari scheme as a solution of the problem. Mr. A. C. Jennings dealt with erosion, especially surface-washing, in Southern Rhodesia, and suggested remedial measures.

In Section C, Prof. J. W. Bews and Mr. R. D. Aitken summarised their work on the aeration system of Natal plants. Prof. Bews also contributed notes on the evolution of plant growth-forms. Dr. T. R. Sim gave notes on South African ferns and Rhodesian mosses. Miss H. Forbes gave an account of the flora of Salisbury Island in Durban Bay, which is now being destroyed by the development of a pleasure resort. Mr. H. H. Curson discussed the three floral regions of Zululand from the point of view of the veterinarian, and gave lists of plants observed therein. An interesting paper was contributed by Mr. E. Parish on the relative economy of ox labour in farming. This labour is the most economical where land is cheap and abundant.

In Section D, sixteen papers were presented. Prof. E. Warren described new-formations in the duodenal mesentery and stomach wall of *Bufo regularis*, some being temporary new growths to supply erythrocytes, some the result of foreign bodies, and others of a sarcomatous nature and due to parasites. Prof. J. E. Duerden and Mr. R. Essex gave an account of the pelvic girdle in the snake, Glauconia. They consider that the retrogressive condition is fixed for the species. Prof. Duerden and Miss M. Ritchie described kempy fibres in the merino sheep, the condition being due to the inclusion of air in the medulla of the hairs. Prof. H. B. Fantham gave an account of his continued researches on parasitic Protozoa, and described a new Giardia from the meerkat, a new gregarine from the locust, and made observations on *Eimeria arloingi* from goats. Prof. Fantham, in collaboration with Miss N. Paterson, also gave an account of Protozoa found in soil and their variation with both season and crops grown, and with Miss C. Weinbrenn, described the parasitic fauna that they had observed in certain South African frogs and toads. Dr. Annie Porter contributed notes on the development of species of Ascaris as observed in Johannesburg at an altitude of nearly 6000 feet. Prof. E. H. Cluver dealt with the variations in body temperature observed in normal subjects under different conditions. Dr. E. M. Robinson supplied an account of the cultivation of a trypanosome of the *T. theileri* type from the blood of South African cattle. Mr. J. Walker gave an account of his work on the application of the conglutinin reaction to the diagnosis of bovine pleuropneumonia. Prof. R. W. Mettam described an abnormality of the right cardiac atrium of the horse, the absence of the omasum in an ox, and the occurrence of pancreatic calculi in the ox. Prof. J. E. Duerden gave a paper on the methods of evolution, showing how differently the same facts can be interpreted when seen from different points of view; this serving to introduce a discussion on Mendelism. Prof. H. B. Fantham contributed a paper on heredity in man, giving a summary of our knowledge of inheritance of various normal and abnormal conditions in man, some of which are inherited according to Mendelian principles while others are not. Dr. F. G. Cawston gave an account of occasional hosts of some South African Cercariæ.

In Section E, Mrs. R. F. A. Hoernlé gave an interesting account of the expression of the social value of water among the Naman of South West Africa. The Naman believe that water has great protective powers against anti-social forces, but is dangerous to members withdrawn from the protection that society affords.

Miss E. D. Earthy described initiation rites for girls in the Masiyeni district of Portuguese East Africa. Mr. W. C. Atkins gave an account of the cash value of native education, concluding that educated natives work longer periods per annum than uneducated ones; he has estimated the annual earnings of different types of working native. Rev. S. S. Dornan described the form and use of divining bones by Bushmen, Hottentots, and various Bantu tribes. He also discussed rain-making by natives in South Africa. Mr. F. W. FitzSimons contributed notes on the cliff-dwellers of Zitzikamma and on the Bushmen of the Zuurberg. Rev. W. A. Norton read a paper on Bantu philology, and exhibited a map of the distribution of the Bantu languages. Rev. J. R. L. Kingon gave some notes on the religion of the Bantu. Rev. C. Pettman discussed Bushmen and their place-names, and Mr. F. H. Melland contributed some notes on the study of witchcraft.

In Section F, Mrs. Mabel Palmer discussed wages, profits, surpluses, and pools on economic bases. Mr. C. Graham Botha shed interesting light on prices at the Cape in the eighteenth century, and also described the dispersion of the stock farmers in Cape Colony during the same period. Mr. F. S. Livie-Noble gave a paper on some lessons from the unconscious, the meeting-place of psychology and philosophy. Prof. R. D. Nauta gave an interesting paper showing Jean de la Fontaine as an unconscious seventeenth-century economist. An able paper was contributed by Prof. T. M. Forsyth on the psychology of autosuggestion.

The next annual meeting of the Association will be held at Cape Town, under the presidency of Prof. J. A. Wilkinson, in July 1924. H. B. FANTHAM.

Prize Awards of the Paris Academy of Sciences.

THE following prizes and grants have been awarded in 1923:

MATHEMATICS.—The Bordin prize to Émile Gau for his work on the general method of integration of Darboux: the Francœur prize to Gaston Bertrand for his work on the theory of integral equations and on the theory of tides.

MECHANICS.—The Montyon prize to Henri Chipart for his work on the gyroscopic theory of light, on electromagnetism, on industrial electricity, and steam-engine governors: the Poncelet prize to (the late) Auguste Boulanger for the whole of his scientific work.

ASTRONOMY.—The Lalande prize to Charles Gallissot for his work in astronomy, especially stellar photometry, distribution of energy on the sun's disc, and the use of photographic methods in astronomy: the Benjamin Valz prize to Walter Sidney Adams for the whole of his work in solar and stellar spectroscopy. The Damoiseau and G. de Pontécoulant prizes were not awarded.

GEOGRAPHY.—The Gay prize to Jules de Schokalsky for his book on oceanography: the Tchihatchef prize to Léon Dussault for his topographical and geological work in south-eastern Asia.

NAVIGATION.—The prize of six thousand francs equally between Charles Lafon for his work entitled "Études sur le ballon captif et les aéronefs marins," and Stanislas Millot for his memoir entitled "Amarrage, remorquage et mouillage des navires, applications aux navires de surface." The Plumey prize was not awarded.

PHYSICS.—The Gaston Planté prize to Marius Latour for his work in the field of electricity: the Herbert prize to Edmond Bauer for his work entitled "La Théorie de Bohr": the Henri de Parville prize to (the late) Maurice Guéritot for his work in magnetism, the specific heats of gases, and wireless telegraphy: the Hughes prize to Eugène Bloch for his studies on ultra-violet radiations: the Pierson-Perrin prize to Pierre Weiss for his work in paramagnetism and discovery of the law which bears his name: the Danton prize to Fernand Holweck for his researches on the radiations intermediate between those of light and of the X-rays: the Clément-Felix prize to Raymond Jouast for his work on the photometry of gas-filled lamps.

CHEMISTRY.—The Montyon prize (Unhealthy Trades) to Eugène Tassilly (2500 francs) for his work on protection against poison gas: an honourable mention (1500 francs) to Roger Douris for his contribution to the study of asphyxiating gases during the War: the Jecker prize to Marc Tiffeneau for his work in organic chemistry, with especial reference to the theory of molecular transformations: the Cahours foundation equally between Mlle. Jeanne Lévy for her studies on molecular transformations, and Mlle. Mélanie Rosenblatt for her work in biological chemistry: the Houzeau prize to Hippolyte Copaux for his work in inorganic chemistry, especially on the complex minerals.

MINERALOGY AND GEOLOGY.—The Delesse prize to Maurice Cossmann for his studies on fossil molluscs: the Victor Raulin prize to René Bourret for his "Études géologiques sur le nord-est du Tonkin": the Joseph Labbé prize to André Defline for his services to mineralogy: the James Hall prize to Gaston Delépine for his thesis on the carboniferous limestones of the north of France. The Fontannes prize was not awarded.

BOTANY.—The de Coincy prize to Henri Humbert for his memoir on the Compositæ of Madagascar: the Rufz de Lavison prize to Gustave Nicolas for the whole of his work in plant physiology. The Desmazières, Montagne, and Jean Thore prizes were not awarded.

RURAL ECONOMY.—The Bigot de Morogues prize to Louis Ravaz for contributions to the progress of agriculture in France.

ANATOMY AND ZOOLOGY.—The Cuvier prize to Clément Vaney for his contributions to zoology, with special reference to insects, echinoderms, and parasitic gasteropods: the Savigny foundation to Gaston Seurat for his researches on the invertebrates of the north of Africa.

MEDICINE AND SURGERY.—Montyon prizes to Georges Bourguignon (2500 francs) for his work in electro-radiotherapy: Georges Guillain, Guy Laroche, and Paul Lechelle (2500 francs) for their work entitled "La Réaction du benjoin colloïdal et les réactions colloïdales du liquide céphalorachidien": Eugène Rochard and Wolf-Maurice Stern (2500 francs) for their work entitled "Diagnostic chirurgical." Honourable mentions to Jean Guisez (1500 francs) for his works relating to the diagnosis and treatment of diseases of the œsophagus: Thierry de Martel and Édouard Antoine (1500 francs) for their work entitled "Les Fausses Appendicites": Maurice Segard (1500 francs) for his work entitled "Consultaire." Citation to Paul Blum for his work entitled "Introduction à l'étude de la thérapeutique. Aperçu critique sur l'évolution des tendances médicales": the Barbier prize to Maurice Fontoynont for his work on the diseases of Madagascar: the Bréant prize (arrears) to Robert Sazerac and Constantin Levaditi for their researches on the therapeutic use of bismuth com-

pounds, especially in the treatment of syphilis: the Chaussier prize (in equal parts) between Justin Jolly for his work in histology, and Maurice Nicolle for his researches in medical bacteriology: the Mège prize to Arthur Leclercq for his book, "Les Maladies du cœur et de l'aorte et leur traitement": the Bellion prize to Paul Ravaut for his book, "Les Maladies dites vénériennes": the Baron Larrey prize to Fernand Visbecq and Armand Jeandidier for their "Guide du Service de Santé en temps de guerre." The Argut and Godard prizes were not awarded.

PHYSIOLOGY.—The Montyon prize to Henry Bordier, for his work, "Diathermie et diathermothérapie": the Pourat prize to Pierre Girard for his researches on the electrical osmosis of living tissues: the Philipeaux prize to Robert Nöel for his work on the functional variation of the hepatic cell in mammals: the Fanny Emden prize to René Marage for his work on the use of the divining rod as a water-finder.

STATISTICS.—The Montyon prize to Alfred Barriol (1000 francs) for work on various questions of political economy and statistics: and an honourable mention (500 francs) to Herbert Edward Soper for a memoir entitled "Frequency arrays, illustrating the use of logical symbols in the study of statistical and other distributions."

HISTORY AND PHILOSOPHY OF SCIENCES.—The Binoux prize to Robert Bouvier for his work entitled "La Pensée d'Ernst Mach, essai de biographie intellectuelle et de critique."

MEDALS.—The Berthelot medal to Eugène Tassilly, Hippolyte Copaux.

GENERAL PRIZES.—Grand prize for physical sciences to Lucien Cayeux for his memoir, "Les Minerais de fer oolithiques de France. II. Minerais de fer secondaires": the Lallemand prize to André Thomas for his work, "Le réflexe pilomoteur": the Serres prize to Georges Pruvot for his work in marine comparative anatomy, embryology, and biology: the Petit d'Ormoy prize (mathematics) to Élie Cartan for the whole of his work in mathematics: the Petit d'Ormoy prize (natural science) to (the late) Grégoire Wyrouboff for his work in mineralogy: the Estrade-Delcros prize to René Baire for the whole of his mathematical work: the Saintour prize to Lee de Forest, inventor of the three-electrode lamp: the Henri de Parville prize to Henri Lenoir for his work, "Historique et législation du salpêtre. Les pharmaciens et les ateliers révolutionnaires du salpêtre (1793–1795)": the Lonchampt prize to Albert Goris for his researches on the conditions of development of the pyocyanic bacillus and the production of its pigment: the Wilde prize to Fernand Delhaye for his geographical and geological work in the Congo: the Gustave Roux prize to Georges Giraud for his works on automorph functions: the Thorlet prize to Adolphe Richard: the Lannelongue foundation to Mmes. Cusco and Rück: the Laplace prize to Louis Léon Charles Neltner and Pierre Marie François Angot: the L. E. Rivot prize between L. L. C. Neltner, P. M. F. Angot, M. R. Mary, Jean Truffot, J. Malavoy, A. A. G. Duchemin, J. Pelissier, A. Schuhl.

FOUNDATIONS FOR SCIENTIFIC RESEARCH.—The Gegner foundation (2000 francs) to Augustin Boutaric for his work, "La vie des atomes": the Hirn foundation to Gustave Eiffel for his work in aerodynamics: the Henri Becquerel foundation to William Bell Dawson for his work on tides and currents: the Bouchard fund to Pierre Loisel for his researches on the radioactivity of thermal waters: the Le Chatelier foundation to Michel Samsoen for researches on the viscosity and expansion of glasses at high temperatures.

The Physical and Optical Societies' Exhibition.

THE fourteenth annual exhibition of electrical, optical and other physical apparatus was held by the Physical Society of London and the Optical Society on January 2 and 3 at the Imperial College of Science, South Kensington. The exhibition is held for the mutual advantage of the makers and users of scientific apparatus, and brought to light as in previous years a goodly array of interesting and in many cases novel instruments.

Amongst the electrical exhibits perhaps the most striking was the Holweck molecular vacuum pump (Mullard Radio Valve Co., Ltd.), which, starting from the vacuum produced by the auxiliary piston pump, can reduce this to an X-ray vacuum in 15 seconds. A cylinder driven by an induction motor revolves inside an accurately fitting cylindrical cover formed with two spiral grooves on its interior surface. Thus the gas is led from the highly evacuated space at the middle of the cover to the auxiliary vacuum at its ends, and the design is such that all non-permanent joints are located in the latter regions. Thermionic valves were shown by this firm, the M.O. Valve Co., Ltd., and Marconi's, Ltd. An interesting demonstration was arranged by H. W. Sullivan, Ltd., to prove the accuracy of their wavemeters to 1 part in 100,000, and the same firm showed an electro-optical magnifier for submarine telegraphy in which selenium cells arranged in a bridge have their inertia neutralised by an ingenious arrangement of shunt inductances. Marconi's Wireless Telegraph Co., Ltd., also demonstrated Dr. McLachlan's recorder for high-speed telegraphy. The received current controls the radial pull, and consequently the friction, between a revolving cylindrical electromagnet and a stationary shoe which slides thereon and completes the magnetic circuit. The resulting tangential pull on the shoe operates a recorder or printer.

The latest types of ammeters, potentiometers, and other testing apparatus were shown by Elliott Bros. (London), Ltd., Evershed and Vignoles, Ltd., Gambrell Bros., Ltd., Nalder Bros. and Thompson, Ltd. (whose rotary synchroscope for testing frequency and phase when paralleling alternators attracted attention), the Record Electrical Co., Ltd., H. Tinsley and Co., Ltd., and Siemens Bros. and Co., Ltd. In the latter firm's four-colour temperature recorder, which runs for three months, a single stylus records the readings of four independent thermocouples, each in succession being periodically switched into circuit while an ink-pad of the associated colour is simultaneously brought into position to co-operate with the stylus when the latter is depressed. Electric furnaces, pyrometers and other apparatus were shown by the Foster Instrument Co., Gallencamp and Co., Ltd., Griffin and Sons, Ltd., and the Cambridge and Paul Instrument Co., Ltd. In a Cambridge and Paul thermostat for gas-fired furnaces a thermocouple is carried by the pointer of a temperature-indicating galvanometer. A fixed heated coil is positioned at that point in the galvanometer scale which corresponds to the required temperature, and on reaching this point the thermocouple is affected and controls the gas supply through a ball relay.

Other electrical exhibits included condensers (Dubilier Condenser Co. (1921), Ltd.), batteries (Darimont Electric Batteries, Ltd.), resistances (Zenith Manufacturing Co.), insulated wires (Concordia Electric Wire Co., Ltd.), and coils and windings (Igranic

Electric Co., Ltd.). The Edison Swan Electric Co., Ltd., showed a variety of Pointolite lamps, and Adam Hilger, Ltd., a new material, "Ilmenite," for arc electrodes, requiring only 1 amp. at 220 volts.

Of the firms exhibiting optical apparatus, Adam Hilger, Ltd., have found several new uses for their excessively thin celluloid, notably in an electrostatic oscillograph (one plate of a condenser being formed by the oscillograph mirror, which is deposited on the celluloid) and a Michelson interferometer showing white light bands without the use of a compensator. This firm also showed a series of spectrographs taken with their Müller apparatus, which is applicable in either the Bragg, the Debye, or the Hull method. In the world of microscopes the development of convenient projection arrangements for drawing purposes was noticeable, as shown for example by C. Baker (at whose stand a lens-maker could be seen at work) and Ogilvy and Co. The "Radial" microscope outfit (R. and J. Beck, Ltd.) is conveniently arranged for viewing a specimen before photographing it, a mere swivelling of the stand effecting the necessary change of position. Microscopes and allied apparatus were also shown by Davidson and Co. and Watson and Sons, Ltd., kinematograph and other lenses by Ross, Ltd., episcopes and lanterns by Newton and Co., opticians' apparatus by Culver, Ltd., and photographic lenses by Dallmeyer, Ltd., who demonstrated by kinematograph the manufacture of a lens. An interesting novelty was the use of stainless steel as a mirror in a refractometer by Bellingham and Stanley, Ltd., whose photometer for use with the spectroscope was also worth noting.

Of interest to mechanical engineers was a machine (Herbert, Ltd.) for testing the pitch of fine screws, a stainless-steel mirror throwing down on to the bench the magnified and vertically projected image of the thread. The Cambridge and Paul Instrument Co., Ltd., are making further use, in their stress recorder and vibrograph, of the plan of causing a sharp stylus to inscribe on celluloid a minute trace which can afterwards be examined microscopically. In the stress recorder a long strip of running film is employed, and the stylus follows the variations in strain of the upper surface of, e.g., a girder subject to variable stress: while the vibrograph, a form of seismograph, is provided with a time-marking device recording tenths of a second. In the optical revolution counter shown by Johnson, a prism is ingeniously cut so that when rotated it causes a fixed object viewed through it to appear to rotate at double its speed. Hence a rotating object appears stationary when viewed through such a prism if the latter rotate at half the speed of the object. The Elverson oscilloscope (Kennedy and Co., Ltd.) achieves a similar effect by intermittent illumination. A noticeable feature of Tinsley and Co.'s stand was the phonic chronoscope. This instrument accurately measures time-intervals by controlling a friction clutch which connects a counting mechanism, during the interval to be measured, to a shaft driven at constant speed by a tuning-fork motor. Mechanical testing apparatus was shown by Casella and Co., Ltd., flow-meters, etc., by Kent, Ltd., and surveying and like instruments by Casella and Co., Ltd., Cooke, Troughton and Sims, Hughes and Son, Ltd. (aerial and nautical), and Ottway and Co., Ltd. Anti-aircraft "gadgets," and the "optophone" for enabling the blind to read, were shown by Barr and Stroud, Ltd. It would have interested visitors to have heard the optophone in operation.

Amongst the meteorological apparatus might be noted a sensitive and accurate barograph by Negretti and Zamba, compensated for temperature and other errors, and Assmann psychrometers and kindred instruments were exhibited by this firm and by Casella and Co., Ltd. It was interesting to see that the Eötvos gravity torsion balance is being put on the market by Oertling, Ltd. This instrument, which measures minute rates of change in space of the gravity constant, has been recently brought to the front in Great Britain after long oblivion for the purpose of mineral surveying. Delicate balances were shown by the same firm and by R. W. McLachlan, and gas calorimeters, etc., by the Sigma Instrument Co.

An instrument well worth the notice of physicists and engineers was the Otis King's calculator (Carbic, Ltd.), which, by the use of a spiral scale and cursor arrangements of novel design, combines the openness of scale of a 66-in. slide-rule with the cheapness and compactness of a pocket model. In the eidograph (W. H. Harling) for enlarging maps, etc., accuracy and freedom are secured by extremely fine workmanship. Mr. J. Rheinberg showed a colour-printing process. Scientific literature was displayed by the Cambridge University Press, H. K. Lewis and Co., Ltd., and the Wireless Press, Ltd.

Discourses were delivered each day on "The Heape and Grylls Rapid Cinema Machine" by Mr. H. B. Grylls, who showed slides illustrating the remarkable deformations of a rubber ball and other objects when struck; and on "The Nature and Artificial Production of Human Speech (Vowel Sounds)" by Sir Richard Paget, Bart., who concluded a sensational demonstration by putting a simple squeaker between his hands and manipulating the latter in imitation of the human mouth, thereby producing a series of sentences which concluded dramatically with "A Happy New Year."

Prof. A. O. Rankine, who recently became secretary of the Physical Society, is much to be congratulated on the success of his first exhibition. C. W. H.

Science Masters' Association Annual Meeting.

THE twenty-fourth annual meeting of the Science Masters' Association was held at King's College for Women, London University, on January 3, 4, and 5, under the presidency of Prof. A. Smithells. Many of the members availed themselves of the kind invitation of the Geographical Association to be present at Sir Richard Gregory's presidential address to the latter body, and also attended the joint conference with members of the Royal Meteorological Society and the Geographical Association on "The Place of Meteorology in Education." Prof. Smithells' presidential address on "The Teaching of Science" was delivered at 8.15 P.M. on the Thursday evening. He said that he had watched with sympathy and interest the rapid growth of the Association from its small beginning nearly a quarter of a century ago to its flourishing state at the present day. The campaign for the introduction of science teaching into schools had proceeded steadily and had extended remarkably, but a generation of science teaching had nevertheless produced a disappointingly small dissemination of scientific knowledge of an available kind among the general public. This was illustrated by Mr. John Galsworthy's recent pronouncement on science, and the president epigrammatically remarked that while the might of science was generally recog-

nised, few people appreciated its right and still less its light. He thought they must admit that, so far, science teaching had edified and instructed the nation far less than might reasonably have been expected from a movement that had been carried out for so long and with such vigour.

Yet Prof. Smithells did not invite the Association to despondency, for there was a great deal to encourage it. Science masters were the missionaries of science, and the attitude of the public towards it in future rested very largely with the Association. The revolutionary discoveries of the last few years afforded them such an opportunity of commending science as had not occurred since Davy and Faraday were expounding the great new knowledge to fascinated audiences at the Royal Institution. If the Science Masters' Association continued strictly on the path it had followed hitherto, it had it in its power to put science teaching in a very different position, and to put it right. He believed that the most important of all the good work they had done was their declaration that school science should primarily take the form of science for all, for science was an essential part of a general education, and the science master should not be considered as standing outside the general body of teachers and as mainly charged with the duty of preparing a few boys for subsequent professional study, in spite of a lingering assumption to the contrary.

Prof. Smithells also explained at some length the changes which university teaching of chemistry had undergone, and remarked that he often felt astonished to think of how much he suffered without complaint in his time at the hands of some university professors. Things had improved since then, but only comparatively recently had science teachers realised that the results of teaching science at schools on the university model were bound to be disappointing. The necessary reconsideration was far from complete, but he was amazed how much good work had already been done.

The address obviously made a deep impression, and on the motion of Sir Ronald Ross, seconded in a characteristically aggressive speech by Prof. H. E. Armstrong, a vote of thanks to Prof. Smithells was enthusiastically carried.

The programme of the two succeeding days included discussions on (*a*) "School Workshops in Relation to the Teaching of Science," (*b*) "The Best Way to introduce Chemical Theory in the School Course," (*c*) "The Cinematograph and the Teaching of Science," and (*d*) "The Properties of Materials as an Introduction to Physical Science." Subject (*a*) was introduced by Mr. C. L. Bryant, of Harrow School, whose main thesis was that the importance of motor activities in promoting mental growth was paramount in childhood. Dr. C. E. Ashford and Mr. S. E. Brown contributed to the discussion, and Mr. V. S. Bryant, of St. Pirian's School, Maidenhead, said that in his school he had found workshop instruction to be very valuable. The discussion on chemical theory in schools was to have been opened by the president, who, however, said he would prefer to close it. Mr. E. J. Holmyard, of Clifton College, was therefore asked to begin, and described the course followed at Clifton. This was a thorough treatment of the atomic theory on a mechanical basis, together with the historical development of chemical thought and a constant insistence upon the pragmatic nature of scientific truth. Mr. T. Rigby gave an account of the method he employed at the West Ham Secondary School, and Mr. T. W. Thompson, of Repton, gave reasons for preferring the molecule to the atom as a starting-point. The subject was evidently one which had caused most members of the Association a great deal of earnest thought, and in which there is room for individual preference. The president wound up with a remarkably clever skit upon the average chemical textbook of not so long ago, and the members then adjourned to the Hygiene Lecture Room for his demonstration on the nature of flame, where he held them entranced for nearly an hour.

On the use of the kinematograph in teaching there was much diversity of opinion, but Mr. C. E. Sladden, of Eton College, voiced the general sentiment when he said that although some of the Nature-study films which had been prepared were excellent, something very different would be required if the kinematograph was to come into general use in science teaching. Mr. V. S. Bryant said that a large number of producing companies were both willing and anxious to turn their attention to this new field of enterprise, and Mr. C. L. Buckle, of the New Era Films, Ltd., asked for the co-operation of the schools in what was necessarily a difficult and complicated problem. Some films were shown, but that which depicted the activities of the tiger-beetle was so intensely horrible that we doubt whether its exhibition was wise. It has also to be remembered that the average child's taste in films is in very many instances highly developed—for good or evil—by those shown at the local kinema; he is therefore likely to find any but the very best scientific films rather dull. Still, the field is promising and should be properly developed.

In the laboratories and library of the College there were exhibitions of pieces of apparatus made by the members and of books published by members during 1923, which bore witness to the vigorous life of the Association. These were supplemented by exhibits of chemicals, apparatus, and books by several of the leading firms of manufacturers and publishers.

At the business meeting on the Friday morning, Sir Berkeley Moynihan, professor of clinical surgery at the University of Leeds, was elected president of the Association for 1924, and it was announced that the next annual conference was fixed provisionally to meet at Leeds. On a ballot to fill three places on the Committee, Mr. W. H. Barrett (Harrow), Mr. T. Hartley (Swindon Secondary School), and Mr. E. J. Holmyard (Clifton) were declared elected.

University and Educational Intelligence.

LONDON.—A course of three free public lectures on "The Influence of Improved Town Planning and Housing in Public Health," will be delivered by Prof. J. Robertson, of the University of Birmingham, at University College, on January 18, February 1 and 15, at 5 o'clock each day. No tickets will be required.

MANCHESTER.—The Senate has conferred the degree of Ph.D. in technological chemistry on Mr. Burrows Moore.

THE University of Sofia is inviting applications for the appointment of a professor of horticulture and pomology. The engagement will be for five years, unless the selected candidate acquires Bulgarian nationality, when it will be renewable indefinitely. Applications should reach the Rector of the University of Sofia not later than January 31. Further information can be obtained from the Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1.

Two Theresa Seessel research fellowships, for the promotion of original research in biological studies,

are offered by Yale University. Each is of the value of 300*l*. Preference will be given to candidates who have already obtained their doctorate, and demonstrated by their work fitness to carry on successfully original research of a high order. The holder must reside in New Haven during the college year, from October to June. Applications should be made to the Dean of the Graduate School, New Haven, Conn., U.S.A., before May 1 next, and be accompanied by reprints of scientific publications, letters of recommendation, and a statement of the particular problem which the candidate expects to investigate.

MANY university men and women working in London will no doubt be glad to avail themselves of the facilities for quiet intellectual work, or needed rest, offered by a country club-house which is being built at Whiteleaf, Princes Risborough, Bucks, and is to be available for members in the early spring of this year. The site of the club is at the focus of a wooded range of the Chiltern Hills, and overlooks Chequers Park, containing the official country home of the Prime Minister. The great growth and increasing distractions of London and other university cities make the provision of suitable retreats in attractive and reviving surroundings an almost essential adjunct to university life and work, and we are glad that the University Country Club, Ltd., has been formed to provide for what is a real need. University graduates and others desiring to apply for membership of the club are invited to communicate with the secretary at 15 Gower Street, London, W.C.1.

THE following have been appointed members of the advisory committee on Native Education in British Tropical African Dependencies :—The Parliamentary Under-Secretary of State for the Colonies (chairman) ; Dr. David, Bishop of Liverpool ; Bishop Bidwell, Sir James Currie, Sir Frederick Lugard, Mr. J. H. Oldham, Sir Herbert Read, and Sir Michael Sadler. Major H. Vischer, formerly Director of Education in the Northern Provinces of Nigeria, has been appointed a paid member and secretary of the Committee, which has been appointed for a period of three years in the first instance. The Trustees of the Phelps-Stokes Fund, of New York, have organised an expedition to proceed to East Africa this year, with the view of making an educational survey of conditions among the natives of East Africa. Major Vischer is to accompany the party.

THE Baillie Library of Chemistry in connexion with the department of chemistry of McGill University, Montreal, was formally opened by a reception on Tuesday, December 11. Dr. Ruttan, the Director, gave a short account of the development of the departmental library of chemistry, and announced that the Baillie Library would be a continuation and development of the old departmental library, for which purpose an endowment of 25,000 dollars had been made by the late Mr. John Baillie. The library, which already possesses thirty-nine sets of journals and periodicals most of which are complete, was endowed in memory of George Irvine Baillie, a student in chemical engineering, who was killed at the battle of Amiens in 1918. The reading-room contains a portrait of Lieut. Baillie and a small, but unique, memorial window. The library will be developed as a reference library, and new sets of reference journals in chemistry, as well as the missing volumes required to complete the present sets, are being added as rapidly as possible.

Societies and Academies.

CAMBRIDGE.

Philosophical Society, December 3.—Dr. H. Lamb, vice-president, in the chair.—C. T. R. **Wilson** : On a simple form of stereoscope and its applications. The instrument has been used for studying stereoscopic pictures of the tracks of ionising particles. The light which enters one eye is deflected through any desired angle by reflection from two adjustable small mirrors held immediately in front of the eye ; the other eye sees the pictures in their undisplaced positions. The two pictures of the stereoscopic pair may be of any size and at any convenient distance apart. The pictures to be viewed by the right and left eyes respectively need not be placed side by side ; the former may, for example, be mounted above the latter. The absence of restrictions on the size and relative positions of the pictures, and the fact that the instrument has merely to be held in front of one eye like a magnifying glass, make this type of stereoscope a convenient one for viewing stereoscopic pictures used as illustrations in books.—J. A. **Crowther** : (1) On an electrostatic oscillograph. The type of electrostatic oscillograph introduced by Taylor Jones has been modified by introducing a torsional control on the mirror. This increases the natural frequency, and makes the instrument easier to work with. (2) On oscillographic study of a Coolidge X-ray tube. To obtain a complete knowledge of the behaviour of an X-ray apparatus it is necessary to obtain simultaneous observations of the potential, the current, the quantity, and the quality of the X-rays emitted at each instant during the discharge. The potential and current wave forms were obtained by the electrostatic oscillograph described above, and a modified Duddell oscillograph, recording on the same falling plate. The corresponding intensity of the radiation emitted was obtained by allowing a pencil of the rays to fall on the same plate through a narrow slit, the penetrating power being estimated by interposing an aluminium wedge in the path of the rays. For a given heating current the Coolidge tube has a definite saturation discharge current, which is reached with potentials of about 12,000 volts.—R. **Vaidyanathaswamy** : On the number of lines, in hyperspace, meeting four regions.—H. F. **Baker** : On the generalisation of a theorem of Steiner.—H. W. **Richmond** : On an extension of Wallace's pedal property for the circumcircle.—P. M. S. **Blackett** : Angular momentum and electronic impacts.—W. **Burnside** : On errors of observation.

DUBLIN.

Royal Dublin Society, December 18.—Prof. E. A. Werner in the chair.—N. G. **Ball** : Phototropic movements of leaves : The functions of the petiole and the lamina with regard to the perception of the stimulus. When a leaf of *Sparmannia africana* is shaded so that a portion of the lamina is exposed to a light intensity which is less than that falling on the remainder of the surface, a slow bending of the petiole takes place, the lamina tending to move away from the shade. The region of greatest curvature is near the base of the petiole, and the stimulus is transmitted through a distance of about 15 cm. The petiole also is sensitive to direct phototropic stimulation. Both petiole and lamina appear to have similar potentialities with regard to the perception of differences in light intensity, but oblique illumination will often affect only the petiole, since if the lamina be flat the intensity of the light falling on it will be uniform.—H. **Ryan** and J. **Keane** : (1) The action of the oxides and oxyacids of nitrogen on phenylbenzylether.

Phenylbenzylether was converted by nitrogen peroxide into 4-nitro- and 4.4′-dinitro-phenylbenzylether together with some benzoic acid. Similar products were obtained by the action of nitric acid on the ether in carbon tetrachloride solution. By the action of concentrated nitric acid on 4-nitro- and 2-nitrophenylbenzylether 2.4.4′- and 2.4.2′-trinitro- as well as 2.4.2′.4′.6-pentanitro-phenylbenzylethers were obtained. (2) The action of the oxides and oxyacids of nitrogen on ethyl-β-naphthylether. Ethyl-β-naphthylether at low temperatures and concentrations nitrated readily, forming 1-nitro-, 1.6- and 1.8-dinitroethyl-β-naphthylethers. On further nitration these substances were converted into 1.6.8-trinitroethyl-β-naphthylether.—H. **Ryan** and T. **Kenny**: The action of the oxides and oxyacids of nitrogen on diphenylethylene-ether. Diphenylethylene-ether formed 4.10-dinitro- and 2.4.8.10-tetranitro-diphenylethylene-ether as main products. Further action of nitric acid on the latter compound formed 2.4-dinitrophenol amongst other decomposition products of the nitrated ether; 4-nitro- and 2-nitro-diphenylethylene-ether melt respectively at 85° and 97° C.; 2.10-dinitro-diphenylethylene-ether melts at 117·5° C.—H. **Ryan** and P. J. **Drumm**: The action of the oxides and oxyacids of nitrogen on diphenylether. Diphenylether was converted into 4- and 2-nitro, 4.10- and 2.10-dinitro-diphenylethers with some 2.4-dinitrophenol. By the action of concentrated nitric acid on the ether or its lower nitro derivatives, 2.4.8.10-tetranitro- and 2.4.6.8.10-pentanitro-diphenylethers were obtained.—H. **Ryan** and N. **Cullinane**: The action of the oxides and oxyacids of nitrogen on diphenylene oxide. Diphenylene oxide formed a mononitro derivative melting at 182° C. and a dinitro derivative melting at 245° C. Concentrated nitric acid converted these substances into a trinitro derivative melting at 223° C. and finally a tetranitro derivative melting at 283° C. This ether reacts with nitric acid less readily than those described above but without the formation of decomposition products.

PARIS.

Academy of Sciences, December 10.—M. Albin Haller in the chair.—L. **Lecornu**: The torsion of transmission shafts.—Marcel **Brillouin**: The tensor of average agitation. Conductibility and the dissipation of the energy of agitation.—Charles **Richet**: Regular and irregular antiseptics. The conclusions drawn by the author from a long series of experiments on the action of antiseptics on the lactic bacillus have been criticised by M. Aug. Lumière. Further critical experiments are described in confirmation of earlier results.—C. **Camichel** and M. **Ricaud**: Hydraulic systems.—Sir C. S. Sherrington was elected Correspondant for the section of medicine in succession to the late Sir Patrick Manson.—B. **Hostinsky**: The problem of the absolute minimum connected with the reflection of light on a surface of the second degree.—M. **Mandelbrojt**: Some theorems on integral series.—G. **Darmois**: The interior problem in the case of a space-time curve with spherical symmetry.—D. **Riabouchinski**: Cavitations and fluid resistance.—P. **Chofardet**: Observations of the Reid comet (1923c) made with the coudé telescope of the Observatory of Besançon. Positions of comet and comparison star are given for December 6. The comet was of 12·5 to 13 magnitude, about 20″ diameter, and without definite nucleus.—J. **Schokalsky**: The surface currents of the north polar sea.—C. E. **Guye**: The spontaneous rotation of the electric discharge. The spontaneous rotation appears to correspond to an electrodynamical phenomenon having its origin in the circuit itself, even although it may be started by external causes, such as a current of air or a magnetic field.—F. **Croze**: The relations between ultimate lines and resonance lines in spectra including several systems of series.—E. **Carrière** and M. **Auméras**: The experimental study of the equilibrium of the system calcium oxalate-dilute hydrochloric acid. The system has been studied by varying factors influencing the equilibrium one by one, keeping the other factors constant. The results are given graphically in four curves, showing the influence of concentration of oxalic acid, of temperature, of excess of calcium chloride, and of excess of oxalic acid.—Camille **Matignon**: The action of high temperatures upon some refractory substances. The substances studied include sodium aluminate, $Na_2Al_2O_4$, melting-point 1650° C.; zircon, melting-point above 2126° C.; zirkite (commercial zirconia), fusing above 1950° C.; tungstic anhydride, not fused at 2130° C.; aluminium nitride, melting-point over 2200° C.—A. **Bouzat** and E. **Chauvenet**: The heats of solution and formation of the double chlorides: $2KCl.CuCl_2.2H_2O$, $2RbCl.CuCl_2.2H_2O$, $2CsCl.CuCl_2.2H_2O$, and of the corresponding anhydrous salts.—C. **Chéneveau** and R. **Boussu**: The estimation of calcium by the nephelometric method. Precipitates of calcium oxalate in suspension appear to obey, within certain limits, the general optical laws of cloudy media; the estimation of calcium by this method is possible, but requires a careful preliminary study of conditions.—Paul **Pascal**: The hexametaphosphates.—Mlle. Germaine **Marchal**: The action of silica and alumina upon calcium sulphate. Equimolecular quantities of calcium sulphate and silica (or alumina) were heated and the equilibrium pressures (sulphur dioxide and oxygen) measured. Both systems give definite monovariant equilibria. The same pressures are shown by the inverse reactions.—V. **Auger**: The solubility of titanic acid in alkalis and in the alkaline carbonates. Crystallised titanium oxychloride.—Paul **Robin**: The chloramidines. These are produced by the interaction of an amidine hydrochloride and sodium hypochlorite solution: they have the constitution, either $R.C(NH_2):N.Cl$ or $R.C.(NHCl):NH$.—E. **Luce**: The production of acetone by the action of potassium acetate upon acetic anhydride.—G. **Malfitano** and M. **Catoire**: Solubility and insolubility of starch.—Léon **Bertrand** and Léonce **Joleaud**: Permian and Triassic strata of the west of Madagascar.—L. **Dangeard** and M. **Solignac**: The geological nature of the Esquerquis bank, from dredgings by the *Pourquoi Pas?* carried out during June 1923 in the western Mediterranean. This bank consists of sedimentary rocks, whilst some neighbouring banks (Graham or Julia) are of volcanic origin.—Mlle. Eugénie **Bellemin**: An attempt at an optical test of the atmosphere carried out at the Lyons Observatory. The method was based on the determination of the height above the horizon (H) at which the scintillation of the stars ceased to be accompanied by changes of colour. The results of three years' observations are applied to study of the relations between H and the coming weather. The method would appear to be of value in weather forecasting.—I. **Pouget** and D. **Chouchak**: The chemical composition of three Algerian radioactive springs.—J. **Pelosse**: Contribution to the study of the thermal régime of the lake of Bourget (Savoie). The results of two years' observations are given in a diagram of the isothermals as a function of the month of the year and the depth.—M. **Henry**: A self-recording thermo-electric actinometer. The temperature differences are recorded by means of a nickel-tellurium couple, sealed in glass. The E.M.F. of this couple is from 10 to 15 times that of the thermocouples

usually employed.—Robert **Lévy**: The mechanism of hæmolysis by the poison of Scolopendra.—Etienne **Rabaud**: The brain and the retina of the anencephalus. A criticism of a recent communication on the same subject by N. A. Barbieri. The facts noted by M. Barbieri (absence of brain and optic nerve, presence of retina) do not necessarily support the view that these are embryologically independent. This is not the original condition but secondary, resulting from the destruction by inflammation of the encephalus and cerebro-spinal column.—Raphaël **Dubois**: A fine auriferous pearl. The purple coloration of a pearl (7 mm. diameter) from a fresh-water mussel. This colour was shown to be due to the presence of a leaflet of metallic gold.—G. Delamare **Achitouv**: The morphological evolution of fæcal spirocheta cultivated in horse broth-serum.—P. **Durand** and P. **Giraud**: The chromogenic streptococci.—W. **Kopaczewski**: The physico-chemical conditions of microbial vitality.—G. **Ramon**: The flocculating power and immunising properties of a diphtheria toxin rendered anatoxic (anatoxin). A description of the preparation of a diphtheric toxin, which completely lost its toxic action on animals, but preserved its flocculating power *in vitro* towards antitoxin. This anatoxin confers immunity on animals and its use is suggested for antidiphtheric vaccination on children.—Georges **Blanc** and J. **Caminopetros**: The reaction of the cornea towards experimental infection of the nerve axis by the virus of herpes and the vaccine.—A. **Peyron**: The action of radium on infectious sarcoma of the fowl.

Official Publications Received.

Maryland Geological Survey. Vol. 11. Pp. 549+11 plates. (Baltimore: Johns Hopkins Press.)

Maryland Geological Survey: Silurian. Pp. 794+67 plates. (Baltimore: Johns Hopkins Press.)

Department of the Interior: Bureau of Education. Bulletin, 1923, No. 49: Statistics of State Universities and State Colleges for the Year ended June 30, 1922. Pp. 16. (Washington: Government Printing Office.) 5 cents.

The Observer's Handbook for 1924. Edited by C. A. Chant. Sixteenth year of publication. Pp. 64. (Toronto: Royal Astronomical Society of Canada.)

The Institute of Chemistry of Great Britain and Ireland. Report of the Conference held at Liverpool, 18th-20th October 1923. Pp. 96. (London: 30 Russell Square.)

Development Commission. Thirteenth Report of the Development Commissioners for the Year ended 31st March 1923. Pp. v+136. (London: H.M. Stationery Office.) 4*s*. net.

Anuario del Observatorio de Madrid para 1924. (Dirección General del Instituto Geográfico.) Pp. 368. (Madrid.)

The Annual Report of the Gresham's School Natural History Society, 1923. Pp. 10. (Holt.)

Department of Agriculture, Federated Malay States and S.S. Bulletin No. 35: Rice in Malaya. By H. W. Jack. Pp. iv+96. (Kuala Lumpur.)

The Marine Biological Station at Port Erin (Isle of Man). Being the Thirty-seventh Annual Report of the former Liverpool Marine Biology Committee, now the Oceanography Department of the University of Liverpool. Drawn up by Prof. Jas. Johnstone. Pp. 48. (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd.) 1*s*. 6*d*. net.

Committee of the Privy Council for Medical Research. Report of the Medical Research Council for the Year 1922-1923. Pp. 143. (London: H.M. Stationery Office.) 3*s*. 6*d*. net.

Diary of Societies.

MONDAY, JANUARY 14.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Sir Alexander Kennedy: The Rocks and Monuments of Petra.

TUESDAY, JANUARY 15.

ROYAL SOCIETY OF MEDICINE, at 5.—General Meeting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. W. E. Dixon: Drug Addictions (1).

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.—N. Crump: Interrelation and Distribution of Prices and their Incidence upon Price Stabilisation.

MINERALOGICAL SOCIETY, at 5.30.—A. F. Hallimond: The Chemical Classification of the Mica Group.—Dr. A. Brammall and Dr. H. F. Harwood: Gold and Silver as Accessory Minerals in the Dartmoor Granite.—A. Russell: Topaz from Cornwall, with an account of the Localities, old and new, at which it is found.—H. C. G. Vincent: Chemical Analyses of Granite from Dufton, Westmorland, and of Mica from Burma.

INSTITUTION OF MARINE ENGINEERS, INC., at 6.30.—Adjourned Discussion on Superheating.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Dr. H. D'Arcy Power: Colour Photography from the Art Standpoint.

WEDNESDAY, JANUARY 16.

ROYAL SOCIETY OF ARTS, at 3.—Mrs. Julia W. Henshaw: Among the Selkirk Mountains of Canada (with Ice-axe and Camera). (Dr. Mann Juvenile Lecture.)

INSTITUTION OF CIVIL ENGINEERS, at 7.—Informal Meeting.

JUNIOR INSTITUTION OF ENGINEERS (at Royal Society of Arts), at 7.30.—Sir J. Fortescue Flannery, Bart.: Marine Propulsion during Fifty Years (Presidential Address).

ROYAL MICROSCOPICAL SOCIETY (Annual Meeting), at 7.45.—Prof. F. J. Cheshire: The Early History of the Polariscope and the Polarising Microscope (Presidential Address).

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.—Annual Meeting.

ROYAL SOCIETY OF MEDICINE (Social Evening), at 9.—Dr. A. Chaplin: Famous Medical Men of the 18th Century.

THURSDAY, JANUARY 17.

ROYAL SOCIETY, at 4.30.—A. Mallock: Summary of the Results obtained from Experiments made during the years 1918 and 1923 of the Effects of Temperature on the Properties of Metals.—M. Brotherton: Experiments on the Emission of Electrons under the Influence of Chemical Action.—M. D. Hart: The Degradation of Acoustical Energy.—*To be read in title only*:—Dr. F. W. Aston: The Velocity of the Positive Ions in the Crookes Dark Space.—Prof. W. L. Bragg: The Structure of Aragonite.—Prof. G. H. Hardy and E. Landau: The Lattice Points of a Circle.—D. Brunt: The Dynamics of Cyclones and Anti-Cyclones regarded as Atmospheric Vortices.—Dr. C. D. Ellis and H. W. B. Skinner: (*a*) The Absolute Energies of the Groups in Magnetic β-ray Spectra.—(*b*) A Reinvestigation of the β-ray Spectrum of Radium B and Radium C.—(*c*) The Interpretation of β-ray Spectra.—H. D. Smyth: Further Studies in Ionisation; Hydrogen and Oxygen.—L. F. Bates and J. S. Rogers: Particles of Long Range emitted by the Active Deposits of Radium, Thorium, and Actinium.—G. M. Shrum: The Doublet Separation of the Balmer Lines.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—H. Marryat: Electric Passenger Lifts.

CHEMICAL SOCIETY, at 8.—R. H. Atkinson: A Suggested Explanation of the Allotropic Transformations of Iron.—H. J. E. Dobson and I. Masson: The Activity of Water in Aqueous Hydrochloric Acid.—J. R. I. Hepburn: The Freezing of Inorganic Hydrogels.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE, at 8.15.—Prof. Besredka: Local Immunity in Infectious Diseases (to be read in English by Dr. H. Platz).

FRIDAY, JANUARY 18.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Col. H. L. Crosthwait: The Survey of India.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—G. C. Weston: Some Practical Points in Pictorialism.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—G. F. Tyler: The Liability of Employers in respect of Personal Injuries to their Workmen.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. H. E. Armstrong: The Scientific Work of Sir James Dewar.

SATURDAY, JANUARY 19.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—R. Reynolds: The Mechanical Reproduction of Music.

PUBLIC LECTURES.

SATURDAY, JANUARY 12.

BIRKBECK COLLEGE, at 5.30.—Dr. F. H. Hayward: Homage Celebration of Leonardo da Vinci.

TUESDAY, JANUARY 15.

GRESHAM COLLEGE, at 6.—W. H. Wagstaff: Geometry (Gresham Lectures). (Succeeding Lectures on January 16, 17, and 18.)

THURSDAY, JANUARY 17.

UNIVERSITY COLLEGE, at 2.30.—Miss Margaret A. Murray: Egyptian History.—At 5.30.—Prof. E. C. Williams: The Aims and Future Work of the Ramsay Memorial Laboratory of Chemical Engineering.

FRIDAY, JANUARY 18.

UNIVERSITY COLLEGE, at 5.—Prof. J. Robertson: The Influence of Improved Town Planning and Housing on Public Health. (Succeeding Lectures on February 1 and 15.)

KING'S COLLEGE, at 5.30.—Dr. J. A. Hewitt: Food and why we require it. (Succeeding Lectures on January 25, February 1 and 8.)