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Co-operative Industrial Research

THE Committee on New Industrial Development last year considered a proposal for the creation of a new national research organisation particularly to assist in the industrial development of ideas, inventions, or processes likely otherwise to remain undeveloped in Great Britain, and thus to close what was alleged to be a definite gap in our existing organisation of research. With this proposal the Committee did not agree and the opinion was recorded that the proposed organisation, the suggested functions of which would go far beyond the organising and undertaking of research, would be superfluous and more likely to cause confusion than to forward the cause of scientific research in industry. Although the Committee's reasons for rejecting this proposal were soundly and convincingly argued, the report did not suggest that the organisation of research in Great Britain was by any means perfected and the Committee indicated indeed points at which much wider use might be made of existing facilities.

On the other hand, a paper like that read a little while ago by Sir Harold Hartley, when he reviewed scientific research on the London Midland and Scottish Railway, gives such an impressive picture of the possibilities in co-operative research already existing in Great Britain that an optimistic view of their resources is easily engendered. It is clear, however, from the reports of the Advisory Council which directs the work of the Department of Scientific and Industrial Research that, while the framework may exist, it has not yet been developed to an extent commensurate with either national or industrial needs. Because the existing facilities are not being adequately used, dangerous gaps do in fact exist between pure science and manufacture, and certain industries are a long way from considering seriously how scientific knowledge can be utilised in their processes. Only in one or two spheres has the Department as yet been able to survey national resources as a whole and to endeavour to provide a basis upon which production and consumption could be planned as a scientific whole, in some such way as was advocated by Sir Arthur Salter at McGill University recently. The development of new industries based on a full knowledge of scientific resources and an economic scientific co-operation with other countries might well build a new industrial Britain.

If, however, one of the most important steps to be taken in closing this gap is the education of

industry to appreciate the contribution which science can render to its everyday needs, there are other directions too in which action seems to be called for. To one of these Dr. A. J. V. Underwood and Prof. W. E. Gibbs recently directed attention in a letter to the *Times*, and Dr. Underwood has since elaborated his ideas in an article entitled "Some Thoughts on Industrial Research" which appeared in the *Chemical Trade Journal* on March 17. Apart from the fundamental scientific research which in the main is the field of the universities, and the industrial research which is concerned with the improvement of processes or the development of new products, Dr. Underwood directs attention to the position in Great Britain of industries too small to support a research association, and to the facilities which exist for research on problems which in scope are far beyond the limits of a single industry.

Dr. Underwood advances no evidence to show that the requirements of the small industry could not equally well be met by utilising the resources, for example, of the National Physical Laboratory or the National Chemical Laboratory, and a proposal to establish an institute for the benefit of industries or firms too small or backward to provide for their own research resources cannot command much support at the best of times. As example of his second point, Dr. Underwood cites the unit processes of chemical engineering, such as drying, filtration, evaporation, mixing, grinding, which are basic in many industries and differ in their application mainly in the materials handled, and here he is on much firmer ground.

Dr. Underwood urges that research in such fields should be conducted on as wide a basis as possible, so that any developments and advances would be available to all the industries concerned and progress in one industry be reflected in other entirely non-competitive industries. On this ground he advocates the establishment of an Institute for Industrial Research on the lines of the Mellon Institute in the United States, and claims that in such fields the proposed institute would offer great advantages in efficiency, economy and the interchange and discussion of ideas among scientific workers. Particularly he stresses the desirability of establishing it in close association with a university, and the value of the institute to firms too small to justify the formation of a separate research association.

It is thus clear that the Institute Dr. Underwood has in mind is something quite distinct from the proposal considered last year by the Committee on New Industrial Development. On the other hand, the Department of Scientific and Industrial Research, as indicated in its current report, has endeavoured with some success to foster fundamental research of this type in fields of common interest to a number of industries. Even in the particular field of chemical engineering used by Dr. Underwood as example, much useful co-operative work is already being done, in which the Department of Scientific and Industrial Research itself is prominent. Examples of this are afforded by the activities of the National Physical Laboratory or of the Non-Ferrous Metal Industries, the British Refractories, and the British Electrical and Allied Industries Research Associations among the research associations, or in the work of the various research boards such as those concerned with fuel problems, building research, radio research, lubrication, etc. There is already in existence a good deal of machinery for co-operative industrial research which might with advantage be more extensively used particularly in regard to exchange of information on non-competitive matters. Organisations like the Association of British Chemical Manufacturers and the British Standards Institution in their work on industrial safety and standardisation of practice are also assisting in the development of habits of co-operation and encouraging the exchange of information on common problems.

Nevertheless, it is difficult to resist the feeling that Dr. Underwood has put his finger on a weak spot in our national structure, whether or not it is desirable to create a fresh organisation or institute to meet the needs. The development of one or more of our schools of chemical engineering to undertake work on such fundamental problems might well prove a more satisfactory alternative and one consistent alike with the existing structure of our national research organisation and with the relations between academic and industrial research which exist in other fields. Obviously such development can only be satisfactorily secured if it is planned in relation to national and not merely sectional or local demands, and success will depend on the enlistment of adequate industrial as well as Government support.

The advantages which Dr. Underwood stresses for his scheme in regard to exchange of ideas and discussion among scientific workers, the more efficient utilisation of expensive equipment, and the more effective training of recruits for this

particular field are too important to be lightly dismissed. They are points which find an essential place in any definite policy or scheme for scientific and industrial research planned in relation to the national resources and needs as a whole. Whether these needs to which Dr. Underwood directs attention are met within the framework of our existing organisation, or whether it proves necessary to create a new institute for the purpose, a much more adequate conception of the place of research in the organisation and development of our national and industrial resources will be demanded of industry as a whole as well as of Government departments. Industry must learn, too, to relinquish the obsolete ideas of trade secrecy, and to co-operate as fully and wholeheartedly as possible in the exchange of information in investigations of those many problems which are common to divers industries and indeed to many departments of our national or municipal life. Already there are signs that the idea of service is permeating large scale industry to a remarkable extent and the growth of this spirit affords the surest foundations on which not only to build an adequate national structure for scientific and industrial research but also to secure, both within industry and without, that fellowship and understanding between the worker in pure and applied science which is the surest passport to success.

Astrolabes

The Astrolabes of the World : based upon the Series of Instruments in the Lewis Evans Collection in the Old Ashmolean Museum at Oxford, with Notes on Astrolabes in the Collections of the British Museum, Science Museum, Sir J. Findlay, Mr. S. V. Hoffman, the Mensing Collection, and in other Public and Private Collections. By Dr. Robert T. Gunther. Vol. 1 : *The Eastern Astrolabes.* Pp. xvii + 304 + 68 plates. Vol. 2 : *The Western Astrolabes.* Pp. viii + 305 – 609 + plates 69–153. (Oxford : Printed at the University Press, 1932.) £10 10*s*. net.

THE Oxford University Press has produced for Dr. Gunther two sumptuous volumes. The binding is elegant, the paper is good, the print, except in the facsimile of Morley's description of a planispheric astrolabe, is clear, and the numerous photographic plates are exceedingly beautiful ; these number no less than 153 in addition to 217 figures. There could scarcely be a book better fitted to lie as an ornament on a library table, and there could scarcely be a book better fitted to be left unread. Wherever I have been able to check the author, I have found him careless both in his statements and in the correction of the press. Of the latter fault there are two examples in the preface. Not all the erudition of the University Press readers has saved Dr. Gunther from the solecism *De Astrolabii Canones*, repeated not indeed in all, but unhappily in most of the passages where the name of Robertus Anglicus's work occurs. In the same sentence the subject 'pages' is followed by the singular 'is'. The Table of Contents not only repeats the incorrect title of Robertus Anglicus's work, but also gives us 'Severas Sabokt' for Severus Sabokt, and in five places it substitutes 'Bleau' for Blaeu. After fifty pages of a mechanical facsimile of Morley's work, the author's own qualities are displayed again. On p. 53 the very name of the instrument to which the volume is devoted is given as ἀστρολάβον instead of ἀστρόλαβος. On p. 59 Prof. Jenkin has become Prof. Jenkins, the date of his astrolabe being variously given as 1925, 1927, and 1928. Dorotheus of Sidon changes sex and becomes Dorothea. After this one cannot complain of a variation between Philopon, Philoponus, and Philopons.

The errors on the history and literature of the astrolabe are more astonishing. The references to Chaldean fragments, to the object found off Anticythera, and to the early invention of the *arachne* are irrelevant. The author seems to know little of the evidence connecting Ptolemy with the astrolabe and implies that it was among the discoveries codified in the Almagest. Misled by a clerical error on the part of Mr. Dalton, whom he does not cite for his statement, he places Ptolemy in the first century A.D. He argues that "the philosopher who invented the astrolabe", mentioned by Severus Sabokt, must be older than Ptolemy, because the former uses the ancient value of 24° for the obliquity of the ecliptic, whilst Ptolemy adopted 23° 51′. Here he overlooks the fact that, in his treatise on the planisphere, Ptolemy suggests the use of the round quantity, 24°. Our principal authority for the early history of the astrolabe, Synesius, seems to be known to Dr. Gunther only at third hand. At all events he gives a quotation by Mr. Dalton of a quotation by W. S. Crawford from the original. He is in error in supposing that Synesius's gift to

Pæonius was an astrolabe. It was a planispheric star-map. He is also in error in supposing that Synesius claimed to have invented the planispheric astrolabe. He claimed that under the guidance of Hypatia he had perfected the theory of the planisphere. John "Philopon" is dated on p. 59 "about the time of the Great Fire at the Library (A.D. 642)", in spite of all that Gibbon has done to disprove the legend of that fire. Of course Philoponus should have been dated a century earlier. On p. 568, however, Philoponus appears as a Greek author in the reign of the Palæologi who rescued several fragments of Persian and Arabian science by translating them into Greek. Nicephorus Gregoras, a fourteenth century writer on the astrolabe, is dated 758–828.

Dr. Gunther's information about the Renaissance literature is equally unreliable. He prints an imposing bibliography, but does not name his sources. It must contain many books that he has never seen. He states that the early work "De Astrolabio" attributed to Proclus was printed at Venice in 1491. The work in question was certainly by Proclus, but it does not mention the planispheric astrolabe, with which alone Dr. Gunther is concerned. It is Georgius Valla's translation of the sixth chapter of the Hypotyposis, and it was printed not in 1491, but in 1498. 1491, as Harles suspected, and, as Mr. Strickland Gibson has kindly verified for me, is merely a misprint for 1498 in the Bodleian Catalogue of 1674, corrected in all later editions. The work is, in fact, part of the collection of translations by Georgius Valla, which Dr. Gunther notices separately, mixing nominatives and genitives in his own way. He has failed to discover that in the same volume Valla gives under the name of Nicephorus Gregoras not only the actual treatise by that writer, but also an older treatise, attributed in some MSS, I think erroneously, to Ammonius, the Greek text of part of which was edited by Hase under the name of Ægyptius along with the text of Philoponus. He has missed altogether the Basle volume of 1544, in which a composite work appears, consisting partly of chapters translated by Valla from the Hypotyposis of Proclus, partly of a translation by Valla of Philoponus's treatise on the astrolabe, partly of chapters supplied by Valla himself.

On the descriptions of individual astrolabes I have little to say, but I would warn readers to be cautious in accepting identifications of saints and to compare with the plates any erroneous letters or figures attributed to the astrolabes in the text. It is to be hoped that it was not Dr. Gunther who "englished" the inscription given on p. 234, including the phrase, "the consumer of the pertinacy".

The two volumes contain work, however, by others than Dr. Gunther. Morley's most scholarly and most valuable description of a planispheric astrolabe has been noticed already. The late Mr. H. W. Greene contributed a translation of the treatise of Philoponus on the astrolabe. Here we must admire the translator's courage as well as his scholarship. Unfortunately he was unable to discover from Liddell and Scott's Lexicon that ἐξάπλωσις in the first sentence of that work means not 'explanation', but 'projection', making plane, not making plain. Mrs. Margoliouth has given us a combination of her own learning with that of Nau in her translation of Severus Sabokt. She has certainly made her author very clear. There are also two instructive chapters by Theodor Wåhlin on astrolabe clocks and on the availability of the astrolabe for the construction of sundials.

We have also to thank Dr. Gunther for printing a mediæval Latin version of Arzachel's treatise on the Saphea, for reprinting the treatises by Bate and Hermannus Contractus, and for reproducing in facsimile parts of the treatises of Robert Tanner and Robertus Anglicus.

The true history of the origin of the astrolabe is best read in Synesius's epistle to Pæonius. He states, probably on the authority of Hypatia, that Hipparchus, the first to attack the theory of the planisphere, had given a mere sketch of his subject. He attributes to him the insertion of sixteen stars on "the instrument". Ptolemy and his successors were, according to Synesius, content with the practical application of the theory and found these sixteen stars sufficient for time-finding (ὡροσκοπεῖον) at night. Now a planisphere used for finding time at night by means of stars marked on it can scarcely be anything but a planispheric astrolabe. It is natural to suppose that Hipparchus's planisphere, showing the sixteen stars, was also designed for finding the time at night by observing them. But that is not directly stated. Ptolemy himself appears to have mentioned the planispheric astrolabe once only, "Tetrab." iii. 2, where he refers to the time-finding (ὡροσκόπιος) astrolabe as giving a better determination of time than the gnomon or the water-clock. Philoponus informs us that Ptolemy inserted the temporal hours in the planispheric astrolabe. These were

the hours in popular use. It should be noted, however, that the planispheric astrolabe is never mentioned by Ptolemy either in the Almagest or, where we should have expected to find it, in his treatise on the planisphere, preserved in a Latin translation of an Arabic translation. There is no mention of it in the published works of Pappus and Theon, or in Proclus. Evidently it was not regarded as an instrument of precision. Heliodorus records an occultation of Saturn, A.D. 503 February 21, where he and Ammonius observed the time of emergence in temporal hours with an astrolabe. This was certainly the planispheric astrolabe. Ammonius, as Philoponus informs us, wrote a treatise on the planispheric astrolabe. Philoponus's own treatise based on this has been mentioned above.

Ammonius, though we know of nothing to connect him with astrology, did in a sense provide the medieval astrologer with all the equipment that he needed. His perpetual ephemeris or "Canonion", called Almanack by the Arabs, gave the places of all planets referred to the ecliptic. The astrolabe gave without computation the reduction from the ecliptic to the horizon, and with the planetary places referred to these two systems of co-ordinates the astrologer could construct his theme. J. K. F.

Central African Volcanoes

Geological Survey of Uganda. Memoir No. 3 : *The Volcanic Area of Bufumbira.* Part 1 : *The Geology of the Volcanic Area of Bufumbira, South-West Uganda ; with Notes on the Petrology and Economic Geology.* By A. D. Combe and W. C. Simmons. Pp. xi + 150 + 12 plates. (Entebbe : Government Printer, 1933.) 15*s*.

IN the brief preface to this new volume, one to be placed side by side with the authors' memoir on the Ankole tin, the Director of the Uganda Geological Survey notes the importance of the area described, distinguished by a recent volcanic activity far grander than the lingering remnants that remain to-day, and suggests, as we are seldom reminded when African volcanoes are concerned, the possibility of renewed outbursts. He mentions also the fact that its leucite-bearing lavas represent, perhaps, one of the largest potash reserves in the world. Moreover, gold has been found.

Part 1, now issued, contains the account of the field geology and the geographical studies of Messrs. Combe and Simmons ; Part 2, by Prof. Holmes and Dr. Harwood, is promised in about twelve months and will deal with the chemical and theoretical sides involving petrogenesis, a continuation, we may suppose, of their recent work on the Toro volcanics to the north.

Bufumbira, about one-tenth of the entire field, is situated in the extreme south-west of Uganda and is continued under other names into the Belgian Congo and the mandated territory of Ruanda, the whole being frequently referred to as the Mufumbiro Mountains, but in this memoir as Birunga, the Lunya-ruanda word for volcanoes. Nowadays volcanic activity is extinct in British territory, but Nyamlagira and Ninagongo are active in the west and two others erupted lava in 1905 and 1912 respectively.

The geological structure of the area is comparatively simple ; the eruptions have forced their way through the slates and quartzites of the Karagwe-Ankolean system, and the interest of the field is bound up in the composition of the lavas, for the content of potash is unusual, though shared to some extent with the Toro area.

Owing to their position athwart the Central African trough between Lakes Kivu and Edward, the Bufumbira flows built a barrier which dammed the streams flowing north along a pre-Rift depression and formed the southern lake. Three smaller lakes similarly came into existence. Eleven types of lava are shown on the geological map, varying from the enstatite-andesites of Sabinyo, the oldest volcano, to more basic successors usually containing olivine, such as the leucite-basalts. Huge flows of leucite-basanite are commonest.

In addition to three major volcanoes, thirty-four smaller cones have been mapped, usually steep-sided, 200–500 ft. high and built of ash and scoria—in other words, explosion vents. Such safety outlets also occur along ridges of ash and breccia corresponding in direction with the regional strike of the steeply dipping beds of the Karagwe-Ankolean system, indicating lines of weakness, an interesting peculiarity.

The comparative youth of the field, for the most part middle or late Pleistocene, has allowed of an exactitude in observation and resulting precision not so easily accomplished, for example, amongst the volcanoes of Kenya, and it is interesting to note that during distinct periods of activity lavas of different appearance and composition may be produced from a given vent, or the reverse ; thus

leucite-basalt may be succeeded by leucite-basanite, with intervening limburgite, or vice versa. On the other hand, no change may occur during successive eruptions. The authors record that a traverse from Kisenyi on Lake Kivu to Nyamlagira showed the lavas were melilite-leucite-nephelinites, quite different from the Uganda rocks, where melilite is absent and nepheline very rare.

One peculiarity of the area deserves mention as having possibly a bearing on puzzling occurrences elsewhere, namely, the boulder deposits occupying the pass between Sabinyo and Mgahinga, consisting entirely of masses of lava derived from the first, but lying on flows derived from the second.

Sabinyo is without a remnant of a crater and, as remarked, is the oldest volcano of the area. The deposits are 10–25 ft. thick, the boulders 5 ft. and occasionally 10 ft. in diameter and have moved some two and a half miles from their source. Combe, who visited the Java volcanoes, compares the Uganda deposits to the streams of mud, sand and boulders, called 'lahar', which are ejected from the throat of a volcano charged with steam or gases or with the waters of a crater lake or excessive rain. The latter 'wet' type of lahar, which is known to have moved eighteen miles from its source, presents a close similarity to the Uganda occurrences. Connexions between the deposits and deep erosion valleys cut in Sabinyo are noted, but the precise explanation of the means whereby the boulders reached their present position remains undefined.

Gold, together with tin and wolfram, occurs in the north of the area. Development is still in the prospecting stage, but a noteworthy point, perhaps only of academic interest, is that the gold is found in the Karagwe-Ankolean rocks, usually considered the repository of cassiterite and the associated minerals, a fact which the work of Kitson in the Kavirondo country has already suggested to be possible. The metal as found is usually coarse, yet the ultimate source has still to be discovered, and again we may meet with that crucial point of alluvial prospecting in Central Africa, the possible reversal of an earlier drainage.

The authors are to be congratulated on the results of their painstaking observations, the Uganda Geological Survey and its director on the manner in which letterpress, plates and the excellent coloured map have been reproduced.

JOHN PARKINSON.

Public Analysts and the Food Industry

The Society of Public Analysts and other Analytical Chemists. Some Reminiscences of its First Fifty Years, by Bernard Dyer, and A Review of its Activities, by Dr. C. Ainsworth Mitchell. Pp. viii + 278 + 4 plates. (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin Marshall, Ltd., 1932.) 12*s.* 6*d.* net.

IT would be difficult to find a greater contrast than exists between the condition of the food industry now and its condition when the Society of Public Analysts was instituted, the history of which up to the time of its jubilee is recorded in this interesting book. Adulteration of the grossest order was then rife: many dealers sought only to make profits, utterly regardless of the quality of their goods or the effect their sophistications might have on the health of those who consumed them. The idea of a merchant or manufacturer employing a chemist to check the purity of supplies or to make suggestions for the improvement of wares or products would have been scouted as an absurdity; and the recently created 'public analysts' were regarded as the natural enemies of the dealer, and looked on with fear and suspicion.

Now, though adulteration is not extinct, and though it has taken on more subtle forms, yet it has greatly diminished in extent. The manufacture and the merchanting of foodstuffs are for a great part in the hands of large and reputable firms, who employ big chemical staffs, for control both of incoming and outgoing goods, and for research with improvement as its aim, and who are banded together into associations, one of the objects of which is to protect the trade against its less scrupulous members; and the public analysts are looked on, by all except those less scrupulous members, as friends and helpers in the task of supplying the public with pure and nutritious food.

This change has come to pass gradually. Many causes have contributed to it; not the least the activities of the public analysts themselves, individually and through their Society; and the history of the process by which it has been brought about is contained in this book. Dr. Dyer's experience as a member of the Society goes back practically to its foundation; and his happy gift of narrative, and the kindly human nature that peeps through his periods, give a fascination to the perusal of the tale, and will make it interesting reading, not only to those professionally or scientifically concerned with analytical chemistry, but

also to any reader who takes an intelligent interest in the things that touch and affect our daily life.

It only remains to say, in the short space available, that Dr. Mitchell's chronological summary of the work of the Society, arranged according to subjects, and dealing not only with the composition of foods and with methods for their analysis, but also with the legal aspects of food adulteration, is a most valuable piece of annotated bibliography, and that Miss Elliott's very detailed index makes it very readily available. J. T. DUNN.

Short Reviews

Incunabula of Tannin Chemistry: a Collection of some Early Papers on the Chemistry of the Tannins reproduced in Facsimile and published with Annotations. By M. Nierenstein. Pp. v+167. (London: Edward Arnold and Co., 1932.) 12*s.* 6*d.* net.

THIS elegant volume will delight chemists and botanists who are interested in the history of their subjects. Dr. Nierenstein has made the study of tannin chemistry peculiarly his own, and it was a happy inspiration that led him to select and reproduce the early classical articles in this field of research. His facsimiles include two pages of a 1485 "Hortus Sanitatis"; an excerpt from Baptista Porta's "Natural Magic", describing a method of writing upon eggs by means of galls and alum; Piepenbring's paper "Ueber die Säure der Galläpfel", 1786; Davy's article on "Different Methods of obtaining Gallic Acid", 1805; and papers by Pfaff, Biggin and others.

The facsimiles are followed by eight pages of historical, chemical and bibliographical annotations, in which Dr. Nierenstein's erudition is employed to advantage but not paraded. We learn that the earliest scientific data on the chemistry of the tannins were due to Tachenius, who in 1677 expressed the view that the black colour produced on mixing extract of galls with a solution of green vitriol was to be explained by supposing that the galls contained an alkali that "doth suck up the *Acid Spirit* of the *Vitriol*". Gallic acid was discovered in 1787 by Scheele, while the estimation of tannin was first successfully elaborated by Biggin in 1799.

Dr. Nierenstein has a sly poke at those who believe in certain interrelationships between the tannins and the resins, remarking that this error of Bouillon-Lagrange "still survives and has its supporters amongst those who write on the tannins, but have not worked on this subject". We congratulate Dr. Nierenstein upon his handsome contribution to historical chemical literature, and his publishers and patrons for their enterprise in publishing and subsidising it.

Through Wonderlands of the Universe. By R. K. Golikere. Pp. xviii+400. (Bombay: D. B. Taraporevala, Sons and Co.; London: Kegan Paul and Co., Ltd., 1933.) 6.4 rupees.

HERE is a compendium of information dealing with our universe from the world in which we live to the most distant stars. Its author tells us it is "a simple elementary study" but it contains the speculations consequent upon the researches of Jeans, Eddington and Jeffreys to which we would scarcely have applied the term "elementary". Yet so clever a form has been adopted that every part of the book is intelligible both to laymen and to "junior students" of science. Our Norman period is usually headed '1066 A.D.', and here most chapters have headings with some figure in feet or miles. Each such figure is followed by a note on the subject, the most striking and modern facts and thoughts thereon. The land surface thus has a series of 135 height headings and the ocean 46 depths. There is a deliberate lack of order in arrangement of these facts—or a very clever conception of human psychology. It is rather boring to have the depths of oceans reeled off in rotation by a lecturer or printed in a column, but if these are interspersed as here with the maximum depths of fish, corals, sponges, starfishes, submarine cables, etc., about each of which there is a pleasant little story, the facts remain with us.

The author is the devoted pupil of Jeans, who is often quoted and discussed. The last chapter is on Hindu cosmogony and cosmography and this we would like extended, a view with which we are convinced most Hindu readers will agree. It is good to see expositions of the far-reaching conceptions consequent on the researches of science and to have these blended with the more striking phenomena in our planet and its civilisation.

Mr. Golikere is brave and original and hence well deserving of success; he is never dull and this is the best that can be said of any author.

La géologie et les mines de la France d'outremer. Recueil de conférences organisées au Muséum par les soins du Bureau d'Études géologiques et minières coloniales sous le haut patronage de A. Lacroix, et avec le concours de L. Bertrand, F. Blondel, J. Bourcart, A. Demay, M. Dreyfuss, L. Dubertret, P. Fallot, M. Glasser, H. Hubert, Ch. Jacob, L. Joleaud, A. Lacroix et L. Neltner. Pp. viii+604. (Paris: Société d'Éditions Géographiques, Maritimes et Coloniales, 1932.) 70 francs.

THE great mining and metallurgical industries of France recently formed a committee to study the mining possibilities of the French colonial empire. This committee established a Bureau d'Études géologiques et minières coloniales, which, with the collaboration of the French Government, was

charged with the training of specialists for the investigation of the mineral deposits of the Empire, and with the education of the French public, especially the official and financial fractions thereof, in regard to the possibilities of their overseas possessions. With this latter end, a series of lectures was given during last winter at the Muséum d'Histoire Naturelle by geologists familiar with the different French colonies. These lectures have been collected in the present work and issued by the Bureau.

The volume is the first general study of this kind dealing with the French possessions. The geology and mineral resources of each colony are set forth in detail and the volume will be of great use to geologists, since a synopsis of this kind has been hitherto exceedingly difficult to make. Those interested in the relative distribution among the nations of the minerals necessary for large-scale modern industry will find in this book food for anxious thought.

Objektive Spektralphotometrie. Von Dr. L. S. Ornstein, Dr. W. J. H. Moll und Dr. H. C. Burger. (Sammlung Vieweg : Tagesfragen aus den Gebieten der Naturwissenschaften und der Technik, Heft 108–109.) Pp. vi+146. (Braunschweig : Friedr. Vieweg und Sohn A.-G., 1932.) 10.80 gold marks.

THIS addition to the well-known "Sammlung Vieweg" monographs is published at a time when considerable attention is being given by spectroscopists to measurements of spectral intensity. It is for this reason, in the first instance, very welcome. The prestige of its authors in this particular field of work gives it at once considerable value. The many workers who are unable, for various reasons, to acquire first-hand experience of the technique of the school founded by Prof. Ornstein at Utrecht cannot do better than study this book. We are here given precisely the kind of information which anyone desirous of undertaking research in this field would wish to possess.

In addition to the principles underlying, and the actual technique of, spectro-photometry with photographic plates, several useful chapters are included. The thermal and the photoelectric methods of measuring radiation are dealt with in some detail. The photographic plate and the factors upon which its blackening depends are treated well. A separate chapter deals with the micro-photometer and its applications. The practical character of this monograph should make it widely appreciated. R. C. J.

Handbuch der Spectroscopie. Von Prof. H. Kayser und Prof. H. Konen. Band 8, Lieferung 1. Pp. iv+654. (Leipzig : S. Hirzel, 1932.) 67.50 gold marks.

KAYSER'S "Handbuch der Spectroscopie", in particular vols. 5 and 6, have been of inestimable service to generations of spectroscopists. The earlier volumes, owing to the rapid development of the subject, are generally regarded by the modern worker as of historic interest only. There must always be a place of value for a compilation of reliable data such as at the time of publication vols. 5 and 6 represented. Vol. 7 and, now, vol. 8 (both in collaboration with Prof. Konen) are an admirable attempt to bring up to date this aspect of the subject of spectroscopy. The task is a formidable one and criticism of any kind would be ungracious. We could have wished, however, that it might have been possible to make use of energy-level diagrams in presenting the data in suitable cases. A list of the elements dealt with may be of interest to those working in this subject. They are : silver, aluminium, argon, arsenic, gold, boron, barium, beryllium, bismuth, bromine, carbon, calcium, cadmium, cerium, chlorine, cobalt, chromium, cæsium, and copper.

While recognising that a work of this kind cannot be published cheaply, most English workers will probably feel that the price is formidable.

R. C. J.

The Annual Register : a Review of Public Events at Home and Abroad for the Year 1932. Edited by Dr. M. Epstein. Pp. xii+318+180. (London, New York and Toronto : Longmans, Green and Co., Ltd., 1933.) 30*s.* net.

THIS valuable summary of the history of the past year compresses into a few hundred pages the vicissitudes of a troubled period in most countries. There was much to record but the task has been accomplished within the customary space without the exclusion of any movement of importance. As usual, British, Imperial and foreign history occupy about two-thirds of the book. Then follow summaries of literature, art, drama, music, science, finance and law with an obituary and biographical notices. Into fourteen pages is condensed an outline of scientific advances during the year. Among the documents published *in extenso* in the volume are the summary of conclusions of the Imperial Economic Conference at Ottawa in July 1932, and the Note to the United States government on the War Debt in December last.

Introduction to Theoretical Seismology. By Rev. J. B. Macelwane and Rev. F. W. Sohon. Part 2 : *Seismometry.* By Rev. F. W. Sohon. Pp. ix+149. (New York : John Wiley and Sons, Inc. ; London : Chapman and Hall, Ltd., 1932.) 16*s.* 6*d.* net.

THIS useful book is the first account in English of the instrumental side of seismology since that of G. W. Walker. It proceeds by easy stages from the simple pendulum to the complications of modern seismographs, going so far as to explain the difficulties attendant on the second and third order terms in the vertical instruments. Methods of determining epicentres are described, but it is surprising to find no mention of Turner's direction-cosine method of determining epicentral distances.

Muscular Movements of Fishes*

By DR. J. GRAY, F.R.S.

IF a body is moving through water at a constant speed, the body must be constantly supplied with energy. In the case of a fish, the requisite energy is supplied by the muscles and is applied in such a way as to exert a backward thrust on the water, which compensates the resistance exerted by the water on the body of the moving fish.

As observed by the human eye, the motions of various types of fish appear to vary considerably from one species to another. At one extreme is the eel, which, during motion, is characterised by distinct waves of curvature which pass alternately down each side of the body from head to tail. At the other extreme is the mackerel or the trout, which appears to progress by means of transverse strokes of the expanded caudal fin. An examination of successive instantaneous photographs shows, however, that the nature of these two types of movement is essentially the same, for in all cases, waves of curvature pass along the body with increasing amplitude as the hind end of the fish is approached. The only significant differences between the eel and the mackerel are the relatively larger amplitude of the waves towards the anterior end of the eel, and the relatively longer body—with consequently longer length of wave—in the eel as compared with the mackerel. Both the nature and frequency of the waves of muscular curvature vary in different cases.

As recorded by the eye, the movements of a fish are almost invariably movements of one part of the body relative to another—we watch the waves of curvature passing backwards relative to the head of the eel, or we watch the tail of a mackerel sweeping from one side of the body to the other. From a propulsive point of view, however, we are more concerned with the motion of the body relative to the surrounding water, and in order to record such movements it is necessary to employ a camera, and to photograph the fish, against a clearly defined background, at known intervals of time. Observations of this type enable us to record the movements of each part of the body relative to other parts and relative to the surrounding medium.

Records have been made of a number of typical fish, but, owing to the well-defined nature of the muscular waves, attention may be first concentrated on a small glass eel (*Anguilla vulgaris*) which is approximately 7 cm. in length. It is found that each point on the animal's body is travelling forward through the water along a sinusoidal curve the 'pitch' or wave-length of which is the same for all points of the body (namely, 3·2 cm.) but the transverse amplitude of which becomes progressively greater as we select points lying farther away from the head. If we select two adjacent points on the body and plot out their movements relative to the background of the fish, it is seen that each sector of the body is moving with its leading surface inclined at an angle to its own path of motion. The photographic records also show that, relative to the head of the fish, each leading surface is always directed obliquely backwards except at the extreme positions of the displacement.

The leading surface of the fish has therefore two distinct properties: (1) it faces obliquely backwards relative to the head of the fish; and (2) it is moving at an angle to its own direction of motion. These two properties are responsible for the forward propulsion of the fish. So long as the leading surface is moving at an angle with its own path of motion, there will be a pressure exerted at right angles to the surface, and so long as the leading surface is directed obliquely backwards relative to the head of the fish, the pressure will be directed obliquely forwards. The forward component of this pressure tends to drive the fish forwards.

The principle is fundamentally the same as in a screw-propeller or in the blade of a sculling oar during the first part of its stroke. In the screw propeller the leading surfaces of the blades represent surfaces directed obliquely backwards relative to the ship and, when the ship is in motion, they are moving forward at an angle to their own path of motion. In the case of the fish, the propellant surfaces are moving in two dimensions instead of in three—and this is possible by virtue of the elasticity of the body, which enables the leading surface to be suitably reorientated at the end of each transverse cycle.

The surface of a screw and the leading surface of a fish's body resemble each other in that they are always exerting a pressure at right-angles to themselves, although, in the fish, the extent of this pressure varies at different points on the body and at different phases of each transverse movement. The waves which pass down the body of a fish also have their counterpart in the mechanical screw. If the pointed end of a household screw is held vertically downwards and the screw be rotated, it can be seen that the edges of the screw surface appear to move along the side of the screw in a direction which varies with the direction of rotation. If the screw is turned 'in' the ridges appear to move upwards; if the screw is turned 'out' the ridges appear to move downwards. If, however, the screw is free to move in a well-fitted nut, the ridges appear to be stationary when the screw is rotated in either direction. It can be shown fairly simply that the screw will only do work when the 'ridges' appear to move upwards or downwards at a greater rate than that at which the screw itself is moving in an opposite direction. The same facts can be summarised by saying that the screw will only exert a pressure when there is

* Friday evening discourse before the Royal Institution delivered on April 28.

an 'angle of attack' between its leading surface and the direction of the latter's motion; within limits, the greater is this angle of attack the greater is the pressure exerted by the screw. So also in the eel, the surface of the body can only exert a forward thrust when the waves of muscular contraction pass backwards along the body at a greater rate than that at which the fish is moving forwards through the water. When a wave passes down the body of a fish at rest, the angle of attack is, at first, of maximum value and the thrust is correspondingly high—consequently the fish rapidly gathers speed until the angle of attack gives a thrust which is equal to the forces resisting the motion of the whole fish; during this period, there has been a steady reduction in the rate at which the muscular waves are travelling backwards relative to the environment. If the fish, having acquired a uniform speed, increases the velocity at which it transmits the waves along its body, then the angle of attack will again rise. A second period of acceleration of movement will occur until the angle of attack has again fallen to an equilibrium value. For any given speed of transmission of the waves along the body there must be a definite speed of forward propulsion which depends on the form of the fish's body. A series of waves passing down the body of a fish must therefore automatically travel at a greater speed than that at which they propel the fish forwards. Correspondingly, if the direction of the waves is reversed, the fish moves backwards—a phenomenon clearly seen in a large conger eel.

We may conclude that the whole body of the eel is acting as a propeller by virtue of the fact that the leading surface is always inclined obliquely backwards relative to the head and at an angle to its own path of motion.

If we now consider the movements of a whiting or other typically pelagic fish, certain points of difference are obvious: (1) the length of the body, relative to its cross-section, is much less than in the case of the eel; (2) the hind end of the body tapers relatively abruptly and ends in an expanded caudal fin. When recorded photographically, however, the movements of the body are found to be of the same fundamental type as those of the eel, for in all cases waves of curvature pass alternately down each side of the fish.

In the whiting, the amplitude of these waves remains quite small until the posterior region of the tail is reached, where it increases more abruptly than in the case of the eel. The effect of these waves is such as to maintain the leading surface of the body inclined obliquely backwards relative to the head. A similar orientation is maintained by the leading surface of the caudal fin, and since the area of the fin is considerable, it is of interest to consider how far it plays an essential rôle as a propellant surface. It is well known that fish with badly lacerated caudal fins can swim actively and the observations of Breder show that amputation of the caudal fin of *Scardineus* does not markedly affect the speed of propulsion. This observation has been confirmed by the removal of the caudal fins of the rudd, the perch, and the whiting. For technical reasons it has not been possible to observe the effect of amputation of the caudal fin in fish moving at a high speed, but it seems fairly clear that the 'cruising' speed is not appreciably reduced.

At first sight, these facts suggest that the main propulsive surface of a whiting is provided by the body itself and that the surface of the caudal fin is relatively insignificant. An examination of the photographic records, however, shows that the removal of the caudal fin alters, in a significant manner, the movements of the fish. In the intact fish, we have seen that the leading surface of the body is always directed obliquely backwards. When the caudal fin has been removed, however, this is no longer the case, for the stump of the tail now swings about its base as a relatively rigid structure; as it moves from the extreme position of displacement towards the central position its leading surface is directed obliquely backwards, but as it moves from the central position towards the extreme position of displacement on the other side, the leading surface is directed obliquely forwards.

The difference between the movements of the intact fish and those of one from which the caudal fin has been removed is clearly due to the resistance which the tail fin offers to transverse movement. The fin represents a surface of high resistance lying posteriorly to the region of muscular contraction and it causes the intervening region of the body (which is flexible) to bend into an arc, with the convex surface towards the direction of motion; in other words, the fin causes the posterior region of the body to lag behind all those parts which lie between itself and the point of contraction so that each group of muscles, as it comes into play, is operating on a region of the body which is directed obliquely backwards relative to the head. The effect of the fin is exactly parallel to that produced by attaching a flat plate to the distal end of a steel wire and oscillating the proximal end of the wire through a small angle. Without a flat plate each part of the wire moves in practically the same phase as any other part—but when the plate is present the distal end of the wire lags behind the proximal end. A series of movements is set up which is strikingly similar to the normal movements of a fish's body; without the attached plate, the movements of the wire are comparable to those of a fish from which the tail fin has been removed.

At first sight, it seems strange that a fish can move forwards without a tail fin, for one might imagine that the propulsive effect produced when the tail is directed obliquely backwards would be exactly neutralised by the action of the tail when directed obliquely forwards during the second half of each stroke. It must be remembered, however, that so far we have been considering the movements of the tail relative to the head. When we

examine the movements of the tail relative to the water, we see how the fish—without a caudal fin—can propel itself through the water. During the first half of the stroke, the tail is not only directed obliquely backwards but it also sweeps through the water, thereby generating a forward thrust, but at the moment it begins to face obliquely forwards, its motion through the water is checked, for it begins to move against the water which is flowing past the sides of the fish. The tail then begins to act as a rudder, and the position of the tail relative to the head is maintained by a movement of the head end of the fish through the water instead of by a movement of the tail. The two phases of each stroke are thus asymmetrical and the fish is able to progress through the water, although not in the smooth steady manner characteristic of the intact fish.

It is clear that by exerting a mechanical resistance to transverse movement through the water, the caudal fin of the whiting maintains the necessary phase difference between successive regions of the muscular body and tail, and thereby enables the whole of the energy of the muscular contractions to be expended in a smooth symmetrical manner. The question may be asked: Why can an eel or dogfish progress smoothly without the presence of a large caudal fin? The answer is that the function of the caudal fin of a whiting is, in the case of the eel or dogfish, carried out by means of the long flexible body itself. In exactly the same way, well-defined waves can be transmitted along a long flexible wire without the presence of a flat plate attached to the distal end. It is only when the wire is short that a flat plate is essential for maintaining an adequate phase difference between successive regions along its length.

Although the removal of the caudal fin does not substantially reduce the forward rate of movement, it is not legitimate to assume that the propulsive thrust from the fin is negligible in the intact animal, for it has been shown that amputation of the fin induces far-reaching changes in the movements of the remainder of the body relative to the surrounding water. A preliminary attempt to estimate the propulsive effect of the tail fin of the whiting was carried out as follows.

A series of vertical rods was so mounted in a metal frame that each rod moved harmonically with the amplitude characteristic of different levels of a whiting's body; the ends of the rods were then inserted into the body of a dead whiting. By rotating a handle, the body of the fish was forced to transmit a series of waves identical with those seen in the normal living fish, and for a given frequency of waves the velocity of the current produced in a tank of water was determined. The caudal fin was then removed and the current again measured for the same frequency of movement. Although the method of measuring the current was not free from criticism, the results suggest that approximately 40 per cent of the propulsive thrust from a whiting is derived from the caudal fin.

It is of interest to note that just as the propulsive thrust represents the forward component of the pressure of the fin against the water, so the transverse component of this pressure plays its part in adding to the resistance offered by the fin to transverse movements, so that the biological functions of the fin are very clearly linked together, just as is the case with the surface of the body itself. If the area of the body surface is large in comparison to that of the fin, the rôle of the fin may be relatively insignificant as in the eel, but in the pelagic type of fish the posterior region of the muscular tail is comparatively narrow and tends to present a convex surface to the water, whereas the tail fin is relatively large and presents a flat surface to the water. In the latter case the fin probably plays an increasingly important rôle as a propeller, just as it plays an increasingly important rôle by virtue of its resistance. Until a very accurate method is devised for measuring the currents produced by various types of tail fin, it is dangerous to speculate on the effect produced by variations in the shape of the caudal fin.

So far, we have only considered the motion of fish which are swimming in a straight line, but one of the most striking features of a moving fish is its ability to change the direction of its motion. In some cases such changes are effected by movements of the paired fins, but the rapid changes so characteristic of pelagic types are effected by the muscles of the body itself. In all cases a change in the direction of motion has been found to be due to the propagation of a muscular wave along one side of the body, and the fish always turns towards the side along which the wave is travelling. These waves are most conspicuous in the case of the eel, but they can be recorded photographically in other types. We may take as an extreme example the goldfish. As observed by the eye, a goldfish appears to turn by a rapid flexure of the tail towards one side. Actually, however, the tail remains practically stationary in the water until the head end of the fish has almost if not completely finished its turning movement—after which the tail swings through the water towards the opposite side to which the animal turns.

The examination of a number of photographic records has shown that the turning movement of such fish is divisible into two parts: (1) the head moves through the water by using the tail fin as a relatively stationary pivot; (2) the tail moves through the water using the head as a stationary pivot. The effect of the tail fin during the first phase of the movement is simply an exaggeration of its effect during normal swimming, namely, to delay the movements of the hind end of the body whilst movements are occurring farther towards the head. As one might expect, the amputation of the caudal fin exerts a very far-reaching effect on the turning powers of the fish. A normal goldfish can turn through nearly 90° by one flexure of the body—but if the caudal fin be removed, the same turn can only be effected by several flexures. With or without a caudal fin

the amplitude of the muscular contractions is practically the same, but in the absence of the caudal fin a muscular contraction on the left side of the body causes both head and tail to move simultaneously to the left of the original axis—in the presence of a caudal fin only the head moves whereas the tail remains stationary. Since the curvature of the body is the same in the two cases, it follows that the angular displacement of the head through the water is greatly reduced by the amputation of the fin. The maximum change in the direction of the fish cannot exceed the initial movement of the head, and this can only be maximal when the posterior end of the body remains undisplaced. Clearly the function of the tail fin is to enable the hind end of the body to act as a fulcrum on which the head turns. As in normal motion, the rôle of the caudal fin is, in the eel or dogfish, carried out by the long flexible body itself.

We have now seen that the caudal fin exerts two forces on a moving fish : (1) it tends to inhibit the transverse movements of the hind end of the body ; (2) it exerts a fraction of the forward propulsive thrust. Both these forces are derived from the pressure exerted on the water at right angles to the surface of the fin. The 'resistant' force is the transverse component of this pressure, and the propulsive thrust is the forward component. The absolute and relative values of these forces remain to be determined.

So far, we have considered the movements of the body without reference to the actual process of contraction of the muscles. The muscle fibres of the trunk and tail all run parallel to the long axis of the body, and they are so controlled that when a fibre on one side of the body is fully contracted, its opposite neighbour on the other side of the body is fully relaxed. Further, it is clear that the fibres along one side of the body do not contract simultaneously but in sequence, beginning with those nearest to the anterior end of the body. Each group of fibres is supplied by motor nerves, and it has been suggested that a muscular wave is the result of the passage of a nervous disturbance down one side of the spinal cord, firing off each group of fibres as it goes. It is difficult, on this view, to account for the very variable speed of transmission of the muscular waves.

There are, on the other hand, a number of facts which suggest that when the muscles (lying on one side of the base of the muscular tail) contract, their energy can be transmitted mechanically along the body of the fish just as such energy can be transmitted along the length of an elastic wire. The energy is transmitted in the form of tension by the stretched skin and muscles of the leading side of the body. If the muscles lying nearer to the tip of the tail are to be usefully employed, they must liberate their energy in phase with that of the mechanical wave. When the mechanical wave reaches any given point it first tends to store energy at that point by bending the body into a convex curve—and then this energy is afterwards liberated as the tension is released. If, therefore, the muscles at any point are to supplement this mechanical cycle, it follows that they must begin to contract at the moment when a similar shortening process is being induced by the mechanical wave. This would occur if the stimulus to contract were automatically induced by a stretching of the muscle itself. Such a proprioceptive mechanism is well defined among other vertebrate types and its existence in fish would account for many otherwise unrelated facts.

Low Auroras

IT is frequently asserted (*a*) that the aurora occasionally descends to the earth's surface so that it can be seen between the observer and relatively near terrestrial objects, and (*b*) that not infrequently unmistakable sounds accompany auroral displays. Several writers have collected reports from residents in regions where the aurora occurs and a large mass of evidence for the reality of low auroras and sounds accompanying auroral display has been accumulated. In NATURE for March 7, 1931, Prof. S. Chapman reviewed one such collection of reports and expressed his opinion that "These letters make it difficult to deny that auroræ occur, very rarely, quite near the earth, and are sometimes accompanied by noises".

In an article which has just been published in the *Quarterly Journal of the Royal Meteorological Society* (vol. 59, p. 249), Dr. G. C. Simpson discusses the whole problem of low auroras and auroral sounds and comes to the conclusion that "the evidence for low auroras is extremely weak and that when one weighs that evidence against the positive information we have about the nature and position of the aurora one is justified in denying that auroras have ever been observed below a height of 80 km." With regard to sounds, Dr. Simpson says that he is not prepared to deny the possibility that there may be some form of objective sound associated with the aurora, but he very much doubts it.

Dr. Simpson uses three main arguments against the reality of low auroras. In the first argument he points out that we now know that the chief spectroscopic line of the light of the aurora is due to a metastable state of atomic oxygen. This condition of oxygen is only possible when the pressure is very low, and trigonometrical measurements have proved that the height of the ordinary aurora is more than 80 km., where the pressure is sufficiently low. If now an auroral streamer passes from this height to the earth's surface where the pressure is too high for atomic oxygen to exist, a second physical process must come into action, and this process, whatever it may be, would have to come into action in exactly the same proportion as the effect of the first process decreased,

for the streamer must remain a streamer, the intensity of the light must not be radically changed and there must be no marked change in its colour. That there should be two such processes is very unlikely on general principles. No suggestion has been made regarding this second process except that it may be due to a high electrical field in the lower atmosphere produced by the aurora itself; but instrumental observations have shown that such high electrical fields do not accompany auroras. Further, no electrostatic field in air at atmospheric pressure can be made in the laboratory to give a glow throughout an extensive region; the highest field attainable only produces localised brush discharges or actual disruptive sparks which are not remotely like the glow of an aurora.

The second argument is based on the principles of perspective. Practically all the observers report that the low auroras look exactly like the normal auroras: they move in the same way, they appear both as streamers and as diffuse glows, they are of the same colour. No difference in breadth of streamer, rapidity of motion, intensity of light or colour is remarked upon. In fact, it is because the low aurora looks like and behaves like the high aurora that their identity is so strongly affirmed. All this is contrary to the laws of perspective. It is generally admitted that the normal aurora occurs in the upper atmosphere at a height of at least 80 km., so that the average distance from the observer must be something like a hundred miles. If such an aurora were suddenly transferred to the neighbourhood of the observer, it certainly would not look exactly the same as it did when it was a hundred miles away. Thus the opinions so strongly held by the observers that they have seen auroras at ground level exactly like the ordinary high auroras is the strongest evidence that could possibly be given against their conclusions.

The third line of attack is to show that all the reported cases of low aurora are optical illusions. The darkness necessary for the aurora to be seen at all makes illusions easy, especially if there is a moon, for moonlight illuminates clouds and snow ridges with an intensity comparable with that of an aurora. Auroras seen between gaps in clouds or between trees when the whole landscape is dark look as though they are in front of the clouds or trees. The aurora appears in the sky simply as light masses and the observer has absolutely no criteria by which to determine the distance; but with ordinary lights their brightness and the sharpness with which they can be seen are the two factors on which judgment of distance is chiefly based. The aurora varies greatly in intensity and without exception the most brilliant auroras consist of rapidly moving, very sharply defined streamers, either in the form of curtains with clear-cut 'folds' or as long narrow shafts with relatively sharp edges. It is therefore not surprising that these auroras appear to be much nearer than those which appear as irregular ill-defined arches and clouds. Many so-called low auroras are simply parts of haloes round the moon or are due to the illumination of fog banks or snow surfaces in bright moonlight.

In concluding his article, Dr. Simpson says that it is not possible to bring the same type of argument against the sound of an aurora as against its low position; but naturally, if the aurora is confined to the high atmosphere, sounds are unlikely. He considers that the observed sounds are psychological, being due to the natural association of sound with the rapid movement of the streamers and the waving of the 'draperies'.

Obituary

Mr. Charles S. Carter

THE death of Charles S. Carter, curator of the Museum of the Louth Naturalists', Antiquarian and Literary Society, and president of the Lincolnshire Naturalists Union in 1928 and 1929, at the age of sixty-seven, took place at Louth (Lincs) on April 14. In addition to being curator of the Museum, Mr. Carter was joint honorary secretary of the Society and conchological secretary of the Lincolnshire Naturalists Union, as well as a member of the Lincolnshire Archæological Society.

Mr. Carter belonged to the distinguished band of self-taught amateur scientific investigators, to which local archæology and natural history in Great Britain are so deeply indebted. Not only by their individual labours, but also by the enthusiasm with which they have inspired others, they have kept alive a tradition of local interest and research, in which Great Britain stands almost, if not quite, alone.

Born in 1866 at East Torrington, Mr. Carter was educated for a short time at elementary schools, and then began work in the fields at the age of nine. He was later apprenticed to a cord-wainer and worked as a cobbler for the remainder of his life. His interest in archæology and natural history began when he took up his residence in Hampshire, under the influence of Dr. S. Andrews of Basingstoke, with whom he traced the Roman road through Pamber Forest and was a close observer of the excavation of the neighbouring Roman city of Silchester. On removing to Kent, he became associated with the late Benjamin Harrison and Dr. Lewis Abbott between the years 1893–1896 in the collection of eoliths. The period of his greatest activity, however, began when he returned to Louth in 1898. Among other achievements, he discovered the neolithic settlements at Tathwell and Kelstern, recorded several botanical and entomological species for the first time in the county, and found a chalk fossil, *Tylopora lorea*, Lang, which was new to science. Mr. Carter was a frequent contributor to the *Naturalist* and the *Proceedings* of the Lincolnshire Naturalists Union.

DR. JOSEF BAUDIŠ

THE death of Dr. Josef Baudiš, professor of Celtic and comparative philology in the University of Bratislava, on May 4 is announced. Dr. Baudiš was widely known as an authority on the Celtic languages and literatures, more particularly of Erse. In addition to academic studies at the Universities of Prague and Heidelberg, he visited Wales and Ireland annually for purposes of linguistic investigation. His published works include "A Grammar of Early Welsh" (1914), "Structure of the Indo-European Languages", a translation of Czech folk-tales (1917) and a large number of contributions to learned periodicals on early Erse and the Irish saga. He was for a time joint secretary of the Philological Society of London, and one of the founders of *Philologica*.

THE Rev. Frederick L. Odenbach, S.J., for the past forty years meteorologist and seismologist at John Carroll University, Cleveland, Ohio, died on March 15 at the age of seventy-five years. It was through Father Odenbach's influence and initiative that seismographic equipment was installed and stations were organised at fifteen Jesuit colleges and universities in the United States and Canada during the years 1909–12.

We regret to announce the following deaths :—

Mrs. Zelia Nuttall, honorary special assistant at the Peabody Museum of Harvard University and honorary professor of archæology at the National Museum of Mexico, known especially for her work on the ethnology, etc., of Mexico and Central America, on April 12, aged seventy-four years.

Prof. J. G. Porter, professor of astronomy at the University of Cincinnati and director of the Cincinnati Observatory, known for his work on the proper motion of stars, and comet orbits, on April 15, aged eighty-one years.

Mr. A. B. Seymour, since 1886 assistant in the Cryptogamic Herbarium at Harvard University, an authority on parasitic fungi, on March 29, aged seventy-four years.

Col. J. C. B. Statham, C.B.E., C.M.G., author of "Through Angola", a well-known traveller and naturalist in West Africa, on April 29, aged sixty years.

News and Views

King's Birthday Honours

THE King's birthday honours list contains the names of the following scientific workers and others associated with scientific work : *K.T.* : The Earl of Elgin and Kincardine, chairman of the Carnegie United Kingdom Trust. *K.C.B.* : Dr. G. F. Hill, director and principal librarian of the British Museum. *K.C.M.G.* : Sir James Currie, chairman of the governing body of the Imperial College of Tropical Agriculture, Trinidad, and director of the Empire Cotton Growing Corporation. *Knights Bachelor* : Mr. H. T. D. Acland, vice-president of the Dominion Council of the Australian College of Surgeons, Dominion of New Zealand ; Mr. A. W. G. Bagshawe, director of the Bureau of Hygiene and Tropical Diseases ; Dr. G. C. Clayton, president of the Institute of Chemistry and a director of Imperial Chemical Industries, Ltd. ; Dr. R. H. P. Crawfurd, consulting physician, King's College Hospital, registrar of the Royal College of Physicians, London ; Dr. Kedar Nath Das, principal of the Carmichael Medical College, Calcutta, Bengal ; Dr. W. S. Duke-Elder, ophthalmic surgeon, St. George's Hospital, London ; Dr. M. O. Forster, lately director of the Indian Institute of Science, Bangalore ; Dr. H. Stuart-Jones, principal of the University College of Wales, Aberystwyth ; Col. R. McCarrison, director of Nutritional Research, Indian Research Fund Association, India ; Mr. R. S. Pearson, director of the Forest Products Research Laboratory, Department of Scientific and Industrial Research. *C.B.* : Col. W. H. Leonard, late Indian Medical Service ; Dr. A. Landsborough Thomson, assistant secretary of the Medical Research Council. *C.M.G.* : Mr. J. L. Gilks, director of medical and sanitary services, Kenya ; Mr. J. Strachan, general manager and chief engineer, Federated Malay States Railways. *C.I.E.* : Mr. H. P. Thomas, chief engineer, Hydro-Electric Department, Punjab ; Mr. J. de Graaff Hunter, director of the Geodetic Branch of the Survey of India ; Lieut.-Col. W. L. Harnett, professor of surgery, Medical College, Calcutta, and surgeon to the College Hospital, Bengal ; Mr. J. N. Duggan, professor of ophthalmic medicine and surgery, Grant Medical College, and superintendent, C. J. Ophthalmic Hospital, Bombay. *C.B.E.* : Mr. H. A. Ballou, Commissioner of Agriculture for the West Indies and professor of entomology in the Imperial College of Tropical Agriculture, Trinidad ; Mr. E. L. Mitchell, assistant secretary, Ministry of Agriculture and Fisheries ; Mr. V. E. Pullin, director of radiological research, Research Department, Royal Arsenal, Woolwich ; Maj. C. E. Williams, chief inspecting engineer, Office of the Crown Agents for the Colonies. *O.B.E.* : Mr. A. J. King, executive engineer, personal assistant to the Chief Engineer to the Government of Bengal ; Mr. C. M. Pitt, surveyor and engineer, Public Works Department, State of Tasmania. *M.B.E.* : Mr. E. W. Dunn, assistant engineer, Assam ; Mr. W. N. Winn, botanist, Royal Botanic Gardens, Kew. *Hon. M.B.E.* : Ragheb Effendi Mohammad, sub-inspector of agriculture, Department of Agriculture and Forests, Palestine. *I.S.O.* : Mr. J. W. Atherton, superintending cartographer and assistant superintendent of charts, hydrographic Department, Admiralty ; Mr. J. L. Frood, superintending inspector, Diseases of Animals Division, Ministry of Agriculture and Fisheries ; Mr. P. H.

Grimshaw, keeper of the Natural History Department, Royal Scottish Museum; Mr. J. Hedley, staff engineer, General Post Office; Dr. C. F. Lassalle, deputy surgeon-general and medical inspector of Health, Colony of Trinidad and Tobago; Mr. W. McAuslan, engineer surveyor-in-chief, Board of Trade.

France and Great Britain in Africa

M. ALBERT SARRAUT, Ministre des Colonies of France, as chief guest at the African Society's dinner on May 23, was both apt and illuminating in the distinctions which he drew between French and British ideals and methods in the administration of native affairs in Africa. The whole of M. Sarraut's speech was inspired with a deep sense of the responsibility which lies upon the two nations—a responsibility "to protect and improve the destiny of the backward races, weighing more heavily than ever on our shoulders". He pointed out that "we are perhaps on the threshold of new times, in which the load that we bear will grow heavier". Even were there no stronger reason, it was the logical consequence of this view that M. Sarraut should enter on a comparison of the two systems of administration in their attitude towards this great problem. He displayed both knowledge and justice in his comparison. While he claimed for France a nearer approach to the life of the native, he admitted for Great Britain a greater regard for tradition. "You," he said, "listen especially to the prudent, but rather cold counsel of experience. We warm our actions in the flame of apostleship. You, in sum, wish the races to place themselves in a condition to make their own happiness; we wish ourselves to make their happiness urgently and with authority."

IT was evident that M. Sarraut had here in mind, more particularly, the methods of 'indirect rule' of Lord Lugard, of whom, indeed, he spoke most warmly. It is this which gives his speech its greatest significance for those whose interests lie in the application of scientific study to the problems of administration. For he went on to point out, what has indeed been apparent for some time in modifications which circumstances have brought about in French methods of administration, that France and Great Britain, with an identical object in view, are "bending towards a meeting point". With this as his justification he appealed for collaboration—an appeal addressed to all colonising nations. In connexion with M. Sarraud's remarks on Great Britain's regard for tradition and the convergence in method of the two systems of administration, it may not be inappropriate to direct attention to a communication which appears in a recent issue of *Africa* (vol. 6, pt. 2) referring to an expedition of M. Henri Labouret, of the École Coloniale, to French West Africa for the purpose of studying the social and economic organisation and the land system of the natives. Not only did this expedition have the official support of the Ministry of Education and the Minister for the Colonies, but also M. Labouret was accompanied by a graduate of the École with a grant from the Rockefeller Foundation to enable him to become acquainted with conditions in the field. This was in furtherance the policy of M. Labouret, himself, it will be remembered, a former Colonial Minister, of introducing trained ethnographers into the French colonial administrative service.

Scientific Problems of the Pacific

A NOTEWORTHY demonstration of the possibilities of long distance wire and radio telephony was given on June 5, when Lord Rutherford, speaking as the representative of science in Great Britain, delivered an address to the Fifth Pacific Science Congress assembled at Vancouver. Lord Rutherford, in the brief space of some eight minutes, touched on a number of problems closely identified with the work of the Congress. He reminded his audience that the investigation of their region was inaugurated by the British Government and the Royal Society more than a century and a half ago, when they sent Capt. Cook on his first voyage of discovery in the Pacific, accompanied by Sir Joseph Banks and other scientific observers. Lord Rutherford referred to the loss of the famous non-magnetic ship, the *Carnegie*, at Samoa, and to the recent investigations carried out in the Antarctic by the "Discovery" Committee and by the Great Barrier Reef Expedition, off the coast of Queensland. Speaking of notable advances in our knowledge of the transmission of radio waves, which have resulted in the discovery of at least two distinct reflecting layers in the upper atmosphere, he congratulated the Australian Radio Research Board on the valuable contributions its workers have made to our knowledge of this question. He also stressed the importance of the problems of the depopulation of the islands of the Pacific, and of the preservation of the fauna and flora of the region. Lord Rutherford congratulated the Canadian organisers of the Congress on their courage and vision in arranging the meeting in spite of economic conditions, and said: "it is of good augury that representatives of all the countries bordering on the Pacific Ocean have met together in a spirit of friendliness and co-operation to discuss the multifarious scientific problems connected with the Pacific. Science is international, and I trust will ever remain so." After his address, Lord Rutherford had a conversation with Dr. H. M. Tory, president of the Congress, Prof. A. S. Eve, and others.

Legal Size Limits and their Effect upon Fisheries

IN California, more than twenty years ago, when the crab fishery was declining, an investigation carried out by F. W. Weymouth, of Stanford University, showed that the then minimum size limit of six inches was too low, since it permitted the destruction of male crabs before they had a chance to breed. On the evidence put before it, the Legislature decided to raise the limit at which the commercial crab might be taken, to seven inches. The result of so small a change has been remarkable. A few years after the passing of the new regulation, when the first crop of crabs under its protection had reached the seven-inch size, the production of the

fishery suddenly doubled, and since then the catch has gone on increasing until now the fishery produces 75,000 dozen crabs more than it did before the law was changed, an increase worth 185,000 dollars to the fishermen (N. B. Scofield in *California Fish and Game*, 1932, p. 260). Yet originally they opposed the change, saying that already at six inches the size limit was too high, and that declining production could be stayed only by permitting the capture of smaller individuals through the reduction of the six-inch limit. Once more, scientifically ascertained facts have triumphed over opinion and so-called experience.

W. E. Dixon Memorials

Two memorials to the life and work of the late Prof. W. E. Dixon, who was reader in pharmacology in the University of Cambridge until his sudden death on August 16, 1931 (see NATURE, **128**, 401, Sept. 5, 1931) are being established. The first, already in being, is due to the action of the British Medical Association, which has named one of its most valuable research scholarships the "W. E. Dixon Memorial Scholarship". The second is to take the form of a lectureship. Certain of Dr. Dixon's friends, under the chairmanship of Sir William Willcox, opened in 1931 a fund for this purpose. The final meeting of subscribers to this fund was held at the house of the Royal Society of Medicine on June 1. This meeting resolved that the money collected (£700) should be used to establish a "W. E. Dixon Memorial Lecture" which should be delivered biennially or triennially, on some subject of pharmacological or therapeutic interest. The Royal Society of Medicine was invited to undertake the trusteeship of the fund. The response to the appeal which was issued has been extraordinarily wide. Present and past students, colleagues, former colleagues, and personal friends in Great Britain, the United States, and on the Continent, have all contributed. In addition, donations have been sent from representatives of commercial firms, and from several learned societies, both at home and abroad. This response shows how wide was Dixon's influence, and how warmly his qualities were appreciated.

Composition of the Stars

ON June 1 the annual Halley lecture at the University of Oxford was delivered by Prof. Henry Norris Russell, professor of astronomy and director of the University Observatory, Princeton, on the subject of the "Composition of the Stars". He remarked that the statement of Comte about a century ago, that no human being could ever learn anything of the composition of the stars, was speedily invalidated by the detection of various elements in the sun by the employment of spectrum analysis. From the adaptation by Huggins of suitable spectroscopes, it was soon ascertained that the same substances as occurred in the sun were also to be found in the stars. It was next made clear that the stars fell into natural classes, white, yellow and red, with intergrades. The stellar conditions of extreme heat made it possible to investigate the properties of matter at their simplest. The intensities of the lines of the spectrum were almost as important as their position. Iron was shown to be abundant in the sun, copper next, silver comparatively rare. Fifty-eight elements are now known in the sun; improvements in apparatus will no doubt disclose others. Sir Norman Lockyer was right in surmising that atoms themselves are structural, they disintegrate in white stars; he was again right in holding that the width of a line is proportional to the number of atoms producing it. In the interior of stars, the atoms of light elements are disintegrated by the collision of protons with the nuclei. There is an unsearchable part of the solar spectrum; the lines of the missing elements may occur within it. At the conclusion of the lecture, diagrams were shown which gave the number of atoms actually concerned in different kinds of stars.

Artificial Transmutation of the Elements

ON June 2 at Oxford, under the auspices of the Junior Scientific Club, the annual Boyle lecture was delivered by Lord Rutherford, who took as his subject the "Artificial Transmutation of the Elements". He described the pioneer achievement of Messrs. Cockcroft and Walton at the Cavendish Laboratory in applying the high-voltage method of generating fast streams of protons for producing atomic transformation, and detailed recent developments of method by which it was possible to obtain still greater results at a lower voltage. Further modifications had led to conclusions of high interest, and the new type of projectile now in use will no doubt result in extending the knowledge of types of possible transformation. It was probable that further assaults would be made on the stability of the nucleus, and there was already evidence of the appearance of a positively charged particle of mass comparable with that of the negative electron.

Constitution and Temperament in Man

IN *Scientia*, **53**, 4, K. H. R. Edwards outlines the chief lines of approach to the study of the relationship between constitution and temperament, namely, the genetic, the teleological, the physiological, and the psychopathological. He realises that such differentiations are of descriptive rather than practical utility. He discusses the data relevant to the problem as presented by Bartlett, McDougall, Kretschmer, Pavlov, and Jaensch, and, perhaps somewhat optimistically, concludes that in the near future the advances in physiology, psychiatry and psychology will solve the problem. Discussions on temperament are complicated by the vagueness of writers as to the meaning of the word, coupled with the fact that popularly it is used for emotional instability, so that a well-balanced person would not be accredited with any temperament. The concept arose out of the observation that individuals differ in susceptibility to disease, and the hypothesis that this was due to some difference in physiological make-up (crasis, temperamentum, complexion) is at least as old as Hippocrates, although generally known

in the form given to it by Galen. It is therefore a legitimate problem to investigate the truth of this hypothesis, and a survey of the literature shows that this has motivated many 'arm-chair' theories and a little experimental work. Physicians also observed that variation in disease susceptibility seemed to be linked with structural differences and psychological differences, and this presents another problem. The observed psychological differences are for the most part emotional in character. We thus have three variables, each very complicated, and for each we need measures. With the passing of time, emphasis has been placed on the psychological differences, but very often one of the old hypotheses is implicit.

Royal Cornwall Polytechnic Society

INCLUDED in the ninety-ninth annual report of the Royal Cornwall Polytechnic Society is an account of the annual meeting held at Falmouth in February 1932. On that occasion the president remarked that he looked back with pride on the very good work that the Society had done since its institution. "It has for 99 years been fostering useful crafts, promoting utilitarian arts, and promulgating the logic and tenets of science, all in the interests of the Cornish industries." The principal event during the preceding year had been the renovation and adaptation of the premises of the Society for receiving the Falmouth Museum, the control of which had been transferred to the Society from the Town Council. The renovations had cost about £1,450. Together with the usual information about membership and finance, the report contains accounts of the summer meeting and seven original contributions. Among these is a short but useful account of the development of explosives and a sketch of the life and work of the Cornish engineer Michael Loam (1797–1871) the inventor of the man engine. Before the days of steam winding engines, miners generally ascended and descended the shafts by ladders, a practice which proved very injurious to their health. At the first meeting of the Society premiums were offered for some improvement on the existing methods and in 1838 a sum of £500 was offered for the application of machinery to facilitate the ascent and descent. Through these offers Loam was led to the invention of the man engine consisting of rods fitted with platforms, which were raised and lowered several feet at a time by an engine. There were fixed platforms in the shaft and men ascended or descended by stepping alternately on to a fixed platform and then a moving platform. The same plan was in use in Germany.

The Pepys Tercentenary

IN commemoration of the tercentenary of the birth of Samuel Pepys, which fell on February 23, a lecture was delivered by Mr. Edwin Chappell, at Clothworkers' Hall, Mincing Lane, London, on that date, recalling the primary circumstances of Pepys's career, these being brought into pleasant and effective remembrance by means of a series of one hundred and forty lantern slides. The lecture was published in the *Mariner's Mirror*, vol. 19, No. 2, April 1933. Pepys was Master of the Clothworkers' Company in 1677, and thirty-six years ago a lecture on Pepys was given in its Hall by Mr. H. B. Wheatley. Since then much valuable Pepysian literature has been issued, and Mr. Chappell himself has made a close study of the subject. We learn that the name Pepys may be pronounced, without criticism, as if written 'Peppis'. The full story of Pepys's association with the pioneer leaders in philosophical inquiries of his period remains to be written ; but it would not be advisable to attach special personal significance to Pepys's imprimatur on the title page of Newton's "Principia" ; it was the outcome of a formal request made to Pepys to license the book, and no more. Some attention was given in the lecture to contemporary portraits of Pepys. Kneller's canvas, which hangs in the rooms of the Royal Society, was Pepys's own gift, made whilst president, and it has never left the Society's keeping. If, as Mr. Chappell remarks, "it seems to be accepted that this portrait is a copy", then Pepys's sense of prestige, and the understanding of his colleagues (one of them Evelyn), are called in question.

Dangers of Very High Voltages

THE Institute of Fire Engineers has recently carried out experiments at Croydon on an overhead wire carrying current at 132,000 volts. A jet of water was projected against this wire at a distance of about thirty feet by means of a fire hose, and pressures of about fifty volts were measured between the nozzle and earth. The fireman said that only a prickly sensation was felt in his hands. An account of the experiments is given in the *Electrical Times* of May 25. In an editorial comment it is pointed out that it is not to be concluded from these experiments that playing a hose on high tension wires is safe. Nothing serious should happen to the man who operates the hose at earth potential, but if a jet of falling water in contact with the wire touched a bystander whose shoes happened to be wet, it might easily kill him. A recent law case in the Leeds County Court illustrates the dangers that arise when any conductor, even a bad conductor, touches a grid main. The mast of a barge being towed on the canal between Goole and Barnsley in Yorkshire touched the grid overhead line. The bargee, who was on the towpath at the time, heard a scream. Running back, he saw all the barge ablaze and his son lying on his back "as if he were dead". All the iron of the mast and the deck was burned and twisted. The chains became liquid and poured about like water and the mast fell down. His son had to go to hospital and the barge was laid up after the accident for six months. As the high tension wire had been strung across the canal at the prescribed height, the bargee got no damages as it was a case of "contributory negligence".

Electrification of an Ice Factory

THE Grimsby Ice Company has now the largest ice factory in the world. The trawlers of Grimsby fish in the North Sea and off the west coast of Greenland. All the six hundred trawlers take supplies of

ice when they set off for the fishing grounds, each boat taking about 15 tons when going to fish in the North Sea and four times as much when fishing in Icelandic waters. In the *Metropolitan-Vickers Gazette* for March and April, J. H. Lamb gives an interesting account of the electrification of the factory. The plant is capable of turning out 1,200 tons of crushed ice a day and delivering it into the holds of the fishing vessels by means of a fleet of motor lorries. Before reconstruction, the plant was driven by ponderous slow-speed engines. It has now been replaced by electrically driven compressors and all the auxiliary equipment has been completely electrified. The refrigerating medium is ammonia and the ammonia gas is raised in the compressors to a pressure of between 100 lb. and 180 lb. per sq. in. It is next cooled and liquified by passing through a condenser. The liquid then passes to the refrigerating plant in tubes surrounded by brine. The liquid expanding to its gaseous form absorbs heat from the brine which is cooled below 0° C. The cold brine is circulated in a large tank containing the cans which hold the pure water to be frozen. The four compressors are driven by four motors each of 600 horse power. These are supplied with electric power by the Grimsby Corporation, through a transmission line at 6,300 volts. The Ice Company is developing a new process of freezing which it is hoped will popularise frozen fish. Complaints have been made that frozen fish are 'soft' or 'mushy' when thawed. By rapidly freezing them the water between the flakes of the fish does not crystallise and when thawed it is stated that the fish is just as firm and white as fresh fish.

Progress at the Indian Institute of Science, Bangalore

THE April number of *Electrotechnics*, the journal of the Electrical Engineering Society of the Indian Institute of Science at Bangalore, proves that rapid progress is being made in developing its activities. It has been decided to instal in the Electrical Department a radio frequency standard which will enable measurements to be carried out with the highest accuracy over a range extending from 10 to 24,000 kilocycles per second. The Government of India will recognise the Institute's certificates. It is hoped that this will prove the first step towards the establishment of a National Physical Laboratory of India. An obituary notice of the late Dr. Alfred Hay, who was appointed to the chair of electrical technology at the Institute in 1908, appears in this issue. Many of his students have done good work in electrical research. He was sadly missed by them when he left for England in 1923. He died in Cyprus in 1932. He was succeeded by Prof. J. K. Catterson-Smith, who is now Siemens professor of electrical technology at King's College, London. He did excellent work in developing radio research at Bangalore. Sir C. V. Raman became director of the Institute in succession to Dr. M. O. Forster, whose well-merited knighthood announced among the King's birthday honours will give particular pleasure to his friends. An interesting account is given of the Uhl River hydro-electric scheme. The combined output of the power stations will be 150,000 kilowatts. From an article by C. B. Sethna, director of the Bombay broadcasting service, on the progress of broadcasting in India, it appears that Calcutta, Bombay and Madras have now a regular broadcasting service. What is wanted seems to be a few high-power broadcasting stations at the centres of culture of the important linguistic areas of India.

Exchange of Goods during Economic Depression

REVERSIONS to simpler types of economic organisation are not uncommon in times of economic stress, and an interesting example is provided by the development of the exchange of goods and services by barter in the United States during the present economic depression. In 1931 a small exchange was opened in Salt Lake City to facilitate the barter of unemployed labour for surplus farm produce. Since then, the movement has spread rapidly to many parts of the country and now covers a wide range of trades and professions. A National Development Association was formed to organise the exchanges, and in July 1932 this body introduced a medium of exchange in the form of paper tokens known as 'scrip'. This 'scrip' represents to the holder the value of the produce or services he has provided and can be exchanged for an equal value of other produce, being readily accepted by traders, shops and theatres. The issue of 'scrip' is, however, far from being an innovation in the United States, and recently Mr. T. T. Belote, curator of history in the Smithsonian Institution, arranged an interesting exhibition of earlier examples. During the decade 1832–42, numerous bank failures led to much money being withdrawn from circulation, and to meet the monetary stringency a large number of so-called 'hard-time tokens' were issued. Some of these bore laudatory or satirical legends referring to the financial policies of Jackson or Van Buren. In the same period, many commercial firms issued a kind of token money known as 'store cards'. Up to the Civil War, paper scrip issued by banks and private firms of almost every imaginable character circulated extensively. Some of it was well-drawn and finely engraved, but so rapidly did many of the issues deteriorate in value that they came to be known as 'skin plasters'.

B.D.H. Products

WE have received from the British Drug Houses Ltd., London, N.1, leaflets describing the nature and uses of certain of their products. 'Spironine', a stable elixir, contains in each fluid drachm 3 grains of di-iodo-caffeine hydroiodide together with the soluble constituents of 7½ grains of coffee. It is recommended for the relief of asthma during the intermittent paroxysms. It should be given at the onset of an attack, its effect being immediate. By checking the paroxysms it prevents the development of such chronic conditions as emphysema and bronchitis. Another drug of great value in the treatment of asthma is 'Ephedrine', which also finds a place in

the treatment of hay fever and whooping cough. Ephedrine B.D.H. is issued in tablets and in solution in ampoules, and as an elixir, an inhalant, a throat-spray and a nasal jelly. 'Acriflavine B.D.' is a useful antiseptic for the treatment of wounds and local septic conditions. It can also be administered by mouth (as neutral acriflavine or euflavine in enteric coated tablets) or by intravenous injection. A new edition of the firm's vitamin booklet has also been prepared. It describes the uses in general practice of 'Radiostoleum' (vitamins A and D concentrate), 'Radio-Malt' (containing vitamins A, B_1, B_2, and D), 'Radiostol' (vitamin D) and 'Avoleum' (vitamin A). 'Radiostoleum' liquid is standardised to a 'blue' value of 500 by the Carr-Price test and contains 3,000 international units of vitamin D (calciferol) per gram. The capsules have a 'blue' value of 1,000 and each contains 1,200 vitamin D units. It is recommended as a preventive against infection and also in the prophylactic and curative treatment of rickets and osteomalacia and dental caries. 'Radiostol' solution is prepared from pure crystalline calciferol. It is standardised to contain 3,000 vitamin D units per gram (B.P., 1932). 'Avoleum' is standardised to a 'blue' value of 1,000.

Pathology and Bacteriology at Leeds

THE annual report for 1932 of the Department of Pathology and Bacteriology, University of Leeds, by Profs. M. J. Stewart and J. W. McLeod, recently issued, surveys the teaching and research work carried out in the laboratories. The research work includes investigations on industrial pulmonary diseases, studies in renal function, and on different cultural types of the diphtheria bacillus. In four hæmatite miners an extreme degree of pulmonary fibrosis was detected. In cancer research, Dr. Bonser has obtained results strongly suggesting that it is possible to breed a race of mice which respond very early to tumour induction by means of tar.

The Ross Institute and Hospital for Tropical Diseases

THE annual report and accounts for 1932 of the Ross Institute and Hospital for Tropical Diseases, Putney Heath, S.W.15, records an increase in receipts of £1,051 compared with 1931, and the net loss on the year's working is reduced to £429. Additional donations and annual subscriptions would be very welcome so that the work of the Institute may be extended, and income and expenditure may at least balance. Information is given respecting the activities of the Institute in various parts of the world, particularly in regard to anti-mosquito measures and malaria control, together with a summary of the research work conducted in the laboratories and elsewhere.

Announcements

THE Research Defence Society will hold its annual general meeting at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1, on June 22 at 3 p.m., when the seventh Stephen Paget memorial lecture will be delivered by Major-Gen. Sir Leonard Rogers on "The Saving in Life and Suffering, due to Medical and Veterinary Research, with special Reference to the Tropics".

WE have received from Messrs. W. Watson and Sons the thirty-third edition of their catalogue of microscopic objects. The contents of this list, which are well classified, include a wide range of slides useful for teaching and demonstration purposes, and many that will appeal to the microscopist who desires slides of named species, for example, of diatoms, prepared for careful examination.

ANOTHER volume of collected researches, published from the wards and laboratories of the London Hospital during 1932, has been issued by the Publications Committee (London: H. K. Lewis and Co., Ltd., 136 Gower Street, W.C.1. 7*s*. 6*d*. net). The papers included, all of which have been published elsewhere, deal with many branches of the science and art of medicine and form a notable contribution to the subject.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant lecturer in mathematics at the University College of South Wales and Monmouthshire, Cardiff—The Registrar (June 12). A temporary assistant at the Mersey Laboratory of the Department of Scientific and Industrial Research—The Secretary, 16, Old Queen Street, Westminster, S.W.1 (June 13). Two full-time lecturers in chemistry at the Polytechnic, Regent Street, London, W.1—The Director of Education (June 16). A lecturer in physiological chemistry at Guy's Hospital Medical School—The Dean, Guy's Hospital Medical School, London Bridge, S.E.1 (June 19). A junior scientific officer at the Fuel Research Station, East Greenwich—The Secretary, Department of Scientific and Industrial Research, 16, Old Queen Street, Westminster, London, S.W.1 (June 19). A full time medical radiologist in the Western Infirmary and University lecturer in the University of Glasgow—J. Matheson Johnston, 87, Union Street, Glasgow (June 21). A professor of electrical engineering at University College, Nottingham—The Registrar (June 21). A principal of the Pontardawe Mining and Technical Institute and Junior Technical Day School—The Director of Education, County Hall, Cardiff (June 22). A lecturer in mathematics and an assistant lecturer in electrical engineering at the Manchester Municipal College of Technology—The Principal (July 1). A professor of mathematics at the Auckland University College, New Zealand—The Secretary of the Universities Bureau of the British Empire, 88a, Gower Street, London, W.C.1 (Aug. 1). A mycologist in the Department of Plant Pathology at Rothamsted Experimental Station, Harpenden—The Secretary (Sept. 15). A professor of organic chemistry at the University of Liverpool—The Registrar. An assistant civil engineer and an assistant mechanical engineer for the Commissioners for the Port of Rangoon—Sir Alexander Gibb and Partners, Queen Anne's Lodge, Westminster, S.W.1.

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.*]

Development of Fuseaux, Aleuriospores, and Spirals on detached Hairs infected by Ringworm Fungi*

So long as hairs infected with *Microsporon audouini*, *Trichophyton gypseum*, and other ringworm fungi remain attached to the body, the fungi attacking them consist only of hyphæ and small round spores. These spores arise by the rounding-off and disarticulation of the cells of the hyphæ and may be regarded as *chlamydospores*. In contrast to the lack of variety of organs found in a hair stands the number of characteristic structures which are produced when these fungi are grown on synthetic and natural media (Sabouraud[1], Langeron and Milochevitch[2]). Thus *Trichophyton gypseum*, when grown on Sabouraud's maltose-peptone agar, develops: (1) *conidia*, resembling somewhat those of the form-genus *Sporotrichum*, which are termed by medical mycologists *aleuriospores*; (2) large, pleuriseptate, spindle-shaped *macroconidia* which are termed by medical mycologists *fuseaux*; and (3) helically coiled hyphæ, known as *spirals*.

FIG. 1.

FIG. 1.—Human hair naturally infected with *Trichophyton gypseum*, showing development of fuseaux after 16 days in a moist cell without the addition of any nutrient medium. Photographed in air. × 273.

It must be assumed that these organs, hitherto known only in culture, develop only under artificial conditions or else, as Sabouraud[3] has suggested, they form part of a saprophytic stage in the life-history of ringworm fungi which so far has remained undiscovered in Nature.

One characteristic of ringworm is that the hairs on the lesion, when invaded by the fungus, become brittle and tend to break off. It can easily be imagined that hairs from ringworm lesions on animals must often fall to the ground in moist places. An attempt has therefore been made to reproduce experimentally the moist conditions in which such infected hairs may find themselves on reaching the ground.

In August, 1932, a boy suffering from kerion of the scalp—a deep, suppurating form of ringworm—was admitted to the Winnipeg Children's Hospital. His parents believed that he had acquired the disease from infected cattle on their farm. Hairs were removed from the lesion and, when examined with the microscope, were found to be infected with a *Trichophyton* belonging to the ectothrix microides group of Sabouraud. Isolations made from other hairs gave cultures of *Trichophyton gypseum*. Some of the infected hairs were stored in a dry place between sterilised glass slides. A few of the hairs which had remained dry for about six months were caused to hang from the under sides of the cover-glasses of van Tieghem cells, but they were not covered with water or a drop of culture medium. These hairs were then exposed to various conditions of humidity controlled by solutions of known osmotic pressure placed in the bottom of the cells. Thus the hairs and the fungus within them were supplied merely with water vapour.

Germination of the chlamydospores in the hairs suspended in the van Tieghem cells soon took place, and each hair slowly became surrounded by a fringe of mycelium. The ends of many of the hyphæ then thickened and formed macroconidia (fuseaux). These macroconidia increased in size and abundance until they formed a halo around the hair, as shown in the photomicrograph reproduced in Fig. 1.

Not only were macroconidia formed by the mycelium which had grown out of the hairs but conidia (aleuriospores) and spirals also. The conidia were much less conspicuous than the macroconidia, from which they could be readily distinguished by their smaller size and rounded unicellular structure. The spirals were closely coiled and resembled the spirals usually produced in cultures on agar and other media.

Macroconidia (fuseaux) and conidia (aleuriospores) have also been obtained on detached hairs naturally infected by *Microsporon audouini* and by *M. felineum*. Other species of dermatophytes are now being studied with the help of the new technique.

The experiments just described demonstrate that a ringworm fungus present in naturally infected hairs may, when the hairs are placed under suitable conditions of humidity without the addition of any nutrient medium, enter upon a new phase of growth. In this saprophytic stage of the life-history, spore-forms and other organs are produced which hitherto have been found only in artificial cultures.

Although ringworm fungi will grow upon various sterilised natural media, such as horse-dung, straw, and grains of cereals, it has not yet been shown that they can flourish on these substrata under natural conditions which involve competition with other organisms. In the fallen infected hairs, on the other hand, a dermatophyte is in an advantageous position relatively to other organisms. By the time the infected hairs and scales fall from the body, the parasite has thoroughly penetrated their substance and converted much of it into fungal spores. A considerable amount of fungal protoplasm is therefore lying dormant within the hair ready to begin growth at once when brought into a suitable environment. Further, a fungus growing on such keratinised tissues as hair and scales has the advantage of

freedom from competition, since it is growing on a substance which few other organisms are able to attack. It is possible that saprophytic stages of ringworm fungi may one day be found in Nature on various substrata other than fallen hairs. However, it may well be that cast-off hairs and epidermal scales are the most important natural substrata on which ringworm fungi pass their saprophytic existence and produce spores capable of infecting new human and animal hosts.

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March 27.

* Part of an investigation being carried out with financial assistance from the Banting Research Foundation, Toronto.

[1] Sabouraud, R., "Les Teignes", Paris, pp. 583–724; 1910.
[2] Langeron, M., and Milochevitch, S., *Ann. Parasit.*, **8**, 422–436, and 465–508; 1930.
[3] Sabouraud, R., *loc. cit.*, pp. 725–727.

A Fly Pest of Timothy Grass

ATTENTION has been directed in recent years to the occurrence of a partial 'stripping' of the flower-heads of Timothy Grass (*Phleum pratense*) before these have emerged from the sheath. In Norway, 1914[1], Sweden, 1912–1916[2], Austria, 1921–1923[3], and Russia, 1928–1929[4], this damage has been traced to the maggots of Cordylurid Diptera, especially *Amaurosoma armillatum* Zett. Similar attacks have been noticed in Scotland and in 1931 Macdougall[5] suggested that "a species of Amaurosoma" might be the cause.

In June and July 1931 we received, from the neighbourhood of Stirling, specimens of the grass showing the damage in progress. The larvæ, which were then feeding, afterwards pupated in soil and were kept in the laboratory until flies emerged in April and May of 1932. These were submitted to the Imperial Institute of Entomology and were identified by Sir Guy Marshall as *Amaurosoma armillatum* Zett. With them were sent flies caught by us, in the original locality, on June 8, 1932, which proved to be of the same species. Some of the latter mated and laid eggs, on Timothy grass, in the laboratory.

The egg is approximately 1 mm. in length, pale yellow in colour, tapering towards both ends, convex and smooth below, having four longitudinal ridges above and a reticulate pattern between these. Similar eggs on Timothy grass were brought in from the field on June 1, 1932. In all cases the egg was laid at the base of a leaf-blade, just above the ligule, long axis parallel to the veins of the leaf, and on a plant of which the flower-head had not yet appeared. We have never found more than one egg on a leaf, seldom more than one on the same plant.

The eggs laid in the laboratory hatched in four to five days and the larvæ gained access to the head, in most cases between the edges of the folded leaves, in one case by perforation of the leaves. Usually not more than one larva has been found in one head. The larva was seen to work round the head and downwards, devouring the flower-buds and cutting off the glumes. As much as one third of the head might be stripped.

When full-fed the insect drops to the ground and pupates immediately beneath the surface of the soil among the roots. It remains in the puparium throughout the following winter. We have found no evidence of a second generation in the year.

Further investigations are being made, in the laboratory and in the field.

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[1] *Review of Applied Entomology*, **3**, A. 107; 1915.
[2] *Ibid.*, **6**, A. 150; 1918.
[3] *Ibid.*, **13**, A. 100; 1925.
[4] *Ibid.*, **19**, A. 283; 1931.
[5] *Trans. Highland and Agric. Soc.*, **43**, 139; 1931.

Effect of Rainfall-Evaporation Ratio on Insects Inhabiting the Soil Surface

CERTAIN insects inhabiting the soil surface are markedly affected by soil moisture, largely owing to its influence on the humidity of their surroundings. Soil moisture is primarily dependent on the ratio of rainfall to evaporation (R/E); important secondary factors being soil type and its vegetative covering. If values for the R/E ratio in an area are known, a useful index to the conditions in the micro-environment at the soil surface is available for ecological studies[1]. Evaporation from a free water surface is

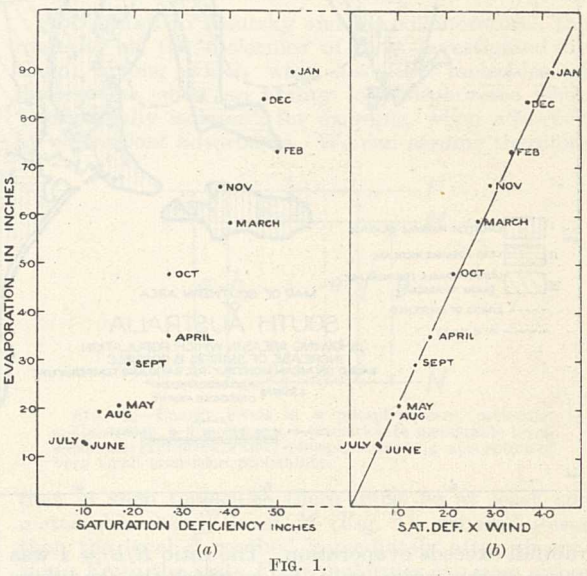

FIG. 1.

nearly proportional to the saturation deficit of the air, other variables being constant. Saturation deficit is available for stations where temperature and relative humidity are recorded, and evaporation values can be determined approximately by reference to evaporation records for comparable stations. Owing to the variables involved, particularly wind and the character of the soil surface, the computed values can be only roughly approximate.

I have used a method with reference to *Sminthurus viridis* L. (Collembola), in South Australia, to show the months in which the species will occur and its probable geographical distribution over the State.

In Fig. 1(*a*) the mean evaporation each month at Adelaide is plotted against saturation deficit. Values for the latter were calculated from the mean relative humidity (9 a.m.) and mean air temperature. In Fig. 1(*b*) the saturation deficiency value was multiplied by the mean total wind miles for the month (abscissa)[2]. The significance of the wind factor is clearly shown.

The mean monthly saturation deficit was obtained for 21 stations in the State, from temperature and humidity records, and monthly evaporation values were calculated by reference to evaporation data for Adelaide. In making the computations, values for wind were considered to be the same as for Adelaide. Mean monthly rainfalls from 220 stations (including the 21 stations above) were used and maps were prepared showing the areas and months in which rainfall exceeds evaporation. The ratio $R/E = 1$ was taken as the critical value below which the conditions may become too dry for the active stage of *Sminthurus*. From these maps, together with monthly isotherms, the areas in the State climatically suitable for population increase of *S. viridis* were defined (Fig. 2). The values for R/E and for temperature in relation to development were used to indicate the months in which the greatest increase may occur. The predicted areas agree closely with the actual records. In areas II and III, soil type and absence of suitable food plants are important edaphic factors restricting the spread of the species in certain districts. The presence of the insect on the swamps along the River Murray in areas II and III is due to soil type and artificial irrigation. The work will be described in full in the *Australian Journal of Experimental Biology and Medical Science*.

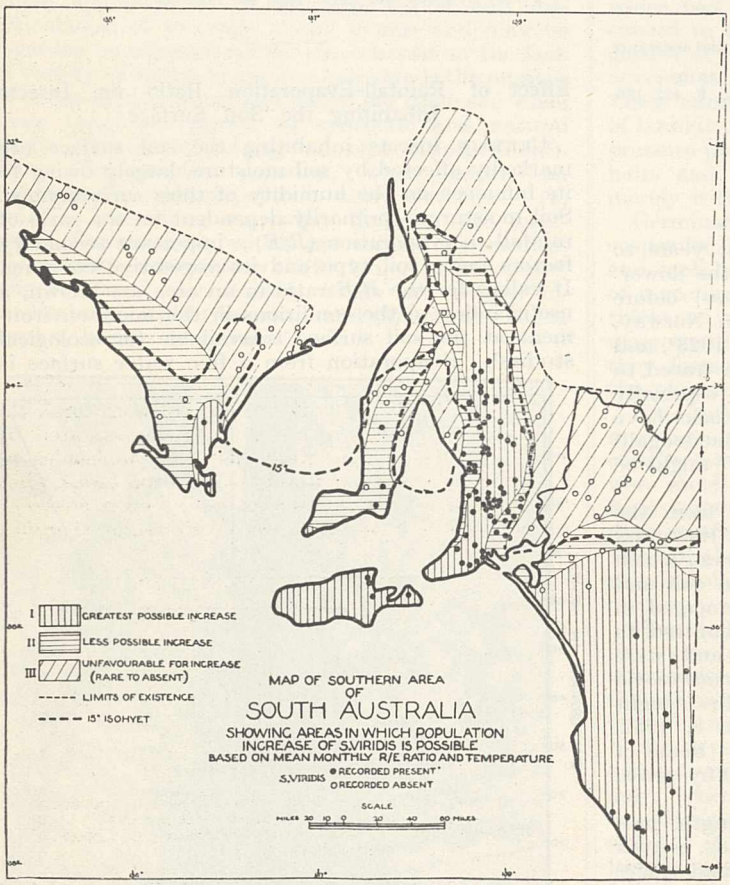

FIG. 2.

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March 8.

[1] Livingston, E. B. and Shreve, F., Carnegie Institution of Washington, Pub. No. 284, 1921.
[2] Data from Official Yearbook, Comm. Australia, p. 23; 1930.

Insect Transmission of Virus *A* of Potatoes

IT has been proved in previous work carried out in this laboratory that the crinkle disease of potatoes is a virus complex caused by the combination of the virus of simple mosaic and a hitherto undescribed constituent which has been designated virus *A* by Murphy and McKay[1]. It had already been shown by Salaman[2] that crinkle was not transmitted as such by needle inoculation, and it is now well established that the disease obtained in this way is equivalent to a simple mosaic or to the needle-borne but not aphis-borne disease (due to virus *X*) secured by K. M. Smith[3] from Up-to-Date. In other words, virus *A* is dropped on needle inoculation.

When attempts were made to transmit crinkle by means of the aphis *Myzus persicæ*, Sulz. it was found that the full crinkle complex was not produced, but that there resulted in healthy President potato a form of veinal mosaic of a mild nature. Crinkle originating from both President and Irish Chieftain gave the same result. Examination of this disease showed that it was not simple mosaic, for it produced acronecrosis by grafting on British Queen and Up-to-Date and vein-banding by needling to tobacco. Attempts to infect *Datura Stramonium* by needle, graft and aphis produced no visible symptoms. These manifestations are the characteristics of virus *A*. When simple mosaic was grafted on President containing the aphis-transmitted disease, typical and persistent crinkle symptoms developed in the stock plants.

Virus *A* was also transmitted direct from Irish Chieftain potato carrying this virus by means of *Myzus persicæ* to healthy President, British Queen, Up-to-Date, tobacco, and President containing a simple mosaic derived by needle inoculation from crinkle. The results were the same as before: a mild veinal mottle resulted in healthy President, acronecrosis in British Queen and Up-to-Date, vein-banding in tobacco, and crinkle in President containing simple mosaic.

It is, therefore, clear that *Myzus persicæ* is an efficient vector of virus *A* from potato to potato and tobacco, and so far as crinkle is concerned it transmits it selectively to the exclusion of the simple mosaic element. This is very convenient in experimental work, since virus *A* is otherwise inoculable with difficulty. On the other hand, if another virus were present of which *Myzus persicæ* was also a vector, it is likely that the insect would transmit both. The aphis-borne virus (afterwards identified as *Y*) trans-

mitted by *Myzus persicæ* from the crinkle in Myatt's Ashleaf used by K. M. Smith[4] was not identical with virus *A*, as is seen, among other reasons, from the fact that Smith's *Y* was readily returned by needle from tobacco to potato, in which it produced 'crinkle and leaf-drop streak' in the variety President. Virus *A* is not so returnable, nor does it ever in my experience produce such symptoms in this variety. As Murphy[5] has already suggested, it is possible that virus *A* was also present in Smith's crinkle, in which case it would be carried by the insect along with *Y*, and since both produce similar vein-banding symptoms in tobacco, no evidence of its presence in that plant would be available, while the effect of this particular *Y* on President was so severe that the faint symptoms of *A* would not become visible.

There is some evidence to show that *Myzus circumflexus*, Buckt. may also act as a vector of virus *A*. *Macrosiphum solani*, Kalt. (*Myzus pseudosolani*, Theob.) failed to transmit the virus, as did the capsids *Lygus pabulinus*, Linn. and *Calocoris bipunctatus*, Fabr.

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April 21.

[1] Murphy, Paul A. and McKay, Robert, *Sci. Proc. Roy. Dublin Soc.*, **20** (N.S.), **20**, 227–247; 1932.
[2] Salaman, R. N., *Proc. Roy Soc.*, B, **106**, 50–83; 1930.
[3] Smith, Kenneth M., *Proc. Roy. Soc.*, B, **109**, 251–267; 1931.
[4] *Ann. App. Biol.*, **17**, 2, 223–240; 1930.
[5] Murphy, Paul A., *Sci. Proc. Roy. Dublin Soc.*, **20** (N.S.), **18**, 193–210; 1932.

Insects and Micro-Climates

MESSRS. LEESON and Mellanby have directed the attention of entomologists to the changes in temperature in small local areas due to evaporation[1]. The present communication is offered in elaboration of their suggestion.

In Morelos, Mexico, there is a long dry season—September to May—followed by a period of steady rains from June through July, August and part of September. In July, during the rains, the relative humidity may stay so high as 90 per cent for days; while in March, the height of the dry season, it may go so low as 15 per cent. This very low humidity, however, is in all probability never experienced by the Mexican fruit fly, *Anastrepha ludens* (Loew); nor for that matter, the high temperature of the day. Direct observations of the flies during the hot arid days showed that they favour the under side of the leaves of the mango trees. The thickness of the foliage of these trees and their high rate of transpiration account for a difference of ten degrees and more (Fahrenheit) from the periphery to the centre of the tree. Transpiration takes place almost entirely on the lower side of the leaves; and there the flies are to be found during the dry season.

The mango is the chief host of the Mexican fruit fly in Morelos. Up to the present, the attention of observers generally has been focused exclusively on the suitability of the mango fruit for the egg and larval stages of the fly. In this, I think, we have been in error. The compactness of the foliage and the amount of transpiration render the tree itself highly suitable as an environment for the adult flies in respect to temperature. The latter move about surprisingly little in the course of their lifetime, indulging only in short circular flights in ordinary circumstances; and as mango fruits are entirely acceptable as an egg-laying medium, a high degree of infestation—about 99 per cent—is the result.

The same kind of effect can be observed in the case of *Opius crawfordi* (Vier), the chief parasite of *Anastrepha ludens*. A study of *Opius* adults was made under laboratory conditions, and showed that the difference between 20 and 45 per cent relative humidity is physiologically enormous, when judged by mortality figures. Under field conditions, *Anastrepha* larvæ in sweet limes are parasitised by *Opius* to a very much lesser extent than larvæ in mangos, even though both types of tree grow in close proximity in the same grove. It was found that the humidity among the open-branched sweet lime trees is very much lower than among the densely foliaged mangos.

The concept of an association between insect and host fruit should be broadened to include the tree itself. The rate of transpiration of a host plant may be a determining factor in the survival of an insect, for two reasons: the lowering of the air temperature by evaporation from leaf surfaces, and the local increase in atmospheric humidity from the same source.

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[1] NATURE, **131**, 363, March 11, 1933.

Efficiency of Anti-Stokes Fluorescence in Dyes

ACCORDING to Kautsky and his collaborators[1], the majority of the molecules of dyes investigated by them, among which were also the molecules of fluoresceine, show an ability to phosphoresce when 'energetically isolated', for example, when adsorbed by convenient adsorbents. We can assume therefore

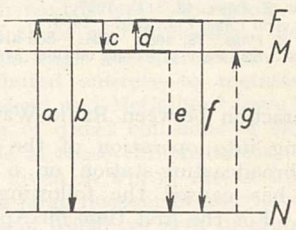

FIG. 1.—Energy levels in a phosphorescent molecule. *a*–absorption, *b*–fluorescence, *c*–transition to metastable level, *d*–thermal excitation, *e* and *f*–phosphorescence, *g*–absorption of very small transition probability.

that in such molecules there must be at least one metastable energy level *M* (Fig. 1), situated lower than the level *F* reached immediately after absorption. From the state *F* the molecules can pass either to a normal state *N*, emitting the band *F*–*N* (fluorescence), or to the metastable state *M*. The probability of the transition *M*–*N* is very small. Therefore when the temperature is sufficiently high, a great majority of molecules will be raised thermally from the level *M* to *F* and will be able to emit the band *F*–*N* (phosphorescence at room temperature). At low temperatures, direct transitions *M*–*N* take place. These transitions are accompanied by the emission of a phosphorescence band which is displaced towards the red relatively to band *F*–*N*; the duration of phosphorescence increases greatly (phosphorescence at low temperatures).

As the mean life τ of the state M is much longer than that of the level F, the phosphorescence is quenched appreciably more than fluorescence. This follows from the formula[2] $I = \frac{I_0}{1 + k\tau}$, where k is the probability of a quenching act, I the observed intensity of photoluminescence.

The absorption band N–M (inverse transition) must also appear if the transition M–N take place, notwithstanding its small probability. However, it will have a very small intensity as compared with band N–F.

Under the influence of disturbing fields, for example of the surrounding molecules of the solvent, the probability of transition N–M can become appreciably greater than that of the isolated molecule.

In solutions, practically all the molecules which have reached the level M in any possible way will be quenched. Therefore the absorption band N–M must be completely inactive.

Such inactive bands, overlapping on the longer wave-length side the active absorption bands (N–F), can cause the falling off of efficiency as observed in fluoresceine solutions[3,4,5]. It is to be noted in this connexion, that in the region of abrupt falling off of yield, the values of absorption coefficients of fluoresceine solutions reach only from 0·2 to 2 per cent of the maximal value.

In the above considerations I have supposed for the sake of simplicity that the levels for absorption and emission acts are identical. I have dealt elsewhere with the relative displacements of emission and absorption bands.[6]

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April 14.

[1] H. Kautsky, "Energieumwandlungen an Grenzflächen", *Ber. Deutsch. Chem. Ges.*, **64**, 2053 and 2677; 1931; and **65**, 401; 1932.
[2] O. Stern and M. Volmer, *Phys. Z.*, **20**, 183; 1919.
[3] S. Valentiner and M. Rössiger, *Z. Phys.*, **36**, 81; 1926.
[4] S. I. Wawilow, *Z. Phys.*, **42**, 311; 1927.
[5] A. Jabłoński, *Acta Phys. Pol.*, **2**, 97; 1933.
[6] A. Jabłoński, *Z. Phys.*, **73**, 460; 1931. See also P. Pringsheim, "Handb. d. Phys.", **23**, Part 1, second edition, 244.

Interaction between Radio-Waves?

THE coming into operation of the Luxembourg high-power broadcasting-station on a wave-length of 1190 m. has caused the following remarkable phenomenon. For the first time on April 10 of this year it was observed at Eindhoven, Holland, that when a radio-receiver was tuned to Beromünster (460 m.), the modulation of the Luxembourg station could be heard on the background to such an intensity that during the weak passages of the programme of Beromünster the programme of Luxembourg was heard with an annoying strength. Since the field-strength of Luxembourg at Eindhoven has the quite normal value of about 10 mv./m. (the distance from Luxembourg to Eindhoven is somewhat more than 200 km.) and the same phenomenon was observed with different types of receivers, this cannot be due to cross-modulation in the receivers. It was also observed with a battery set away from the electric distribution system of the town, so that any disturbing influences from these sources were eliminated. Hence it seems that the phenomenon has its origin somewhere in the transmission between Beromünster and Eindhoven. It may be remarked that Luxembourg is situated nearly on the line joining Beromünster and Eindhoven.

Since the first observation the same phenomenon has been observed at Eindhoven with different intensities on Radio Paris (1725 m.), Budapest (550 m.), Munich (533 m.), Lyons la Doua (466 m.), Sottens (404 m.), Mühlacker (361 m.), Strasbourg (345 m.), Milan (332 m.), Poste Parisien (328 m.) and Frankfurt (259 m.), which all lie somewhat in the direction from Eindhoven to Luxembourg and at a greater distance from Eindhoven than Luxembourg. It has also been observed on Beromünster at Rotterdam, near Arnhem and at Düsseldorf. It was always the modulation of Luxembourg which could be heard on the background. This modulation has not been observed on Langenberg (472 m.) and Brussels (509 m., 338 m.), or on a British station.

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Kinetics of the Iodine-Oxalate Reaction

SINCE 1916, when one of us[1] reported that this reaction is very sensitive to light and that the dark reaction has a high temperature coefficient, a large amount of work has been carried out on this chemical change by several chemists[2].

The majority of workers believe that the velocity of this reaction in light is not directly proportional to the light intensity but varies as the square root of the intensity of the incident radiation, although Bhattacharya and Dhar[3] have observed that by using an aqueous solution of iodine in the absence of potassium iodide, the relation between velocity and light intensity for this reaction approaches unity in radiations of mean wave-lengths 5650 A. and 7304 A.

We have carried out further experiments on this reaction using normal potassium oxalate and $N/850$ aqueous solution of iodine without the addition of potassium iodide, and some of the results are as follows:

	Dark	8750 A.	8500 A.	3340 A.	3512 A.	3452 A.	3125 A.	3536A.
$k_{25°}/k_{15°}$	4·64	3·92	3·54	2·02	2·25	2·38	2·38	2·44

When potassium iodide ($N/277$) was added to the reaction mixture, the velocity was greatly diminished and $k_{32°}/k_{22°}$ assumed the high value 8·84 in the dark.

In the absence of potassium iodide and with normal oxalate and $N/850$ iodine, the following results were obtained for the relation between light intensity and velocity:

Wave-length in A.	Observed ratios of velocities	Ratio of light intensity
3500	1·32	4
3340	1·79	4
3536	3·25	6·25
8500	3·97	4·34
8750	2·71	2·44

It appears that the relation between the velocity and light intensity varies from 1/3 to 5/4 approximately. Several other photochemical reactions taking place in aqueous solutions behave in a similar manner. It is now well known that the photochemical reactions between chlorine and hydrogen and bromine and hydrogen in the gaseous state are proportional to the square root of the light intensity under certain conditions and are directly proportional to the light intensity under other conditions. We have shown experimentally and theoretically that the relation

between the velocity and the light intensity (or the amount of absorbed light) in a photochemical change is not constant but changes with the acceleration of the reaction by light absorption[4].

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[1] Dhar, *Proc. Akad. Wetensch. Amsterdam*, **18**, 1084; 1916.
[2] Berthoud and Bellenot, *Helv. Chim. Acta*, **7**, 307; 1924. Briers, Chapman, and Walters, *J. Chem. Soc.*, **129**, 562; 1926. Mukerji and Dhar, *J. Phys. Chem.*, **32**, 1308; 1928. Allmand and Young, *Faraday Soc. Discuss.*, 515, April 1931. Young and Style, *ibid.*, 493. Griffith and McKeown, *Trans. Faraday Soc.*, **28**, 752; 1932.
[3] Bhattacharya and Dhar, *J. Indian Chem. Soc.*, **6**, 473; 1929.
[4] Dhar and Bhagwat, *Z. Anorg. Chem.*, **190**, 415; 1930. Malaviya, Dhar and Bhagwat, *ibid.*, **199**, 406; 1931. Dhar, "Chemical Action of Light", Blackie and Son, 1931.

Ultra-Violet Bands of Oxide of Phosphorus

THE Phosphorus arc in air gives out a band spectrum in the ultra-violet, which is attributed to the PO molecule. The vibrational quantum analysis of these bands has been previously done by one of the authors[1]. The rotational structure analysis of the (0, 0) band at λ 2477·80 shows that it consists of six main branches, namely, $P_1\ Q_1\ R_1$ and $P_2\ Q_2\ R_2$ and two other faint satellite branches. For low quantum numbers, the satellite branches ${}^{R}Q_{21}$, ${}^{Q}P_{21}$, ${}^{P}Q_{12}$ and ${}^{Q}R_{12}$ are superposed on the main branches. The intensity of the lines of the different branches satisfy the criterion of a ${}^2\Sigma \rightarrow {}^2\pi$ transition. The band structure is analogous to the ν-bands of NO_1 as is anticipated from theoretical considerations. The following molecular constants (cm.$^{-1}$ units) have been obtained.

$\nu_e' = 1{\cdot}416 \times 10^{-8}$ $\quad \nu_e'' = 1{\cdot}458 \times 10^{-8}$
$B_e' = 1{\cdot}3060$ $\quad B_e''\left(\frac{\pi}{2}\right) = 1{\cdot}2332$; $B_e''\left(\frac{3\pi}{2}\right) = 1{\cdot}2256$
$D_e' = -4{\cdot}60 \times 10^{-6}$ $\quad D_e''\left(\frac{\pi}{2}\right) = -4{\cdot}96 \times 10^{-6}$;
$D_e''\left(\frac{3\pi}{2}\right) = -4{\cdot}86 \times 10^{-6}$
$\alpha' = \alpha'' = 0{\cdot}0073$

The detailed results will be published elsewhere.

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[1] P. N. Ghosh and G. N. Ball, *Z. Physik.*, **71**, 362; 1931.

Conductivity of Mixtures of Gases

IT is well known that the electrical conductivity of certain gases may be greatly increased by the addition of very small quantities of other gases. For example, the electrical conductivity of pure helium is greatly improved by the addition of 0·01 per cent of pure argon. In gases, the electrical conductivity in uniform fields between parallel plates depends upon the ratio X/p, where X is the electrical intensity in volts per centimetre; and p is the pressure in millimetres of mercury, and is a maximum for a certain value of X/p depending upon the nature of the gas. The photo-electric currents obtained with a constant force between parallel plates at different distances apart are represented by the ordinates of the curves, Fig. 1, and the potential differences between the plates by the abscissæ. The three curves give the currents in pure helium, in pure argon and in helium containing 0·025 per cent of argon. The values of the ratio X/p were, 50 in pure helium, 200 in pure argon and 15 in the mixture. Under these conditions the rate of increase of the current with the distance between the plates was a maximum.

Two theories have been advanced to account for the increase in conductivity of the mixture, namely, the action of direct collisions of electrons with the atoms of argon, and the action of metastable atoms of helium which are formed by electron collisions

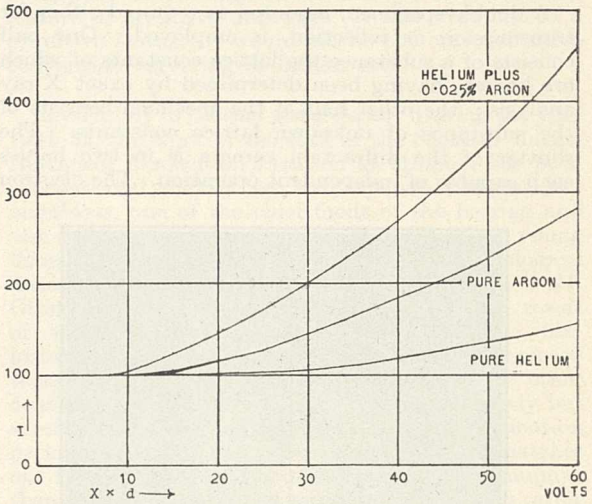

FIG. 1.—Conductivity between parallel plates. I, current between plates in arbitrary units; X, forces between plates in volts per centimetre; d, distance between plates in centimetres.

with helium atoms. These metastable atoms of helium may be formed when the electrons attain an energy corresponding to approximately 20 volts. It is then supposed that the metastable atoms of helium ionise the atoms of argon, which require an energy corresponding to approximately 16 volts. There is much controversy concerning the relative importance of these two processes. For example, Penning[1] states that the increase in conductivity may be attributed entirely to metastable atoms, whereas Townsend and McCallum[2] have pointed out that the effect of direct collisions of electrons may be considerable in these circumstances.

The results given in Fig. 1 are of importance in showing that a large number of new ions are formed in the mixture of 0·025 per cent of argon in helium when the potential between the plates is increased from 9 volts to 18 volts, the distance between them being adjusted so as to maintain a constant force. As no metastable atoms of helium could be formed until the electrons attained an energy of 20 volts, the increase in conductivity in these circumstances must be attributed to the direct collisions of electrons with argon atoms. It would not appear from the curve that any important new process occurs when the potential between the plates exceeds 20 volts, such as might be attributed to the action of metastable atoms.

More complete results will shortly be published elsewhere.

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[1] F. M. Penning, *Physica*, **12**, 66; 1932.
[2] J. S. Townsend and S. P. McCallum, *Phil. Mag.*, **5**, 695; 1928.

Determination of Crystal Lattice Constants by Electron Diffraction

THE accuracy of the determination of crystal lattice constants by electron diffraction has hitherto been limited by various sources of error, chief of which is that due to the lack of precision attendant upon the measurement of high voltages. We have recently succeeded in eliminating this and other sources of error in the following manner :

A double specimen, mounted as required either for transmission or reflection, is employed. One half consists of a substance the lattice constants of which are known, having been determined by exact X-ray analysis ; the other half of the specimen consists of the substance of unknown lattice constants. The shutter of the diffraction camera is in two halves each capable of independent operation. The electron

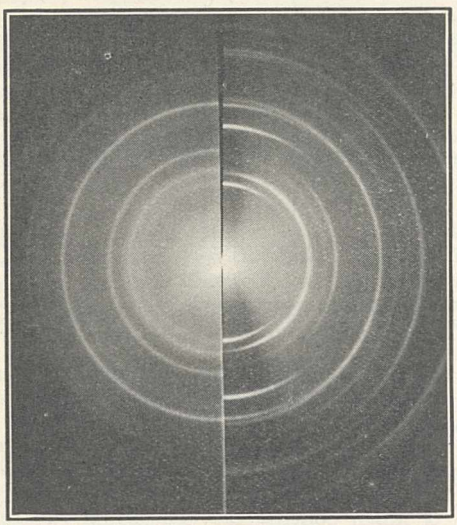

FIG. 1.

beam penetrates or impinges upon one half of the specimen and the corresponding electron diffraction pattern is recorded upon one half of the photographic plate. Thereupon the specimen is either traversed through the beam or rotated in the azimuthal plane, thus bringing the second half of the specimen under examination. The hitherto unexposed half of the photographic plate is now exposed. The accompanying reproduction (Fig. 1) of a transmission photograph obtained in the manner outlined above will serve to make clear the principle underlying the method, which is analogous to the use of the iron-arc reference in spectroscopy.

A more detailed account of this method will be published shortly.

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Selective Lattice Distortion in Wires under Torsion

X-RAY analysis of metals affords a means of detecting the type of internal strain which is accompanied by distortion of the crystal lattice. The distortion is reflected in the X-ray diffraction photographs in that it causes a broadening of the spectrum lines ; the effect has been noted for metals which have been cold-worked or which contain a highly dispersed solute.

I find that lattice distortion is produced also in wire (copper, nickel) under torsion, and a point of particular interest appears. Since torsional stress can be applied gradually, the rate of broadening of lines from different planes can be compared. It is found first, that the (420) planes distort more rapidly than do the (331) ; and, secondly, the lines do not broaden continuously with increasing stress, but exhibit instead alternating periods in which their definition is partially recovered.

The selective distortion of the planes is of such an order that the (331) $K\,\alpha_1\,\alpha_2$ doublet is easily discernible after the (420) doublet has diffused into a single broad line. The recovery effect is most marked on the (331) line ; the doublet diffuses and reappears, though to a less and less degree, as the torsion of the wire is increased.

The observations implement the view that lattice distortion grows, as stress is applied, to the maximum characteristic of the metal ; that the more highly distorted grains disrupt, and then tend to re-crystallise, presumably adopting a more convenient orientation, in a temporarily less distorted state. The latter stage would coincide with the recovered definition of particular lines.

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May 8.

Extension of the Visible Absorption System of NO_2 to Longer Wave-Lengths

IN two recent letters to NATURE, Cassie and Bailey[1] as well as Harris, Benedict and King[2] report new investigations of the infra-red and ultra-violet absorption spectrum of NO_2. We should like to remark that we have recently made new investigations of the *visible* absorption system of NO_2 which, as is well known, is extremely complicated. In consequence of this, neither its vibrational nor rotational structure has as yet been analysed. A possible explanation for this complicated structure is that, in consequence of the Franck-Condon principle, chiefly the higher vibrational levels in the upper state are excited.

On this assumption it was to be expected that the system would extend to longer wave-lengths with sufficient absorbing length and there become more simple. This proved in fact to be the case. We have found a rather simple series of bands starting at about 8900 A. and extending to shorter wave-lengths. The distance between the main bands is about 740–730 cm.$^{-1}$. This must be a vibrational frequency of the upper state.

We are engaged now in the investigation of these new bands with longer absorbing layers and with high resolution. On account of the absence of overlapping of different bands in the region now being investigated, it seems very likely that it will be possible to analyse the vibrational and rotational structure.

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May 6.

[1] NATURE, **131**, 239, Feb. 18, 1933.
[2] NATURE, **131**, 621, April 29, 1933.

Research Items

Social Organisation and Marriage in Madagascar. An account of the culture of the Tanala, a group living on the southern third of the eastern massif of Madagascar, which was visited by the Marshall Field expedition to Madagascar, 1926, has been prepared by Mr. Ralph Linton (Pub. 317, Anthrop. Ser., 22, Field Mus. Nat. Hist.). The Tanala live at the meeting point of four fairly distinct cultures. They are, and would appear to have been always, an agglomeration of groups, of which the composition was continually changing. Yet their culture is fairly uniform in its details, and in comparison with that of the rest of Madagascar, relatively simple and archaic. The social organisation, as in other groups of Madagascar, is based on a combination of two factors, common descent and common residence. Next to the family, the smallest group is the lineage, a local group of relatives, who claim descent from a common ancestor in the male line. Next comes the gens and then the tribe, the latter not necessarily an organic unit, but often a group of gentes brought together by conquest or alliance. The family consists of the man, his wife, or wives, and their children, the father in theory being absolute, not only over his own children, but over his son's children as well. In one of the two main divisions, the Ikongo, however, the mother has authority over the children, while control of the property is vested in the father. Marriage between different generations, or within the lineage is undesirable, and formerly there was a strong feeling in favour of marriage within the village. The Ikongo, however, in their fear of incest, favour marriage outside the village. Relationship affecting marriage is reckoned by blood, marriage and 'blood-brotherhood'. Among the Menabe marriage between the descendants of two sisters traced in the female line is absolutely forbidden. Cross cousins are urged to marry and marriage of cross cousins in the second generation is considered the most desirable form of union. The bride-price legalises the union. It is not returnable, except among the cattle tribes, and even there only in theory and not commonly in practice, as it determines the rights in the children.

'Western Indian' Art. An interesting document relating to the comparatively little-known Jains has been edited by Prof. W. Norman Brown, professor of Sanskrit in the University of Pennsylvania, and published by the Freer Art Gallery of the Smithsonian Institution, Washington (Oriental Studies, No. 1). The manuscript, which was purchased by Prof. Brown at Benares in 1922, is in folio, written in gold ink on a specially prepared background of red, black or blue, and illustrated with seven primitive paintings in brilliant colouring and of skilled draughtsmanship. It deals with the story of the monk Kalaka, one of the saints of the Jain cult, a pseudo-historical figure. Apart from the historic and religious interest of Jain manuscripts, they are of importance for the history of Indian art, an aspect which, virtually, has been neglected. They form a school, for which Dr. Brown suggests the name 'Western Indian', which preceded and on the Indian side was the parent of Moghul and Rajput art. The school lasted from the beginning of the twelfth to the seventeenth century. A peculiar characteristic of the school in drawing is the externalisation of the second eye in the representation of the profile, a feature also found, Dr. Brown notes, in paintings at Pagan in Burma. Dr. Brown thinks that among the Jains it is an attempt to represent the protruding glass eyes of the stone figures in Jain temples. It may be pointed out, however, that externalisation of the eye is a common feature in primitive drawings. If this were indeed a primitive feature, it would not be the only primitive convention surviving in Indian art.

Life-History of *Calanus finmarchicus*. During the year 1931–32, the work of the staff of the Scottish Marine Biological Association's station at Millport has been concentrated mainly on the copepod *Calanus finmarchicus*, one of the chief foods of the herring and also an important constituent of the food of young fishes of other species (Scottish Marine Biological Association: Annual Report, 1931–32. Pp. 1–24. Glasgow: 185 St. Vincent Street). As the result of well-regulated team work, the complete life-history of this copepod crustacean is being pieced together, and the physical, chemical and other conditions which determine its abundance slowly but surely ascertained and recorded. After an incubation period of about twenty-four hours, *Calanus* hatches out from the egg as a nauplius larva. This nauplius then moults through five more nauplius stages, after which it enters into a kind of intermediate or pre-adult phase known as the first copepodite stage. There are, in all, six copepodite stages, of which the last is the true adult. *Calanus* stops breeding in the autumn, most of the population which exists through the autumn and early winter being pre-adults of stage 5. During this resting season the total numbers show a steady decrease, so that very few *Calanus* are present when eventually moulting into the final adult form begins. Males appear first and females predominate later. Eggs are then laid and the brood produced develops quickly, producing full adults in about a month. By this time the parent (autumn) brood has entirely died out. The size of the *Calanus* remains the same throughout the autumn, but the winter brood consists of much larger animals. In addition to these studies of the *Calanus* population as a whole, detailed laboratory work is also being carried out on the digestive, respiratory, and other physiological activities of these animals.

The Arachnid Group, Opiliones-Laniatores. Dr. W. Sørensen, who died in 1916, left a number of descriptions of species of harvesters, and notes on their families and genera, which would have formed part of his proposed monograph on the sub-order Laniatores of the Opiliones. These manuscripts have been revised, first by Dr. C. With and latterly by Dr. K. L. Henriksen, and are now published (*Kong. Danske Vidensk. Selsk. Skr.*, 9, iii, 4, pp. 199–422) as a memorial to the extensive work done by Sørensen on these Arachnida. In Prof. C. F. Roewer's classification, the Laniatores were divided into six families, with thirty-two sub-families. The present work covers five of these families, but arranges them in five super-families and fourteen families. Three of these families are new; twenty new genera are also established and many new species from all parts of the world are described. All diagnoses are in Latin and the editor's notes are in English. These give

the history of the specimens examined and make clear the relationship between the systems of Sørensen and Roewer. The work is of considerable interest as a supplement to Roewer's great volume, "Die Weberknechte der Erde", 1923, and a fitting tribute to the memory of its author.

Disinfection of Glasshouses with Sulphur. Burning sulphur as a means of disinfecting vacant glasshouses has been found liable to result in a serious type of damage to a subsequent chrysanthemum crop (*J. Min. Agric.*, 39, 1085). The injury, which has frequently been encountered by growers, could not be traced to any fungal, bacterial or insect pest and had hitherto remained beyond control. Investigations by W. H. Read and O. B. Orchard of the Cheshunt Research Station, however, have shown that the scorching and wilting of the plants is due to zinc sulphate, formed on the overhead galvanised wires and painted surfaces and conveyed to the plants in drops of condensation water. Confirmation of the cause of damage was obtained by the production of similar injury when solutions of zinc sulphate were applied directly to the plants, 1 part of the salt in 300 of water being the maximum amount tolerated without visible injury resulting. No trouble was experienced if a lead or barium paint were substituted for 'zinc white' or if the atmosphere were kept very dry, but prevention of damage by means of these alternatives has obvious disadvantages. In the event of burning sulphur having already been used as a disinfectant, the possibility of damage can be greatly minimised if the house is thoroughly hosed down with water at frequent intervals. The substitution of another type of fumigant such as naphthalene or formaldehyde is, however, to be preferred. The use of sulphur as a dusting powder, on the other hand, is quite a safe procedure, as it is only when burnt that the formation of zinc sulphate takes place.

Disintegrating Action of Roots of Trees. In *Current Science* (Vol. 1, No. 3, 78, Sept. 1932) a brief account was published of the work of Mr. Mohammad A. R. Khan, principal of Osmania University College, on the "Disintegration of Igneous Rocks due to the Action of the Roots of Certain Rock-loving Plants", the observations having been made in the Deccan. The species more specifically referred to were *Carissa carandus*, *Gymnosporia montana*, *Butea frondosa* and *Anona squamosa*. A communication to NATURE, which we are unable to print in full, reports further investigations of this phenomenon. Mr. Khan attributes the extraordinary positions taken by the fantastically rounded igneous rocks of the Deccan in large part to the action of the roots of certain trees. Amongst these he considers that *Gymnosporia montana*, which is found for hundreds of miles in the rocky districts round about the city of Hyderabad, is the most formidable rock-disintegrator. It is well known that the roots of plants and trees exert an enormous influence in breaking up rocky strata beneath the surface of the superimposed soil layers; and that this is accomplished by the finer rootlets penetrating into tiny crevices and, through their subsequent growth in diameter, disintegrating the previously homogeneous mass. It is perhaps not so commonly appreciated that this action proceeds at a much more rapid pace in tropical countries, owing to the greater heat and moisture conditions. But Mr. Khan's observations would appear to show that the vegetation and the masses of smaller rootlets, which form a kind of lacework over the bases of the individual rock pieces of the curious Deccan formation, play a larger part in the disintegration and break up of the surface rocks than may have been so far attributed to it. "Where," he says, "the rocks are in contact with the soil (already formed) and the fine root-hairs of these plants have reached them, they (the root-hairs) enter the cracks and gradually draw upon the felspars and ferro-magnesium silicates for food. . . . These root-hairs spread over the rocks and permeate into the rocky material far and wide . . . producing a specific disintegration".

Spectrograph for Study of Fibrous Substances. Messrs. Adam Hilger, Ltd., have recently added to their X-ray diffraction apparatus a spectrograph constructed for the study of such fibrous substances as cotton-wool or silk. It is designed by Mr. W. T. Astbury of the University of Leeds, whose experience in such work is such as to ensure its construction on practical lines. The spectrograph proper is simple and follows orthodox lines. It consists of a collimator of variable aperture, specimen and plate holders mounted rigidly on a graduated triangular steel bar. A sector mounted on the plate holder enables photographs from the same fibre under different conditions or from different fibres to be obtained on the same plate and thus facilitates the detection of any change in lattice size. In such an apparatus the accessories are most important and the new spectrograph is very fully equipped in this respect. Among the fittings supplied with it are frames for mounting fibres in different positions relative to the X-ray beam and under different conditions of tension. Attachments are also provided to enable fibres to be studied under varying humidity conditions and during treatment with steam or acids. The apparatus is essentially practical and should have important applications.

Hyperfine Structure and Nuclear Moments. In *Current Science* (vol. 1, pp. 264 and 303, 1933) Prof. B. Venkatesachar and L. Sibaiya give the nuclear spins of zinc ($\frac{1}{2}$), caesium (5/2) and sodium ($\frac{1}{2}$) as obtained from hyperfine structure observations with the use of Lummer plates and a new type of source. The experimental value given for zinc has been deduced by a somewhat arbitrary selection of some of the reported components, and differs from the value 3/2 given by Schüler and Westmeyer (*Z. Phys.*, 81, 565; 1933). The intensities of the observed components, however, are not even in approximate agreement with the known abundance percentage of the odd isotope, and it seems quite probable that the observations were affected by ghosts or self-reversals. The values given for caesium and sodium were obtained from intensity measurements on the resonance lines, and are not in agreement with data based on a more rigorous analysis. The spins of the alkali metals are discussed in relation to a theory of nuclear spins previously proposed by Venkatesachar and Subbaraya (NATURE, 131, 552, April 15, 1933), but this discussion is based on early results now known to be inaccurate, and adds nothing to the known facts. An elaboration is made of Venkatesachar and Subbaraya's theory which predicts the spins for most of the elements of the periodic table. A critical examination of the theory, however, suggests that agreements between predicted and

observed values are fortuitous, arising largely because for most elements a whole regular series of alternative values is given, the observed value naturally agreeing with one of these. It follows that the predicted value for cæsium (5/2) carries no weight.

Analysis of Cast Iron. The British Cast Iron Research Association has recently published a monograph on "Recommended Methods for Sampling and Analysis of Cast Ferrous Metals and Alloys" (Special Publication No. 1. Pp. 44. Birmingham. 10*s*. 6*d*.), which will be found of great value by all who have to deal with cast iron and its uses in industry. The analysis of cast iron presents difficulties of its own, which begin with the sampling, special care being necessary in order to ensure that the quantity taken for analysis is representative of the composition of the metal. The precautions which should be taken are well described. Owing to the increasing use of alloy cast irons, where increased strength or resistance to chemical attack or to oxidation at high temperatures is required, the analyst must be prepared to look for elements other than those found in ordinary pig iron, including nickel, chromium, aluminium, copper, cobalt, molybdenum, tungsten, vanadium and titanium, and the analytical methods become correspondingly complex. The procedures here described are those which have proved themselves in the course of the life of the Association, during which the staff has had to conduct the analyses needed in the course of the research work undertaken at the laboratories in Birmingham, as well as those demanded by members. They may therefore be regarded as authoritative. The methods are clearly described, and with only sufficient detail for the guidance of competent analysts. Some useful hints, such as a reference to the presence of manganese in asbestos wool used for filtration, are to be found in the text. A closing section is concerned with the polishing and etching of specimens for microscopical examination. This might be improved in some details. Recent American workers have shown how slight modifications of technique greatly increase the truth of rendering of the graphitic constituents. White metal for embedding irregular specimens is greatly inferior to bakelite in powder form, which has no electrolytic action and is easily applied.

Astronomical Topics

A Star occulted by Jupiter. Mr. A. Burnet has for some years predicted occultations of stars by the planets. He lately predicted the occultation of the ninth magnitude star B.D. 8°, 2456 by Jupiter, which was visible in the United States on the night April 20–21. A Science Service bulletin of April 29 reports that the phenomenon was observed and photographed at the Yerkes Observatory. The director, Prof. O. Struve, sent copies of the photographs to Science Service. It is stated that they show the approach of the star to the planet; on the last photograph it is nearly in contact with the limb. The four large satellites also appear on the photographs. Planetary occultations of stars are not very common. On one occasion a sixth magnitude star was occulted by Jupiter, and with the large reflector at Melbourne the star remained visible for some distance within the limb of the planet. Stars have also been seen to remain visible when passing behind Saturn's ring.

Recent Observations of Mars. The March issue of the *Journal of the British Astronomical Association* contains a preliminary report of the work of the Mars Section, by its director, Dr. R. L. Waterfield. Midsummer of the northern hemisphere occurred on April 10; rapid shrinking of the north polar cap occurred; Olympia became separated from the cap on March 12, and Lacus Hyperboreas appeared as a dark spot on the snow-line on March 22. Another rift across the cap was seen at the end of March in longitude 300°. The northern maria, Casius, Propontis and Acidalium were very dark. The southern maria were pale, presumably owing to mist over them. The two bright bridges across Acidalium, known as Baltia and Achillis Pons, were very bright, as was also Herculis Pons. Margaritifer Sinus was shorter than usual, and had a blunt north end, instead of the usual point. Solis Lacus, which changes much in appearance at different oppositions, was small, pale and difficult to see. The canals Ganges, Euphrates, Hiddekel and Gehon were not seen early in the apparition, but reappeared at the end of March. A sketch by Mr. Hargreaves shows Nilokeras doubled.

Comets. Circulars from New Zealand appear to indicate that the comet Dodwell-Forbes was independently discovered there; the name of the discoverer is not stated. It was at first suspected to be Tempel's comet of 1866, but this was soon disproved by its motion. It is, however, moving in an elliptical orbit; the two following orbits have been recently published, based on an arc nearly two months long: the equinox is that of 1933·0.

T	1932 Dec. 30. 52167 U.T.	Dec. 30. 51633 U.T.
ω	327° 20′ 4·2″	327° 19′ 40·8″
Ω	77 40 21·7	77 38 54·5
i	24 30 3·6	24 30 33·0
e	0·972064	0·973560
q	1·130720	1·131018
Period	257·5 years	279·9 years
Computer	H. Hirose	A. D. Maxwell
Reference	*U.A.I.Circ.* 429	*Pop. Astr.*, March

Peltier's comet shows no deviation from a parabola; the following orbit was derived by Mr. Möller from observations up to February 28, and satisfies observations made a fortnight later (*U.A.I. Circ.* 428):

T	1933 Feb. 6. 689 U.T.	
ω	135° 58′ 41″	
Ω	311 31 51	1933·0
i	86 40 5	
q	1·00060	

Comet Schwassmann-Wachmann is now in aphelion; it passed perihelion on 1925 May 15, two years before its discovery; its period is 16·3 years, so aphelion passage will be early next July. In spite of its great distance it is still showing activity; a remarkable brightening up at the end of last year was noted both at Bergedorf and at Yerkes. It is probably more massive than most comets.

Recent Developments in Coal-Mining Explosives

IN British mines, about thirty million pounds weight of explosives are used annually. This involves the firing of about sixty million shots. When any shot is fired there is potential danger, particularly in gassy mines. Recent improvements in coal-mining explosives have aimed at increasing both their safety and efficiency. The three main developments have been (1) low-freezing explosives, (2) low-density explosives, and (3) 'Cardox'.

In a paper read recently before the Midland Institute of Mining Engineers, Dr. W. Payman, chief chemist to the Explosives in Mines Research Committee, discusses these developments. Nitro-glycerine freezes at 13° C. (55° F.) so that during storage in cold weather all explosives containing it become solid. Consequently many attempts have been made to render nitro-glycerine explosives non-freezing. The first method adopted in Great Britain was the substitution of a portion of the glycerine used in the manufacture of nitro-glycerine by polyglycerine. Though quite effective, this has now been replaced entirely by nitro-glycol. Polyglycerine was difficult to make and was not of constant composition. Glycol resembles glycerine in many respects and is largely used for preventing freezing in motor-car radiators. The efficacy of the use of low-freezing explosives is indicated by the fact that no fatal accident due to handling hard or frozen explosives has been reported for several years.

Low-density explosives have been developed mainly to reduce the shattering effect of high explosives and to increase the yield of lump coal. The average density of the new low-density explosives is about 0·7, whereas that of the older explosives is 1·0; their respective weight-strengths, however, as judged by Government tests, are about the same. The decrease in density has been brought about by the incorporation with the explosive of bulky wood sawdust or plant fibre. The reduced shattering effect of the low-density explosive appears to be due mainly to the spreading of the direct action of the explosive on the coal.

The introduction of 'Cardox' is one of the outstanding contributions to safety of recent years. The 'Cardox' blasting device consists of a strong steel shell containing a charge of liquid carbon dioxide and a heating element which converts the liquid carbon dioxide almost instantaneously into gas at high pressure. The pressure produced is sufficient to shear a disc at one end of the shell or cartridge, when the gas escapes and exerts a disruptive effect on the surrounding strata. The advantages claimed for the 'Cardox' blasting device are: (1) increased safety in the presence of firedamp and in handling; (2) increased yield of lump coal; (3) easy recovery of misfires; (4) little disturbing effect on roof near the shot-hole; and (5) absence of fumes.

It is encouraging to learn that the merits of the 'Lemaire sheath' are at last being given the serious attention of the Safety in Mines Research Board. This safety device consists of a thin cylinder of plastic clay mixed with sodium fluoride or another agent or both; the clay cylinder or 'sheath' envelops the explosive and largely damps out the flame resulting from its detonation. The Lemaire 'safety sheath' has been officially adopted in Belgium for many years.

Radio Direction-Finding

AT a meeting of the Wireless Section of the Institution of Electrical Engineers held on April 5, two papers were read describing recent research carried out at H.M. Signal School in the development of radio direction-finders for use in naval ships. In the usual form of direction-finder, it is customary to employ a figure-of-eight reception characteristic for taking the direction, and then, by a separate operation, to resolve the 180° ambiguity by determining the 'sense' of the bearing previously obtained. The ordinary cardioid reception characteristic employed for the latter operation is not suitable for determining the bearing to any great accuracy, so that the two operations are necessary, involving an increase in the time required to obtain a bearing.

In one of the papers, entitled "A Radio Compass Developed in H.M. Signal School", Messrs. C. E. Horton and C. Crampton described a system whereby both the direction and the sense are determined by a single operation. The system employs two rotating loops or frame coils fixed together at right angles; one loop is arranged to give a figure-of-eight characteristic while the other gives a cardioid, the two characteristics being combined in such a way that the minimum of the cardioid is coincident in direction with one zero of the figure-of-eight. The paper included an analysis of the behaviour of such a direction-finding system, when installed in a steel ship, and also an account of experiments carried out to verify the results. It was shown that by a suitable arrangement of the circuits the errors in bearing due to currents set up in the ship itself can be reduced to the values obtained with the equivalent simple direction-finder in the same position.

The second paper, by Mr. J. F. Coales, comprised a calculation, with subsequent experimental measurement, of the magnitude of the errors experienced on a ship's direction-finder due to the shape and orientation of the aerial at the transmitting station. The experiments were carried out in a light cruiser, with a destroyer as the transmitting ship. The aerial on the latter was of the inverted 'L' type, and errors of 1° or 2° were found in the calibration of the direction-finder, when the receiving ship was not in line with the horizontal portion of the transmitting aerial. This error decreased rapidly with increasing distance between the two ships, becoming negligible at about four miles. A knowledge of this error is important in carrying out a calibration of the direction-finder at very short distances, and it is desirable to take two sets of readings, with the transmitting ship steaming round the receiving ship, first in a clockwise, and then in an anticlockwise direction. The mean of the readings so obtained will form a true calibration of the direction-finder for signals arriving from a distance.

Investigations on Timber

UNDER the auspices of the Department of Scientific and Industrial Research, the report of the Forest Products Research Board for the Year 1931 has been issued. It is combined with the report of the Director of Forest Products Research for the same year.

The investigations carried on during the year fall roughly into three groups : (1) the dry rot investigations being carried out in the new experimental building erected for the study of this subject, (2) investigations into the death-watch beetle and into the damage caused by the *Lyctus* powder-post beetles, and (3) investigation work on Empire timbers, more especially in the tropical hardwoods. Under (3), the report of the Research Board has some pertinent remarks on the subject of encouraging and organising the placing of Empire tropical timbers on the markets. Several of the points discussed have been already alluded to in NATURE (129, 696, May 7, 1932).

The report describes improvements in the design of seasoning kilns, new apparatus for the determination of humidity in the kilns, and a method of employing the photoelectric cell in the study of wood structure by using it to measure the percentage of empty space in the interstices of a timber due to its cell structure. Apparatus is also described which determines the gloss of a machined surface by measuring the amount of light scattered or reflected from it. Another instrument measures the finish on a surface by recording the frictional resistance experienced by dragging a standard metal plate over the surface.

The report emphasises the importance of research on wood-working tools. "A new Empire timber is often condemned by the machinist as 'unworkable' simply because machines, developed to deal with timbers in common use, are not suited to the very different structure of the new timber. A modification of feed speed, cutting speed or cutting angle may be all that is necessary to make the most obdurate timber workable, but in order to foretell these modifications a knowledge of the way in which the cutting action of any tool, whether plane, saw or drill, should be related to the structure of the wood on which it is to work is essential."

During the year, 689 specimens of structural timber were tested, while 3,470 test pieces cut from a material free from knots, etc., were submitted to almost every conceivable mechanical test. Tests on physical properties, etc., numbered more than 9,500. A total of 4,800 specimens treated in various ways with eight wood preservatives, including low temperature tar and its distillates, have been exposed for test and are kept under constant observation.

Antarctic Geology and Glaciation*

THE sub-antarctic islands south of the Indian Ocean—Prince Edward and Marion Islands, the Crozet Islands, St. Paul and Amsterdam Islands, the Kerguelen Archipelago, and Heard Island—are all of the character of oceanic islands. So also is Macquarie Island in the Australian sub-antarctic. They are the summits of vast igneous extrusions heaped upon the sea floor. Volcanic activity has ceased only in recent times. Hot springs are still met with at St. Paul and have been vaguely reported from Kerguelen Island. All those islands in higher latitudes than 40° S. show evidence of severe glaciation during geologically recent times. Glaciers are still a feature of Kerguelen Island, Heard Island, and the Crozets. As a consequence, morainic debris, fluvial sands, and peat beds occur irregularly distributed over their surface.

Magmas contributing to the formation of these islands are, in the main, very basic. Varieties of peridotite, basanite, and basalt have been extruded on a vast scale. Next in order of abundance but subordinate in quality is an interesting range of trachytes and phonolites. Coarse tuff beds on Macquarie Island, Heard Island, and Kerguelen contain fragments of a dense, recrystallised *Globigerina* ooze, indicating that the igneous outbursts have broken through pelagic sediments. The occurrence of unsaturated magmas amongst the volcanic effusions may be attributable to the assimilation of quantities of such calcareous oozes.

Acid lavas are scarce, the only notable record so far being the appearance of rhyolite amongst the earlier eruptive debris of St. Paul Island.

Macquarie Island is unique amongst these localities in exhibiting some of its basic igneous rocks in an advanced state of serpentinisation. There, also, are found former submarine volcanic centres where tachylite now considerably palagonitised was extruded.

Kerguelen, which is much larger than any of the other islands under consideration, also reveals a more complicated geological structure. This appears in the deep fjords, where sections are exhibited cut down through several thousand feet of strata. In the south-western portion of the island, there are thus brought to light plutonic rocks such as monzonite, mica-diorite, and even syenitic types. These have doubtless originated, as Lacroix has explained, by injection into the already solidified effusive lava system.

Chronological evidence is limited and is so far found only at Kerguelen. There, a land surface composed of igneous rocks, basalts, trachytes, and the like, appears to have been in existence in early Tertiary times. Upon this surface, fluviatile conglomerates were laid down on a grand scale. These incorporate in their upper limits irregular intercalations of lignite. The fossil vegetation recorded is dominated by an Araucarian flora very similar to that existing to-day in the considerably warmer climate of Norfolk Island. The age of this lignite is likely to be late Oligocene.

Thereafter follows a vast succession of basalt flows and ash beds, high up in which series has been located a band of coarse littoral sediment rich in fossil mollusca with a Pliocene facies. The mollusca, by their nature, indicate water warmer than prevails

* Substance of a lecture entitled "Geology and Glaciation of some Islands of the Southern Ocean and the newly discovered Antarctic Mainland" delivered by Sir Douglas Mawson at the Geological Society of London on May 10.

to-day along those shores. Further volcanic outpourings both basic and trachytic conclude the series.

Then came the glacial period. Almost the entire land area became buried under ice. Only now is Kerguelen emerging from a period of profound glaciation, which re-moulded pre-glacial topography and has yielded an outstanding example of fjord and skerry development.

To turn now to the antarctic regions nearer the pole. It has been shown that southward of Australia and the Indian Ocean there exists a continuous, circumpolar, continental bulge. This has been delineated in the neighbourhood of the antarctic circle through 3,000 miles of arc. Thus, for the first time, it is demonstrated that under the antarctic ice there lies a continent and not merely scattered islands holding together an ice mass. Everywhere around this great sector the rocks outcrop on the coast; also those ice-borne from the land and shed on the sea floor are continental in type. The antarctic land south of the Indian Ocean is characterised by rock forms typical of the deeper continental sub-strata, such as varieties of granite, norite, and charnockite; also gneisses and schists in which garnet, cordierite, and sillimanite figure abundantly.

Though most of this land region is smothered beneath an ice cap, continental in dimensions, yet there is clear evidence that the intensity of glaciation has greatly diminished since the peak period. There seems no reason to doubt that the latter coincided with the ice flood of the Pleistocene, recorded in the northern hemisphere. At the height of the glaciation, the continental ice cap extended everywhere to the margin of the continental shelf which, in the antarctic, is still unduly depressed, owing apparently to lag in isostatic readjustment after subsidence under the ice load. Submarine banks found distributed along its margin and elsewhere on the continental shelf indicate standstill periods of the ice front. Rock-floored, ice-scoured, moat-like depressions are a feature between the off-lying submerged banks and the present coast.

University and Educational Intelligence

BRISTOL.—The following appointments have recently been made: Dr. J. F. Baker, to the chair of civil engineering; Prof. A. E. Trueman, professor of geology in University College, Swansea, to the chair of geology; Prof. G. Hadfield, professor of pathology in the London School of Medicine for Women, to the chair of pathology; Mr. J. W. de Witt G. Thornton, lecturer in pharmacology; Mr. J. D. A. Gray, senior pathological officer in the Department of Preventive Medicine; and Mr. J. W. Edgell, dairy bacteriologist with the standing of an assistant lecturer in the University.

CAMBRIDGE.—The following have been appointed to University lectureships: Mr. R. F. Kahn, of King's College, in the Faculty of Economics and Politics; Mr. A. H. Wilson, of Emmanuel College, Mr. W. V. D. Hodge, of St. John's College, and Mr. P. Hall, of King's College, in the Faculty of Mathematics.

A vacancy exists for a University demonstrator in the Department of Mineralogy and Petrology, who will be required to teach crystallography and crystal physics. Applications should be sent to Prof. C. E. Tilley, at the Mineralogical Laboratory.

It has been recommended that the plans prepared by Mr. Redfern for an extension of the Chemical Laboratory be approved and that the tender of £3,360 received from Messrs. Coulson and Son Ltd. for the work be accepted.

Mrs. G. Stephenson has presented to the University a valuable gift of books from the library of her late husband, Dr. J. Stephenson. Some of these books have been added to the Balfour Library and some to the library of the Advanced Laboratory of Zoology.

ST. ANDREWS.—Mr. John Anderson, surgeon in Dundee Royal Infirmary and lecturer in clinical surgery in the University, has been appointed professor of surgery in succession to the late Prof. L. T. Price.

THE Science Scholarships Committee of the Royal Commission for the Exhibition of 1851 has made the following appointments to senior studentships for 1933: on the recommendation of the University of Cambridge, Mr. E. H. F. Baldwin, for research in biochemistry; on the recommendation of the University of Edinburgh, Dr. H. W. Melville, for research in physical chemistry; on the recommendation of the Imperial College of Science and Technology, London, Mr. J. I. Armstrong, for research in plant physiology, and Dr. W. G. Penney, for research in physics; on the recommendation of the University of Oxford, Dr. B. K. Blount, for research in organic chemistry.

RURAL education in East Suffolk is in process of re-organisation along lines described in pamphlet No. 93 of the Board of Education (H.M. Stationery Office, pp. 40, 9*d*.). The new 'area' or 'senior' schools for children of 11–15 years of age, which are being set up in pursuance of a scheme prepared in 1929 for giving effect to ideals formulated in the Hadow report on the education of the adolescent, have already demonstrated how very materially their pupils may benefit, not only in the direct results of their instruction but also very obviously in health, deportment and confidence. Among salient features of the new regime is the spacious planning of the school premises. It is usual for an area school to possess or have the use of five or six acres, and this gives scope for developing "the conception of the school as a social unit, as nearly as possible a self-sufficing community, and of its site as an estate". Here is to be found the key to success in rural re-organisation; nor is it necessarily an expensive one, for the cost per place of the new schools has in no case exceeded £33. The lay-out has been left to the individual planning of the head teacher with assistance from the official organiser of gardening. Plans of a typical lay-out are appended to the pamphlet. Another important point is that the whole of the children's education is brought under one roof and under one direction. Instead of working in isolation not only from one another but also from the head teacher and class teachers, those who specialise in wood and metal work and domestic science find ample opportunities of close co-operation with the happiest results. Essential particulars are given of the arrangements for conveyance, school canteens, methods of dealing with the problem of individual differences, games and other physical activities. The pamphlet is well worth reading from cover to cover, not only by all concerned with rural education but also by all who value the welfare of rural England.

Calendar of Nature Topics

Egg-Laying and Incubation of Painted Turtle

From 1915 until 1928, J. T. Nichols collected seven records of the egg-laying of the painted turtle (*Chrysemys picta*) and these range from June 8 to July 17, the time of egg-laying in four of six cases recorded being between 4.30 and 5.30 p.m. Eggs laid about June 25, 1928, were carefully marked as to place, but were left undisturbed until it seemed very unlikely that they would emerge before spring even if by chance lack of frost permitted. On October 28 the nest was opened, disclosing 11 fully developed young turtles in a bunch with fragments of old egg-shells. They measured one to one and a half inches in shell length. It would appear that although the young of the painted turtle hatch in the autumn, they do not emerge from the ground until the following spring, differing in this respect from the young of the snapping turtle, which are to be found above ground in September.

Egg-Laying of the Leathery Turtle

The leathery turtle (*Dermochelys coriacea*), the largest of its kind, is more highly adapted for aquatic life than any other testudinate, and yet it is perhaps the most primitive of the group. Its breeding range is confined to about lat. 15° N. and 15° S. and during the months of May and June the majority of the females deposit their eggs upon some sandy shore. Leaving the sea at any hour of the night between 8 p.m. and 3 a.m., the turtle makes its way fifteen or twenty metres up the shore and there places her spherical soft-shelled eggs in a deep nest from which the young hatch after 58–65 days according to the intensity of the sun. In every nest of embryos examined by P. E. P. Deraniyagala there were two eggs containing twins. This author has made a very careful study of the development of the embryo and has found that the characteristic smooth-skinned condition of the adult results from the thinning out of the infantile scales which are not directly responsible for the corselet platelets (*Spolia Zeylanica*, 17, 73 ; 1932). Nothing is known of the later development and growth of this turtle, of which the adolescent stage is unknown and appears to be spent far from land. The newly hatched young invariably sickened and died on a diet of fish. The morphological changes of the embryonic stages suggest a closer approach to the larval stages of Amphibia than is shown by any other living reptile. Apart from this feature, several of the adult characters, such as the clawless limbs, smooth skin, crested tail, skull characters, general build of the pelvis, and the cartilaginous nature of the skeleton, are reminiscent of the Amphibia.

The Painted Lady Migrates

In June the mass-movements of the painted lady butterfly (*Vanessa cardui*) reach their height in Europe. At the same time the migrations assume a new character which shows that mid-summer is for the painted lady the vague boundary which divides spring habits from autumn habits. Up to mid-summer, according to Dr. C. B. Williams, there is a prevailing tendency for the insect to move to the north and west, 94 flights in these directions have been recorded as against 59 in a southerly and easterly direction. In June, flights towards the south and east become more common and then predominate in July and August ; but although there is evidence of a definite movement northwards, there is no sound evidence of return migrations in autumn. The painted lady occurs in every continent of the world, yet their place of origin is still a little doubtful. In Europe the species does not survive the winter in numbers such as would give rise to large movements, and on account of the appearance of swarms entering Egypt and Algeria from the south, Dr. Williams surmises that the centre of dispersal lies somewhere south of the Sahara desert. His view is supported by the evidence of Skertchly, who in March 1869 saw emerging from their pupæ in grass in the Sudan, a cloud of painted ladies which was certainly more than a mile long and a quarter of a mile in breadth. The speed of migratory flight in this species appears to vary between 11 and 15 miles per hour whether with or against the wind, and a summation of the records suggests that there is probably no relationship between the direction of flight and the direction of the wind at the time.

American Pronghorn increasing in Numbers

In May or early in June the fawns of one of the oddest of horned ungulates are born, generally two at a birth, sometimes three. Although it resembles an antelope in appearance, the pronghorn (*Antilocapra americana*) is not closely related to the true antelopes of the Old World, and it is the only hollow-horned creature which sheds its horns every year. When white men first invaded the plains of western America, the pronghorn was more numerous than the bison ; but the spread of agriculture and grazing, and the gun, brought it a generation ago nearer to extinction than even that species. A campaign for the protection of the pronghorn has been most effective. A census just concluded by the New York Zoological Society gives the numbers (according to Science Service, Washington, D.C.) as approximately 68,000 in the United States and 2,400 in Canada ; whereas ten years ago, when the U.S. Biological Survey made a similar count, the numbers were 27,000 in the United States, and 1,327 in Canada.

Resistance of Turnips to Finger and Toe Disease

This is the turnip-sowing season in the north of England and in Scotland. In this connexion the experiments recently described by Prof. J. Hendrick of Aberdeen (*Trans. Highland and Agric. Soc. Scotland*, 1932, p. 52) with a variety of yellow turnip that is highly resistant to the 'finger-and-toe' organism, *Plasmodiophora brassicæ*, are of interest. For several seasons the Bruce, as the variety is now called, has produced good crops of usable quality on the well-known continuous turnip plots at Craibstone. Ordinary varieties of turnips are quite worthless on this heavily infected land. The control of finger and toe by liming is well understood, and represents one of the classic cases of the combatting of plant disease by modification of the soil reaction. Nevertheless, cropping with oats, potatoes and grass can proceed quite successfully on 'finger and toe land' and it may not be feasible or even desirable in all cases to undertake liming on such a scale as would cure the disease. A resistant variety offers a simple way out of the difficulty, and if the resistance of the Bruce is maintained, the variety should be a real contribution to the farming of acid soils in the turnip-growing districts.

Societies and Academies

LONDON

Physical Society, May 5. N. R. CAMPBELL: The measurement of visual sensations. The paper is a criticism of Dr. L. F. Richardson's proposed method of measuring sensations by 'mental estimates'. In the absence of agreed principles the discussion is conducted in the light of an analogy with thermometry. It is argued that if Dr. Richardson's facts and his implied propositions are true, indirect measurement by means of his S must be preferable to direct measurement by R. Arguments based upon the fact that this method of measurements leads to a numerical law between R and S would be valid only if the law is true and not empirical. If the method measures anything, that something is almost certainly not a sensation. Dr. Richardson's method indicates the theoretical possibility of a method of measurement based upon ordering differences of increasing degree; but there is no evidence that the method is ever practically possible. V. H. STOTT: The measurement of the viscosity of a molten metal by means of an oscillating disc. It has been found necessary to calibrate the apparatus on molten metals having viscosities and densities not too different from those of the metals to be investigated. The viscosity of tin at different temperatures has been determined by Sauerwald and Topler by the capillary tube method, and the present experiments have lengthened the range of temperature for which the viscosity of tin may be regarded as fairly well established. Discontinuity in the (viscosity, temperature) curve of molten tin at temperatures near its freezing point is very improbable, and certainly does not occur at temperatures more than 6° C. above that point.

DUBLIN

Royal Dublin Society, Feb. 28. J. CARROLL: Study of the potato eelworm (*Heterodera schachtii*) in the Irish Free State. The investigations include a study of the relationship between the parasite and the hydrogen ion concentration of the soil, and also a study of the relationship between the intensity of potato sickness symptoms and the number of eelworm cysts present in the soil. The experiments which were carried out, although of a limited nature, demonstrated satisfactorily that *Heterodera schachtii* can of itself give rise to severe symptoms of potato sickness, and that there is a positive relationship between the intensity of potato sickness and the number of cysts present. The paper also includes references to experiments on soil treatment and refers to other strains of the parasite which have been found in Ireland. H. H. POOLE and W. R. G. ATKINS: Some experiments on the suitability of photocells of the dry rectifier type for the measurement of daylight. Tests on these cells in intense illuminations show that the current illumination curves are rarely linear, their forms depending greatly on the resistance of the galvanometer employed. Temperature effects are important with some cells, and should be minimised by avoiding excessive exposure to strong light except for brief periods. Low resistance galvanometers are preferable as giving curves more nearly linear and less subject to temperature effects. A number of different cells were tested for their spectrum sensitivities, which were widely different according to the type of cell. The Bergmann cell is sensitive throughout the whole of the visible spectrum, its maximum being in the orange red. The permanence of this cell has not so far been tested, but all other cells tested have shown a fall of sensitivity with time and exposure. The cells appear to be well suited for rapid comparative measurements of daylight where great accuracy is not required.

PARIS

Academy of Sciences, April 24 (*C.R.*, 196, 1177–1252). The president announced the death of R. de Forcrand de Coiselet, *Correspondant* for the Section of Chemistry. L. CAYEUX: The rôle of the Trilobites in the genesis of the Palæozoic deposits of calcium phosphate. From the author's discussion it would appear that no important contribution of phosphate to Palæozoic strata can be attributed to Crustacea, especially Trilobites. CH. MAURAIN: The interval of time between solar phenomena and terrestrial magnetic disturbances. Historical summary of published work on this subject. J. COSTANTIN: Variations in the virulence of degenerescence in the potato. Discussion of the causes of resistance to disease. It is shown that the weight of crop per plant is a valuable criterion for determining the resistance to disease. M. GIGNOUX and L. MORET: The Briançonnais zone and the roots of the Savoy pre-alpine sheets. MLLE. MARGHERITA PIAZZOLLA-BELOCH: A remarkable family of plane topological curves. MLLE. MARIE CHARPENTIER: Closed curves and their first ends. N. BOTEA: Holomorph functions. W. STEPANOFF and A. TYCHONOFF: The spaces of nearly periodic functions. L. PONTRJAGIN: Nearly periodic functions and *Analysis situs*. JACQUES DEVISME: Two questions relating to the equation of P. Humbert. ANTOINE APPERT: The rôle of the second condition of F. Riesz in abstract spaces and certain properties of connexion. GIOVANNI LAMPARIELLO: The analytical nature of the solutions of canonical equations integrable by quadratures. ROBERT L'HERMITE: An indefinite plane piece submitted to the action of massic forces in the plane and the application to the calculation of rectangular drums supporting interior and exterior forces. J. ELLSWORTH: Remarks on the double system *RZ* Cassiopeiæ with eclipses. From an analysis of the known data the author concludes that contrary to the opinion of Hellerich, the photometric and spectroscopic data are not irreconcilable. J. J. TRILLAT and L. LEPRINCE-RINGUET: Studies of the molecular phenomena at the surface of separation of oil and water. Applications to the control of oils. Changes in the surface tension at the oil water surface have been studied by Lecomte de Noüy's method, with special reference to the effects of traces of impurities in the oil. Proportions of impurities so small as 1/100,000 can be detected in this way. JEAN CAYREL: A new detector. Studies in metal-crystal rectification. P. LAINÉ: The magnetic double refraction of liquid oxygen. The magnetic double refraction of liquid oxygen was found to be $-1{\cdot}96$ times that of nitrobenzene, slightly greater than the value found by Zernike ($-1{\cdot}85$). The dispersion was measured for three wave-lengths. PIERRE DUBOULOZ: The yield of fluorescence of sodium salicylate. Studies of a potassium photoelectric cell coated with sodium salicylate. Applied to the photometry of the ultraviolet, it gives a convenient means of obtaining a very slightly selective receiver the sensibility curve

of which is independent of the cell and its preparation. J. P. MATHIEU: The alkaline tartaric solutions of chromium. GASTON CHARLOT: The catalytic oxidation of organic compounds in the form of vapour. P. MONDAIN-MONVAL and ROGER WELLARD: The direct oxidation of acetylene by air. Acetylene reacts with air at temperatures well below the polymerisation temperature, with production of peroxides. The peroxide is regarded as producing the spontaneous inflammation of detonating mixtures. A. E. FAVORSKY and J. N. NAZAROW: The question of the existence of metal ketyls in the fatty series. ANDRÉ MEYER and MARCEL TUOT: The dehydration of some tertiary alcohols by anhydrous copper sulphate. Anhydrous copper sulphate possesses the advantage over other dehydrating agents that, while giving good yields of pure ethylene derivatives, no isomerisation is produced. RAYMOND HOCART: The orientation of arsenolite and of senarmontite by mica. These minerals, sublimed on to a thin plate of mica obtained by cleavage, are oriented by the mica. H. LAGOTALA: The continental formation subjacent to the limestones of Niari (French Congo). The author regards the conglomerate formations studied as a continental formation of glacial origin, partially fluvio-glacial. N. MENCHIKOFF: New data on the geology of the western Sahara. ANDRÉ EICHHORN: The supposed existence of centrosomes and of asters in the higher plants. The observations of Feng on *Lonicera* are not confirmed and another interpretation is given to his results. VLADESCO: The development of the octants in the embryo of the leptosporangiate ferns. R. QUETEL: The variations of the proportion of nitrogen in the lilac in the course of forcing. Study of the effects of exposure to ether vapour followed by placing in a moist, warm atmosphere. J. VERNE and C. SANNIÉ: Study of the toxic action of cations on fibroblasts cultivated *in vitro*. P. PONTHUS: The action of an ultra-violet radiation on aqueous solutions of gelatine. Modifications of some physico-chemical characters. Probable photolysis. F. RATHERY, MME. ANDRÉE PLANTEFOL and LUCIEN PLANTEFOL: The reactions of the respiratory exchanges resulting from the ingestion of glucose and of insulin in diabetics.

ROME

Royal National Academy of the Lincei, Jan. 8. F. SEVERI: The compatibility of systems of algebraic and analytical equations. C. CARATHÉODORY: Generalisation of a theorem of Euler on brachistochrone movement. E. ALMANSI: Deformations of elastic plates (3). P. ALOISI: An andalusite twin. The crystal here described was found on Mount Perone (Elba) and represents the only case of twinning in andalusite. The twinning plane has, however, the simple symbol {101}, which is one of the few known forms of frequent occurrence in andalusite, and the various optico-crystallographic elements are arranged regularly in the positions proper to a twin on {101}. C. AGOSTINELLI: Concurrent directions in a variety V_n. Study of the notion of concurrent directions, introduced by Myller (1928), by vectorial methods furnishes the conditions of concurrence in a very simple form and allows of the deduction of various noteworthy geometrical properties not previously recorded. S. AMANTE: Reduction of a special class of matrices to canonical form (1). L. CAMPEDELLI: Certain invariant series of groups of points on a surface. RUY LUIS GOMES: Linear operators: limited matrices. E. GUGINO: Transport by parallelism along a closed circuit in a Weyl space. M. KOURENSKY: Integration of the equations to the partial derivatives of the second order with two functions of two independent variables (5). Systems containing two (or one) derivatives of the second order. S. MINETTI: A general theorem on the succession of functions converging towards a holomorphous function. MARIA PASTORI: Tensorial aggregates generated by absolute Pascal-Vitali systems: relation to the derived aggregates. EMMA SENIGAGLIA: Complement of a theorem of A. Hurwitz on the basis of the modulus of the algebraic forms passing through a normal rational variety. D. BONVICINI: The second variation of the elastic potential in isotropic solids. An expression, sufficiently approximate for investigating the stability of the equilibrium, is derived for this variation. G. LAMPARIELLO: The quadrature which effects the integration of canonical systems with one degree of freedom. L. SONA: Forced viscous rotations. A. WEINSTEIN: Wakes caused by circular arcs. F. ZAGAR: Increase in the mass of a planet by cosmic dust. (2) General case. A. QUILICO and A. DI CAPUA: Aspergillin, the pigment of the spores of *Aspergillus niger* (1). Of various media tried, molasses–agar gave rise to most abundant fructification of the mould. The Pollacci strain gave spores containing more than 24 per cent of aspergillin, whereas with a strain isolated from Abruzzian cheese the content did not exceed 15·6 per cent. Yields of aspergillin of 0·24–0·34 gm. and 0·10–0·22 gm. per square decimetre of medium surface were obtained; these may be increased considerably by removing the mycelium as well as the spores. R. GIGANTE: Preliminary investigations on a non-parasitic alteration of the olive. During last season the olives of Latium frequently developed slightly depressed greenish-brown spots of diameter 1–6 mm., which afterwards darkened. These were not the result of photolytic processes, deficient transpiration, or insect punctures, but appear to have been caused either by insect secretions or by fungicides having a molasses basis.

VIENNA

Academy of Sciences, Jan. 27. HERBERT SCHOBER: The spectra of rhenium (4). Arc spectrum in the ultra-violet region on copper electrodes between 2400 and 4000 A. In the ultra-violet, more than 1800 lines have been identified in this spectrum, so that the total emission of rhenium in the copper arc between 8000 and 2400 A. shows about 3000 lines. The measurements agree well with those made simultaneously by Meggers at the American Bureau of Standards. HERBERT HABERLANDT: Luminescence investigations with fluorites (2). The occurrence, at Alland in Lower Austria, of a fluorite with a natural red photo-luminescence, is recorded. In general, the luminescence of fluorites is intimately connected with the paragenetic relations. Thus, in one case, it must be ascribed to the rare earths present and in another to bituminous impurities. LUDWIG LÄMMERMAYR: Comparative studies on the plants of eastern Styrian basalts and basaltic tufas (3). ERNST NOWACK: The geological relationships of the region between Eregli and Bolu (Northern Anatolia). GUSTAV GÖTZINGER and HELMUT BECKER: Stratigraphy of Wienerwald-Flysch east of Traisen.

Feb. 2. GUIDO MACHEK: Action of gaseous cyanogen on phenols and naphthols. (2) Dicyanogen

and trihydroxybenzenes. (3) Dicyanogen and certain naphthols. The cyanisation of pyrogallol, β-naphthol, 2 : 3- and 2 : 7-dihydroxynaphthalenes proceeds with formation of molecular compounds. With phenol and hydroxyquinol, no individual products could be obtained, and phloroglucinol, α-naphthol, 1 : 3- and 1 : 4-dihydroxynaphthalenes did not react with cyanogen. HANS PETTERSSON and JOSEF SCHINTLMEISTER : Atomic fragments of short range from heavy elements. A new method of procedure is applied to the heavy noble gases, etc. GERHARD KIRSCH and ROBERT TRATTNER : Atomic disintegration with emission of neutrons. Of a number of elements subjected to irradiation with polonium α-particles, boron alone gives a number of neutrons comparable with, although smaller than, that yielded by beryllium. When tested by the Wilson method, the elements Li, C, N, Mg, Al, S, Fe, Cu, Zn, Pd, Ag, Sn, W, Pt, Au and Pb give definite but small effects, which are about 1 per cent of that obtained with beryllium. Molybdenum and nickel give effects of a lower order of magnitude and possibly emit no neutrons. With platinum and palladium, the effect has been confirmed in other ways (Geiger counter and photography) by measurement of the secondary absorption. LUDWIG SELTENHAMMER : Stability of the frame-rod arranged with parallel edges and compressed centrally. KARL FRITSCH : Observations on flower-visiting insects in Styria, 1913. Pollination of *Draba verna* L. is effected mostly by small species of the genus *Halictus*. With *Prunus*, the size of the pollinating insect conforms to that of the flowers ; thus *Prunus spinosus* L. is visited more especially by small aphids, such as *Halictus* and *Andrena* species, and *P. avium* L. often by *Bombus* species. The names of various insects, not previously observed as pollinating insects in Styria, are given.

Forthcoming Events

Monday, June 12

VICTORIA INSTITUTE, at 4.30.—Sir Ambrose Fleming : "Free Will versus Determinism" (Presidential Address).

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—T. H. Harrisson : "The Oxford University Exploration Club's Expedition to Sarawak".

Thursday, June 15

ROYAL SOCIETY. Discussion on "The Experimental Production of Malignant Tumours" to be opened by Dr. J. A. Murray.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE, at 8.15.—Annual General Meeting. Lieut.-Col. H. W. Aston (Director of School of Tropical Medicine and Hygiene, Calcutta) : "Carriers of *Entamœba histolytica* and their Treatment".

Official Publications Received

GREAT BRITAIN AND IRELAND

The University of Leeds : Department of Coal Gas and Fuel Industries (with Metallurgy). Report of the Livesey Professor (John W. Cobb) for the Session 1931–32. Pp. 12. (Leeds.)

Proceedings of the Royal Irish Academy. Vol. 41, Section A, No. 7 : The Influence of Condensation Nuclei and Dust Particles on Atmospheric Ionisation. By P. J. Nolan, Pp. 61–69. (Dublin : Hodges, Figgis and Co. : London : Williams and Norgate, Ltd.) 1*s*.

The Himalayan Journal : Records of the Himalayan Club. Edited by Kenneth Mason. Vol. 5. Pp. vi+iv+168+25 plates. (London : Oxford University Press.) 8*s*. net ; 5 rupees.

Transactions of the Royal Society of Edinburgh. Vol. 57, Part 3, No. 22 : Studies on the Scottish Marine Fauna ; the Natural Faunistic Divisions of the North Sea as shown by the Quantitative Distribution of the Molluscs. By A. C. Stephen. Pp. 601–616. 2*s*. Vol. 57, Part 3, No. 23 : The Diurnal Incidence of Disturbance in the Terrestrial Magnetic Field. By Dr. A. Crichton Mitchell. Pp. 617–632. 2*s*. (Edinburgh : Robert Grant and Son ; London : Williams and Norgate, Ltd.)

Journal of the Society for the Preservation of the Fauna of the Empire. New Series, Part 19. Pp. 97. (Hertford : Stephen Austin and Sons, Ltd.) 2*s*. 6*d*.

University College of Wales, Aberystwyth : Welsh Plant Breeding Station. Four Addresses on the Improvement of Grass Land. By Prof. R. G. Stapledon. Pp. 50. (Aberystwyth.) 1*s*.

Mind and the Machine : a Lecture delivered at the League of Industry Easter Study School, Exeter College, Oxford, April 1933. By Dr. Leonard P. Lockhart. Pp. 14. (London : The League of Industry.) 2*d*.

OTHER COUNTRIES

Canada : Department of Mines : Mines Branch. Investigations of Fuels and Fuel Testing (Testing and Research Laboratories) 1930 and 1931. (No. 725.) Pp. 166. (Ottawa : F. A. Acland.)

Conseil Permanent International pour l'Exploration de la Mer. Journal du Conseil. Rédigé par E. S. Russell. Vol. 8, No. 1, Avril. Pp. 141. (Copenhague : Andr. Fred. Høst et fils.) 4.50 kr.

Madras Fisheries Department. Report on a Systematic Survey of Deep-Sea Fishing Grounds by S.T. *Lady Goschen*, 1928–29. By Dr. B. Sundara Raj. (Report No. 3 of 1930, Madras Fisheries Bulletin, Vol. 24.) Pp. 199–232. 12 annas. Administration Report for the Year 1931-32. By Dr. B. Sundara Raj. Pp. iii+88. 8 annas. (Madras : Government Press.)

Journal of Science of the Hiroshima University. Series A (Mathematics, Physics, Chemistry), Vol. 3, No. 2, March. Pp. 137–242. (Tokyo : Maruzen Co., Ltd.) 83 sen.

Bulletin of the Earthquake Research Institute, Tokyo Imperial University. Vol. 11, Part 1, March. Pp. 122+ii+18 plates. (Tokyo : Iwanami Shoten.) 2.00 yen.

Seismological Report of the Earthquake Research Institute, Tokyo Imperial University. 1932, Part 2 (July 1–September 30, 1932.) Pp. 13–18+plates 10–15. (Tokyo.)

Smithsonian Institution. Explorations and Field-Work of the Smithsonian Institution in 1932. (Publication 3213.) Pp. iv+96. (Washington, D.C. : Smithsonian Institution.)

N.Z. Department of Scientific and Industrial Research : Apia Observatory, Apia, Western Samoa. Annual Report for 1931. Pp. iv+96. (Wellington, N.Z. : W. A. G. Skinner.) 5*s*.

Reports of the Newfoundland Fishery Research Commission. Vol. 1, No. 3 : Observations upon the Economic Biology of the Caplin (*Mallotus villosus* O. F. Müller.) By G. F. Sleggs. Pp. 66+2 plates. (St. John's : Newfoundland Fishery Research Commission.) 1 dollar.

Publications of the United States Naval Observatory. Second Series, Vol. 13 : Results of Observations with the Nine-inch Transit Circle, 1913–1926 ; Observations of the Sun, Moon and Planets ; Catalogue of 9989 Standard and Intermediary Stars ; Miscellaneous Stars. By H. R. Morgan. Pp. iii+365. (Washington, D.C. : Government Printing Office.)

Collection des travaux chimiques de Tchécoslovaquie. Rédigée et publiée par E. Votoček et J. Heyrovský. Année 1933, No. 4, Avril. Pp. 139–186. (Prague : Regia Societas Scientiarum Bohemica.)

Mémoires du Musée Royal d'Histoire Naturelle de Belgique. Hors série. Résultats scientifiques du Voyage aux Indes orientales Neerlandaises de LL. AA. RR. le Prince et la Princesse Léopold de Belgique. Publiés par V. Van Straelen. Vol. 1 : Introduction. Par V. Van Straelen. Pp. 222+91 plates. (Bruxelles.)

Council for Scientific and Industrial Research. Pamphlet No. 37 (New South Wales Department of Agriculture, Science Bulletin No. 40) : The Sheep Blowfly Problem in Australia. By the Blowfly Committee. Pp. 136+6 plates. (Melbourne : H. J. Green.) 1*s*. 6*d*.

Memoirs of the Punjab Irrigation Research Institute. Vol. 4, No. 4 : The Use of the Antimony Electrode for determining Soil Reaction. By Dr. Amar Nath Puri. Pp. 11. (Lahore : Government Printing Office.) 5 annas ; 6*d*.

Report of the Director of the Royal Observatory, Hong Kong, for the Year 1932. Pp. 9. (Hong Kong.)

Annual Report of the Imperial Council of Agricultural Research for the Year 1931–32. Pp. 39. (Calcutta : Government of India Central Publication Branch.)

The Indian Lac Research Institute. Bulletin No. 15 : Notes on the Use of *Schleichera trijuga* (Kusum) in Lac Cultivation—Pruning and Cropping. By Dorothy Norris. Pp. 19. (Nankum.) 1.4 rupees.

Conseil Permanent International pour l'Exploration de la Mer. Faune ichthyologique de l'Atlantique nord. No. 12. 24 plates. (Copenhague : Andr. Fred. Høst et fils.) 4.00 kr.

The Science Reports of the Tôhoku Imperial University, Sendai, Japan. First Series (Mathematics, Physics, Chemistry), Vol. 22, No. 1, March. Pp. 199. (Tokyo and Sendai : Maruzen Co.,)Ltd.

The American Museum and Defeatism. Sixty-fourth Annual Report of the Trustees for the Year 1932, The American Museum of Natural History. Pp. vi+130+11 plates. (New York City.)

CATALOGUES

Livogen (Liver Extract with Vitamin B and Hæmoglobin). Pp. 4. (London : The British Drug Houses, Ltd.)

Installation and Maintenance of Instruments. Pp. 4. Thermometric Lag. Pp. 16. (London : Negretti and Zambra.)

Philips Industrial X-ray Service. Pp. 20. (London : Philips Metalix.)

Catalogue of Secondhand Books on Anthropology, Botany, Entomology, Evolution, Ornithology, Zoology, General Natural History, etc. Pp. 40. (London : W. and G. Foyle, Ltd.)

Catalogue de livres anciens et modernes rares ou curieux relatifs à l'Orient et a l'Amérique. (No. 24.) Pp. 189–248. (Paris : Libr. Adrien-Maisonneuve.)