NATURE

SATURDAY, SEPTEMBER 13, 1930.

CONTENTS.

Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

No. 3176, Vol. 126]

Fertilisers and Soil Fertility.

THE extent to which the phosphatic fertilisers have dominated the outlook of farmers all the world over is well seen by the fact that when a country first embarks upon anything approaching a large scale use of artificial manures, it is the phosphatic fertilisers that are almost invariably employed, to the practical exclusion of all others. This is understandable, and within certain limits entirely reasonable: for when rainfall and sunshine are adequate, and where leguminous plants can thrive abundantly, a deficiency in phosphates is often the sole limiting factor to greatly increased production, and under these conditions phosphates frequently occasion results of such a pleasing magnitude that the farmer is, perhaps naturally, not in a hurry to look for methods of still further increasing his productivity—although, of course, it seldom happens that the addition of phosphates is all that is necessary to produce the highest yields obtainable.

Thus, for example, in a pastoral country like New Zealand, in the main with abundant rainfall and conditions potentially favourable for the spread of leguminous plants, the benefits from phosphatic manures have been enormous, and the increase in their use during the last decade very remarkable; while in the case of those areas in the wheat belts of Australia where the methods of fallow practices have been perfected and water conserved to the maximum, it has been found remunerative to increase the dressing of superphosphate very appreciably above the amounts that were originally considered adequate.

The position of South Africa (the Union and Southern Rhodesia) is perhaps unique, and agriculturists—not only of that continent, but also of the world at large—should derive inspiration from Sir Frederick Keeble's critical survey* of the fertiliser position, part of which appears elsewhere in this issue (p. 417), and more particularly from the penetrating suggestions he makes as to the problems which South Africa sets the scientific investigator for solution.

Sir Frederick has had the advantage of studying extreme conditions. In South Africa, as he tells us, not only are enormous tracts subject to slight precipitation, but also mineral deficiency is universa—and, we might add, leguminous plants are not abundant, for there, unlike New Zealand, wild white clover has not run riot, and, unlike large

* "Agricultural Problems in South Africa." Paper read before Section M (Agriculture) of the British Association at Bristol on Sept. 5

areas in Australia, a host of little European annual clovers have not become tantamount to wild plants. What are the limiting factors to a satisfactory scale of production in South Africa? This is the question Sir Frederick has set himself, if not to answer, at least to explore; not, he thinks, by any means necessarily the scant precipitation, but rather the inherent deficiency in plant foods—first and foremost an acute deficiency in phosphates and in lime, and secondly, a deficiency in nitrogen.

From the point of view of grassland, the effects of drought are no doubt greatly accentuated by the prevailing mineral deficiency, which must tend to stunt even the native vegetation and render colonisation by a more desirable and nutritious flora impossible, and in this connexion it is probable that a scarcity of available nitrogen must rank with a scarcity of phosphates as a contributing factor of no mean importance. That this is indeed the case is rendered the more likely from the results of experiments recently conducted in Great Britain, which have shown that in dry seasons it is the pastures manured with a complete and well-balanced combination of fertilisers that not only maintain the highest productivity, but also suffer the least damage. It is significant, too, and corroboratory, so far as it goes, of Sir Frederick's far-reaching thesis, that it is scarcity of plant food rather than of water that is the outstanding cause of low productivity in South Africa; that experiments with which we have been concerned on soils of very low fertility have shown that the difference between success and failure in the establishment of new sward-forming plants, through the intermediary of seeds, may turn upon the application of a complete and well-balanced manurial dressing at or a little before sowing. Sir Frederick adduces cogent reasons in support of his view that the South African grasslands are not only on the face of it likely to be, but also in fact are, nitrogen-starved; and by reference to small-scale experiments conducted by Mr. T. D. Hall, shows that these grasslands, despite the inherent deficiency in phosphates, none the less show a remarkable response to ammonium sulphate when applied by itself—the response, however, being greater when the added nitrogen (in sufficient quantity) is supported by phosphates, and greater still when supported by phosphates and lime.

The position that clovers may possibly be made to take in the improvement of South African grasslands, in our view, therefore, deserves greater emphasis. White clover, for example, is by no means unknown in the Union, and it is more than probable that by sowing the seed in conjunction with heavy phosphating this all-valuable pasture plant, or for that matter some kindred legume, might be established on a telling scale, and consequently we should like to see added to the experiments and researches that Sir Frederick suggests, trials with a large number of species and strains of leguminous plants; but further than this, such trials should in all cases be supported by inoculation, for it is more than probable that the organism appropriate to the several legumes is but sparingly present, or totally absent, in these mineral-deficient soils. On the evidence placed before us, there would seem to be little doubt that the careful balancing of manurial ingredients will have to play a more than usually important rôle in the improvement of South African grasslands, but the economic prospects will be greatly enhanced if by proper manuring it is thus rendered possible to introduce better species of plants, and especially if these can be made to include legumes, the successful introduction of which would not only add to the nitrogen-calcium content of the ration offering to the grazing animal, but also react economically on the nitrogen-phosphate balance that the scheme of manuring adopted should aim to maintain.

With regard to the grasses, no preconceived reservation should be made as to what species might prove valuable: thus for certain difficult situations in New South Wales such an unlikely grass as tor grass (*Brachypodium pinnatum*), which is nothing but an objectionable weed in Britain, has been shown to be of possible value and worthy of more serious trial; while on soils as deficient in minerals as those of South Africa, creeping soft-grass (*Holcus mollis*), perhaps the least desirable of grasses in British pastures, might prove to have a certain, though probably very limited, application.

The extreme poverty of South African soils in organic matter must tend to create an unsatisfactory soil condition from the bacteriological point of view, and this leads Sir Frederick to the opinion that the chief chemical rôle of organic matter is perhaps to supply carbon for the soil bacteria, and that a substance rich in organic carbon should contribute to complete fertilisers. To make good, so far as possible, the humus deficiency of these soils is obviously of the first importance, not only to maintain soil fertility, but also, perhaps almost equally, as a means of ameliorating the influence of drought, and consequently the farmer needs to adopt a system of management which will so far as possible augment the plant residues returned to, or retained in, the soil.

Thus in this connexion the time of application of nitrogenous fertilisers in support of phosphatic manures is perhaps as important as its presumable effect on the plant's ability both to collect and utilise water to the best advantage, since the root system (the development of which is favoured by phosphatic manures) of an arable crop must bear a close relation to humus formation in the soil. Consequently, investigations designed to establish 'the most water-economising' scheme of manuring applicable to different crops should go beyond merely an exploration of the factors which influence the economic use of water by the plant in the production of dry matter of the part or parts of the plant constituting a particular crop.

The insistence on the significance of humus deficiency adds emphasis, we think, to the importance of a crop like lucerne in the economy of South African husbandry, and the more so if, as Sir Frederick considers probable, the nitrogen-fixing organism associated with the wattle (another leguminous plant) is also capable of bringing the phosphates of the soil into organic combination. The growing of lucerne does not, however, represent the only cultural means of increasing the humus content of arable soils; the same end could be achieved by maintaining leys consisting of other plants, or by encouraging, in the first instance by the purposeful sowing of seeds and the generous application of manures, a volunteer flora of annual grasses and clovers such as undoubtedly contributes to the fertility of the Australian wheat belts.

On the balance, there would seem to be evidence to suggest that the evolution of high farming in Australia and in South Africa presents something in the nature of an antithetical parallel. In Australia, it was when the husbanding of water by improved fallow methods became well understood that the need of artificial manures (still chiefly phosphates) was fully appreciated and the potential usefulness of the alien annual flora realised; in South Africa, perhaps it will be when the deficiencies in plant foods have been artificially rectified that an impetus will be given to further endeavour in the direction of conserving moisture, and to the introduction of valuable sward-forming and humus-creating plants.

The problems of the two countries are in many respects very similar, and Sir Frederick's final suggestions, though made to the geneticists of South Africa, are equally applicable to those of Australia, as indeed they are in their broad implications to the whole body of economic plant breeders. In laying emphasis on the desirability of discovering races of maize with male inflorescences which will continue to produce pollen over a long period, he in fact directs attention to the need of the fertilisation affinities of our cultivated races of plants being in accord with the restrictions imposed by the conditions under which we expect them to grow. It is probable that the chances of successfully inducing the spread of a plant like white clover through some of the grasslands of South Africa would be increased in proportion as early and abundant seeding races could be selected for introduction, while it is equally probable that the most successful pioneer plants in regions of low rainfall are self-fertile annuals with the maximum ability for setting and ripening seed quickly. The plant breeder who seeks to take up Sir Frederick's challenge and to breed varieties of crops designed to utilise manures to the most economic advantage may take heart from the fact that it is undoubtedly true that different strains of grasses of one and the same species, at all events, react to fertilisers, both qualitatively and quantitatively, in an appreciably different manner.

Future of Australian Aborigines.

FOR some time past certain sections of the public in Australia have been much exercised by the present conditions and the future of the aborigines. The question was brought into special prominence some five or six years ago by Dr. Basedow, the anthropologist, on his return from one of his expeditions to Central Australia. As a result of his observation of conditions among the aborigines on that occasion, he organised a number of public meetings in Adelaide and elsewhere and aroused a public feeling sufficiently strong to secure the setting aside by the South Australian and Western Australian Governments of a reservation for the aborigines of 62,000 square miles lying across the boundary of the two territories.

There is, however, reason to believe that the hopes for the amelioration in the condition of the aborigines then entertained by the promoters of the movement have not been fulfilled, and it has been stated categorically by Prof. Wood Jones, in an address to the Australian Association for the Advancement of Science, that the provision forbidding the granting of concessions for the exploitation of minerals within the reserved area has been deliberately ignored by one of the governments concerned. At present the aborigines come under the respective State governments, each of which has its own Protector of the Aborigines, with

a subordinate staff; but there has been a strong expression of opinion that the care of the aborigines should be under the Commonwealth Government.

Recently the Commonwealth Government has had under consideration certain recommendations made by Mr. J. W. Bleakley, Chief Protector of the Aborigines for the State of Queensland, dealing with the aborigines and half-castes of North Australia and Central Australia. Mr. Arthur Blakeley, Minister for Home Affairs, has now made known the decision of the Commonwealth Government on the proposals, after taking into account recommendations which had been put forward by the Melbourne Conference of Missionary Societies and other bodies interested in the aborigines, as well as the administrations of North Australia and Central Australia and the Department of Home Affairs.

Certain recommendations as to wages are to be adopted, though not that which urges the payment of wages in goods instead of money—a point upon which a strong opinion has been expressed at one time and another in view of wasteful expenditure of the money wage. Accommodation for workers is to be improved under the supervision of the Protectors; and though the co-operation of employers is to be invited in securing an improved moral atmosphere, no extension of the existing law against soliciting and procuring is proposed, nor are employers to be required to employ only the married. The administration of the existing law, however, is to be tightened up. A recommendation for an aboriginal hospital contiguous to the general hospital is set aside, on financial grounds, for later consideration. It is not considered necessary that the existing reservations lying contiguously in the three States of Central, South, and Western Australia should be extended, as they are only sparsely populated by aborigines at present; but the Commonwealth Government is in communication with the State governments in connexion with the suggestion that the whole of the area in the three reserves should be placed under Commonwealth control. The most important decision, however, is that the whole of Arnheim Land is set aside as a reservation for aboriginals.

The decisions of the Commonwealth Government, excepting for the creation of a reserve in Arnheim Land, may seem relatively unimportant. Actually they mark an advance in dealing with the aboriginal question upon which all who are concerned with the interests of the aborigines may well feel cause for congratulation. In a recently published book, "The Australian Aboriginal as a Human Being", by Mr. M. M. Bennett, the case for the aboriginal is temperately set out. In that book, those who will may read the grave indictment of the treatment of the black fellow by the white—all the more serious because the greater part of the evidence is drawn from official documents.

There can be little doubt that, unless measures are taken without delay, in a few years the aboriginal will become extinct. On humanitarian grounds this is, to use a mild term, discreditable; on scientific grounds it is to be deplored. From the scientific point of view, the disappearance of the aboriginal, even as he exists to-day, would be a calamity. Spencer and Gillen saved from oblivion a vast amount of material which demonstrated the value of the Australian evidence in its bearing upon the early history of society and culture. Even now much further study is needed, for which the data still exist, especially among the remoter and less known tribes. A few years more and it will be too late; the evidence will have vanished for ever.

Scientific Bibliography.

Commonwealth of Australia: Council for Scientific and Industrial Research. Catalogue of the Scientific and Technical Periodicals in the Libraries of Australia. Edited by Ernest R. Pitt. Pp. xxiv + 1208. (Melbourne: H. J. Green, 1930.) 10*s*.

THE problem of rendering available to scientific workers the torrent of information now being poured out by the Press is in urgent need of thorough investigation. Obviously, the task comprises five processes—(1) it is necessary to ascertain exactly and immediately all that is published, so that no information may be overlooked; (2) means must be provided for collecting all the material, in order that it may (3) be thoroughly indexed, so that (4) complete bibliographies on special subjects may be supplied to research workers on demand and (5) they may be able to obtain the volumes containing the desired information for study. Merely to state these requirements is to realise that not a single one of them is adequately met. Yet the cost of an organisation to deal completely with the task would not be much greater than that of the upkeep of one of the large public libraries, certainly much less than of some in America, and, until a practical solution to the problem, as a whole, has been found, scientific workers must continue to waste their energy in useless repetition. It is time that the question was taken in hand.

Although, however, librarians generally appear scarcely to have realised the existence of the problem, they are at least beginning to appreciate the need for attempting to make lists of published literature, hence what may be called the union catalogue movement.

Union catalogues are confined mainly to periodical literature. The earliest known example of such a catalogue appears to have been one of 44 pages published in Milan in 1864. The German "Gesamtverzeichnis der ausländischen Zeitschriften" issued in 1914 to 1924 contains about 14,000 periodicals filed in about 1400 libraries. A French union catalogue "Inventaire des périodiques des bibliothèques de Paris" was issued by the Academy of Sciences in 1924–25. This catalogue represents 115 libraries and contains 16,000 periodicals. The Swiss catalogue is entitled "Verzeichnis ausländischer Zeitschriften"; the third edition, published in 1925, contains nearly 9000 periodicals from 387 libraries. A Norwegian union catalogue, "Utenlandske Tidskrifter", appeared in the same year, containing 4200 periodicals from 96 libraries. The British catalogue known as the World List of Scientific Periodicals was completed in 1927. It is a list of upwards of 24,000 periodicals contained in about 150 libraries. The union list in America is even larger, containing about 75,000 periodicals representing 225 libraries, but includes other than scientific periodicals. A new edition of the "List of Serial Publications in the Union of South Africa" was completed in 1927 and contained about 3000 periodicals from 44 libraries.

The figures quoted serve to show the inadequacy of the provision for scientific reference in different countries. Great Britain is fortunate in having one of the largest collections of scientific periodicals. But many of these are not available for loan to any research worker who may require them, and numbers of periodicals are not represented at all.

The present work contains about 10,000 periodicals filed in 132 libraries in the Commonwealth of Australia, is clearly printed, and shows evidence of very careful compilation. The editor is to be congratulated particularly on having resisted the popular clamour for a catalogue prepared without rules, "as reason panders will". The preface states: "The main object of the catalogue is to enable the research worker to ascertain readily where a reference met with in the course of his studies may be consulted. A subsidiary, but nevertheless important, purpose is to serve as a guide for Australian librarians to the latest methods of cataloguing periodicals." It would be an enormous simplification of the task of listing scientific literature if all catalogues could be prepared on a uniform system, so that entries prepared in different libraries could be brought together readily into one alphabet. As has already been pointed out for indexing information, so in cataloguing also, there is need for the adoption of a standard system. It is encouraging to see that in Australia this need is recognised.

Unfortunately, this cannot be said of some of the countries in which larger union catalogues have been prepared. The public may be excused for asking that periodicals should be entered where they may expect to find them. The librarian knows that the first essential of a good catalogue is a rigid system of rules, which shall provide one place, and one place only, for a given publication. Nevertheless, some members of the profession appear still to be in sympathy with Mr. J. G. Cochrane, who, when asked before the Royal Commission on the Management of the British Museum, in 1850, "Do you object to rules in any compilation of catalogues?" said, "Yes, very much". Thus a number of important union catalogues of periodicals attempt merely to list periodicals under their titles, with the result that entries are collected in masses under general headings such as 'Bulletin', 'Journal' and 'Report', and, owing to the great variety of small changes possible in the titles, it becomes exceedingly difficult to find the periodicals at all.

In the present work Mr. Pitt has eliminated a great deal of confusion by recognising that publications are characterised more particularly by the name of the issuing body than by their titles, and has entered them accordingly. Still further difficulties would have been avoided if the British Museum rule had been followed exactly.

S. C. BRADFORD.

Landscape for the People.

National Parks: and the Heritage of Scenery. By Dr. Vaughan Cornish. Pp. xi + 139. (London: Sifton Praed and Co., Ltd., 1930.) 5*s*. net.

THE appointment by the Prime Minister of a Departmental Committee to inquire as to the desirability and the feasibility of establishing one or more national parks in Britain has stimulated interest in the claims of different areas to be regarded amongst the elect. Often the claims are backed by local sentiment and little more, small

attention being given to the minimum requirements which any national park must possess if it is to meet the needs of the people. The ideal park must be spacious; it must be varied in aspect, representing many types of unspoiled Nature, mountain and valley, moorland and forest, stream and lake; its fauna and flora also must be varied and rich; it must be peaceful, accessible, and yet remote from the bustle of traffic; and, if the project is to make headway in the near future, it must be land the value of which is not exorbitant.

Dr. Vaughan Cornish examines with the eye of the practised geographer the areas in Britain which he regards as suitable for national parks. They are not very many: in Scotland, the wild regions of Glen Affric, the Cairngorms, and the Cuillin Hills of Skye; in Wales, Snowdonia; and in England a variety of aspects, from the moorlands of Tynedale, adjacent to the Roman Wall, and the wilder scenery of Lakeland, to areas of special and restricted character, such as the Norfolk Broads, Dartmoor, the South Downs, the New Forest and the Forest of Dean, and the sea-cliffs of Pembroke and North Cornwall.

In enumerating the characteristics and merits of each of these regions, Dr. Cornish restricts consideration to the scenic aspects, on the ground that he is dealing with "sanctuaries of scenery for the preservation of the sense of communion with Nature on the part of our people". It is an unfortunate restriction, for it ignores the fact that to many the sense of communion with Nature is bound up with observation of the plants and animals of the country; natural history and natural scenery march side by side. How can one assess the value of the Cairngorms as a national park, without discussing the interests of the unique primeval pine-woods of Rothiemurchus and Glen More (simply mentioned as 'forests'), or the outstanding members of its fauna, red deer and roe and Arctic hares, its golden eagles, ptarmigan, dotterel, greenshanks, and snow-buntings? It was for good reason that the terms of reference of the National Parks Committee included "fauna and flora", and the omission of this aspect of the question limits the value of the analysis presented in this volume.

We know that specialists in botany and natural history have declared that preservation of fauna and flora is incompatible with the full play of a national park, and the author concedes this point. But from our knowledge of the expert egg-collecting which now takes place, without let or hindrance, in that area, we are convinced that the rare birds would be safer under the watchful eyes of the park wardens; so also would it be with the wild beasts. As for the people, they themselves, recognising their heritage and the danger it would run from selfish molestation, will become the best protectors of flowers and animals.

A strong plea is made for the preservation from the spread of the seaside bungalow, so encouraged by modern ease of transport, of goodly strips of sea-cliff. That is a southern problem, for Scotland will always have its cliffs and islands, haunts of innumerable sea birds, which need no protection other than their remoteness, and the areas suggested in Pembroke and Cornwall have the great advantage that their climate favours winter as well as summer visitors.

The second part of the volume analyses the qualities and combinations of natural and artificial features which make for pictorial grouping in agricultural and urban landscape, at home and in various parts of the world. It shows the dangers of hasty and unconsidered building, and ought to suggest to local authorities and architects ways in which the needs of civilisation may be served without grievously interfering with Nature's majesty and beauty. J. R.

The Historical Approach to Science.

Pour l'histoire de la science Hellène. Par Paul Tannery. *De Thalès à Empédocles.* Deuxième édition, par Prof. A. Diès. Pp. xxiv + 435. (Paris: Gauthier-Villars et Cie, 1930.) 80 francs.

THE new second edition of this standard book is to be warmly welcomed for several reasons. It first appeared in 1887, and has been long out-of-print. It is now reissued with some additional matter (a letter and essay on Melissus by Tannery and some notes by the editor, M. A. Diès). Above all, it has an admirable preface by M. Federico Enriques, putting the case for the study of the history of science and giving an estimate of Tannery's work as a whole. Hence it will be understood that this is a book to be possessed by all who make the history of thought the main line of their study of the past, but it should be accompanied by Tannery's two other books, "La Géométrie grecque" (1887) and "Pour l'histoire de l'astronomie ancienne" (1893).

There can be no question of the unique importance of the evolution of thought which these three works cover; it is nothing less than the establishment of the framework of science in which the human mind has worked ever since, which it has

continually elaborated and is elaborating to this hour. It is therefore of perennial interest, for mankind will always be thinking it over and refashioning it in the light of new discoveries and fresh points of view. As it stands at present, there are still abundant lacunæ, frequent issues on which doubt remains and on which more than one opinion may be legitimately held. On the other hand, certain conclusions now stand out above all question. It may be interesting to set down a few of these as they appear from this latest edition of Paul Tannery's book.

In the first place, we know for certain that Greek science arose from the intercourse of Greek minds with Egyptian and Babylonian, especially the former. It can first be dated in the sixth century B.C., and was always connected in Greek tradition with the name of Thales of Miletus, the leading name among the seven Sages. What we do not know is how much to attribute to Thales personally and how much to the Egyptians, how far the Egyptians had gone in geometry, arithmetic, or astronomy, or whether these sciences are due, as sciences, entirely to Thales and his successors. On these questions Tannery is pro-Greek, but not pro-Thales. Thales himself he treats as a somewhat mythical figure, but has no doubt that it was Greeks of about that time who built up the first geometrical and rational cosmological conception of the world. There is probably much more to be discovered about the early thought and achievement of the Egyptians, and those who have seen the marvellous architecture lately uncovered by Mr. Firth at the foot of the Step-Pyramid at Saqqara, and attributed to the fourth millennium B.C., will hold their judgment as to the presence or absence of any particular geometrical conception in the minds of Egyptians of that age. It is hard to believe that the men who erected these things, or the Great Pyramids, had no notion of angular measurement—much easier to think that the Rhind papyrus, on which so much has been based, is a careless or ill-informed production of inferior minds.

In the volume before us, Tannery was discussing the exact import and affiliation of the cosmological ideas of the pre-Socratics—Nous, the infinite, the elements, etc. Here, it must be confessed, the importance of the speculation is much less evident than in the thinking which led to the foundation of mathematics. There is no doubt as to the affiliation of modern mathematics to that of the Greeks; Descartes goes back to Pappus, and Copernicus improves on the Ptolemaic system. But can one say the same of modern physics and chemistry? Are the atoms of Dalton in the direct descent from Anaximenes or Democritus? These physical speculations of the early Ionians often strike one as the clear but quite crude ideas of children, and, by themselves, would not justify the high esteem of the Greeks as scientific founders. This is why the three aspects of Tannery's studies—the geometrical and astronomical as well as the cosmological—should go together.

M. Federico Enriques' preface is the best defence of the study of the history of science, within that compass, that we have ever seen. It should be printed as a pamphlet and broadcast. He sees in the historical approach to science the best, perhaps the only, means of preventing science becoming a mass of detached specialisms with less and less of a spirit of synthesis or any obvious place in the general history of social progress. In the study of history man preserves his continuity with the past and consciously builds up the future; it is his special prerogative. As science, that is, orderly thinking, is more clearly recognised as the central thread in this process, it must take a corresponding place in the record which each age makes afresh for itself of its own past. F. S. MARVIN.

Our Bookshelf.

(1) *Elementary Inorganic Chemistry.* By Dr. J. W. Mellor. Pp. x+229. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1930.) 3*s*. 6*d*.

(2) *Intermediate Inorganic Chemistry.* By Dr. J. W. Mellor. (New edition of "Introduction to Modern Inorganic Chemistry".) Pp. xx+690. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1930.) 7*s*. 6*d*.

DR. MELLOR has divided his well-known "Introduction to Modern Inorganic Chemistry" into two separate volumes in order to meet more adequately the needs of schools. The more elementary volume is written about the properties of air, water, and the common non-metals, with a simple discussion of some of the fundamental principles of chemistry, together with biographical notes of some of the founders of the science. Most of the text has been incorporated into the "Intermediate Inorganic Chemistry", which includes also some chapters on organic compounds and on the common metals. Both volumes are admirably illustrated and the subject matter is presented in an attractive fashion. The "Intermediate" volume contains questions at the end of each chapter, and here and there one comes unexpectedly across delightful quotations from such works as "Alice in Wonderland" and Shelley's poems. It also contains a fair amount of physical chemistry.

In the chapter on energy and matter a series of illustrations of the kinetic theory is given with the

view of enabling the imagination to grasp some idea of the "scale of magnitudes in the world of molecules". This is followed by a discussion of the bearing upon the theory of the study of ultra-microscopic particles. No mention is made of electrons, nor are the modern views of atomic structure dealt with. This is rather surprising, since an elementary discussion of the subject would probably make a stronger appeal to the young student's imagination than Planck's conception of energy quanta and Einstein's extension of his ideas, which are introduced into the section on specific heats. The chapter on classification is perhaps the weakest part of the book. It opens with a highly condensed scheme of qualitative analysis which seems to serve no useful purpose. Both the scheme and the doggerel verses which precede it might well be banished from the modern text-book. Classification of the elements is discussed up to the work of Mendeleéff, with the addition of elements discovered since then. No explanation is given of the atomic numbers which are to be found in the table on p. 289.

Telegraphy and Telephony, including Wireless: an Introductory Textbook to the Science and Art of the Electrical Communication of Intelligence. By Dr. E. Mallett. Pp. ix+413. (London: Chapman and Hall, Ltd., 1929.) 21*s.* net.

ELECTRIC communication whether by wires or by radio is now an art of great commercial importance. It is not surprising, therefore, that there are many text-books written on the subject. Many of these deal with highly specialised applications and several are written for the telegraphist or the telephone linesman, but there are very few which attempt to give an outline exposition of the scientific principles on which the whole art is based.

In the book under notice, Dr. Mallett successfully gives such an exposition. It is designed to meet the needs of the university or technical college student who has studied electricity and magnetism up to the second year standard. It should prove useful for students preparing for the final examinations in telegraphy and telephony for the B.Sc. (Eng.) of the University of London. From the student's point of view it would have been desirable to include a few examination questions with complete solutions in various parts of the book. The explanation of the so-called skin effect is perhaps too brief, and in several places not sufficient stress is laid on the fact that sine assumptions have been made. We can commend this book to the student who intends to take up electric communication as a career.

Human Biology and Racial Welfare. Edited by Prof. Edmund V. Cowdry. Pp. xviii + 612. (London: H. K. Lewis and Co., Ltd., 1930.) 28*s.* net.

THIS book is addressed to the student about to specialise and to the general reader. It consists of twenty-five essays by eminent authorities in their own fields, and is divided into five parts leading from the origin of man to a consideration of his destiny. The contributions maintain a high scientific level and nevertheless are so written as to be easily understood by those not acquainted with technical terms. This is a somewhat remarkable achievement. But it may be asked whether the editor has not set himself an impossible task. Though care has been exercised in arrangement, the effect cannot be other than to give the impression of a collection of scraps. The field is vast and those parts of it which are touched upon are briefly, sometimes very briefly, treated. There seems to be no reason why some problems are included and others omitted. The reader finds himself setting off on a number of journeys, and before he has got accustomed to the scenery he is off again in a new direction. Integration, which is presumably one of the objects of the book, is not achieved. Those to whom the book is addressed require a guiding thread, which perhaps could be given if the book was the work of one hand; but no one with a reputation to lose would attempt the task single-handed. A worthy attempt has been made to fill a gap which undoubtedly exists by the alternative method, but with a degree of success that is necessarily limited by the defects of that method.

Fütterung der Haustiere: ihre theoretischen Grundlagen und ihre wirtschaftliche Durchführung. Von Prof. Nils Hansson. Deutsch von Dr. Franz von Meissner. Zweite, umgearbeitete und erweiterte Auflage. Pp. xv+274. (Dresden und Leipzig: Theodor Steinkopff, 1929.) 10 gold marks.

THE first edition of this work appeared in 1926. In the present edition, Prof. Hansson has reviewed the subject matter of the former edition in the light of the progress which has been made in animal nutrition research during the last decade. A chapter on vitamins, their distribution and significance, has been inserted. The question of the biological value of the constituents of feeding stuffs is also dealt with. Other new features of the present edition include: accounts of feeding stuffs which have been introduced recently into feeding practice; the scientific aspects of poultry nutrition; the regulation of bulk in the feeding of farm animals; the mineral requirements of different classes of farm stock. The tabular matter in the final section has been augmented by the inclusion of data showing the reactions of the ash constituent of the common feeding stuffs.

The Material Culture and Social Institutions of the Simpler Peoples: an Essay in Correlation. By L. T. Hobhouse, G. C. Wheeler, and M. Ginsberg. (The London School of Economics and Political Science: Series of Studies in Economics and Political Science, No. 3 of the Monographs on Sociology.) Pp. v+299. (London: Chapman and Hall, Ltd., 1930.) 10*s.* 6*d.* net.

THIS is a photographic reproduction of a book first published in 1916, though there is no intimation to that effect and the title-page bears the date 1930. It was, and still is, a monograph of great value for the study of primitive peoples, but so much work has been done since it was compiled that it requires considerable additions and some revision.

Letters to the Editor.

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Fine Structure of α-Rays.

IT is usually assumed that the long range α-particles observed in C'-products of radioactive series correspond to different quantum levels of the α-particle in the nucleus. If after the preceding β-disintegration the nucleus is left in an excited state with the α-particle on one of the levels of higher energy, one of the two following processes can take place: either the α-particle will cross the potential barrier surrounding the nucleus and will fly away with the total energy of the excited level (long range α-particle), or it will fall down to the lowest level, emitting the rest of its energy in the form of electromagnetic radiation (γ-rays), and will later fly away as an ordinary α-particle of the element in question. Thus there must exist a correspondence between the different long range α-particles and the γ-rays of the preceding radioactive body. If p is the relative number of nuclei in the excited state, λ the corresponding decay constant, and θ the probability of transition of the nucleus from the excited state to one of the states of lower energy with emission of energy (in form of γ-quanta or an electron from the electronic shells of the atom), the relative number of long range α-particles must be $N = p\frac{\lambda}{\theta}$. Knowing the number of α-particles in each long range group and calculating, from the wave mechanical theory of radioactive disintegration, the corresponding values of λ, we can estimate for each group the value θ/p, giving a lower limit for the probability of γ-emission. For example, for thorium-C' possessing besides the ordinary α-particles also two groups of long range α-particles, we have for transition probabilities from two excited states to the normal state $\theta_1 < 0{\cdot}4 \times 10^{12}$ sec.$^{-1}$ and $\theta_2 < 2 \times 10^{12}$ sec.$^{-1}$, which is the right order of magnitude for the emission of light quanta of these energies. With decreasing energy λ decreases much more rapidly (exponentially) than θ, so that the number of long range α-particles from the lower excited levels will be very small. (From this point of view we can also easily understand why the long range α-particles were observed only for C'-products for which the energy of normal α-particles is already much greater than for any other known radioactive element.)

A difficulty arises with the recent experiments of S. Rosenblum (*C.R.*, p. 1549; 1929; p. 1124; 1930), who found that the α-rays of thorium-C consist of five different groups lying very close together. The energy differences and intensities of the different groups relative to the strongest one (α_0) are, according to Rosenblum:

$$E\alpha_1 - E\alpha_0 = +\ 40{\cdot}6 \text{ kv.} \quad I\alpha_1 = 0{\cdot}3$$
$$E\alpha_2 - E\alpha_0 = -287 \text{ ,,} \quad I\alpha_2 = 0{\cdot}03$$
$$E\alpha_3 - E\alpha_0 = -442 \text{ ,,} \quad I\alpha_3 = 0{\cdot}02$$
$$E\alpha_4 - E\alpha_0 = -421 \text{ ,,} \quad I\alpha_4 = 0{\cdot}005$$

If we suppose that these groups are due to α-particles escaping from different excited quantum levels in the nucleus, we meet with very serious difficulties. The decay constant λ for the energy of thorium-C fine structure particles is very small ($\lambda \sim 10^{-2}$ sec.$^{-1}$), and in order to explain the relatively great number of particles in different groups we must assume also very small transition probabilities. We must assume that thorium-C nucleus can stay in an excited state without emission of energy for a period of half an hour!

We can, however, obtain the explanation of these groups by assuming that we have here a process quite different from the emission of long range α-particles. Suppose that two (or more) α-particles stay on the normal level of the thorium-C nucleus. It can happen that after one of the α-particles has escaped the nucleus will remain in an excited state with the other particle on a certain level of higher energy. (In this case the energy of the escaping α-particle will be smaller than the normal level and obviously will not correspond to any quantum level inside the nucleus.) From the excited state the nucleus (thorium-C'' now) can afterwards jump down

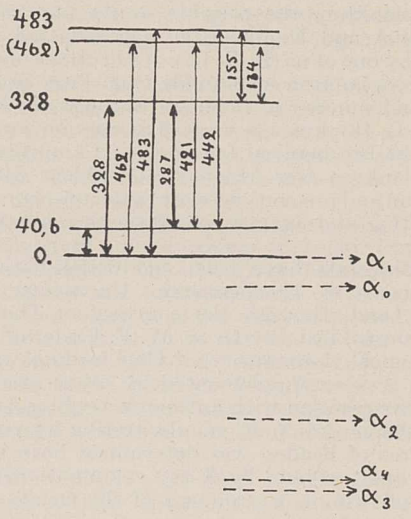

FIG. 1.

to the normal level, emitting the energy difference in form of a γ-quantum.

Thus the relative number of different groups will not depend on the probability of γ-emission but only on the transition integral:

$$W = \int f(r_{1,2})\psi_{E_0}(a_1)\psi_{E_0}(a_2)\bar{\psi}_{E_n}(a_1)\bar{\psi}_{Ea_n}(a_2)dv_1dv_2$$

where $f(r)$ is the interaction energy of two α-particles at a distance r apart, ψ_{E_0} and ψ_{E_n} the eigenfunctions of an α-particle in the normal and n^{th} excited states, and ψ_{Ea} the eigenfunction of an escaping α-particle with the energy: $Ea_n = E_0 - (E_n - E_0)$.

According to this scheme, the γ-rays corresponding to different fine structure groups of thorium-C must be observed as γ-rays of thorium-C (ejecting electrons from K, L, M, . . . shells of the thorium-C''-atom) and not as the rays of thorium-B, as we would expect in the case of long range particle explanation. The level scheme of the thorium-C''-nucleus as given by fine structure energies is represented in Fig. 1.

In the observed γ-ray spectra of thorium-$C + C''$ (Black, *Proc. Roy. Soc.*, pp. 109-166; 1925) we can find lines with the energies: 40·8; 163·3; 279·4; 345·8; 439·0; 478·8; 144·6 kv. fitting nicely with the energy differences in Fig. 1.

Thus we see that the fine structure group of highest energy corresponds to the normal level of the nucleus, while the other groups are due to the ordinary α-particles which have lost part of their energy, leaving the nucleus in an excited state.

I am glad to express my thanks to Dr. R. Peierls and Dr. L. Rosenfeld for the opportunity to work here.

G. GAMOW.

Piz da Daint,
Switzerland, July 25.

Vitamin Content of Marine Plankton.

THE synthesis of vitamin A in *Nitzschia* and other organisms grown in cultures of artificial sea-water (Jameson, Drummond, and Coward, *Biochem. J.*, **16**; 1922, and subsequent workers) has constituted the main evidence for assuming that marine organisms rely upon phytoplankton for their supplies of vitamins. A search for vitamin D in the same diatom (Leigh-Clare, *Biochem. J.*, **21**; 1927) proved unsuccessful; and little further attention has been given either to the possible presence and rôle of vitamins A and D in planktonic organisms or to the origin of the exceptionally rich stores found in the cod's liver.

To determine what may be, in the natural habitat of the plankton, the possible source and supply of vitamins A and D, plankton was collected and extracted by one of us (E. R. G.). Collections of diatoms and of zooplankton were made from Port Erin in the spring and summer of 1928, and through the kindness of Sir F. G. Hopkins the work of extraction was carried out at the Biochemical Laboratory, Cambridge. The dried plankton was treated in soxhlets with light petroleum and precautions were taken to ensure against overheating and against oxidation through access of air.

Vitamin tests have been conducted both at the Department of Biochemistry, University College, London, and, through the courtesy of The British Drug Houses, Ltd., by Dr. S. W. F. Underhill in their Physiological Laboratory. The feeding tests for vitamin A were supplemented by observations upon the colour reaction with antimony trichloride and by spectroscopic examination. In testing for vitamin D the degree of healing was determined both by histological (line test) and by X-ray examinations.

The following is a summary of the results hitherto obtained:

Nature of Test.	Result from Phytoplankton.	Result from Zooplankton.
VITAMIN A.		
(1) Growth tests .	Positive (in 20 mgm. doses)	Negative
(2) Antimony trichloride	Strong blue colour obtained	Negative
(3) Absorption spectrum	..	No band at 310–330 $\mu\mu$
VITAMIN D.		
(1) Line test . .	Doubtfully positive (much less than 100 Coward antirachitic units per c.c. in 0·02 c.c. doses)	Positive (less than 100 Coward antirachitic units per c.c. in 0·02 c.c. doses)
(2) X-ray . . .	Negative (in 50 mgm. doses)	Negative (in 20 mgm. doses)

The extracts of both animal- and phyto-plankton were strongly pigmented and with antimony trichloride produced red and yellow colours which in some samples were so intense as to render the determination of the blue colour almost impossible. When the antimony trichloride reaction was applied to the unsaponifiable fractions prepared from some of the oils the response was much more definite. A clear blue colour was given by the material isolated from the phytoplankton oil. How far this was due to carotene was not determined by spectroscopic examination, as the quantity of material available was insufficient, but that pigment was undoubtedly present. The unsaponifiable fraction examined from two zooplankton oils did not give a blue coloration with the antimony trichloride.

The probable absence of vitamin D in the phytoplankton is in agreement with the result obtained by Leigh-Clare for *Nitzschia*, which showed no antirachitic activity. It has not been possible to test the amount that would be required to show an order of activity much lower than 100 units per c.c.; therefore the possibility of its having a strength comparable to that of butter (2 units per c.c.) remains an open question. Small doses of the animal plankton, on the other hand, seemed to show fairly definite signs of antirachitic activity, and the possible discrepancy arising in the X-ray examination may be due to the greater delicacy of the line test. The tests suggest that the small amount of vitamin D which appears to be present in these animals results from their irradiation while in surface waters, rather than from a prolonged diet of phytoplankton.

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E. R. GUNTHER.

London.

Scattering of X-Rays by Bound Electrons.

IN two letters to NATURE (May 17 and June 7), Dr. B. B. Ray announces an interesting experimental observation on what he calls "Scattering of X-rays by Bound Electrons". He allowed $K\alpha$ radiation of copper to pass through soot and air, and found that the photograph of the transmitted beam showed, besides the primary $K\alpha$ beam, lines of lesser frequency, namely, $\nu - \nu'$, where ν is the characteristic K-frequency of carbon, oxygen, and nitrogen (matter traversed). The nickel $K\alpha$ radiation also shows a similar modification, the quantum being deprived of a part of its energy corresponding to the K-radiation of the substance traversed.

The object of the present note is to point out that the phenomenon observed has nothing to do with scattering as Dr. Ray seems to think, but is a case of photoelectric ionisation. When a beam of frequency ν traverses matter, it may hit an electron in the K-shell, and will thereby be deprived of a part of its energy equal to $h\nu_K$ where ν_K is frequency of the characteristic K-radiation of the substance traversed. The modified beam will have, according to energy principles, the energy $h(\nu - \nu_K)$, and this may pass on as such, or be absorbed by the electron, which will be ejected with an equivalent velocity. This method has been utilised by De Broglie and Robinson in determining the energy levels of different atoms (from an analysis of the photoelectrons emitted), and by Ellis, L. Meitner, and others in determining the wave-length of nuclear γ-rays. This last application is very interesting, because as the γ-rays from the nucleus of a radioactive substance, say radium-actinium, pass through the nucleus, they release β-rays having the energies $h(\nu - \nu_K)$, $h(\nu - \nu_L)$, etc., and when the β-ray spectrum is analysed, it reveals the characteristic difference $(\nu_{K_1} - \nu_{L_{11}})$, etc., of the atom traversed.

Dr. Ray has, however, gone a step further, and has been the first to analyse the modified (by absorption) beam of primary quanta by a spectroscopic method, and supplemented the work of De Broglie and Black. It is therefore a remarkable experimental verification of photo-ionisation, and hence it easily explains why no modified beam is observed in any other than the forward direction.

The diffuseness of the modified lines is due to the fact that the characteristic $K\alpha$ radiation of the light elements from neon downwards is very diffuse, as observed by Söderman (*Zeit. f. Physik*, 52), and the diffuseness increases the lighter the element. It appears to me that it affords probably a far more accurate and less troublesome method for determining wave-lengths of the softer radiation from light

elements, and also of such radiation as originates from the outer levels of compound and other aggregate formations.

SALIGRAM BHARGAVA.
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University of Allahabad,
July 10.

IN continuation of my previous notes in NATURE (May 17 and June 7, 1930), I have further observed the following lines :

Incident Radiation.	Scattering Substance.	Modified Lines.	Origin.
$NiK\beta_1$ $\nu/R = 608{\cdot}7$	C	1552 X.U. (587·0)	$NiK\beta_1 - CK\alpha$
	N	1573 X.U. (579·0)	$NiK\beta_1 - NK\alpha$
	O	1602 X.U. (569·0)	$NiK\beta_1 - OK\alpha$
$FeK\beta_1$ $\nu/R = 519{\cdot}9$	C	1825 X.U. (499·0)	$FeK\beta_1 - CK\alpha$
	N	1859 X.U. (490·0)	$FeK\beta_1 - NK\alpha$

The figures in the bracket denote the values of ν/R.

The values of the $K\alpha$ radiations (in ν/R) of carbon, nitrogen, and oxygen are 20·4, 28·7, and 38·3 respectively (Söderman, *Zeit. f. Phys.*, **52**). These modified lines are broad, diffuse, and weak, and as such they were only measured by a glass scale. The error in the measurement may be so great as 4 X.U.

Though Coster, Ehrenberg, and Kast (as mentioned in my previous notes), following Bergen Davis and his collaborators, who were the first to report the detection of such modified lines in the scattered rays, have failed to detect any line on the photographic plate, through the scattering of X-rays by an atom in a direction at right angles to the direction of propagation, where the Raman effect is usually observed, this experiment clearly shows that the modified lines produced by the "scattering of X-rays by bound electrons" are observed in the direction of transmission of the incident radiation. It further follows that to be consistent with the current definition of scattering and absorption, the effect observed by me, which was described in my previous notes to NATURE as "modified lines due to the scattering of X-rays by bound electrons", would be more correctly described as modification due to part-absorption of the incident radiation by atoms.

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Optical Investigations on the Formation of the Latent Photographic Image.

THE effect of colouring of the alkali halides, such as rock salt, with X-rays, radium radiation, or far ultra-violet radiation, is due in the light of modern knowledge to the transference of the valency electron from the chlorine to the sodium. The latter is suspected to be deposited in the lattice in the state of neutral atoms. The new absorption band, causing, for example, the yellow colour of rock salt, can be made to disappear by exposing the coloured salt to the rays it absorbs, that is, the blue-violet ones, or by heating it. A plausible theory is that in this case the backward transference of a valency electron takes place. In both cases the liberated electrons must cause the photo-conductivity effect, and this was indeed observed for the decolorising effect and studied by Pohl and Gudden and their collaborators.

On the other hand, the photo-conductivity effect was found in silver bromide and was investigated by Dr. Toy and his collaborators and also by Kirilov (*Zs. f. wiss. Photographie*, 1928) ; as Dr. Toy shows, it is closely correlated with the primary photographic process, and both are due to the same primary separation of the electron from the bromide ion.

This analogy between the processes taking place during the illumination of rock salt and silver bromide suggested some optical investigations on the absorption spectra of unexposed and exposed silver bromide, in the hope that they may contribute to the theory of formation of the latent photographical image. The silver bromide was used in the form of layers of fused salt or in large crystals, obtained by the Kyropoulos method. The following results were obtained :

(1) The silver bromide layers and crystals, when not illuminated, are lemon coloured ; their absorption band lies in the blue-violet and the near ultra-violet region of the spectrum, and can be regarded as analogous to the far ultra-violet absorption band of sodium chloride (near 1800 A.).

(2) Illumination with rays it absorbs or with X-rays makes the layer quickly change its colour from yellow to emerald-green. The absorption band of this phase lies in the red and infra-red parts of the spectrum ; it was measured by us as far as 2000 $m\mu$ and found to consist of a maximum at 610 $m\mu$ and a continuous absorption in the infra-red. It seems to be analogous to the absorption band of the yellow rock salt and can be regarded as the "absorption spectrum of the latent image" (A. Smakula, *Zs. f. Phys.*, **59**, p. 604 ; 1930).

(3) This view is supported by the observed disappearance of this 'latent image' on heating and by the action of red and infra-red radiations, which is analogous to the decolorising of the yellow salt (Herschel's phenomenon).

(4) Przibram and his collaborators have found that radiations of a given intensity cannot cause colouring of rock salt exceeding a certain maximum limit. The same is observed for the silver bromide layers. The increase of exposure does not completely compensate the decrease in the intensity (analogous to the Schwarzschild law).

(5) My investigations on the coloured rock salt, which are to appear shortly in the *Zeitschrift für Physik*, have led me to conclude that under some conditions (simultaneous illumination and heating) the neutral sodium atoms can aggregate into larger colloidal clumps ; the absorption spectrum of such a colloidal system can be evaluated on the basis of the known theories of Maxwell-Garnett and G. Mie. The application of this evaluation to the system sodium–sodium chloride gave results which are in good agreement with the observed red, violet, and blue colour of the rock salt samples.

On the other hand, silver bromide layers, when exposed to the simultaneous action of the active and decolorising radiations, become brown or, when slightly heated, reddish brown (visual blackening) ; different samples may have a slightly different colour. The analogy with the change of colour of the blue rock salt by heating and other considerations leads me to assume that the brown colour is due to colloidally-distributed silver particles ; the application of Mie's theory to the system silver–silver bromide seems to support this view.

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The Splitting of Spectral Lines at Scattering of Light by Liquids.

As was pointed out in my previous communication (see NATURE, Aug. 9, p. 201), when light is scattered by liquids or crystals, there can be observed a splitting of spectral lines which may be ascribed to the influence of elastic heat waves. In the case of strongly scattering liquids, the change of the frequency is given by the following equation :

$$\nu = \nu_0\left(1 \pm 2n\frac{v}{c}\sin\frac{\theta}{2}\right) \quad n = 0,\ 1,\ 2,\ 3,\ \ldots$$

where ν_0 is frequency of the incident light, v and c are velocities of sound and light in the medium, θ is the angle between the incident and scattered rays. It is interesting to note that the length of sound waves to which this splitting may be ascribed is of the same order of magnitude as the wave-length of light.

I wish to give here some details regarding this phenomenon and also to describe some new experiments.

The observed displacement of components does not strictly follow the above equation. In all cases, with the exception of aniline, the observed values are somewhat greater than the calculated ones. In these calculations, the experimental values for the velocity of sound obtained chiefly by the Kundt method were used. However, the velocities of sound calculated from the coefficient of compressibility and density of liquids also do not give values which are in full agreement with experiment.

The intensities of 'red' and 'blue' components are, as it seems, nearly equal. The intensities of inner components (that is, corresponding to $n = 1$ in the above equation) are greater than those of the outer ones (corresponding to $n = 2,\ 3,\ \ldots$), and the intensity of the undisplaced line is still greater but perhaps is not greater than twice the intensity of the nearest displaced components. The greatest relative intensity of the undisplaced line was observed in benzene and water. Perhaps the increased value of the intensity of this line is due, at least partly, to dust and contamination of the liquids, which did not in these experiments undergo a special purification (this refers particularly to water, for which the intensity of scattered light is small). It must be remembered that it is very difficult to judge the relative intensity of lines from spectrograms obtained with the echelon grating.

The width of displaced as well as of undisplaced components is not the same for different liquids. It is less in benzene, which gives the displaced lines most distinctly ; on the other hand, ethyl alcohol and ethyl ether give diffuse, barely distinguishable lines. In benzene the width of components may be estimated at 0·025 A. Between all the components there is a continuous spectrum.

Some experiments on polarisation of scattered light were made with benzene. When the incident light is not polarised, the undisplaced and the two neighbouring displaced components, that is, lines corresponding to $n = 0$ and $n = 1$ in the above equation, are strongly polarised, the electric vector being perpendicular to the direction of the incident beam. On the contrary, the other components, that is, corresponding to $n = 2,\ 3,\ \ldots$, are, as it seems, almost quite unpolarised.

I wish to return to the question of the maximum possible value of n, or the maximum possible displacement of components. If the appearance of these displaced components is due to the diffraction by 'heat wave gratings' of harmonics, the value of n will be limited by the fact that in liquids as well as in solids it is possible to assume a limiting maximum frequency of Debye's 'acoustic spectrum' which corresponds to a wave-length equal to twice the mean distance between molecules. If this distance is of the order of 3–4 A., the limiting frequency will be of the order of $2\text{–}2{\cdot}5 \times 10^{12}$ sec.$^{-1}$ and will produce a displacement of about 15 A. Maybe this is the cause of the broadening of the scattered lines in both directions extending nearly to the above distance which was noticed in liquids (for example in benzene) by many observers (Cabannes et Daure, *C.R.*, **186**, p. 1533; 1928; Raman, *Ind. Jour. of Phys.*, **4**, p. 399; 1928; Gerlach, *Ann. d. Phys.*, **5**, p. 301; 1929). Experiments which are now in progress seem to support this view.

E. GROSS.

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The Atomic Diameters of Hydrogen and the Inert Gases with respect to Electrons of Very Low Velocity.

THE wave-mechanical treatment of the problem of the scattering of α-particles by neutral atoms has been given by Sommerfeld ("Wave-Mechanics", pp. 192-199). To simplify the calculations he assumes that all the electrons in the atom under consideration are concentrated in the K-shell and have no influence on one another. With similar assumptions, but by a somewhat different procedure, we have made an approximate calculation of the scattering of very slow *electrons* by neutral atoms. This has enabled us to calculate the atomic diameters of hydrogen, helium, neon, and argon with respect to electrons of vanishingly small velocity (0-volt electrons). We obtain the surprising result that the atomic diameters of these gases should vary *inversely* with respect to their atomic numbers. It is obvious that this result should come out most correctly by experiment in the relative magnitudes of the atomic diameters of hydrogen and helium, as only the K-shell exists in their case, and that the error introduced by the above assumptions as applied to the present problem will become much greater as we pass to the higher atomic numbers owing to the greater number of electrons far outside the K-shell.

Actual experimental values of these atomic diameters with respect to 0-volt electrons have not yet been obtained. The best available data for comparison are those obtained from experiments by Townsend and Bailey. In Fig. 10, p. 28, of Townsend's "Motion of Electrons in Gases" (Oxford) curves are given which exhibit the relationship between the mean free paths of electrons of varying velocity in hydrogen, helium, neon, and argon. The velocity of the electrons ranges from 2 volts to 1/9 volt in this diagram for the case of hydrogen and helium, but only from 2 volts to slightly below 1 volt in the case of argon and neon. At an electronic velocity of 1 volt the mean free paths are in the ratios 3 : 8 : 40 : 140 for hydrogen, helium, neon, and argon respectively, of which the atomic numbers are 1, 2, 10, 18. All the curves are divergent towards lower velocities, so that these ratios would become correspondingly larger below 1 volt.

Townsend and Bailey showed in 1921 that the mean free path in argon reaches a maximum at 0·39 volt (as has recently been verified by Ramsauer and Kollath : see NATURE, Mar. 15, 1930, p. 427), and, as there is reason for believing that a maximum occurs in the case of all gases, extrapolation of these curves towards lower velocities is impossible. Since we may take the mean free paths as inversely proportional to the atomic cross-section or the square of the atomic

diameter, the above ratios show that the wave-mechanical treatment of the problem gives the correct experimental result qualitatively for hydrogen, helium, neon, and argon ; in the case of hydrogen and helium there is even fair quantitative agreement.

We wish to emphasise that our calculation can be regarded only as a first approximation, because we are dealing with slow electrons, which will be considerably influenced by the extra-nuclear electrons beyond the K-shell, whereas in the case of the scattering of α-particles the effect of the electrons outside the nucleus is only of secondary importance. The way in which this fact modifies the results above mentioned will be given in our detailed paper which will be published shortly.

HENRY L. BROSE.
E. H. SAAYMAN.

Physics Department, University College,
Nottingham, Aug. 25.

Noise Associated with Lightning.

SOME years ago I directed attention in NATURE to a swishing sound that is sometimes heard when a flash of lightning is very close to the observer. I had at that time never heard the sound myself. I heard it, however, very distinctly on the night of Aug. 29–30. I had been expecting a flash to come close, as a very active storm centre had been moving directly towards this spot, with steadily decreasing intervals between the cloud to earth flashes and the thunder. I did not see the actual flash, only the illumination of the garden through the open window ; it was very brilliant and was followed instantly by a noise as though a shower of large water drops had been thrown on to a hot metal plate ; this was followed almost instantly by the thunder. I think there was a slight interval between the swish and the thunder, but it must have been only a fraction of a second ; I had been counting seconds after previous flashes, but with this one I had not time to begin to count before the thunder came. The flash must have struck a point well within a hundred yards of my room, and I suspect that it struck the lightning conductor on the house. The noise was heard by my daughter and by two other people in the house. It was also heard by two people in a cottage about 50 yards from the house ; one of them likened it to a red-hot poker being plunged into cold water, the other to the sound of the arc when two electric cables are short circuited.

The origin of the noise is obscure. I feel inclined to think that it is caused by some of the branches into which the main discharge often divides before reaching the ground ; it may well happen that a number of these may be nearer to the observer than the main discharge and so be heard first. The noise was not unlike the crackle of a brush discharge on a large scale. The chief argument against this explanation is that a correspondent in NATURE described the sound as occurring not after but before the flash. But it seems possible that on some occasions brush discharges may occur just before a flash. At any rate, this sometimes occurs with a highly charged Wimshurst machine.

Another point that I noticed (not for the first time) in the recent storm was that there seemed to be definite active centres. When I first observed the storm about 9 P.M., summer time, there were two centres where most of the brightest flashes were occurring, one on a line through Chichester, the other on a line just north of Portsmouth, though both centres were probably at a good distance farther than either town ; almost all the flashes at this time were connected with one or other of these centres, though many of the cloud to cloud flashes travelled long distances in the sky. The 'Portsmouth centre' moved nearer, taking a course that brought it within about five to six miles to the north-west of us. Meanwhile, another centre of activity had moved a little south of us ; this produced some very good flashes a mile or two to the south-east and east, and finally moved away in the direction of London. It could be followed for a long time, the flashes appearing, owing to increasing distance, to become shorter and fainter. Finally, I noticed another centre on a line a little to the south of the direction of Portsmouth, and this centre it was that was responsible for the flash described above ; it also produced three other flashes quite close by, and one of these made the peculiar noise, though I did not hear it myself, probably because I was going round the house to see if any damage had been done by the first flash and happened to be in a passage where there was not an open window.

C. J. P. CAVE.

Stoner Hill, Petersfield, Sept. 1.

Sunspots and Pressure Distribution.

THE issue by the Meteorological Office of the daily charts of the weather in the northern hemisphere has enabled me to ascertain the barometric changes which take place from day to day in high latitudes. As a rule, the cyclones and anticyclones are large as compared with the polar uncharted area, and it proved possible to extend the isobars of the surrounding areas over the Arctic Sea. However, east Siberia could not, in the absence of the Japanese daily charts, which reach England about six months late, be dealt with.

From the partially completed charts the mean pressures were calculated for each day along latitudes 30°, 40°, 50°, 60°, 70°, and 80° north. When plotted they showed irregular periodic variations, some of which had a swing of something more than 25 days. As this is about the apparent period of rotation of the sun and pointed to our chief luminary as the cause of the variability of pressure from day to day, I decided to consider the sunspot question carefully.

By the courtesy of the Astronomer Royal, I have been supplied with bromide prints for each day for January, February, March, and April, and been allowed to see some of the later negatives of the solar disc. Also, by the courtesy of the director of the Meteorological Office, I have obtained the pressure charts—issued to the public, since March—for January and February.

The sunspots have been plotted upon a diagram, the abscissæ of which are days and the ordinates degrees on the sun's surface measured from the apparent centre of the disc. They clearly show the movements of each spot or group of spots, as they approach or recede from the centre of the disc, owing to the sun's rotation.

An examination of this diagram demonstrates the fact that the pressure is low over the Arctic regions when there are sunspots near the sun's centre, and that there are high pressures over the Arctic regions when there are no spots near the centre of the disc. Such low pressures due to sunspots occur in the long Arctic winter quite as markedly as they do during the summer. When the sun's disc was clear in the centre on April 24, the mean pressure north of 60° was 1025 millibars. On Mar. 8 the mean pressure was 1001 millibars and there were spots near the sun's centre.

I hope to be in a position to publish full details concerning the matter soon after the receipt of the Japanese weather charts of the North Pacific area for June.

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Theories of Terrestrial Magnetism.*

By Dr. F. E. SMITH, C.B., C.B.E., Sec.R.S.

EARTH'S MAGNETIC FIELD AND SECULAR VARIATION.

VERY valuable criteria have been given by Gauss and by Schuster, the former showing that the main origin of the earth's magnetic field is within the earth, and the latter that the cause of the daily variations is external to the earth's surface. Any predominant magnetic effect due to external causes need not, therefore, be looked for.

What do we know of the so-called permanent field? Examination of the available data leads to the conclusion that the magnetic field may be regarded as moving westwards along a parallel of latitude at the rate of a few seconds of angle per day, the rate of movement being such that, if continued for some hundreds of years, the field would make a complete revolution round the earth, the motion being in the opposite direction to that of the earth's rotation. The secular variation may therefore be regarded as caused by change in direction of the axis of magnetisation. If outer space is a conducting medium, there will be relative motion between the magnetic field of the earth and it, and the moving field will induce currents in the outer conducting medium, and these currents in turn will react and induce other currents and associated magnetic phenomena. There will also be mechanical reactions, and Schuster showed how these reactions can be calculated. It is certain that the induced currents must tend to destroy the motion of the inducing field, and that one effect must be to reduce the period of rotation. Such a reduction in the period of rotation would result even if the magnetic axis coincided with the axis of rotation, but when the two axes do not coincide there is another retarding couple acting on the magnetic field.

A circular movement of the magnetic pole about the axis of rotation may be regarded as produced by two radial movements at right angles operating from that axis. Such motions of the magnetic field will induce currents in the conducting layer, and the reacting forces will tend to destroy the movements which produce them, that is, the tendency will be to make the two axes coincide. The total result is, therefore, to slow down and eventually destroy the rotation of the magnetic axis and to reduce the angle of separation of the two axes and eventually cause them to coincide. A bird's-eye view of the magnetic and geographical poles taken over a long period of time would reveal a spiral path for the magnetic pole, the latter drawing nearer and nearer to the geographical pole.

It is, of course, not necessary to assume a large volume of outer space to have uniform conductivity to produce such effects. An outer layer will suffice, and the conductivity may be uniform or patchy, but the reactions will be of the sign indicated. It is certain that the movements of the magnetic field are not simple as outlined above but are very complex, and that unexpected reversals occur, so that it is not possible to predict the conditions even twenty years ahead. The theory advanced is, however, still capable of explaining the variations, for any conducting layer may not only vary greatly over considerable areas, but there may be relative motion between the earth and portions of the layer which also varies.

ELECTRIC CURRENTS CIRCULATING ROUND THE EARTH.

The next simplest theory to that of a magnetic core is that the magnetic field is due to electric currents circulating round the earth, and this naturally gives rise to the question of the seat of origin of the electromotive forces necessary to maintain such currents. If the currents are uniform in density throughout the volume of the earth, the magnitude of this density would be about 10^{-8} amp. to produce the necessary intensity of magnetisation. If we suppose that there was once a source of electromotive force but it has long ceased to operate, the currents produced would take a very long time to die down owing to self-induction. But it is much more profitable to look for a possible electromotive force not only to produce but also permanently to maintain a current system.

Such a possible source was indicated by Larmor at a meeting of the British Association in 1919. Larmor pointed out that in the case of the sun, surface phenomena indicate the existence of a residual internal circulation mainly in meridian planes. If this circulating conducting material cuts a magnetic field which in direction is the same as that of the earth, circulating currents will be set up in such a direction as to augment the magnetic field, and eventually a condition of equilibrium will be set up between the producing electromotive force and the attenuation effects. The system is, in fact, that of a self-exciting dynamo, and the energy of the system is obtained at the expense of the energy of the circulating conducting material.

While in the case of the earth any internal circulation of matter in meridian planes or near thereto is entirely conjectural, the theory does provide not only for the main field but also for the secular variation by changing the paths of the circulating currents.

Ross Gunn has recently put forward a theory attributing the magnetic field to electrical currents set up inside the earth in the high temperature regions where the thermal motions are considerable. Gunn suggests that the temperature of the inner earth is of the order of 10,000°, and as a consequence the material will be highly ionised and the conductivity correspondingly great. In the case of the upper atmosphere, Gunn has analysed the motions of ions and electrons of long free path spiralling about the magnetic lines of force, and in such a case a diamagnetic effect and drift currents are produced.

* From the presidential address to Section A (Mathematical and Physical Sciences) of the British Association, delivered at Bristol on Sept. 8.

An extension of the calculation to the inner earth where the free paths are short is made, and it is considered that the primary current system of the earth results from the motions imposed upon ions having a mean free path of the order 10^{-7} cm., the motion being imposed by the internal gravitational electric field at right angles to the magnetic field. The currents produced augment the original field in a regenerative manner.

Magnetic Effects associated with Earth's Rotation.

Let us consider the possible ways in which a body may by virtue of its rotation act like a magnet. First consider the earth as a body carrying a positive or negative electric charge. If the surface density of the charge be ρ, the magnetic force at the equator parallel to the surface is

$$H_e = \frac{4}{3}\pi\rho r\omega$$

where ω is the angular velocity and r the radius of the earth. If Q is the total charge on the surface, the horizontal magnetic force may be written

$$H_e = Q\omega/3r = \frac{V\omega}{3}$$

where V is the potential. In this case it is obvious that any small sphere charged at the same potential and rotating at the same angular velocity would produce the same surface field, since the radius of the sphere is not involved.

If, however, the charge be distributed uniformly throughout the earth—and this is necessary for uniform intensity of magnetisation—the value of the horizontal field at the equator is $Q\omega/5r$. If the charge on the earth be negative, the resultant field is such that there would be an upward vertical component at the north pole, and a south to north horizontal field at the equator. A field of this type does not exist in practice, the field of the earth being such that its direction is south to north at the equator and vertically downwards at the north pole. Moreover, it is not possible to produce by means of a single rotating charge, fields of the correct sign both at the pole and the equator, for if we change the sign of the charge the resultant fields at pole and equator are also changed in sign.

To overcome the difficulties of a surface charge, Sutherland suggested an equal but opposite charge concentrated at the centre of the earth, thus neutralising the electrostatic field due to the surface charge but not the magnetic effect of the charges in motion. Later he suggested that an inequality in the distribution of the earth's atomic charges might be a cause. There are a number of variants of this idea of separated charges. One is that the rotation of the earth brings about an electric polarisation in the atoms perpendicular to the axis of rotation, such polarisation producing a magnetic and also an electrostatic field. The direction of magnetisation of the field is not, however, that actually observed on the earth, the same difficulty presenting itself as that already considered with the charged sphere.

In 1891, and on several occasions since, Schuster has raised the question whether every large rotating mass is not a magnet, and so far back as 1891 he put forward the suggestion that the sun has a magnetic field associated with it.

The observed similarities between the magnetic fields of the earth and the sun, especially as the physical conditions are so different, naturally lend support to the theory that the magnetisation is brought about by rotation, and the fact that the axes of rotation and magnetisation do not coincide, while disturbing, may possibly be explained by reasonable assumptions.

If rotation of matter is necessary to produce the magnetic fields of the earth and the sun, the angular velocity, the radius, and the density must be important factors. If the magnetic effect is proportional to $D\omega r^2$, where D is the density, the calculated intensity of the sun's field agrees with that observed, taking the earth's field as the standard. Unfortunately, owing to the square of the radius being involved in the expression for the field, an effect proportional to $D\omega r^2$ cannot be tested by experiments in the laboratory, as a value of ω necessary to produce a measurable effect could not be obtained. A magnetic effect proportional to $D\omega r$ can be and has been tested in the laboratory, but the effect is far too small to account for the earth's magnetism.

A theory which has been tested by laboratory experiments is one depending on gyroscopic action. If the magnetic condition of iron arises from the rotation of the electrons in the constituent atoms, the axes of rotation should tend to become parallel to the earth's axis of rotation. The net result so far as the magnetic effect is concerned is to cause each molecule to contribute a minute magnetic moment parallel to the earth's axis of rotation. The effect will be proportional to the angular velocity and not the radius, so that the effect can easily be tested in the laboratory. Barnett first succeeded by laboratory experiments in showing that magnetisation was produced in this way and that the intensity of the field observed was proportional to the angular velocity. The direction and general shape of the magnetic field of the earth could be accounted for by this gyromagnetic theory, but the intensity of magnetisation produced is far too small. The estimated value is about 10^{-11} times that of the earth.

Possible Modification of Laws of Electrodynamics.

The difficulties confronting such theories as an electrically charged earth and the smallness of the gyromagnetic effect, have led to suggestions that the field may be due to some departure from the commonly accepted laws of electrodynamics.

In 1894 J. J. Thomson pointed out that if atoms exerted slightly different attractions on positive and negative electricity, then a large rotating body could produce a magnetic field. In such case the intensity would be proportional to ωr^2, so that no laboratory experiments could confirm or refute the theory.

Swann, who has put forward a theory based on a slight modification of the laws of electrodynamics, points out that the ratio of the magnetic fields for the earth and sun would be obtained also for an expression of the form $D\omega^4 r^4$, since the ratio of the values of $\omega^4 r^4$ differs inappreciably from that of ωr^2. According to this theory, spheres of such size that they may be used in laboratory experiments should give effects which are just measurable, and Swann and Longacre have made experiments with a copper sphere 10 centimetres in radius rotating at 200 revolutions per second, but the results obtained differ very appreciably from those calculated on the theory, that is, an effect proportional to $\omega^4 r^4$.

Vertical Electric Currents.

There is, however, a possibility that a small portion of the earth's magnetic field may be due to vertical electric earth-air currents, which can easily be distinguished from currents circulating in the upper atmosphere or in regions beyond.

Rücker chose areas in Great Britain where the magnetic forces were well known, and failed to find any evidence of such vertical currents. Dyson and Furner made an examination of data available in 1922, and conclude that although there is some evidence, such currents are not indicated with any certainty. On the other hand, Bauer has made many calculations, and on all occasions has been forced to conclude that such vertical currents do exist.

The probable error, however, associated with the measurements is considerable; but sufficiently precise measurements could be made over a carefully chosen area which would enable a definite decision to be reached with respect to such vertical currents.

Daily Variations.

Schuster's analysis shows that the daily variation is probably due to electric currents in the upper atmosphere, but in addition to the magnetic effects of these currents there is an effect due to currents induced in the earth by them. These induced currents are naturally in the opposite direction to the inducing ones, and hence the magnetic effects for the horizontal intensity are additive, while those for the vertical force are opposed.

Chapman's analysis shows the system in the sunlit hemisphere to consist of two closed circuits which (at the equinoxes) may be taken as symmetrical with respect to the equator, their foci lying very nearly on the 11 A.M. meridian. As the electric currents are supposed to be induced by the movement of conducting layers of air in the magnetic field, such currents must also be produced near the ground, but the conductivity of the air near the ground is so low that their effect may be neglected. In the upper regions the movements, while larger, cannot be regarded as immeasurably greater than near the earth's surface, and the increase in current intensity can only be attributed to an increase in the conductivity, a view which Balfour Stewart was forced to adopt, although at the time there was little evidence to support it.

The magnitude of the dynamo effect is dependent on three factors—(1) the horizontal movement of the air, (2) the conductivity of the air, (3) the intensity of the vertical magnetic field. All these factors vary with latitude, and hence it is to be anticipated that the magnitude of the variations will also vary with latitude, which is the case. The intensity of the field can be calculated with considerable accuracy but the conductivity and movements of the upper air are not known, although such movements are attributed to thermal effects and hence will be a maximum in the daytime.

As a first and crude approximation we may imagine a spherical conducting layer to surround the earth, and in addition a conducting hemispherical cap over the hemisphere facing the sun, the height of this cap being a few hundred kilometres. Neither the complete spherical conducting shell nor the hemispherical cap are of uniform conductivity, and the matter constituting these layers moves with the earth, so that ionisation and recombination are always taking place.

While we have from wireless measurements fairly good evidence of the height of the lower conducting layers, our knowledge of the extent of the ionisation is not sufficiently good to enable us to do more than speculate on the merits of the theories advanced, for in addition to the dynamo theory there is one due to Ross Gunn known as the diamagnetic layer theory, and a third called the drift current theory. The differences between the theories are best brought out by considering the ionisation effects in the hemispherical conducting cap facing the sun. Pederson has calculated the number of electrons and ions per cubic centimetre at various heights, and he and Ross Gunn have considered the nature and magnitude of the conductivity of the upper ionised regions. They have shown that the conductivity varies with the direction of the magnetic field, the conductivity at right angles to the field being at times very small, and under certain conditions it approaches zero, while the conductivity in the direction of the field is unaffected by the field's intensity. Hence in layers where the conductivity transverse to the magnetic field is very small, such large circulating currents as are necessary for the dynamo effect cannot flow, and where there is an appreciable vertical magnetic field there can be but negligible horizontal electric currents. In the case considered by Gunn, where a charge in its spiral path can execute many revolutions between successive collisions, the spiral motion of the charge has the same effect as a small magnet opposed to the field, so that the whole hemispherical cap is equivalent to a diamagnetic layer, and to this diamagnetism Gunn attributes the diurnal variation. There appears to be no doubt that such a diamagnetic effect does exist, and that it contributes to the diurnal variations, but its magnitude is much too small to explain the whole of the diurnal variation.

Chapman has shown how the ionisation in the diamagnetic layer contributes far more effectively to the diurnal variation. He shows that the less the contribution made by a charged particle to the

transverse conductivity (relative to the magnetic field) the greater is the mean drift velocity which it experiences, and in the case of the earth's magnetic field such drift currents are eastward in direction. There is, in fact, a steady drift of electrons and ions in a direction perpendicular to the lines of magnetic force and the gravitational field.

With regard to the relative merits of the three theories, an effect of the diamagnetic layer appears certain, but with it is associated the drift current effect which is much larger. The diamagnetic layer effect must therefore be regarded as secondary in importance. The dynamo theory involves motions of the air as well as ionisation, and while on the whole the drift current theory appears to be superior, more information is needed of the number and distribution of ions and electrons in the upper atmosphere before coming to a final decision.

Sunspots and Magnetic Storms.

Any unevenness in the radiation from the sun as it rotates must also affect the conductivity and hence produce variations. Examination of magnetic records shows that many variations are related to the sun's period and also to sunspot periods, and it appears not improbable that there is overlapping of several periods probably intimately connected. The results obtained show that with rise and fall of sunspot frequency there are corresponding changes in the diurnal variation. Moreover, the amplitude of the daily changes rises and falls with the intensity of the magnetic disturbance. It follows, therefore, that change in amplitude of the diurnal variation in years of many sunspots is due to the same ultimate cause, namely, solar radiation, as that causing magnetic disturbance.

Magnetic storms are marked disturbances of solar origin, and to explain these many theories have been advanced, but the facts are not easy of explanation. One of the first theories put forward attributed magnetic storms to the magnetic fields produced by streams of charged particles from the sun acting like an electric current and producing a direct magnetic effect. Schuster showed that such a stream moving between the sun and the earth would move in a magnetic field of constantly increasing intensity, and would be subject to a retarding force also continually increasing. Lindemann has overcome this difficulty by suggesting solar streams which are ionised but on the whole neutral. The groups of particles are assumed to be projected from the solar prominences, and the gases in these are of such high velocity, 10^8 cm. per sec., that the journey from the sun to the earth should be possible in less than two days, without serious recombination taking place. Moreover, owing to its neutrality such a stream will not tend to spread outwards by the mutual repulsion of its constituent particles.

Maris and Hulbert attribute the increase in ionisation to the action of ultra-violet light. They conclude that at heights of 300-400 kilometres temperatures of 1000° K. are reasonable, and at heights exceeding 400 kilometres the free paths of the particles are very long, the motions due to formal impact considerable, and the ionisation entirely due to the action of ultra-violet light. When the activity of the sun increases it is assumed that there is a tremendous increase of ultra-violet light; thus Maris and Hulbert estimate that if one ten-thousandth part of the solar surface (temperature 6000°) were removed and there were exposed regions of black body temperature 30,000°, the total ultra-violet energy would be increased 10^5 times, whereas the solar constant would be increased by only 1 per cent.

Recently Chapman and Ferraro have suggested that magnetic storms are essentially connected with the approach of a neutral ionised stream towards the earth, the more important changes in the stream taking place in the direction of the sun at a distance equal to a few times the radius of the earth. Retardation of the stream results, and this retardation is naturally greatest at that part of the front of the stream in direct line with the centre of the earth. On either side the stream will advance and partly enclose the earth, and along the sides of the enclosure there will be charged layers due to the polarisation of the stream by the magnetic field. Across the space on the dark side of the earth it is assumed that a westerly current is set up due to charges passing over the space between the charged layers.

Need for more Precise Data.

This very hasty sketch of some theories relating to terrestrial magnetism reminds me of Dr. Chree's remarks that the deductions from such theories are just as hypothetical as the theories themselves, and I am very sensible that this rapid survey is not only incomplete, but also that no theory considered is completely satisfactory. Moreover, while fully realising that they are vital links in any chain of evidence, I have avoided the companion subjects of auroræ, atmospheric electricity, and earth currents, because to have considered them would have taken far too long. I do, however, wish to emphasise that data of a precise kind are much needed to modify existing theories and to produce new ones, and I cannot do better than conclude with a remark of Rücker's in Bristol thirty-two years ago. Rücker said: "If there be any who are inclined to ask whether the careful study of terrestrial magnetism has led, or is leading, to any definite results, or whether we are not merely adding to the lumber of the world by piling up observations from which no deductions are drawn, we may answer that, though the fundamental secret of terrestrial magnetism is still undiscovered, the science is progressing. . . . But there are special and cogent reasons why the science of terrestrial magnetism should be cosmopolitan. For those who would unravel the causes of the magnetic movements of the compass needle concerted action is essential. They cannot, indeed, dispense with individual initiation or with the leadership of genius, but I think that all would agree that there is urgent need for more perfect organisation, for an authority which can decide not only what to do but what to leave undone."

The Fifth International Botanical Congress.

NEVER has there been such a large and representative gathering of botanists as was assembled in Cambridge on Aug. 16–23 for the Fifth International Botanical Congress. Of the twelve hundred members who registered, nearly one thousand attended. As was to be expected, Great Britain supplied most members, but the United States of America sent a large contingent, and, including the overseas portions of the British Empire, about fifty-five peoples were represented. The original intention had been to hold the Congress in London, but it was decided that Cambridge would be a more convenient centre.

London, however, shared in the programme. The Linnean Society generously supplied a reception room at Burlington House for the two days preceding the meeting at Cambridge, and threw open its rooms to members of the Congress. In addition, a selection from the Linnean collections was exhibited and members were presented with a descriptive catalogue, which also included an account of the foundation and history of the Society. The story of the efforts of the younger Linnæus to prevent the sale of his father's collections and to preserve them from deterioration; of their offer by his mother to Sir Joseph Banks after her son's death, in order to provide suitable marriage portions for her daughters; of their purchase at Banks's suggestion by James Edward Smith; of the foundation of the Linnean Society and its early meetings at Smith's house in Great Marlborough Street, where the collections were for a time housed; of their subsequent homes, including for many years Sir Joseph's house in Soho Square, until their arrival at Burlington House in 1857; and of their purchase from Smith's executors at a price ruinously increased beyond the original cost, is well told in the pamphlet, which overseas members will value as an interesting memorial.

On the Friday evening a reception was held at the Imperial Institute, where the members were received on behalf of His Majesty's Government by the Right Hon. Christopher Addison, H.M. Minister of Agriculture and Fisheries.

At Cambridge many of the members were accommodated in the colleges, a privilege which was evidently much appreciated, especially by American visitors. The sunny weather which lasted through most of the week showed Cambridge at its best.

The business of the Congress opened with a plenary meeting in the large Examination Hall at Cambridge, where the members were welcomed, in a Latin speech, by the Vice-Chancellor of the University, in state, and by the president of the Congress, Prof. A. C. Seward. At a second plenary meeting on the following Wednesday, two hundred delegates conveying greetings from governments, departments of state, universities, societies, and institutions were presented to the president. At this meeting also Prof. F. A. F. C. Went, of Utrecht, presented an invitation to Holland for the next Congress, to be held in 1935. The invitation was unanimously accepted. Morning and afternoon throughout the week were devoted to sectional meetings, the business closing with a plenary meeting at noon on Saturday.

Apart from the value of the papers and discussions in the sectional meetings, which were well attended, the Congress afforded ample opportunity for intercourse among fellow-workers from all parts of the world. Old friendships were renewed and colleagues known only by correspondence or exchange of papers took human shape, and the reception room (always a centre of activity), social meetings, excursions, and meals in common in the old college halls were media for conversation, discussion, and exchange of ideas.

Serious work was distributed among eight sections—bacteriology, phytogeography and ecology, genetics and cytology, morphology and anatomy, mycology and plant pathology, plant physiology, palæobotany, and taxonomy and nomenclature. A volume of abstracts of the communications, a copy of which was given to every member, facilitated the work of the sections.

An important duty of the Congress was to review the rules of botanical nomenclature. The code of rules formulated at the previous Congresses at Vienna (1905) and Brussels (1910) had been re-examined by an international committee appointed for the purpose at the previous Congress held in America in 1926. The function of the committee was to receive and report on suggestions and resolutions submitted by botanists generally, and the results of its deliberations in the form of a Synopsis prepared by the Rapporteur-général, Dr. John Briquet of Geneva, formed the basis of discussion by the Sub-Section on Nomenclature. It was hoped that certain differences in practice, and more especially the fundamental differences between the majority of workers on one hand and a school representing an important section of American botanists on the other, might be amicably settled, and that the 1930 Congress might witness the achievement of a system to which workers generally would be willing to conform. Pleasing features of the discussions were the evident wish to arrive at a common agreement and the absence of that somewhat polemic atmosphere which was noticeable at Vienna in 1905. Dr. E. D. Merrill, Director of the New York Botanic Garden, presided over the meetings, and, guided by the Rapporteur-général and other experts, the sub-section was able to formulate a revision of the Vienna and Brussels "Rules" which was adopted at the final plenary meeting of the Congress and left to an editorial committee to prepare for press. Especially helpful in securing this revision were the suggestions contained in a code drawn up by the British sub-committee appointed at the Imperial Botanical Conference in 1924, and a series of amendments to the international rules presented by Mr. Rehder, of the Arnold Arboretum.

An important outcome of the discussions on nomenclature was the appointment of a representative International Advisory Committee, to hold

office until the next Congress, which would adjudicate on debatable points in the interpretation of the rules. In the course of the debates the starting-point for the various groups evoked some discussion. While 1753, the date of the first edition of Linnæus's "Species Plantarum", was generally accepted for flowering plants and ferns (excepting fossil plants), later dates were suggested for some groups of cellular plants. To avoid upsetting well established names of genera by the strict application of the law of priority, the principle of lists of *nomina conservanda* was accepted for all groups. The scrutiny of these lists was to be a function of the Advisory Committee. The principle of similar lists of conserved names of species was rejected by a large majority.

Battle was joined afresh on the question of a compulsory Latin diagnosis when describing a new genus or species. The original alternative of the three best-known European languages is no longer tenable with the increasing spread of the study of taxonomy, and the only alternative to Latin was obviously the use of any tongue, a practice which would add to the difficulties of taxonomic work. It was also pointed out that the embodiment in a short diagnosis of the salient points of a genus or species would be helpful both to the author and other workers. The vote on the question indicated an almost complete disappearance of the opposition to Latin; an appeal from bacteriology and palæobotany to be excepted owing to inherent difficulties was, however, allowed. In order to legitimise names already published in a vulgar tongue, the rule will not come into force until January 1932. Another decision was the recognition of standard-species in fixing the identity of genera.

A discussion on methods of furthering the advance of taxonomy emphasised the importance of a broader training for the taxonomist and especially the value of a phylogenetic view-point. The formation of an International Taxonomic Bureau to assist and correlate systematic work and to relieve individual institutions of certain extraneous duties was also adumbrated. The question of finance was a serious factor. The species-concept was the *motif* of joint discussions, with the geneticists in relation to cytogenetics, and with the ecologists in relation to geographical distribution. The ecologists also considered standardisation in description and terminology in the study of vegetation-areas and plant-communities. The morphologists returned to two favourite subjects of discussion, the shoot-unit and the origin of the leaf, and floral organisation with special reference to the carpel. The mycology and plant-pathology section discussed the effect of environment on disease, plant-viruses (with the bacteriology section), and the dissemination of cereal rusts; in connexion with the last-named a resolution was formulated asking the co-operation of overseas governments in the study of these pests of cereal crops. The plant physiology section dealt with protoplasmic organisation and the cell, and problems of growth and nutrition; and the palæobotany section, the antiquity and origin of angiosperms, early terrestrial vegetation, and plants as stratigraphical indices. Life-cycles of bacteria and criteria for differentiation were subjects of debate by the bacteriologists.

In connexion with the various sections, exhibits and demonstrations germane to the discussions were arranged. Evening lectures, including a topical one by Mr. G. F. Hickson on the University of Cambridge and its Colleges, and other subjects of general interest, provided a change from the more specialised work of the sections, which with their differing technicalities of language recalled, as Prof. von Goebel remarked, the Tower of Babel.

The honorary degree of doctor of science was conferred by the University of Cambridge on Dr. John Briquet, Director of the Geneva Conservatoire and Botanic Garden; Prof. Ludwig Diels, Director of the Botanic Garden and Museums at Berlin; Prof. T. G. Halle, Keeper of Palæobotany in the Swedish Natural History Museum; Prof. L. R. Jones, of the University of Wisconsin; Prof. C. J. Schröter, a pioneer in ecology, and Prof. F. A. F. C. Went, Director of the Botanic Garden and Laboratory at Utrecht; and (in absence) Prof. P. A. Dangeard, of the Paris Museum.

Social functions included a garden party by the president and Mrs. Seward in the grounds of Downing College, a reception by the Master and fellows of St. John's, and a dinner in the hall of Trinity College, where overseas delegates were entertained by their British *confrères*. Among the excursions were a whole-day visit to Wicken Fen. A select party visited Halesworth, Suffolk, where a memorial tablet to William and Joseph Hooker was unveiled by Sir David Prain (see NATURE, Aug. 23, p. 287).

Though the business of the Congress finished on Aug. 23, many members availed themselves of excursions and visits arranged from London in the following week. These included visits to Darwin's House at Down, Kent; the Rothamsted Experimental Station; the Royal Horticultural Society's Gardens, Wisley; the John Innes Horticultural Institute, Merton; and the nurseries of Messrs. Sutton and Carter. The Director and members of the staff of the Royal Botanic Gardens, Kew, received the visitors on Monday; and a special exhibit was arranged at the Department of Botany, British Museum, where the keeper and his assistants were in attendance on two afternoons. In connexion with the visit to the Museum a booklet had been prepared explanatory of the exhibits and giving an account of the origin and growth of the botanical collections since the foundation of the Museum as the result of the bequest of Sir Hans Sloane's collections in 1753. Of special interest to overseas visitors were volumes from the Sloane Herbarium containing the early collections from Jamaica and other parts of the New World, and the original specimens which were the basis of Linnæus's first great systematic work, the "Hortus Cliffortianus", and of his "Flora Zeylanica" (1747).

For the success of the Congress and the smooth working of the arrangements in Cambridge and London, special thanks are due to the secretaries, Mr. F. T. Brooks and Dr. T. F. Chipp, and their willing helpers.

The British Association and a Centenary Fund.

IN 1931 the British Association for the Advancement of Science will hold its centenary meeting in London. No more appropriate place of meeting could have been selected. The Association may justly claim to be fully representative of science as a whole within the British Isles; by its overseas meetings it has stimulated scientific activities and focused the aims and interests of scientific workers in the dominions and dependencies. This dual function makes it inevitable that so momentous an occasion in its history should be endowed with a significance which can most fittingly find expression only in the capital city of the Empire.

The imperial character of the meeting and the place in which it is to be held will make serious demands on the organisation and resources of the Association. On normal occasions the annual meeting is a heavy burden, financial and otherwise, on the locality in which it is held. In London expenditure will be altogether on a higher scale. The cost of entertainment of foreign guests and visitors from the dominions and dependencies, if it is to be such as will be regarded as commensurate to the occasion, will be far beyond anything the Association has been able to contemplate hitherto. Without entering into detail, it is abundantly clear that the financial resources of the Association, derived as they are largely from subscriptions which are liable to fluctuation and on ordinary occasions provide no very large margin over the expenses incurred, cannot be relied upon to produce the sum which will be required.

The British Association, having this in view, proposes to raise a fund for its centenary which will be sufficient to meet necessary and desirable expenditure for the meeting. But, in addition, it asks for a sum which will place its finances on a basis adequate for the future development of the Association's approved activities. The appeal was launched at the opening of the recent meeting at Bristol. Everyone connected with scientific work in Great Britain would surely wish that the centenary of the Association should be celebrated with the dignity and circumstance befitting the occasion; but it is perhaps only those who have been intimately in touch with the inner working of the Association who will appreciate fully all that is implied in the reference to the future development of its work.

During the hundred years of its existence, the Association has striven for the advancement of science primarily by promoting intercourse between scientific workers through its annual meetings. By encouraging the attendance of those not specifically engaged in scientific work or even not specially trained in any one branch of science, the Association has endeavoured to extend the interest in science among the public, especially when occasion offers in regard to its practical application to the affairs of everyday life. While a larger public has been made aware of this side of the Association's work through the good offices of the daily press in reporting the proceedings in the sections and at general meetings, it has had little opportunity to appreciate the valuable support given to research by the money grants administered through research committees. These grants, made year by year on the nomination of the sectional committees representative of the various sciences comprised within the Association, constitute one of the greatest, if not the greatest, of its services in the advancement of science. Many of the committees have produced results of national and even international importance. Even though the sources outside the Association from which grants for research are available have increased in recent years, the assistance of the Association is still in demand, especially in the initial stages of research. At the present moment, indeed, the Association maintains some seventy research committees distributed among the various sciences. For some years the Association has disbursed an average annual amount of £1100 on the work of its committees—a sum expended entirely in the actual cost of research, the members of the committees receiving no remuneration for their work. The amount available for these grants is to a great degree dependent upon the amount of the subscriptions received, and in the past has frequently been inadequate to the demands.

It is probable that the public is not aware that the activities of the Association are not confined to the duration of each annual meeting. In the interval between sessions the organisation of the Association is not even solely engaged in preparing for its next meeting, heavy as is the work entailed thereby. The Council is also occupied in giving effect to the resolutions passed at the preceding annual meeting, which are usually of considerable moment and, as they frequently affect public interests or policy, involve the submission of the resolutions to Government departments, administrative bodies, and kindred societies. Further, the Council may be said to hold a watching brief for science throughout the year. It is prepared to take action, if need arises, in all matters in which science may be directly or indirectly affected.

While other aspects of the Association's work must here be passed over, reference may be made to the Association's custody of Down House, the home of Darwin, which will in future entail no inconsiderable expense.

The annual income of the Association at the moment is about £5600, of which nearly a half is derived from the fluctuating annual subscriptions. The amount at which the Association aims for its fund has been put at £40,000. If from the sum raised part is added to endowment, the Association will be placed in a position to assure its activities and extend them in directions which cannot fail to be of advantage to science. In particular, the amount available for research will be increased; the burden of the annual meetings, now so heavy on the place of meeting, may be somewhat lightened, and the imperial obligations of the Association,

which have come increasingly into prominence of late years, may be more adequately met.

It should be scarcely necessary to press the claim of the Association in further detail. The position which it has won by its work during the past hundred years is a sufficient warranty of its deserts and of its fitness to administer wisely any funds committed to its charge. On the ground of its services to science and to the community, the Association has well earned the right to expect the support for which it asks.

The greater part of the Bristol meeting of the British Association was favoured by fine weather, of which full advantage was taken by all the sections. Owing to the easy access of many points of special interest, these purely sectional excursions were more fully organised than is usually the case. The Norman Lockyer Observatory at Sidmouth was visited by a party of physicists and astronomers, while Wookey Hole and the Mendips attracted geographers, zoologists, geologists, and anthropologists. The Forest of Dean was included with other excursions by botanists. In the sections themselves, apart from the presidential address, physicists listened with great interest to a summary of the present state of the theory of cohesion by Prof. Lennard-Jones, who showed that through the new mechanics a most promising theory is at last in the process of development. The subject of the present position of the British dyestuff industry provoked an important discussion in Section B, to which many well-known academic and industrial chemists contributed. The memorial lecture to Dr. Beddoe by Sir Arthur Keith emphasised the important anthropological work which has been and is still being done in Bristol, which Sir Arthur pleaded should be recognised by the foundation of a chair in that subject in the University. Airships, both British and German, naturally attracted engineers in Section G; while members had an opportunity of seeing the gyroplane in action at the new Bristol airport. The largest available theatre was filled for a joint discussion between geology, geography, and anthropology, on the relation between past pluvial and glacial periods, under the chairmanship of Prof. Fleure.

The following were included amongst the foreign guests present at the meeting: *Section A* (Mathematical and Physical Sciences): Prof. R. S. Mulliken (Chicago), M. R. Bureau (Paris), Prof. M. Siegbahn (Uppsala), Prof. Van Vleck (Wisconsin); *Section B* (Chemistry): Prof. J. H. Hildebrand (Berkeley, California); *Section C* (Geology): Prof. G. Delépine (Lille); *Section D* (Zoology): Prof. D. de Lange (Utrecht); *Section E* (Geography): Prof. A. E. Douglass (Tucson, Arizona); *Section G* (Engineering): Prof. A. E. Kennelly (Cambridge, Massachusetts); *Section H* (Anthropology): Prof. E. Fischer (Berlin-Dahlem), Dr. M. Vassitz (Belgrade); *Section K* (Botany): Prof. T. H. Goodspeed (Berkeley, California), Prof. D. H. Campbell (Stanford, California), Prof. W. J. V. Osterhout (New York), Prof. F. A. F. Went (Utrecht).

The total membership for the Bristol meeting was 2650.

The General Committee of the Association has approved the arrangements made by the Council for the centenary meeting to be held in London next year. The president will be the Right Hon. J. C. Smuts, and a long list of vice-presidents prepared by the Council, together with a representative London Committee, was also accepted by the General Committee.

As the Albert Hall will not be available for the inaugural meeting in London, the Council booked the Wesleyan Central Hall and annexes for this meeting. The General Committee approved of this and also of the proposal that the inaugural meeting should be devoted mainly to receiving addresses and other messages, the president-elect finally addressing the meeting. His presidential address will, however, be delivered on a separate occasion, namely, the final evening of the meeting, Tuesday, Sept. 29. The reception room, sectional meeting rooms, etc., will be in and near Exhibition Road, South Kensington, at such institutions as the University of London, Imperial College of Science, Imperial Institute Science Museum, Victoria and Albert Museum, Royal College of Music, and the Royal Geographical Society.

The new members of Council elected by the General Committee are: Prof. H. Clay, Prof. W. T. Gordon, Dr. C. W. Kimmins, Sir Peter Chalmers Mitchell, and Dr. H. T. Tizard.

The meeting of the Association in 1932 will be held at York, and in 1933 at Leicester. The Lord Provost of Aberdeen and the Principal of the University, Sir George Adam Smith, attended the meeting of the General Committee on Sept. 5 to invite the Association to meet at Aberdeen in 1934, and the invitation was unanimously accepted.

News and Views.

THE fact that definitely anti-social actions have been committed under the cloak of rationalisation is responsible for many of the misgivings with which labour regards the rationalisation of industry. Moreover, the displacement of workers by machinery has led to some distrust of science by labour. Labour-saving machinery is too often labour-displacing machinery, and although mechanical science is gradually eliminating from industry many of the most unhealthy and exacting conditions of labour, notably in the mining and metallurgical industries, science is often held responsible for creating unemployment. Labour frequently fails to realise that originative discoveries of science create new demands and open fresh avenues of employment in which displaced labour is absorbed. Such discoveries are, of course, those with which science is most closely associated. In this connexion, addresses such as that given by Sir Richard Gregory on Sept. 7, in connexion with the Bristol meeting of the British Association, before the Bristol Branch of the

Independent Labour Party on "Science and Labour", are particularly valuable at the present time as tending to bridge a gulf which, since the days of Darwin, Huxley, and Kingsley, has gradually developed between science and labour.

SIR RICHARD GREGORY referred in his address to the development from fundamental scientific discoveries, such as those of Faraday and Cavendish, many of which were regarded as of no practical value when made, of a wide range of new industries—electrical engineering, the fixation of atmospheric nitrogen, automobiles, aviation, metallic filament lamps, the gramophone, and the many branches of wireless telephony. In every one of these cases the application of scientific discovery has resulted in increased employment and frequently has been accompanied by an increase in the pleasures of life. It may well be that the future of civilisation largely depends on the ability of science once again to co-operate with labour. Unsatisfactory social conditions are often a consequence of incapacity to use aright the results of scientific advances. Such incapacity is frequently due to the political impotency of scientific workers and their failure to co-operate, and the re-establishment of harmony between science and labour would do much to remove that political weakness. Such co-operation and harmony can, however, only be achieved by scientific workers demonstrating, as Sir Richard Gregory does in his address, that science is not merely mechanical invention but rather creative knowledge which enables man to control his environment, and by their participation in social movements as citizens whose motives are above suspicion and whose knowledge is at the service of the community for the promotion of the greatest good.

PROF. T. E. GREGORY'S presidential address to Section F (Economic Science and Statistics) of the British Association, on "Rationalisation and Technological Unemployment", which was read in his absence on Sept. 8, is welcome indication that the Association recognises not only a duty to inform the general public on all scientific advances but also a corresponding obligation to assist in the control and solution of some of the problems created by such discoveries and their applications. The international character of the rationalisation movement and its undoubted effect in most cases in reducing the cost per unit of output make it impossible for any single country engaged in international trade under competitive conditions to contract out of its consequences except at the expense of its international trade. Since rationalisation effects a lowering of real costs, given a desire for a rising standard of life, Prof. Gregory believes there is no reason to suppose that the volume of unemployment will not again fall. The most optimistic view of the situation, however, must recognise that a grave transfer is involved and the difficulties may be accentuated by monetary and other independent circumstances. Scientific workers have no right to delude themselves into thinking that a new era of orderliness will come automatically, and must concern themselves much more seriously about the use or misuse of the new knowledge they have acquired and the social consequences of the improved methods of production which mechanical invention has developed. Increased productivity may tend to enhance the problem of unemployment, even if only temporarily, but it provides society with the margin of lower prices and increased leisure out of which unemployment can be relieved. The better use of the arts of production made possible by scientific methods and investigations is unlikely to endanger the organisation of society unless the process is applied with a wanton disregard of the injury which may be inflicted upon other industries or upon the workers rendered superfluous.

SIR ARTHUR KEITH'S Beddoe Memorial Lecture, which was delivered in the course of the meeting of the British Association at Bristol, and of which we print a summary elsewhere in this issue, was an eloquent affirmation of the enduring value of the work of this great pioneer. Beddoe's originality and vision, as well as his patience in inquiry, place him in a rank apart among the greatest of the anthropologists of the nineteenth century. It was only fitting that Sir Arthur should couple his appreciation of Beddoe with a strong plea for the institution of a chair of anthropology in the University of Bristol, The work of the Spelæological Society has shown that enthusiasm for the subject and the true spirit of inquiry are there among the members of the University. Bristol presents opportunities for anthropological investigation that are unrivalled. As a gateway of Britain from the earliest times to the present day it holds a key position. The caves of the Mendips; the lake-villages of Glastonbury and Meare; the traditions of early contact with Ireland, hostile and otherwise; the ethnology, archæology, and folklore of the border counties of Wales—these are some only of the fields in which we should look to the University for enlightenment. Of the practical considerations in relation to civic affairs upon which Sir Arthur touched it is unnecessary to enlarge. To a public-spirited business community such as the City of Bristol, they should carry conviction without further emphasis.

THE report submitted at the Bristol meeting of the British Association to Section D (Zoology) by the subcommittee appointed to inquire into the position of animal biology in the school curriculum is, on the whole, encouraging: for there is evidence that biology is receiving wider recognition as a subject of educational value. It is a hopeful sign that a committee of the Economic Advisory Council has been appointed "to consider the obstacles which stand in the way of the education and supply of biologists for work in this country and overseas, and to submit recommendations for the removal of such obstacles". The British Social Hygiene Council, too, is pressing the claims of biology, and the Colonial Office is awake to the importance of the subject. All the examining bodies, with the exception of the Oxford and Cambridge Schools Examination Board, which is understood to have the matter under consideration, now provide syllabuses in biology for the school certificate examination. The percentage of candidates offering biology in this examination has been steadily

rising for the last seven years, and that of those offering botany as steadily falling. But unsatisfactory features in this report are the statements that the great majority of the biological candidates are girls, very few boys' schools taking biology in the school certificate examination; and that the shortage of men teachers with biological training persists. The vicious circle has not yet been broken down. The report suggests remedially the institution of general honours degrees, which four of our universities do already confer, by all universities as alternatives to the existing special honours courses. To this may be added the recommendation that all colleges in the residential universities should accept biology as a subject in their entrance examination. The refusal of some colleges to do so is a serious obstacle to the supply of biologists.

ON Sept. 5, Section B (Chemistry) of the British Association devoted the whole morning session to a discussion on the present position of the British dyestuff industry. Prof. A. G. Green, formerly director of research of the British Dyestuff Corporation, who opened the discussion, surveyed the position of the industry up to the time of the Dyestuffs (Import Regulation) Act, which came into force in January 1921 for a period of ten years. Since that date, the dyestuffs industry in Great Britain has made great strides; it now supplies 25,000 tons of dyestuffs annually, or about 11 per cent of the world's requirements. While the proportion supplied by Germany, Switzerland, and the United States has remained constant in the past few years, the British contribution has increased from 8·9 per cent in 1925 to 11·7 per cent in 1928. Prof. Green is of opinion that a further period of State assistance is both justified by past progress and by the present world position. Prof. J. F. Thorpe emphasised the need for the production of new dyes for new fibres coming into use, and referred in particular to the inevitable interdependence of flourishing schools of research in organic chemistry and a stable and vigorous dye-making industry. Sir William Pope also discussed the effect the Dyestuffs Act has had in promoting the training of chemists for all branches of industry. The industrial side was dealt with by Mr. J. Morton, of Scottish Dyes, who pleaded that the industry has justified the continuation of the Dyestuffs Act; but Sir Joseph Turner, managing director of the British Dyestuffs Corporation, urged that the Act has served its purpose and should be allowed to lapse.

THE third triennial conference of the Pathological and Bacteriological Laboratory Assistants' Association was held in the Medical School of the University of Manchester on Aug. 25–29. It was opened by Prof. W. H. Lang, pro-vice-chancellor of the University, who expressed appreciation of the skilled assistance rendered by the laboratory assistants in scientific work. Workers often do express their indebtedness to their assistants when contributing to the medical and scientific journals. Prof. Lang hoped that the time was close at hand when the laboratory assistants of other sciences would attach themselves to the Association. The following papers were read at the conference: H. R. Hardie (London), the development of chemistry, from alchemy to biochemistry; P. H. Osmond (Liverpool), the pathogen selective culture method; S. G. Laws (Uganda), a simple flocculation test for the diagnosis of syphilis; R. J. Bromfield (London), equipping a biochemical laboratory and selecting biochemical methods; D. B. Colquhoun (Glasgow), a new method of isolating the typhoid and paratyphoid group from fæces; A. H. Walters (London), the examination of rats for plague in the Port of London; F. Dale (Manchester), Vincent bacilli and spirilli in cervical smears. The subject for general discussion was the training of juniors, opened by Mr. J. McLean (London). Prof. W. Blair Bell welcomed the conference to Liverpool on Wednesday, Aug. 27, and also spoke on laboratory research in cancer investigations. At the conference dinner, Sims Woodhead memorial medals were presented to Prof. A. E. Boycott and to W. A. Mitchell (Cambridge) for conspicuous services to the Association. The attendance at the conference was representative of the widespread organisation, members attending from Uganda, north and western Ireland, as well as all parts of England, Scotland, and Wales.

THE hurricane that reached Santo Domingo on Sept. 3 last is said to have caused many thousands of deaths, to have practically obliterated the capital of the Dominican Republic, and to have given rise to wind speeds so great as 160 miles an hour. Accurate measurements of wind speeds so high as this are not likely to have been obtained, but the material damage done supports the view that speeds of exceptional magnitude even for a tropical cyclone occurred. The large death-roll was evidently due in part to the unfortunate chance whereby a populous city felt the full force of the storm at its height. According to Fassig, the mean path of West Indian hurricanes in September lies to the north of the Leeward Islands and near to the north coast of Haiti. The particulars received so far suggest that the recent storm, at least in its earlier stages, followed a path slightly to the south of the normal track, for Dominica (Leeward Islands) was mentioned as the first island to be affected, and suffered some loss of life, while most of the islands immediately to the north of Dominica were unaffected. It is to be hoped that the full figures for loss of life will not be found to be so great as for the Galveston hurricane that occurred on Sept. 8, 1900, when 3000 people were killed in that town alone, but they evidently do not fall far short of those for the earlier disaster. Even if the storm reaches the mainland with reduced intensity, as predicted, it will rank as one of the very worst in a record that goes back to the fifteenth century.

THE Russian Soviet Union Society for Cultural Relations with Foreign Countries has issued the first number (Jan.–Feb. 1930, pp. 120) of *V.O.K.S.*, an illustrated literary and scientific publication in English. The object of this journal is to acquaint readers abroad with current affairs and cultural development in Russia, and the first issue contains more than

thirty contributions. Most of these are signed articles of general interest, such as, "Women of the U.S.S.R.", by Sophia R. Farman; "Building a New State", by A. Gurowitsch; "Excavations in the Crimea" and "Culture over the Ether", by "E. L." There are also descriptive travel articles on Samarkand, Tadjikistan and Turkmenistan, but the present issue does not devote much attention to scientific matters, although Prof. B. Arendt describes the Soviet archæological expeditions in 1929 and an account is given of the Leningrad Institute of Experimental Medicine and of the work conducted at the laboratory for experimental biology in the Moscow Zoological Gardens.

THE Leningrad Institute of Experimental Biology has undoubtedly performed most valuable work for the Russian people during the last decade. Side by side with the investigations of Profs. Kravkov, Omelyansky, Pavlov, and Vinogradsky, much urgently needed routine work has been performed in connexion with hygiene and sanitation and the preparation and application of curative and preventive serums. Prof. Daniel Zabolotny, president of the Ukrainian Academy of Science and former Commissar for Public Health, was also connected with the Institute of Experimental Medicine until he died recently. An obituary notice of him appears next to an account of the medical research work in progress at Leningrad. Prof. Zabolotny will be remembered for his studies of plague epidemics and the rôle of rodents as carriers of disease. Attempts have been made in several of the contributions to emphasise the progress being made under the *P'atiletka* or five-year plan of economic reconstruction and industrialisation. This is exemplified by "The Non-Stop Week", an article illustrated by the new Russian calendar for January and February, in which there are eleven weeks of five days each—a scheme which, it is claimed, has added sixty working days to the year. It is announced that twenty issues of *V.O.K.S.* will appear annually, the subscription being six roubles, or 12*s*.

THE eleventh International Conference of the Apis Club was opened on Monday, Sept. 8, at 3.30 P.M., in the Apothecaries' Hall, kindly lent for the occasion by the Society of Apothecaries, by Lord Ebbisham, who laid stress on the desirability of promoting apiculture among small-holders and other land workers, and referred to the increasing appreciation in other lands of the work of the Club. Miss A. D. Betts, in her presidential address, recapitulated the history of beekeeping, showing how it appears to have attained its maximum of national importance among the worshippers of the mother-goddess in neolithic or bronze age times. It has gradually fallen to its low status of a century ago through the loss of its religious standing, and by the economic difficulties caused by the substitution of other beverages for mead, the diminution of the wax market at the Reformation, and especially through the effects of the use of sugar upon the demand for honey. She pointed out that modern apiculture is built up upon science and must remain allied with science if it is to prosper, and indicated some of the directions in which apiculture is, or could become, of national importance. The Conference continued throughout the week, Sept. 8–13, and included the reading of papers (at the Crystal Palace, in conjunction with the National Show of Bees and Honey) and an excursion to view the apiaries of Messrs. Sturges and Soden at East Dean, Sussex.

WE have lately received the first three Reports of the National Research Council of Japan. The first number is a reprint of one published in March 1922. The manuscript of the second number, and all the other materials, together with the office of the Council, were destroyed by the great earthquake and fire of Sept. 1, 1923. The issue of the later numbers has been delayed on this and various accounts, and the Council has now decided to bring out four double numbers in quick succession to cover the eight years, 1922–30, after which a single number will be published every year. The work of the Council is divided into eight sections, dealing respectively with astronomy, geophysics, chemistry, physics, geology and geography, biology and agriculture, medical sciences, and engineering, and each section issues its own *Japanese Journal*, except that astronomy and geophysics are combined in one, while that of biology produces separate journals of botany and zoology. The ideal that the Council has set before itself is that all original memoirs on one branch of science shall be published in the same periodical. Also, since papers written in the Japanese language are closed to western readers, authors are pressed to write either in English, French, or German, or if in Japanese to prepare full abstracts in one of these languages.

A CONFERENCE on steel structures research will be held in the lecture theatre of the Institution of Civil Engineers on Oct. 16 next. The purpose of the conference is to promote discussion of the work and objects of the Steel Structures Research Committee of the Department of Scientific and Industrial Research. This Committee has been set up to review existing regulations for the use of structural steel in buildings and bridges, and to investigate the possibilities of more efficient and economical design. In order to ensure the effective application of the results of the Committee's work, it is felt to be desirable at an early stage to enlist the interest and co-operation of various bodies concerned. The conference will, therefore, provide an opportunity for an exchange of views and for a consideration of various suggestions that have been made, in particular the feasibility of formulating a standard practice in the use of structural steel in building throughout Great Britain. Those interested are invited to communicate with the Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, Westminster, S.W.1.

MESSRS. A. Gallenkamp and Co., Ltd., have written to us in connexion with the Research Item entitled "Electrical Heating in Laboratories" which appeared in NATURE of Aug. 30, p. 326. They have sent us lists No. 75 G and No. 231 F describing small electric furnaces and electrically heated laboratory apparatus which they have been making for several years. We think that apparatus of this type might

advantageously be more widely used in many laboratories in Great Britain. In several districts the cost of electricity has been largely reduced recently and the many uses of electrically heated apparatus should be more generally appreciated.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—An assistant teacher of nautical subjects at the Boulevard Nautical School and School for Fishermen, Hull —The Director of Education, Education Offices, Guildhall, Hull (Sept. 16). A bacteriologist and pathologist for the County of Lanark—The County Clerks, Lanarkshire House, 191 Ingram Street, Glasgow, C.2 (Sept. 17). An assistant bacteriologist for the City of Bradford—The Medical Officer of Health, Town Hall, Bradford (Sept. 18). A head of the Building Department of the Leeds Technical College—The Director of Education, Education Department, Calverley Street, Leeds (Sept. 25). A lecturer in logic at Birkbeck College—The Secretary, Birkbeck College, Breams Buildings, E.C.4 (Sept. 25). A demonstrator in physics at St. Bartholomew's Hospital Medical College—The Dean, St. Bartholomew's Hospital Medical College, Smithfield, E.C.1 (Sept. 27). An assistant research and advisory officer in plant husbandry at the West of Scotland Agricultural College—The Secretary, Blythswood Square, Glasgow (Sept. 27). A principal of the Municipal Technical College, Bath—The Director of Education, Education Office, Sawclose, Bath (Oct. 7). A principal of the L.C.C. South-East London Technical Institute, Lewisham High Road—The Education Officer (T.1), County Hall, Westminster Bridge, S.E.1 (Oct. 11). An assistant in the Cancer Research Laboratories, Bristol Royal Infirmary—The Secretary, Royal Infirmary, Bristol. A Dr. Robert Pollok lecturer in materia medica and therapeutics in the University of Glasgow —The Secretary, University Court, The University, Glasgow. A research assistant, with degree in engineering, under the Research Association of British Motor and Allied Manufacturers—The Technical Secretary, Research Association of British Motor and Allied Manufacturers, 5 Bolton Road, Chiswick, W.4.

Our Astronomical Column.

Eros.—*Circ.* No. 296 of the U.A.I. announces that the first observations of the present very important apparition of this planet were obtained at Neubabelsberg by Dr. G. Struve, as follows :

1930.	U.T.	R.A. 1930·0.	N.Decl. 1930·0.	Mag.
Aug. 26d	0h 55m 30·7s	3h 33m 4·13s	34° 25′ 44·6″	11·8
27	23 44 18·6	3 38 22·47	35 0 35·6	

It was very close to the position indicated by a manuscript ephemeris prepared by Prof. G. Witt, who discovered the planet in 1898. Prof. Witt published an approximate ephemeris for the present apparition in *Mon. Not. Roy. Ast. Soc.*, vol. 85, No. 9. He gives a more precise one for October 1930 in *Astr. Nach.* No. 5729. The perturbations were computed partly by himself, partly by E. Noteboom ; he notes that the 1928 observations show a puzzling discordance of some 3·5 sec. in R.A. Further search for its cause is postponed until after the present apparition. The distance of Eros from the earth is now just under a unit. It will be only one-sixth of a unit at the end of January. The magnitude will then be 7 ; it will be 9·6 on Nov. 1.

Rotations of the Stars.—A recent bulletin issued by Science Service, Washington, D.C., describes some investigations on this subject by Mr. C. T. Elvey at Yerkes Observatory. Provided that the axis of the star is not directed towards us, its rotation causes different portions of the star's surface to have different radial velocities. This produces a widening in the spectral lines. Mr. Elvey selected for examination the magnesium line at 4481, since it is normally sharp and narrow, so that its widening may be mainly ascribed to rotation. The contour of the line is studied by a microphotometer, which exhibits on a large scale the degree of opacity of each portion of the negative. If the whole of the widening of the line is correctly attributed to rotation, the majority of the stars studied are rotating much more rapidly than the sun. The mean rotational speed found for fifty-nine stars is 60 km./sec., about thirty times that of the sun ; if a correction were introduced for limb-darkening, the value for the stars would be still greater. Drs. Shajn and Struve deduce that the variable star W Ursæ Majoris has a diameter of 650,000 miles, and rotates in one-third of a day. This, if correct, would produce great ellipticity of form.

Planets and the Sunspot Cycle.—There have been many attempts in recent years to find an explanation of the variations in solar activity by planetary action. The latest is by Mr. Luby in *Astr. Jour.* No. 943. He notes that several investigators have made out a good case for the influence of Mercury, Venus, and the earth on individual spots, but that, to explain the principal cycle we must look rather to the giant planets ; the tidal action of Jupiter is twenty-three times as great as that of Saturn, which in its turn bears a still higher ratio to those of Uranus and Neptune. It seems, however, that the length of time through which they act in the same direction raises the action of these last-named planets to an appreciable amount. Mr. Luby contends that the true sunspot period is 11·86 years, agreeing with Jupiter's period of revolution ; but that it is subject to disturbance by the three other giant planets, so that it needs a long series of observations to deduce the correct value ; he says that Wolf gave too much weight to the rough observations of the eighteenth century, which were made before the sunspot cycle was recognised. It is well to point out, however, that confirmation of the 11·2-year period has been obtained from ancient Chinese observations of sunspots, also by study of the annual rings in old trees ; Mr. Luby's period should therefore be received with some caution. As a check on his theory he notes that the present cycle should be an abnormally long one, lasting until 1936. He further suggests that the variation of solar rotation with latitude may also be due to planetary action, comparing the similar behaviour of Jupiter and Saturn.

Mention may also be made of Prof. Dinsmore Alter's work, on the lines laid down by Prof. E. W. Brown, of which a description was given in the *Journal* of the British Astronomical Association for last January. This ascribes the principal term in spot-variation to the combined action of Jupiter and Saturn, but recognises the action of the inner planets in producing variations of shorter period.

Research Items.

Sumerian Copper.—Further analyses of samples of prehistoric and early copper have been made on behalf of the British Association's Committee on Sumerian copper, the report of which was presented at the Association's meeting at Bristol. The number of specimens containing nickel is again to be noted, though no further light is yet thrown upon the sources of Sumerian copper. Specimens from Mohenjo-Daro numbering sixty-four were examined. Most were of copper, showing no traces of nickel, but twenty contained appreciable quantities, the highest being 1·49 per cent and the usual 0·3 per cent, this proportion being similar to that found in specimens from Mesopotamia. Nine specimens were of bronze, the tin ranging from 5·6 to 19·1 per cent. The specimens from the 1927 excavations were richer in nickel than those found in 1926. Specimens from the grave of Queen Shub-ad at Ur contained 0·51 per cent of nickel, while six bronzes from Kish (1928) showed 0·006 to 0·21 per cent with tin from 5 to 15 per cent. Mr. Woolley provided specimens from last year's excavations at Ur of First Dynasty date which showed nickel ranging from 0·165 to 0·46 per cent, while of five further samples from the British Museum two only showed nickel in appreciable quantities—0·84 and 1·61 per cent. The spearhead from the stratum immediately above the flood level, held to be the earliest metal object so far found, proved to be of copper with no more than traces of foreign material. Twenty specimens from Makran furnished by Sir Aurel Stein, in which tin ranged from 0 to 27 per cent, contained no nickel or only traces, except in one specimen, which contained no less than 1·27 per cent. In view of the suggested connexion between South African and Sumerian copper, a number of specimens from South Africa were examined but yielded no support to this theory, and an examination of Chinese bronzes ranging in date from the Chow to the T'ang period also demonstrated that their material appeared to be derived from entirely different sources from that of Sumeria.

Ancestor Cult in Ancient Egypt.—Mr. G. D. Hornblower, in *Ancient Egypt* for 1930, pt. 1, has a further note on ancestor worship in ancient Egypt. In his previous communication Sir Flinders Petrie's identification of the *ka* as an ancestor's spirit was confirmed and amplified. When Egyptian civilisation developed, the ancestor cult took on a form which obscured the essential principle. The cult originated in fear of the dead generally, who if neglected led a miserable existence, for which they might exact vengeance from the living. From this it was only a step to the loving care of the family for the spirits of the forefathers. In Egypt it was the sons, and especially the eldest son, who were responsible for carrying out the periodical funerary rites; and offspring were greatly desired to ensure the continuance of the funerary offices. The connexion was very close, and a son on receiving an injury would call on one or both of his parents for help. A dead husband or dead wife was addressed in the same way. Ancestor cult eventually culminated in the king, as the son of the strongest and greatest of the ancestors and the source of fertility. The king himself became a god. Thus, when in the sixth Dynasty the king assumed the title "Son of the Sun," it was with the political object of extending to the new sun worship the popularity of the earlier cult of the great ancestor Osiris, while by a compromise it was conceived that the king had two fathers, the sun and Osiris.

African Fresh-water Fishes.—Mr. Henry W. Fowler ("The Fresh-water Fishes obtained by the Gray African Expedition 1929." With Notes on Other Species in the Academy of Natural Sciences of Philadelphia. Vol. 82, 1930), in continuation of his studies of fishes from the Academy collections, describes a very interesting series obtained by Mr. Prentiss N. Gray on his recent expedition to equatorial Africa. Mr. Gray was accompanied on the expedition by Mr. W. W. Bowen representing the Academy as field collector, and valuable fishes were secured of twenty-five species, twelve of which are new to science. These belong to the Characidæ, Cyprinidæ, Clariidæ, Pœciliidæ, Anabantidæ, and Cichlidæ. There are detailed descriptions and good text figures, in many cases showing striking variations in marking. Besides Gray's fishes, other African fresh-water fishes from the Academy Collection are also described, including those from Lake Rudolph, collected by Dr. A. Donaldson Smith, and from Angola and Chilosngo, chiefly in the Quanza basin, purchased from Dr. W. J. Ansorge. Amongst these are two species of Polypterus, *P. bichei* and *P. senegallus*, in both of which variation of the head scales is shown.

Diurnal Migration of Plankton in Japanese Lakes.—Dr. Kenzo Kikuchi in his paper "A Comparison of the Diurnal Migration of Plankton in Eight Japanese Lakes" (*Memoirs of the College of Science*, Kyoto Imperial University, Series B, Vol. 5, No. 1, Article 3, 1930) records the results of his investigations in six freshwater lakes, one brackish and one of sea-water, the last closely connected with the Japan Sea by means of a small canal. With very few exceptions there is a distinct diurnal migration on the part of the plankton, and this is of several types, but the type is not constant for the species in all the lakes, the vertical distribution of the plankton in the daytime being presumably affected by the turbidity of the water. In a few cases temperature seems to determine the upper limit of both the diurnal vertical distribution and the nocturnal ascent. The upward movement of Crustacea takes place when the intensity of sunlight is changed. It is found that the younger forms of *Diaptomus pacificus* and *D. japonicus* are distributed nearer the surface than the old animals in the daytime and also they appear on the surface earlier in the evening, whilst the reverse is true in the order of leaving the surface in the morning. The nauplii of *Diaptomus* and *Bosminopsis* in Lake Kizaki have three maxima on the surface, in the evening when the sun sinks, after sunset, and at dawn. Other species have two maxima or one only. *Sagitta* and certain Crustacea are most abundant near the surface a few hours after sunset. Tables are given of the physical features of the lakes, the temperature, oxygen content, and hydrogen ion concentration, and in two cases the chlorine and hydrogen sulphide, taken on the same day as the plankton catches, also of the diurnal changes in the number of individuals and vertical distribution in the various planktonic species in the different lakes.

Origin of Nepheline-Syenite.—The nepheline-syenite gneisses and associated rocks of Dungannan Township, Ontario, are shown by F. F. Osborne to have had a complex origin; in part due to consolidation of magmas; in part to *lit-par-lit* injection; and in part to metasomatism (*Am. Jour. Sci.*, July, 1930). The sequence of differentiation in the granite and nepheline-syenite pegmatite dykes shows a remarkable parallelism. The evidence suggests that the parent magma of the nepheline-bearing rocks did not have the high content of volatile materials that has been claimed by some petrologists as a necessary factor in the genesis of such rocks. It is suggested that during the

formation of schists there is an elimination of the constituents that do not form foliated minerals, and that some of these constituents are those in which nepheline-syenite is rich. If they could reach a magma, they would necessarily modify its composition in the required direction. A similar suggestion for the origin of the spilitic suite of albite-rich rocks has been offered by Holmes (*Geol. Mag.*, p. 277, 1927). Both are supported by the work of Cooke on the constituents eliminated during thermodynamic metamorphism (*Museum Bull.* 46, Geol. Surv. Canada, p. 22, 1927).

The Disappearance of the Huronian.—Under this title T. T. Quirke and W. H. Collins describe the results of an investigation to ascertain what became of the Huronian formations of the Pre-Cambrian of Canada east of the line north-eastward from Killarney (Georgian Bay, Lake Huron) against which they seem to end (*Mem.* 160, Geol. Surv. Canada, 1930). They find that vestiges of the Huronian, highly metamorphosed and merging into gneisses of igneous aspect, do occur east of the line. The gneisses graduate in turn into massive granite from which it is not practicable to separate them. The authors suggest that the granite is mainly derived from parts of the transformed Huronian sediments which became liquid, while the gneisses were produced without reaching the fluid state. Structural considerations indicate that some of the belts north-west of the line were once buried about six miles and that the country to the south-east represents a still deeper section of the earth's crust, probably one of the deepest to be seen anywhere on the earth's surface. The gneisses and granites are called Killarnean. Sills and dykes of probably Keweenawan diabase (quartz-dolerite) preceded the intrusion of the Killarnean batholiths, and scattered dykes of fresh olivine-diabase followed. These facts show that the problems of the correlation and succession of the Canadian Pre-Cambrian are still very far from being solved.

Carthaginian Lenses.—The July issue of the *British Journal of Physiological Optics* contains a communication from Mr. H. L. Taylor on "The Origin and Development of Lenses in Ancient Times", which ascribes the development of the lens to the Cretans of 1800 B.C. His examination of the contents of museums of the eastern Mediterranean has led him to the conclusion that ivory and steatite, the materials used for beads prior to 2000 B.C., were replaced at a later period by rock crystal, onyx, agate, and cornelian. The discovery of the magnification produced by a bead of rock crystal led to the production of lens-shaped beads, and eventually of lenses such as those of the "royal gaming board" found in the palace at Cnossus and to the perfect lenses, found also at Cnossus and at Mount Ida, now in the museum at Candia. They are all plano-convex with powers between 5 and 8 diopters. The Phœnicians appear to have carried such lenses to the mainland, to Troy, Tyre, Nineveh, and Britain. At Carthage five glass lenses have been unearthed at the ancient necropolis, two of them, of power 5·5 diopters, in the sarcophagus of a prominent individual, who it is presumed suffered from presbyopia and wished to protect himself against this disability in his next existence.

Iridescent Colours.—In a paper in the August issue of the *Proceedings of the Royal Society*, Lord Rayleigh, after describing in some detail his experiments on the origin of the iridescent colours of birds and insects (see NATURE, vol. 125, pp. 211 and 474), discusses the action of light and of chlorine on these. The phenomena are complex, and perhaps the only generalisation that can be made is that stability of a colour under the chemical action of chlorine is a proof that no pigment is involved. The colours of the moth *Urania ripheus*, of the *Morpho* butterflies, and of metallic beetles survive such treatment, and there is much in favour of regarding these as interference colours. In other instances, such as that of the peacock's feather, where there is definite evidence that the colour is a structure effect but it is nevertheless affected by light, the conclusion reached is that the action of the latter probably consists in a photochemical destruction of the materials going to build up the structure. In another case, faded and unfaded parts of a *Morpho* wing were exposed to ultra-violet light, and it was found that the latter fluoresced, whereas the former did not; it seems likely that what had been destroyed in fading was some fluorescent body, itself colourless, which was built up into the colour-producing structure. A number of the properties of the peacock feather still remain to be explained.

Polar Properties of Ice Crystals.—In spite of its importance, there is still little general agreement on the crystallography of ice, largely because of the difficulty experienced in producing authentic single crystals. Prof. J. M. Adams, in some work described in the *Proceedings of the Royal Society* for August on crystals of microscopic dimensions, has obtained evidence that they are polar. When these were observed in an atmosphere favourable to their disintegration, individuals were occasionally found which, although possessing the simple external form of a short right hexagonal prism terminated by basal planes, nevertheless developed a pit at one end only of a certain axis (the *C* axis). In addition, two other types of disintegration were found with crystals of the same external form, one characterised by a pit at each end of this axis, and the other by a cavity at the middle, these being explicable as due to the two possible modes of twinning on the basal plane. Prof. Adams points out that there is further evidence for polarity in the form of certain rod-like snowflakes which appear to be pointed only at one end, whilst others, terminated at both ends by basal planes, look as if they have grown by the union of two of the former, point to point, and ascribes the polarity tentatively to an asymmetric location of hydrogen ions in a non-polar oxygen lattice.

Wave-Length of Hydrogen Atoms.—Although the wave-properties of electrons are now so well established that a 'camera' has been described for the application of electron diffraction to the investigation of structure (Prof. G. P. Thomson, August issue of the *Proceedings of the Royal Society*), very few experiments have been performed which show the undulatory nature of atoms or ions. The fact that the proton and electron of a moving hydrogen atom are together equivalent to a wave is, however, demonstrated by an investigation of the reflection of atomic hydrogen by lithium fluoride, described by T. H. Johnson in the issue of the *Journal of the Franklin Institute* for August. The hydrogen atoms were generated in a discharge tube, and after passing through a collimating system, were reflected from the crystal on to a target coated with white molybdenum oxide (MoO_3). This is reduced to a blue lower oxide where the atoms are incident, and so gives a permanent record which can be examined visually or photographed. So far only first order diffraction patterns have been obtained, with rather poor definition, but the wave-length of the atoms calculated from these is in accord with theory. Lithium fluoride is of special value for this work because it appears to retain any hydrogen atoms

which are not immediately reflected for a sufficient length of time for them to recombine to molecules, which do not then affect the target.

Alkali Photoelectric Cells.—The second July number of the *Physical Review* contains a paper by A. R. Olpin, of the Bell Telephone Laboratories, on the properties of photoelectric cells in which the alkali cathode has been coated with a film of a simple dielectric or an organic dye. Most of the substances studied have been found to increase considerably the sensitiveness of the cell to red and infra-red light, their action being accompanied by the appearance of a new maximum in the spectral response curve for the composite surface, to the long wave-length side of the single important maximum in the curve for an untreated surface. The frequency difference between the maxima is often about the same as that of the 1·5 μ infra-red vibration of the oxygen–hydrogen, carbon–hydrogen, and nitrogen–hydrogen linkages, and it is suggested that there is a real connexion between this vibration-rotation frequency of the molecules and the changes in the properties of the surfaces. One important fact which emerges incidentally from this investigation is that many of the substances used to sensitise photographic plates also increase the electron current of a photoelectric cell, and, at least in some instances, affect primarily the same spectral regions. Einstein's equation for the maximum energy of emission of photoelectrons has been found to be valid for composite surfaces exposed to near infra-red radiation.

Transmission of Short-Wave Beams.—If the wave-length of a radio beam is less than about ten metres, experiments have shown that it will act in a very similar way to a light beam. These beams follow the inverse square law and obey the ordinary laws of refraction. In addition, obstacles of every kind appear to produce shadows. In a paper in the *Wireless World* for July 23, Dr. F. Noack describes experiments on the transmission and reception of these beams recently carried out in Germany. Messrs. C. Lorenz, of Berlin, in conjunction with Prof. Esau, of the University of Jena, have made experiments with a transmitter placed on the peak of the Brocken, in the Harz Mountains, at a height of 1140 metres. It was found that reception was best north-east of the Brocken, where the country is more or less flat and from whence the peak can always be seen. According to theory, the range would be about 110 kilometres, the distance of the visible horizon. At first the transmitter was erected at ground level on the Brocken, and it was found that the range varied between 76 to 100 metres. It was noticed that all over the range the signal strength was practically constant. Beyond this range it decreased with extraordinary rapidity, the width of the region over which this rapid decline took place being about 10 kilometres. It seems probable that in this region reception is no longer carried out by the aid of direct radiation, but is due to indirect refracted rays. It seems highly probable that the range of reception depends mainly on the distance of the horizon from the transmitter. Further experiments at a height of 500 metres, the transmitter being placed on a tower 16 metres high so as to cut out possible 'earth' effects, confirm this conclusion.

Indium.—The element indium, although widely distributed, occurs only in very small quantities and it is usually recovered from zinc blendes and flue dusts. In the *Chemical News* for July 18, Dr. G. Druce describes the preparation of indium sulphide from the black residue left after generating hydrogen sulphide from commercial ferrous sulphide and sulphuric acid. About half a gram of the element was obtained from about 150 lb. of the commercial iron sulphide.

The Geber Problem.—The question of the authorship of the Latin treatises ascribed to Geber and their relation to the Arabic chemical works of Jabir ibn Hayyan has been somewhat complicated by a discussion as to the authenticity of the latter. In a note in *Forschungen und Fortschritte*, July 10, Prof. Ruska announces the results of an investigation of some hitherto unknown writings of Jabir published by Dr. Holmyard in 1928. He concludes that the whole system of Jabir's writings are of Ismaelite origin.

Ignition of Carbon Monoxide.—A criticism of the work of Smithells, Whitaker, and Holmes on the above subject, reference to which was made in NATURE of April 5, p. 545, has been published by Bradford and Finch in the July number of the *Journal of the Chemical Society*. The authors describe experiments which lead them to consider that the experiments of Smithells, Whitaker, and Holmes were vitiated by the circumstance that the dielectric strength of the mixtures of carbonic oxide detonating gas with water vapour and with hydrogen were different. The conclusion of the previous experimenters, that hydrogen is more effective than water vapour in conferring ignitibility, is considered to be valid.

Adsorption by Silica Gel.—In the July number of the *Journal of the Chemical Society*, D. C. Jones and L. Outridge describe experiments on the adsorption by silica gel in the system *n*-butyl alcohol and benzene. Measurements on the adsorption both from the liquid and vapour phases were made, and the difference between the true adsorption as defined by Williams and that given by the equation of Ostwald and Izaguirre is attributed to capillary adsorption. The concentration of the solution thus adsorbed is shown to be equal to that of the equilibrium solution, in agreement with theory. Success in the measurements was possible owing to the use of a new method of analysis devised by D. C. Jones, which could be used with both very dilute and very concentrated solutions. The main theoretical point of interest of the paper is probably the use of the assumption that a certain amount of internal gel solution, varying considerably with the equilibrium concentration, is adsorbed not by the solid but owing to the liquid capillary forces, and in experiments where the adsorbent is immersed in the solution, or where the adsorption is from saturated mixed vapours, this portion will have the same concentration as the equilibrium solution.

Complex Soil Colloid.—Most of the information at present available concerning the colloidal complexes existing in the soil has been derived from consideration of the analogies in behaviour which such complexes exhibit when compared with similar complexes prepared by synthetic methods. In the *Rendiconti* of the *Reale Istituto Lombardo* for the present year (Parts 2-5), Dr. C. Antoniani describes a soil colloid containing 93 per cent of organic matter which he has succeeded in separating directly from soil. This substance maintains a constant composition, even after dialysis, and is regarded as homogeneous. In an acid medium it coagulates when the *p*H value is equal to or less than 6, whilst peptonisation occurs for values below 8; the isoelectric zone is included between these limits. The complex is composed of three distinct individual colloids of humic, silicic, and ferric character, the last being electropositive and protected. The protective influence is exerted by both the electronegative constituents, but mainly by the humic colloid.

Soils and Fertilisers in South Africa.*

By Sir FREDERICK KEEBLE, C.B.E., F.R.S.

THE problems of South African agriculture which await solution fall into two groups—those of arable and those of grassland. Of the two, the problems of grassland are potentially of greater importance.

GRASSLAND.

The grasslands of South Africa are poor and barren. Over vast areas the scant herbage serves scarcely to cover the ground even during the growing season. It turns brown and grows yet scarcer during the dry season. There are green hills in Natal and green pastures, and even in regions of low rainfall after summer showers the brown herbage grows green again. There are large areas of grassland in which the spring herbage is luxuriant and nutritious, but as spring advances the feeding value of the grass declines and cattle have often to submit and succumb to conditions of starvation.

It seems to be universally assumed that this state of affairs is due to lack of water and that it can best be remedied by introducing from other countries grasses of greater powers of resistance to drought. Much work of great interest along these lines, both on irrigated and non-irrigated land, has been done in South Africa, particularly by Dr. Pole-Evans at Pretoria. He has shown that it is possible to establish many grasses from other parts of the world and to obtain large amounts of food for stock from them. But the suggestion which has now to be made casts doubt upon this method as being the most important means of rejuvenating the pastures of South Africa. This suggestion is that many of the troubles attributed to drought are more properly to be ascribed to mineral deficiency. The hunger of the soil for phosphates is only one symptom, albeit a most important symptom, of these deficiencies. The land, or much of it, also lacks lime, and although the lack is well known, little is being done to remedy it. Yet lack of lime may prove to be a limiting factor of yield on both arable and grassland. Many officials maintain that the addition of lime depresses yield, and fail to consider that this in itself may be a passing symptom of a deep-seated trouble and want. It is encouraging therefore to report that both in Natal (Cedara) and in Rhodesia (Salisbury) experiments are now being carried out which point to benefits from liming.

With an insufficiency of lime and phosphates in the soils the herbage must perforce be deficient in these essential materials; the yellow or pale green colour of the grass betokens that it lacks nitrogen; and it is certain that there are also deficiencies in potash. What other deficiencies there are of other more obscure elements which may prove to be important only further research will show.

It is suggested that all these deficiencies have been brought about by simple cosmic processes.

South Africa is the stem of a funnel, the mouth of which is the equator. Of all that teeming life bred in the warmth and moisture of the tropics there must from time to time, as bees swarm, have migrated hordes of all kinds of animals. Debarred by the desert from invading the north, these migrant hordes have gone ever southward. Sometimes the grasslands which these migrants invaded were lush with spring grass and sufficed to feed the beasts; but at other times when the sun was fierce in summer and the growth of grass stood still, there was lack of herbage. Thus pushed by hunger the herbivora grazed the pasture bare to the bone. The grass over-grazed became worn and thin. Like a garment too much used, the herbage became rent, and through the rents rains, often of torrential violence, pierced and swept away the soil, aggravating the effects of over-grazing. So the vicious circle was completed and remains complete to the constant impoverishment of South African soils.

Any traveller in the Union may see the rivers leap to life in the rains which attack the earth, carve it out and bear it away, and run red with the soil washed from the land. He may likewise see in the veldt-burning practised by farmers yet another aid to soil impoverishment: for though burning brings young and sweet and early grass, the partial sterilisation of the soil which it produces releases the little store of hardly won organic nitrogen which is absorbed greedily by the young grass in the flush of its spring growth. The soil is soon depleted, so that long before drought imposes its veto, growth wanes and the veldt becomes brown and bare and barren. Flocks and herds are decimated, and the patient farmer praying for rain fails to realise that he himself offered them as a burnt-offering to the god of ignorance.

Under these conditions of over-grazing and erosion an age-long struggle for existence must have waged among the plants of South African grassland, and the struggle must have been of ever-increasing intensity as the soil became more and more depleted of its mineral contents and its nitrogen compounds. In this struggle those grassland plants with larger requirements of minerals and of nitrogen were the first to succumb. They ceased to be members of the grassland community but, retiring from the unequal struggle, continue to survive here and there in those favoured mineral oases wherein their larger mode of life finds satisfaction. The struggle is still going on, and now only the most niggardly of the plants, mean in what they get and what they give, survive. Except for a brief period in the flush of spring they yield but little sustenance to the animals which graze upon them.

If this picture of the evolution of the grassland of South Africa be true, conclusions of fundamental importance follow. The first of these conclusions is that the restoration of South African pastures is possible. The second conclusion is that the way of improvement lies in the restoration to the soil of conditions under which plants of larger requirements and higher nutritive value may live. The third conclusion is that the picture of the decadence of grassland in South Africa, although more vivid, is none the less identical with the, albeit more drab, picture presented by the world as a whole. The factor which has determined the trend of evolution in this as well as in earlier geological epochs is the decreasing supply of minerals stored in the grasslands and arable fields of the world.

Deficiency of nutritiveness of the plants of arable crops means deficiency of nutrition in man and beast, which in turn means disease, and it may be that the wealth of animal diseases which Africa possesses is but another symptom of the gradually lowered vitality of living things due to gradual decrease in the supply of essential minerals.

If this be true, then in grassland management with its insistence on the restoration of minerals there are means of arresting the downward trend of evolution, or at least of slowing down the rate at which nitrogen

* From a paper read before Section M (Agriculture) of the British Association at Bristol on Sept. 5.

and phosphorus escape, the one into space, the other into the abysms of the ocean.

Whether these large conjectures prove true or no, the first two conclusions require brief consideration. If it be true that a restoration of minerals to the soil brings about a return of plants of good grazing value, we shall have a most important vindication of intensive grassland management. For the general principle underlying the intensive management of grassland is that conditions may be provided wherein more nutritive native and introduced plants will flourish. That it will prove possible to transform the grassland of South Africa is rendered probable by the remarkable results which Mr. T. D. Hall's small scale experiments on grassland in different parts of South Africa have already achieved.

These experiments show :

(1) That grassland in South Africa responds in an almost magical way to nitrogen.

(2) That the relation between nitrogen and phosphates which obtains in grassland is the reciprocal of that which obtains on arable land. Though a dressing of phosphates adds but little growth to that produced by a single dressing of nitrogen, a dressing of phosphates added to a double dressing of nitrogen brings about a marked increase. The explanation would appear to be that the grassland plants surviving to-day are able to extract even from the impoverished soil just enough phosphates to live on ; but in that grassland there is not enough nitrogen to go round, and so growth languishes until additional nitrogen is supplied. Addition of more nitrogen produces little effect. Addition of more phosphates as well as more nitrogen gives rise to a further increase in growth.

(3) The treatment of grass with a complete fertiliser together with lime gives the largest response.

These experiments suggest the conclusion that a brilliant future awaits South African grassland. It is even safer to conclude from them that our knowledge of the proper fertiliser treatment of grassland is only just emerging from the empirical into the scientific stage, and that the investigation of the nitrogen-phosphate balance with potash in attendance will lead to the discovery that grass can be made far more productive than is at present supposed.

The opinion that grass will play an important part in the future of South African agriculture is reinforced when South African rainfall is considered. Much of South Africa is a land of summer rainfall. Grass is the opportunist among plants ; it grows during growing weather and dies down when conditions are unfavourable to growth. A drought may cut off an arable crop in its prime, but it can rarely do more than check the growth of grass. Experiments now being conducted in Natal, at the Cedara School of Agriculture, lend confirmation to the view that grassland in South Africa will respond to intensive management no less readily than the grassland in Great Britain. Mr. R. A. Fisher's experiments show that even a grass (*Paspalum* sp.) reputed by farmers to be of low grazing value, responds to fertilisers so remarkably as to produce enough food during the grazing season to enable one cow to yield 1000 gallons of milk.

One more suggestion may be made with respect to nitrogen on grassland. Owing to the intensity of the struggle for existence, grassland plants must always be hungry for nitrogen. Such nitrogen as grassland contains, and for which the plants have perforce to scramble, is derived from the breaking down of organic nitrogen compounds. The breaking down proceeds by orderly stages until compounds of ammonium are formed. The nitrifying bacteria then convert the ammonia first into nitrites and then into nitrates. It is usually believed that all plants of grassland, hungry as they are for nitrogen, wait passively until nitrate is formed before they attempt to supply their wants. It would seem more likely, however, that with capacities sharpened by the struggle, there would emerge from among some of the grasses the capacity to absorb nitrogen in the form of ammonia, or even in organic form, and such plants would be victorious in the struggle for existence. It may therefore be predicted that amongst grassland plants, some at all events may be found which possess the power of obtaining nitrogen in the form of ammonia, and it may prove that the grass family is distinguished from other plants by this capacity.

The dicotyledons, including the common weeds of pastures, can obtain nitrogen only in the form of nitrates, and to them ammonium compounds are poison. But the grass plants are able to utilise and thrive on the nitrogen obtained in the form of ammonia. Two facts support these suggestions. The first is that sulphate of ammonia and ammonium phosphates have a lethal effect upon the common weeds of grassland ; the second, that sulphate of ammonia is at least the equal of nitrate nitrogen in calling forth the growth of grassland in spring. This equality is difficult to explain if the common view be accepted that before ammonia can be utilised by the plants it must first be converted into nitrates.

The power of sulphate of ammonia to evoke early growth of grass would be self-evident were it to be proved that ammonium compounds are the proper nitrogenous food for grass, and, needless to say, such proof should be of great value. Of no less value should be the proof, if it can be obtained, that ammonium phosphate is the right fertiliser to use on a plant which responds markedly to a proper balance of nitrogenous and phosphatic fertilisers.

Arable Land.

The arable crops of South Africa are poor. The yield of maize in the Union is on the average three bags to the acre, that is, about one-third of a crop even when measured by American standards. Poor cultivation is in part responsible for low yields, far more so indeed than seems to be realised in South Africa. Other limiting factors are water and phosphatic deficiency, and it is a general obsession in South Africa that most of the agricultural troubles from which that country suffers are due to lack of water. Science should aid effectively in curing this obsession. It has already shown that in spite of low rainfall, crops can be produced if the deficiency of the soil in phosphates be made good. But even after applications of phosphates the crop remains small, and the expert attributes the low yield to insufficiency of water. In this he is partly, albeit only partly, right. When he adds nitrogen on the top of his phosphates the result is often disappointing, and he draws the conclusion that nitrogen, by encouraging the growth of leaf and stem and thereby increasing the loss of water from the plant by transpiration, does more harm than good by making the limited amount of water in the soil still more insufficient. For this reason the expert and the farmer avoid using nitrogen. Sometimes an additional reason is advanced ; namely, that nitrification goes on so quickly in South African soils that there will always be enough nitrogen available when the plant needs it.

The latter explanation may be considered briefly and dismissed. South African soils are desperately poor in organic matter. Organic matter is the sole source of supply of natural nitrogen. If the source

of supply of natural nitrogen is almost non-existent, to believe that nitrification can supply enough nitrogen to the plants is to believe in the making of bricks without straw; albeit that it is possible to hold, as has been suggested, that the plant residues in the soil supply just enough material to permit of an amount of nitrogen fixation sufficient, and no more than sufficient, to make good the annual loss through nitrification.

The extreme poverty of South African soils in humus and the essential part which organic matter plays in the feeding of crops are facts which those interested in the use of fertilisers must take into careful consideration. Observations in South Africa have led me to propound some ideas which may throw light upon the rôle which organic matter plays in the soil. Hitherto it has been believed that the chief virtue of organic matter, apart from its physical effect on the soil, lies in the nitrogen which it supplies. Experiments made in South Africa on irrigated land are claimed by their authors to show that, whereas the addition of inorganic nitrogen produced no increase in crops, the addition of even so small an amount as 1 ton per acre of Kraal manure brings about marked crop increase. It is difficult, although perhaps not impossible, to believe that a small quantity of nitrogen in organic form is more beneficial to plants than a larger quantity of inorganic nitrogen. It is more reasonable to seek the benefit of the Kraal manure in the carbon which it contains, and it may be conjectured that the chief chemical rôle of organic matter is to supply carbon for the soil bacteria, and particularly for those soil bacteria which are engaged in nitrogen fixation. This consideration suggests a line of research of practical importance. If carbon in organic form be proved to play such an important part in enhancing soil fertility, it may become necessary to use as a 'filler' in the manufacture of complete fertilisers some cheap waste product rich in organic carbon. There are expert growers, some of them among the best in the world, who act empirically as though they held this view and use always large amounts of organic matter together with artificials in order to produce large crops of fruit and vegetables.

Considerations of the bacterial changes in the soil lead to yet a further suggestion; the wattle growers in Natal have proved that phosphates give a much larger growth of the tree than is obtained without their use. Now in a fairly wide excursion throughout South Africa, one of the few signs of nitrogen plenty was shown in the green-black colour of the leaves of wattles treated with phosphates. The dark colour suggests that the wattles have received plenty of nitrogen. But the soil is poor in nitrogen. Therefore the trees must have obtained it from the nitrogen-fixing nodule organism which infects the roots.

Inquiry showed that on the roots of the phosphate-treated trees the nodules are far larger than on the roots of trees without added phosphates. Phosphates are known to encourage nitrogen-fixing bacteria, but it is now suggested that these latter organisms are no less intimately connected with phosphates than they are with nitrogen; in other words, that they not only bring nitrogen from the air into organic combination, but also that they do the like for the phosphates of the soil. If so, these nitrogen-fixing soil bacteria are the foundation-stones of soil fertility and their prevalence is determined first by the supply of organic carbon in the soil, and secondly by the supply of phosphates.

In support of this suggestion it may be mentioned that the nodule-forming nitrogen-fixing organism of clover is said to possess the power (denied to other grassland plants) of obtaining its phosphates from insoluble sources — a belief which could be easily verified. If it be true, it should be possible to balance, as a juggler does balls, the clovers and grass constituents of a pasture by supplying phosphates now in soluble now in insoluble form. If this possibility were achieved it would have great practical value. All these things considered, it may prove that although South African soils are at present poor, their defects can be gradually remedied by the systematic use of fertilisers containing nitrogen and all the essential mineral elements as well as carbon compounds in a suitable form.

Another and extraordinary fact lends confidence to this prediction. Trees of many kinds and in the different States of the Union—Natal, Orange Free State, and Transvaal—grow with far greater vigour than they do in Europe. This fervour of growth is attributed in South Africa to water. It cannot be: for water could at best make the trees grow only as fast as they grow in Europe and not faster. Therefore among contributing causes to the vigour of growth not the least must be larger supplies of minerals. Unlike surface-rooting plants, trees can dive deep in the soil and from the deepest layers recover the phosphates which have vanished from the surface.

Lastly, there remains to consider the second of the two alternatives already mentioned in explanation of current failure of nitrogen to give increased crop production on land treated with phosphatic fertilisers; this suggestion may be stated thus. The amount of phosphates given to crops is 200 lb. to the acre —an extremely light dressing. The soils of South Africa are desperately hungry for phosphates. There is no reason to suppose that 200 lb. per acre satisfies their needs, especially for such a phosphate-greedy crop as maize.

Lack of phosphates may still be limiting crop production, and if so the addition of nitrogen would certainly do more harm than good. A double dressing of phosphates is known to give further increase of crop yields, but there is no reason why even a double dressing should completely make good phosphatic deficiency. There is evidence that 800 lb. or 1000 lb. to the morgen goes on increasing yields; and it is therefore suggested that the fundamental experiment is one in which a phosphate-needing plant (for example, maize) is grown in a series of soils which receive from 200 lb. to 1200 lb., or more, per acre together with a uniform light dressing of inorganic nitrogen, in order to ascertain whether when phosphate deficiency is completely remedied, nitrogen does not begin to come into beneficent operation.

With that experiment should be made an inquiry into the morphological effect of phosphates, that is to say, the effect of phosphates on modifying the relative growth of the root system and the shoot system. Phosphates are known to encourage root growth. It is suggested that with progressive increases in phosphates root growth may be more and more increased with the corresponding discouragement of stem growth. That would mean that the plant becomes both a more and more efficient collector and a greater and greater economiser of water. For with increased root more water is absorbed, and with reduced leaf and stem loss of water from the plant is reduced. If this proves indeed to be the case, then a changed technique might vindicate nitrogen as a crop producer in the dry soils of South Africa. The change would consist in regulating the amount of nitrogen in relation to the phosphates and in applying it as a top-dressing after development has proceeded to a certain extent, and not as at present with the seed. Along with this series of experiments there should be another which would analyse more

completely than has yet been done the well-established fact that fertilisers increase water economy in the growing plants. It has been shown in India and elsewhere that when fertilisers are supplied to plants economy in the production of dry matter is increased. But at the same time the total amount of dry matter may be so increased as to make more demands upon the soil water-supply than are made by the plant which receives no fertilisers. One of the most important problems before scientific agriculture must therefore be a working out of the most water-economising ration of artificials to be supplied to different kinds of plants.

There are also experiments to be made in discovering varieties of maize and corn which will respond to fertilisers more effectively than those now grown, and there are also other genetical experiments which need to be carried out designed to discover races with male inflorescences which will continue to produce pollen over a long period, so that even if drought comes there may still be some pollen left after rain has restored growth to the plant.

There are other experiments of no less essential importance in relation to liming—a practice which is neglected in South Africa—and there are yet others: to seek in carbon fixation carried on in uncropped soils the origin of the amazing renewal of fertility which fallowed fields display.

This sketch of the scientific problems which await solution shows incidentally how closely the future of the industry of agriculture depends upon the advances of pure science, and suggests how important it is for that industry both to encourage the investigations and to take part in them.

I found South Africa in large part barren land; if the ideas with which it has inspired me are true, they may yet make it fertile. I myself believe that a great future lies before that country, for I think that on those high uplands so near the skies and so richly irradiated by the sun the plants and the animals derive greater sustenance from the irradiated foods than do the animals of lower altitude and lesser suns. I believe, moreover, that in that great mineral deficiency which has been described lies the original source of all those troubles which South Africa endures. It is, I believe, defective nutrition that has brought in its train the many maladies which afflict man and beast. If so, when the grass is restored to its full vigour animals will renew their youth and defeat the attacks of now victorious parasitic pests. On those parts of South Africa from which those parasites are banished the trees grow stronger than they do elsewhere, the men and women are sturdier, and even the flowers are more exuberant and more substantial than they are when we grow them under our sadder skies.

Anthropology—Old and New.*

WHEN we look back to the times in which Dr. Beddoe lived and worked and note the doings of the men who were searching into the beginnings of the British people, we see that we owe more to him than to any other anthropologist of the Victorian epoch. It was he who laid our present knowledge upon a sure basis. He set out in his youth to find an answer to an age-old query: Of what race or races are we British?

Dr. Beddoe was born in Galton's 'brain-belt', which, passing from Liverpool to Swansea, includes the English counties bordering on Wales. Bristol is indebted to this belt for many of her most distinguished citizens. It gave her Dr. James Cowles Prichard, who made England famous in the annals of anthropology in the first half of the nineteenth century. This belt coincides with an old ethnological frontier across which Saxon and Celt have freely exchanged their heritage of blood; and it was their place of birth which turned the minds of Prichard and Beddoe to the problems of race.

Beddoe while still living in his father's house at Bewdley listened to discussions concerning the Celts, especially as regards their colouring. No one, he discovered, had made a census of the colouring of the people called Celts or of any other race of mankind. He determined to investigate the colouring of the British races by exact methods. He entered into a virgin field of investigation, and it was necessary for him to invent methods of making records of colour of hair, eyes, and complexion. He began his investigations at the age of twenty, and visited Ireland, Wales, the Highlands of Scotland, the Orkneys and Shetlands, and France in the pursuit of his investigation. The Crimean war, in which he served as a medical man, and a subsequent period of study at Vienna gave him the opportunity of observation in the Baltic, the Near East, Croatia, Styria, and Italy. When he settled down to practise in Bristol in 1857 there was no one in Europe had his exact knowledge of the western peoples. There was not a single year between 1857 and 1891, when he retired to Bradford-on-Avon, that Dr. Beddoe did not carry out an anthropological raid of some kind—on the Continent, or in Ireland, Wales, Scotland, or England.

There was another side to Dr. Beddoe's inquiries. There were many in Dr. Beddoe's day who feared that industrialism would ultimately undermine the health and strength of the people of England; but he was one of the few to pass from speculation to actual inquiry. So he set himself to measure height, weight, size of head, colour of hair and eyes, not only of every stratum of the population of Bristol, but also of the open-living inhabitants of surrounding counties. From his results there emerged a suspicion that city life was shortening stature and favouring the lighter rather than the darker haired types.

Beddoe was the first to ascertain how city life affects racial types. He found that far from the type becoming uniform under the influence of city life, there was a tendency to segregation of types: the racial traits which prevailed among business men were not those which marked the artisan. In the selection of their mates, the men of Bristol preferred blondes to 'reds' and 'blacks'. Disease and conditions of industrial life, on the other hand, favoured those who had a dark complexion rather than those who were fair-skinned. Emigration was selective; it tended to rob Bristol of its best. Beddoe perceived that the effects produced by city life on the body and mind of man presented problems which could be solved only by patient and careful inquiry. It is this side of Beddoe's pioneer labours which needs to be stressed. We cannot be comfortable concerning our future until we know what is happening to us. A city population cannot stand still. The medical officer keeps his finger on the pulse of public health; there should be an anthropologist to keep his finger on the pulse of type—physical and mental. Beddoe's work on the population of Bristol should find its logical outcome in the institution of a chair of physical anthropology in the University of Bristol.

Dr. Beddoe devoted the spare time of his manhood to amassing data concerning the colouring and other physical traits of the peoples of western Europe—

* Abstract of the Beddoe Memorial Lecture delivered by Sir Arthur Keith, on Sept. 5, in connexion with the Bristol meeting of the British Association.

particularly of the communities of the British Isles. What was the net result of all this labour? The gain was two coloured anthropological maps—one of the British Isles, another of Europe. It may be felt that Dr. Beddoe's 'unequalled perseverance' had a meagre reward. That is not the case; these two maps are the most valuable contribution ever made to our knowledge of the history of the inhabitants of western Europe. Dr. Beddoe was born in a period when men believed that all that can be really known about the history of our ancestors was in the works of ancient writers. Dr. Beddoe was the first to show us that our racial history is written in our hair, eyes, skin, skulls, faces, and temperaments.

It is the business of anthropology to gather from every source facts which throw light on the origin and nature of nationalities and races. Dr. Beddoe performed this service for Britain in a way that no one has done before or since. How do we treat men who render our country such a signal service? In 1885 Dr. Beddoe published his greatest book, "The Races of Britain". Into this book he compressed thirty-two years of devoted labour. Yet no one proclaimed then what the book was—and what it still remains: the greatest treasury of anthropological fact which has ever appeared in any language. How can amends best be made? Orthodox honours came his way but were not commensurate with his deserts. In what way can we honour his memory better than by seeking for the means to establish in the University of Bristol a chair of anthropology? Beddoe was the great amateur in his chosen subject. With the present century anthropology reached the stage in which professionalism became imperative. In order that a professional anthropologist may live, a university must provide him with a chair. In return he gives a service of knowledge to the university and to the community in which that university is situated. Dr. Beddoe's teaching and example are not dead, and there awaits the occupant of a chair of anthropology in the University of Bristol an infinite number of problems which need solution.

From 1810, when Dr. Prichard began practice, until Dr. Beddoe's death in 1911, Bristol was known throughout the learned capitals of Europe as a centre for the study of the human races. In Bristol the time is ripe—more than ripe—for the institution of a faculty of anthropology. No university, no city, no locality can rival Bristol in the opportunities it offers for the scientific study of mankind. Above all, the institution of a chair of anthropology in its University is an act of justice due to the memory of a great citizen—the late Dr. John Beddoe.

University and Educational Intelligence.

THE Worshipful Company of Woolmen has awarded a silver medal to Mr. F. F. Darling, of the University of Edinburgh, whose thesis on "Studies in the Biology of the Fleece of the Scottish Mountain Blackface Breed of Sheep" is considered as likely to prove basic to all future studies on both this particular breed of sheep and on other breeds in general. The Company has also awarded a silver medal to Mr. N. H. Chamberlain, of the University of Leeds, for a thesis upon "The Thermal Conductivity of Textile Materials and Fabrics". Certificates of merit have been awarded to Miss Emma Stott, of the University of Leeds, for "A Contribution to the Theory of Milling: a New Method of Measuring the Scaliness of Fibres", and to Mr. N. Cryer, of the University of Leeds, for a thesis on "Variation in Spindle Speed".

THE London County Council has again arranged courses of lectures for teachers, and a Handbook has been issued which includes synopses of the courses (County Hall, London, S.E.1). Last year the entries for these courses exceeded 14,000. Any person engaged in teaching in London, Croydon, Kent, Middlesex, or Essex is eligible for admission at fees which average less than 1*s.* a lecture, while other teachers are admitted at fees 50 per cent higher. The lectures undoubtedly form an important part of the educational system in London, for they bring teachers into touch with new developments in educational methods, and give them opportunities of hearing leading authorities in various branches of learning. Readers of NATURE will be interested in the following courses: Five special single geographical and travel lectures, by Mr. A. Victor Murray, Mr. J. A. Steers, Major R. W. G. Hingston, Dr. T. F. Chipp, and Dr. L. Dudley Stamp; and the courses on types of geographical regions (Dr. J. F. Unstead); geography in senior schools (Mr. R. H. Ducé); history of geographical discovery (Prof. E. G. R. Taylor); mathematics in senior schools (Sir Percy Nunn); practical mathematics in senior schools (Mr. J. A. Phillips); psychology of the junior pupil (Prof. Cyril Burt); fundamentals of psychology (Dr. J. G. Vance); vocational guidance (staff of the National Institute of Industrial Psychology); science teaching in senior schools (Mr. G. H. Leslie); physics in senior schools (Prof. C. R. Darling); biology in senior schools (Miss C. von Wyss). The attention which is being given to the needs of teachers taking up the new post-primary work is noteworthy. It is stated that the loan collection of lantern slides at the County Hall now exceeds one hundred thousand.

HIGHER education in the United States forms the subject of a symposium published in vol. 69, No. 5, of the *Proceedings of the American Philosophical Society*. This comprises an address by Abraham Flexner and papers by Frank Aydelotte and F. J. E. Woodbridge. The first surveys the conditions, actual and probable, of the advancement of knowledge (*a*) by individuals working independently, (*b*) through academies and associations of specialists, (*c*) through research institutions devoted to specific ends, (*d*) through foundations that award stipends for research, and (*e*) through universities. Under the headings (*a*), (*b*), and (*c*) the conditions are pronounced to be propitious. As regards (*d*), Dr. Flexner emphasises the increasing difficulties in the way of proper selection of stipend holders. He devotes the latter part of his address to a trenchant criticism of the "heterogeneous conglomeration of useful and useless, of important and trivial activities, now carried on under this term—university", which he likens to a metropolitan drug store. For the moment the trend in universities is away from what seems to him sound, natural, and ideal and towards what is unsound, unnatural, and unideal. The other two papers deal only with college administration. Both recognise the existence of the evils deplored in Dr. Flexner's address and offer constructive suggestions for combating them, the former by means of a tutorial system for students who have demonstrated their capacity to profit by it. This system has been in operation for some years at Dr. Aydelotte's own college, Swarthmore, with the happiest results. Dr. Woodbridge develops a plausible argument for scrapping half of the ordinary college curriculum, simplifying and strengthening the remainder for the explicit purpose of pre-professional training for the professional schools, and utilising the financial saving thus effected for expanding the calibre of the staff.

Historic Natural Events.

Sept. 14, 1716. Thames Dry.—After an excessive drought, which continued from February to the end of August, a strong west-south-west wind prevented the tide from coming in for 24 hours, so that there was only a narrow channel some 10 yards wide, and so shallow that thousands of persons passed across on foot, under the arches of London Bridge.

Sept. 14, 1899. Floods in Austria.—Heavy rains fell on Sept. 8–14. At Mühlau the fall on Sept. 12 was 11·3 in. in 24 hours, and the total for the six days exceeded 24 in. The Danube rose to a level nearly 25 feet above the low-water stage at Vienna and nearly twice this amount in some other localities. The floods, which were exceeded only by those of 1501, did great damage.

Sept. 15–17, 1929. Thunderstorm near Channel Islands.—A remarkably severe thunderstorm raged almost without cessation over a small area near Dinard and the Channel Islands from 6 P.M. on Sept. 15 to 4 P.M. on Sept. 17, accompanied by violent winds from the north-east. There was considerable damage both by lightning and flood; the power station at St. Brieux was put out of action, and at Dinard an Englishman was blinded. A bridge on the main Dinard-St. Lunaire road was swept away and a motor-car crossing at the time was washed out to sea. St. Lunaire was flooded to a depth of two feet and the streets torn up.

Sept. 16, 1363. Beginning of Severe Winter.—According to various old chronicles, a "very terrible" frost continued from the middle of September into April. Holinshed, quoting "Walsingham and other old writers", says Dec. 7–Mar. 19. In Paris the frost began on Dec. 6 and lasted 14 weeks. The Rhine was frozen from Jan. 5 to Mar. 17, and waggons were driven over the ice. In France the winter was very snowy.

Sept. 17, 1882. Great Comet.—On this day, the great comet, visible to the naked eye in full daylight, was followed telescopically right up to the edge of the sun by Mr. Finlay (the discoverer of the comet on Sept. 7) at the Cape of Good Hope Observatory. Even the nucleus was quite invisible, however, as the comet crossed before the sun's disc. At Melbourne the comet was watched with the unaided eye to within 4° of the sun. By Sept. 24, it was visible with a tail 15° long in the bright dawn. Success in photographing this comet and its background of stars at the Cape Observatory under the direction of Sir David Gill was an important factor in the inception in 1887 of the Astrographic Chart and Catalogue. The period of the comet is 761 years.

Sept. 18–19, 1926. Florida Hurricane.—Early on Sept. 18 the south-eastern coast of Florida from Miami to Palm Beach was struck by an intense hurricane, which on the previous day had ravaged the Turks and Caicos Islands. The centre, moving towards the west-north-west, passed almost over Miami, where the official barometer fell to 936 mb. (27·65 in.). During its approach the wind reached hurricane force (75 miles per hour and upwards) for nine hours, and the greatest velocity is estimated as 130 miles per hour. Then, as the centre passed over, there was a lull and large numbers of people, not realising that a second phase was coming, ventured out, to be caught when the wind rose again to hurricane force in the rear of the centre. The strength of the wind is shown by the nature of the damage; an 18-story skyscraper recently completed was twisted so badly that it had to be demolished, and another tall building was bent over twenty degrees from the vertical. Yachts and small ships were lifted bodily on to the land. After passing Miami the hurricane curved away to the north-west, striking the Gulf Coast between Mobile and Pensacola on Sept. 20 and dissipating over eastern Texas on Sept. 22. In Florida 327 persons were killed and more than 6000 injured, and the damage to property probably exceeded 100,000,000 dollars, and was greater than in any previous hurricane in the United States.

Sept. 19, 1387. End of Hot Summer.—The summer in Europe was extraordinarily dry and hot and was proverbial for centuries as "The Old Hot Summer". From Feb. 28 to Sept. 19 it rained only six times in Switzerland, and men waded across the Rhine at Cologne. The year was not especially dry in England.

Sept. 19, 1540. Drought.—After a calamitous year, fine weather and heat lasted from February until Sept. 19, during which interval scarcely any rain fell in Europe.

Sept. 20, 1909. Storm Wave through Yucatan Channel.—A tropical hurricane of great intensity and large extent passed through this Channel on Sept. 17 and struck the coast of Louisiana a short distance west of New Orleans on Sept. 20. A great storm wave swept inland, and the water, checked by the swamp forests and levees, reached a depth of 7-10 ft. over a large area to the right of the centre, including New Orleans. The damage to property caused by this storm exceeded six million dollars and 353 lives were lost.

Sept. 20, 1929. Hurricane in West Indies.—This disturbance was first reported about 300 miles north of Porto Rico on Sept. 20; at that time it was of moderate intensity, but by Sept. 24 it had reached hurricane force. It was, however, chiefly noteworthy for its abnormally slow rate of movement and aberrant track. From Sept. 24 to Sept. 28 it actually moved in a south-westerly direction across the Bahamas and through Florida Strait near Miami. At Nassau, Bahamas, on Sept. 25 a violent westerly gale caused a 'hurricane wave' which destroyed the sea wall and flooded the town, carrying away many houses. Many others were unroofed, stores, churches, and shipping were damaged, and many lives were lost. In Florida the damage was much less, and the centre was evidently decreasing rapidly in intensity, but at Miami there were a number of waterspouts and at Key Largo the wind velocity during gusts was estimated as 150 miles per hour. From Miami the centre moved very slowly north-westwards to Panama City near Pensacola, where a few wharves and stores were destroyed on Sept. 30.

Societies and Academies.

PARIS.

Academy of Sciences, July 21.—**G. Bigourdan**: The astronomical stations of Châtillon-sous-Bagneux.—**L. Blaringhem**: The heredity of the phases of flower opening in poppies.—**F. Mesnil**: The adaptation to man of the trypanosomes pathogenic to mammals. The author considers that it has been experimentally demonstrated that a trypanosome of animal origin, such as *Tr. brucei*, can adapt itself to man.—**M. Aubert and R Duchêne**: The propagation of combustion in carburetted mixtures.—**G. Bruhat and J. Terrien**: The comparative absorption of active and racemic acids in aqueous solution. Between the wave-lengths 2653 A. and 2400 A., if racemic acid absorbs light differently from solutions of the active acids, the deviations are always less than 4 or 5 per cent in one direction or the other, and the average of

the results shows that the absorptions are practically identical. These results confirm those deduced by Darmois from polarimetric measurements.—**Daniel Chalonge**: The mechanism of the continuous emission of the hydrogen molecule.—**H. Ollivier**: The thermal variation of the specific magnetic rotatory power in the case of cerium nitrate and nickel chloride.—**F. Joliot**: The determination of the period of radium-*C′* by Jacobsen's method. Experiments with thorium-*C′*.—**Horia Hulubei**: The preparation of very pure hydrogen in notable quantities by means of an electrolytic osmoregulator with palladium. The palladium tube of an osmoregulator is saturated with hydrogen by electrolysis of phosphoric acid, the anode being arranged so that the palladium tube is not altered in shape. By afterwards heating this tube, relatively considerable quantities of hydrogen are introduced into the vacuous tube.—**Picon**: Rendering some salts of camphocarbonic acid soluble in organic solvents. Various camphocarbonates, rendered anhydrous by prolonged exposure in a good vacuum over phosphoric anhydride, were examined for their solubilities in organic solvents. Some of these (neodymium, cerium, bismuth, gold) are readily soluble in organic solvents, others (copper, calcium, zinc, lead) when anhydrous are practically insoluble. But boiling with benzene, with subsequent removal of all the benzene, renders these salts more or less soluble in organic solvents.—**Mlle. M. Montagne and B. Casteran**: The action of potassium hypobromite on some trisubstituted amides. The α-trisubstituted amides give good yields of iso-cyanates when submitted to the Hofmann reaction; subsequent treatment with hydrochloric acid gives the corresponding amines in quantitative yield.—**Jean Gubler**: The geological structure in central western Cambodia (Indo-China).—**A. Marin, M. Blumenthal, and P. Fallot**: Stratigraphical comparisons between the western extremity of the Betic and Penibetic zones of Andalusia and the north of the Riffian arc.—**Louis Besson**: The daily variation of rain at Paris. A discussion of twenty years of observations made at the Observatory of Montsouris. The mean daily variation has two maxima and two minima, and this is due to two different causes, the daily convection currents and the nocturnal cooling.—**M. and Mme. H. Labrouste**: The relation between certain periodical components of the solar activity and the daily amplitude of the magnetic declination.—**Couvreur**: Preliminary note on the structure of the shells of Gastropods.—**Alb. J. J. Vandevelde and Alfr. Verbelen**: New biochemical researches on earth. The dye absorption method gives very variable results with the same earth, even with the same dye; results using methylene blue were the most concordant, but further study is necessary. The adsorptions of dye, peptone, and centrifuged milk were compared. The three methods gave roughly comparable results.—**M. and Mme. A. Chauchard**: Researches on the relation between functional velocity and chronaxy.—**Raymond-Hamet**: The comparative physiological action of aspidospermine and quebrachine. In opposition to the usually accepted view, the alkaloids of *Aspidosperma Quebracho* must be classed in two different pharmacological groups. The experiments described show that the total alkaloids of this plant can act at once on the vagus nervous system and on the sympathetic nervous system. This suggests a new therapeutic application of these alkaloids.—**G. Belloc, R. Fabre, and H. Simonnet**: Contribution to the study of the biological activity of the sterols. Study of the plankton sterols. From two samples of plankton, taken at different periods of the year, the sterols were extracted and purified, care being taken to exclude the action of air and light so far as possible. These sterols were submitted to physical (absorption in the ultra-violet), chemical, and biological tests. One, collected in July, was biologically active; the other, collected in April, only acquired biological activity after irradiation. The biological activity of the plankton depends on several factors, the chief of which are light and the zoological nature.—**Mme. Y. Khouvine, E. Aubel, and L. Chevillard**: The activity of sodium fluoride towards the transformation of pyruvic acid into lactic acid.—**H. Colin and E. Guéguen**: The constitution of the sweet principle of *Rhodymenia palmata*. This is shown to be a monogalactoside of glycerol; the fresh alga may contain up to 5 per cent of this substance.—**M. Marcille**: The injection of formolated ether into the lymphatics of cancerous tumours. Injection of ether containing 0·5 per cent of formol is proposed, and one case in which it proved beneficial is described.

CAPE TOWN.

Royal Society of South Africa, June 18.—**H. H. Karny**: On the geographical distribution of the Indo-African and Mediterranean Gryllacoids. Seven subfamilies are considered, representing the forms occurring in the regions under consideration. In the case of the *Stenopelmatinæ* and *Anostostominæ* there is a discontinuous distribution. In the case of the other subfamilies, some forms are endemic in India, but all other forms occurring in India show relationships to those found farther east, where more species also occur.—**B. F. J. Schonland**: Thunderstorms and the penetrating radiation. An examination of the effect of thunderclouds upon the intensity of the penetrating radiation, using a new type of ionisation-electroscope, was made at Johannesburg, in the summer of 1929–1930. Overhead storms give rise to a reduction in intensity, amounting to so much as 40 per cent. No evidence could be obtained for the existence of beams of 'run-away' electrons below these clouds. The reduction effect indicates that the majority, if not all, of the ionising particles have energies less than 5×10^9 electron-volts.—**Enid Hogben**: Sex differences in serum calcium in different classes of vertebrates. In the rabbit, dogfish, and crawfish, the calcium content was higher in males than in females, but the difference was not statistically significant. In the fowl and toad, the calcium content was significantly higher in females. In the rabbit, fowl, and toad, magnesium determinations gave parallel results to those of calcium. In the crawfish the magnesium content of the serum was significantly higher in females. In the dogfish the magnesium content of the serum gave a wide range of values. This variability may be connected with the different stages of the reproductive cycle in the female.

MELBOURNE.

Royal Society of Victoria, July 10.—**T. Rayment**: New and remarkable bees. *Meroglossa miranda*, a West Australian species with maxillary palpi larger than the antennæ, was described. Also the first recorded female of *Neopasiphae mirabilis*, from the Best collection in the National Museum. Other descriptions include *Paracolletes maculata*, *Neoceratina rubinii*, *Trigona cockerelli*, and the allotypes of *Halictus demissus*. An emendation of *Melitribus* is given.—**C. J. Gabriel**: Catalogue of the land shells of Victoria. The records of previous authors are here brought up-to-date and a critical revision of the species made. Eight new species are described.—**W. J. Parr and A. C. Collins**: Notes on Australian and New Zealand Foraminifera. (1) The species of *Patellina* and *Patellinella*, with a description of a new genus, *Annulopatellina*. A trimorphic variety of *Patellina corrugata*

is recorded, resembling *P. advena* Cushman. A new species, *Patellinella annectens*, is described. The new genus, *Annulopatellina*, is founded on the genotype *A. annularis* (Parker and Jones).—**F. Chapman** and **Irene Crespin**: Rare foraminifera from deep borings in the Victorian Tertiaries. Six new species and a new variety are described.

Official Publications Received.

BRITISH.

Canada. Department of Mines: Mines Branch. Investigations in Ore Dressing and Metallurgy (Test and Research Laboratories), 1928. (No. 711.) Pp. ii+166. (Ottawa: F. A. Acland.)

The Central Library for Students (from March 1930 onwards, The National Central Library). 14th Annual Report of the Executive Committee, 1929-30. Pp. 50. (London.)

Transactions of the Royal Society of Edinburgh. Vol. 56, Part 3, No. 23: The Feeding Mechanism, Formation of the Tube, and Physiology of Digestion in *Sabella pavonina*. By Dr. E. A. T. Nicol. Pp. 537-598+2 plates. 8*s*. 6*d*. Vol. 56, Part 3, No. 25: Metamorphism in relation to Structure in the Scottish Highlands. By Dr. Gertrude Lilian Elles and Dr. Cecil Edgar Tilley. Pp. 621-642+2 plates. 4*s*. Vol. 56, Part 3, No. 26: Reports of the Jasper Park Lakes Investigations, 1925-26. The Molluscs of Jasper Park. By Alan Mozley. Pp. 647-669+2 plates. 3*s*. 6*d*. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Jamaica. Annual Report of the Department of Agriculture for the Year ended 31st December 1929. Pp. 36+4 plates. (Jamaica: Government Printing Office, Kingston.)

Report of British Delegates of the Meeting of the International Council for the Exploration of the Sea, held in Copenhagen, June 1930. Pp. 11. (London: Ministry of Agriculture and Fisheries.)

Madras Fisheries Department. Administration Report for the Year 1928-29. By Dr. B. Sundara Raj. (Report No. 1 of 1930, Madras Fisheries Bulletin, Vol. 24). Pp. vi+103+6 plates. (Madras: Government Press.) 1.4 rupees.

The Journal of the Institute of Electrical Engineers. Edited by P. F. Rowell. Vol. 68, No. 404, August. Pp. 945-1088+xxviii. (London: E. and F. N. Spon, Ltd.) 10*s*. 6*d*.

The Scientific Proceedings of the Royal Dublin Society. Vol. 19 (N.S.), No. 42: Report of the Irish Radium Committee for the Year 1929; including Reports by Dr. Oliver Chance, Andrew Charles, Oswald J. Murphy, Dr. Walter C. Stevenson, C. M. Taylor and Josephine Walsh. Pp. 475-489. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 1*s*.

Experimental Researches and Reports published by the Department of Glass Technology, the University, Sheffield. Vol. 12, 1929. Pp. iv+220+3 plates. (Sheffield.)

Proceedings of the Cambridge Philosophical Society. Vol. 26, Part 3, July. Pp. 285-428. (Cambridge: At the University Press.) 7*s*. 6*d*. net.

British Non-Ferrous Metals Research Association. Tenth Annual Report for the Year ending December 31st, 1929. Pp. 57. (Birmingham.)

Research Association of British Motor and Allied Manufacturers. Tenth Annual Report of the Council for the Year ending 31st March 1930. Pp. 7. (London.)

The Institute of Chemistry of Great Britain and Ireland. Register of Fellows, Associates and Students, corrected to 31st May 1930. Pp. 372. (London.)

The Quarterly Journal of the Geological Society. Vol. 86, Part 2, No. 342, July 31st. Pp. xlix-cxlvi+129-330+15 plates. (London: Longmans, Green and Co., Ltd.) 7*s*. 6*d*.

FOREIGN.

Report of the Aeronautical Research Institute, Tôkyô Imperial University. No. 62: Acoustical Properties of some Sound Collectors for the Aircraft Sound Locator. By Jûichi Obata and Yahei Yosida. Pp. 231-247+plates 25-27. (Tôkyô: Kcseikai Publishing Office.) 0.15 yen.

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 82. New Land Shells from the Solomon Islands. By E. G. Vanatta. Pp. 263-264+1 plate. (Philadelphia.)

The Cleveland Museum of Natural History. Annual Report for the Year 1929. Pp. 39. (Cleveland, Ohio.)

U.S. Department of Commerce: Bureau of Standards. Research Paper No. 191: The Geiger Tube Electron Counter. By L. F. Curtiss. Pp. 115-123. (Washington, D.C.: Government Printing Office.) 5 cents.

The Academy of Natural Sciences of Philadelphia. Special Publication No. 3: Gubb's California Cretaceous and Tertiary Type Lamellibranchs. By Ralph B. Stewart. Pp. 314+17 plates. (Philadelphia.) 3.50 dollars.

Smithsonian Miscellaneous Collections. Vol. 82, No. 8: Four New Raccoons from the Keys of Southern Florida. By E. W. Nelson. (Publication 3066.) Pp. ii+12+5 plates. (Washington, D.C.: Smithsonian Institution.)

Bulletin of the National Research Council. No. 76: Handbook of Scientific and Technical Societies and Institutions of the United States and Canada. Second edition. American Section compiled by Clarence J. West and Callie Hull; Canadian Section compiled by National Research Council, Canada. Pp. 352. (Washington, D.C.: National Academy of Sciences.) 3 dollars.

U.S. Department of Commerce: Bureau of Standards. Bureau of Standards Journal of Research. Vol. 5, No. 1, July, R.P. Nos. 183-193. Pp. 211. (Washington, D.C.: Government Printing Office.) 40 cents.

Field Museum of Natural History. Museum Technique Series, No. 3: Restoration of Ancient Bronzes and Cure of Malignant Patina. By Henry W. Nichols. Pp. 51+11 plates. (Chicago.)

Proceedings of the American Philosophical Society. Vol. 69, No. 4. Pp. 117-256. (Philadelphia.)

Smithsonian Institution: United States National Museum. Bulletin 152: The Cancroid Crabs of America of the Families Euryalidae, Portunidae, Atelecyclidae, Cancridae and Xanthidae. By Mary J. Rathbun. Pp. xvi+609+230 plates. 2 dollars. Bulletin 153: Birds collected by the Childs Frick Expedition to Ethiopia and Kenya Colony. By Herbert Friedmann. Pp. xiii+516+12 plates. 1 dollar. (Washington, D.C.: Government Printing Office.)

CATALOGUES.

Acriflavine "B.D." Brand, with references also to Euflavine and Proflavine. Pp. 26. (London: The British Drug Houses, Ltd.)

Laboratory Fittings, including "Technico" Standard Unit Type Benches. (List F, revised August 1930.) Pp. 48. Electrically Heated Laboratory Apparatus. (List No. 231F.) Pp. 24. Small Electric Furnaces for Laboratory and Works. (List No. 75G.) Pp. 20. (London: A. Gallenkamp and Co., Ltd.)

Diary of Societies.

TUESDAY, SEPTEMBER 23.

INSTITUTE OF MARINE ENGINEERS, at 6.—Lt.-Comdr. Sir August B. T. Cayzer, Bart. (Presidential Address).

MONDAY, OCTOBER 6.

IRON AND STEEL INSTITUTE (Additional Autumn Meeting) (at the Cleveland Technical Institute, Middlesbrough), at 7.30 P.M.

CONGRESSES.

SEPTEMBER 13 TO 20.

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (at Liverpool).

SEPTEMBER 15 TO 20.

IRON AND STEEL INSTITUTE (Autumn Meeting) (in Czechoslovakia).

Monday, Sept. 15, at 10 A.M.—A. Kříž: The Heterogeneity of an Ingot made by the Harmet Process.
J. Šárek: What Reasons Compelled the Prague Ironworks to Introduce Thin-Walled Blast-Furnaces.
W. H. Hatfield: Permanence of Dimensions under Stress at Elevated Temperatures.

Tuesday, Sept. 16, at 10 A.M.—O. Quadrat: A Contribution on the Problem of the Analysis of Basic Slags and the Representation of their Composition in a Triangular Diagram.
H. C. Wood: Open-Hearth Furnace Steelworks. A Comparison of British and Continental Installations and Practice.
D. F. Campbell: High-Frequency Steel Furnaces.
L. W. Schuster: The Effect of Contamination by Nitrogen on the Structure of Electric Welds.

SEPTEMBER 19 TO 22.

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX (at New College, Oxford).

Friday, Sept. 19, at 7.15 P.M.—Dr. H. T. Tizard: Presidential Address.
At 8.30 P.M.—Brig.-Gen. M. Mowat: The Year's Work of the Association.

Saturday, Sept. 20, at 9.45 A.M.—Col. Sir H. G. Lyons, Dr. F. A. Bather, and J. M. Walker: The Dissemination of Information by Exhibition and Display.
Capt. C. W. Hume: Animal Welfare, its Dependence on Accurate Information.
At 11.45 A.M.—Prof. A. F. C. Pollard and Dr. S. C. Bradford: The Inadequacy of the Alphabetical Subject Index.
At 5.30 P.M.—Annual General Meeting.
At 8.30 P.M.—D. A. Bremner: The World Power Conference.

Sunday, Sept. 21, at 9.45 A.M.—C. C. Fagg, G. L. Pepler, and S. K. Ruck: Surveys and Planning, their Relation to Organised Information.
G. F. O'Riordan and B. M. Headicar: The Technique of Information in the Training of Students.
At 11.45 A.M.—T. W. MacAlpine: Suggestions for the Improvement of Scientific Literature.
At 8.30 P.M.—A. Schlomann and Dr. Prinzhorn: The Organisation of Information in Germany.

SEPTEMBER 22 TO 24.

CERAMIC SOCIETY (Joint Meeting of the Refractory Materials Section and Building Materials Section) (at the Building Trades Exhibition, Olympia, London), at 2.30 P.M.

SEPTEMBER 22 TO 27.

INTERNATIONAL CONGRESS OF THE HISTORY OF MEDICINE (at Rome).—Subjects for Discussion: How Europe protected herself against Leprosy in the Middle Ages, introduced by Prof. Jeanselme; The Medical and Scientific Relations between Italy and other European Countries during the Scientific Renaissance in the Sixteenth and Seventeenth Centuries, introduced by Prof. K. Sudhoff and Prof. A. Castiglioni; The Necessity of Making the Study of the History of Medicine a Compulsory Subject in all Universities, introduced by Prof. L. Szumoski; also the following papers: The Problem of Medical Historiography, by Prof. Siegerist; van Helmont, by Prof. Ostachowski; Girolamo Cardano and Leonardo da Vinci, by Prof. Bilancioni; Plastic Surgery in Italy and Europe at the Time of the Renaissance, by Dr. G. Sansevero-Roselli; and The Influence of Folk-lore on Medicine, by Dr. D. Mackenzie.

SEPTEMBER 29 TO OCTOBER 1.

FARADAY SOCIETY (at the Laboratory of Physical Chemistry, Free School Lane, Cambridge).—General Discussion on Colloid Science Applied to Biology.