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The Development of Natural History Museums.

At the present time there are scores of natural history museums, national, municipal, and semi-private, scattered throughout the British Isles, all attempting to serve science by presenting to the people the crude material of scientific study and, less generally, the results of certain kinds of scientific research. Their condition causes uneasiness to the onlooker who realises how potent an instrument museums might be in instilling scientific knowledge and creating that staunch popular backing which is necessary to bring science to its own in the life of the nation.

The story of many, perhaps the majority, of provincial museums is the same. They begin in a burst of enthusiasm, the white heat wanes, the care of the collection falls upon a dwindling number of voluntary workers, there is no proper provision for upkeep, and the end is disrepair, mouldy collections, dust-laden shelves—the 'museum' of the comic papers. These museums need encouragement, help, and money. The Carnegie United Kingdom Trustees have decided upon a work of national importance in undertaking, with the help of Sir Henry Miers, an inquiry into the conditions of these "imperfectly organised and to a large extent unappreciated" institutions. The national museums and the museums of the larger municipalities stand in a different category. They are for the most part well tended and well cared for, their exhibited collections are kept up-to-date, in so far as up-to-dateness is satisfied by the replacement of poor specimens, the occasional filling in of blanks and a little more. But have even these museums realised the need of marching with the advance in knowledge?

The purpose of a great natural history museum is twofold, as Sir Ray Lankester has pointed out in a recent letter to Nature (Feb. 26, p. 314). It is a storehouse for the safeguarding of objects of natural history which are of historic interest, and of the vast collections of specimens gathered from every quarter of the globe and from the world's seas. On these are founded to a large extent our knowledge of the basic natural history of geographical regions, and they afford the raw material for further researches, geographical, morphological, and phylogenetic. Much more importantly, so far as the living generation is concerned, they give the ordered facts on which alone can be based the war against disease, and the search for Nature's wealth, which together determine the economic fate of the

human race; but this is an aspect which demands description by specialists. For all these ends the storing of such material, if it is to be at all valuable for reference, demands a minuteness of classification in proportion to the extent of the collections, and therefore a prime duty of a museum staff must be that of the systematic classifier.

The other great purpose of the large museum (and almost the sole purpose of the small museum) is exhibitory and educative, for the instruction not only of the unlearned but inquiring public, but also of all grades of receptive mind even to the professional expert, since there is no book-knowledge but may be bettered by reference to the facts themselves, and these could often be displayed from the great stores of museum properties. The growing recognition that an essential duty of museums supported by the public purse is educative, is shown in the placing of the newer State museums under the departments identified with public education, the Victoria and Albert Museum under the Board of Education, the Royal Scottish Museum under the Scottish Education Department. It is a kind of linkage that might well be extended to other public museums, provided the State department concerned is prepared to recognise and develop the enormous teaching potentiality of museums instead of permitting them to adhere as excrescences on the educational body.

Have the natural history museums in Britain played up to their educational function? They have not. Take the Natural History Museum at South Kensington, not because it is worse than the others, but because its size emphasises the defects. Its galleries are for the great part filled with thousands of specimens arranged 'systematically.' The principle underlying systematic natural history is phylogeny, that is to say, systematic collections must be looked upon as illustrating natural relationships and ultimately the evolution of life upon the globe. Since no one can claim that these great collections with their multiplicity of genera and species *visibly demonstrate* throughout the series natural relationships or the lineage of animal life, their primary purpose fails, and they must be regarded mainly as groupings convenient for showing a conspectus of the animal world and for the identification of specimens.

How do the collections meet these needs? It is impossible as a matter of quantity to exhibit every species; it would be useless from a qualitative point of view to do so, for the discrimination of the modern expert seizes upon differences invisible even to the observant eye. But this impossibility makes accurate identification from the exhibited collections a hazardous matter for the non-expert. The collections meet neither the phylogenetic nor the identification point of view. The indication is that their future development must be along the lines of drastic reduction, so that the series shall contain only readily distinguishable forms selected because of their historical, phylogenetic, or morphological interest, or because of a special attractiveness in themselves.

The implication of such a reduction is important. It means that, more and more, not only the specialist but also the general inquirer after detailed knowledge must be encouraged to supplement his observations in the galleries by appeal to the cabinet collections. This demands the presence of facilities not at present available in the museum, of easily accessible store collections, of well-lit, well-equipped, reasonably comfortable rooms available for the outside inquirer. Much more it implies such facilities for the museum staff which spends a lifetime organising and sorting the collections in gallery and in cabinet. Hitherto, in this technical aspect of reference collections containing specimens authoritatively named, the British Museum has been the central museum of the world. This position depends largely on the proportion of original specimens, 'type-specimens,' deposited by the naturalists who have named them; and obviously, the museum which has already the widest collection is the museum in which a new type-specimen can be most usefully deposited. It is to examine these type-specimens that naturalists visit England from all over the world. The hidden cabinets form the 'British Museum' which is the premier natural history museum in the world; it remains to be seen whether it can retain this position in face of the intelligent expenditure of America and Germany.

Sir Ray Lankester suggests that the exhibition space saved (and he contemplates reduction by one-half) might be used for the purpose of bringing up-to-date this hidden British Museum of research. With this view we disagree. There is a better purpose for the exhibition space, for the Natural History Museum has scarcely touched the fringe of real education, which must become part of the duty of a State museum. The greater American museums have spent much ingenuity and vast sums of money on the creation of realistic Nature groups, which transport the spectator into new realms. The main hall of the Natural History Museum at South Kensington, with its dark alcoves, is admirably adapted for such groups, and might well be given over to this purpose. But

while such groups are instructive, their main interest is spectacular, and the public demands more than a pageant: it thirsts for a deeper knowledge.

Nearly seventy years ago, Charles Darwin, an Englishman, with a new view-point revolutionised the thought of the world. What has the Natural History Museum of his own country done to make Darwin's world-moving discoveries current amongst his own people? What has it done to convert the 'fundamentalists,' of whom Great Britain as well as America has its share? Nothing! Except for a few isolated exhibits, shown almost in holes and corners as if with an apology lest they should intrude upon the systematic collections. Yet Darwin's mind was detailed and material; his theories are not as it were in the air; they rest upon accumulated facts and examples of a kind eminently suitable for exhibition in a museum. Some years ago the late Dr. Benjamin Peach in arranging the collections of Hugh Miller in the Royal Scottish Museum, Edinburgh, placed together a few of the actual specimens which had led the Cromarty stone-mason to certain of his conclusions. This practice might be extended. There is a vast body of general biological truths of vital importance in scientific thought, which could be illustrated, not by one or two examples, but by such a multiplicity of examples, culled from a wide range in the realms of zoology and botany, as would compel belief. Sir Ray Lankester thinks that such subjects—evolution, heredity, variation, natural selection, geographical distribution and variation, sex dimorphism, and hosts of others—should be the subject of museum lectures, and with this view we are in entire agreement; but how much more ought they to fill the galleries of a public museum for the constant reference and edification of the people?

Such collections to reach their highest efficiency must be planned and wrought out with a breadth of knowledge, and with a museum gift which is comparable to the creation of a striking and artistic poster; to them each specialist must make his contribution; they must be symposia rather than individual efforts. The hard-pressed specialists on the museum staff, overladen with identification and classification and the sorting of new collections, cannot spare the time and consideration demanded by such biological exhibits. The ideal exhibitor is by nature a creative artist; the British Museum authority, to consult whom a zoologist comes from Japan or a tropical pathologist from Uganda, should be by training a field-naturalist, must be by nature a methodist and a scholiast. The reorganisation of the exhibited collections on the lines of the advancement of modern natural history demands the reorganisation of the staff.

On this, as well as on the grounds summarised by Sir Ray Lankester, an inquiry by Royal Commission into the "status, purposes, and organisation of the British Museum (Natural History) and other related institutions" is urgently needed. There are many aspects of museum activities, relationships, and influences which might be bettered by inquiry and definition: the aims of the museum itself; the overlapping and duplication of collections in London; the relation of the State museum as an educator, to the recognised educational and particularly the teaching institutes; its relation to other natural history museums supported by State funds, and to the public museums of Great Britain in general; and not least, when the Dominions, Crown Colonies and dependencies are equipping staffs of researchers into the Nature which surrounds them and the death which encompasses them, who risk their lives to fight disease and to bear the torch of scientific knowledge to the ends of the earth, let the Government of our Empire consider the imperial relationships of the British Museum.

Ethnology of Tuareg Tribes.

People of the Veil: being an Account of the Habits, Organisation and History of the Wandering Tuareg Tribes which inhabit the Mountains of Air or Asben in the Central Sahara. By Francis Rennell Rodd. Pp. xvi + 504 + 51 plates. (London: Macmillan and Co., Ltd., 1926.) 30*s.* net.

BY the "People of the Veil" are meant the Tuareg, whose country extends from the eastern edge of the central Sahara to the far edge of the western deserts of North Africa before the Atlantic zone begins, and from southern Algeria in the north to the Niger and the equatorial belt between the river and Lake Chad in the south. The name 'Tuareg' is not used by the people themselves; it is really a term of opprobrium originally applied to them by their enemies. They became known to the Arabs as the 'Veiled People,' because their men after reaching a certain age were, as they still are, in the habit of wearing a strip of thin cloth wound around their heads in such a manner as to form a hood over the eyes and a covering over the mouth and nostrils, only a narrow slit being left open for the eyes; and, in default of a national name, they themselves use the same locution in their own tongue to describe

the whole society of different castes which compose their community. They are usually included among the Berbers of North Africa; but Mr. Francis Rennell Rodd, the author of the latest book dealing with them, prefers to use the geographical term Libyans, and even doubts whether

FIG. 1.—Tuareg camel-driver. From "People of the Veil."

the Tuareg are Berbers at all, like the other people so called in Algeria and Morocco. There are to-day four principal divisions of them. One of these groups consists of the people inhabiting Air, which is a mountainous oasis situated on a great caravan road from the Mediterranean to central Africa; and it is chiefly with this people and their country that Mr. Rodd's book deals in detail, as a result of a nine months' journey in the Tuareg country.

The people of Air have for several centuries had a king, residing in the city of Agades, but he seems never to have enjoyed much authority, unless backed by the more important chiefs. His office is not hereditary, but he is elected by the representatives of certain tribes; and his tenure of office has always been very precarious. The reigning king is of slave descent, and the same has been the case with all his predecessors. The legal practice of slavery has of course been abolished in Air since the advent of the French in the beginning of the present century, but master and slave continue to regard each other by mutual consent in the light of their former relationship. Slavery among the Tuareg never involved great hardship; it was in slave-trading and not in slave-owning that they sinned against the ethical standards which are usually accepted in Europe. There are further the so-called *imghad*, or serfs, who are clearly the descendants of groups or individuals captured in war and afterwards released from bondage to form a caste enjoying a certain amount of freedom; they are in no sense considered to be the property of the noble tribe which originally possessed them, but the relationship is closer than that of suzerain and vassal. In the first stage the noble tribe represents the original pure Tuareg race, while the oldest *imghad* are the first extraneous people whom they conquered, "in some cases perhaps as early as in the Neolithic ages."

In addition to the social distinction between nobles and serfs, the Tuareg attach great importance to tribal classification. Among the inhabitants of the Air mountains a tribe is either of the category called the "People of the King" or of the Kel Owi, and this distinction means all that the difference between an ancient landed nobility and a parvenu commercial aristocracy denotes. Many of the older men of the "People of the King" say that there are no nobles among the Kel Owi at all.

In Air, as elsewhere among the Tuareg, a man's or woman's social status is determined by that of the mother; a woman, they say, carries her children before they are born, and so they belong to her and not to the father. If she marries a man of another tribe the children become members not of his but of her tribe; and Mr. Rodd states that "should inter-tribal hostilities break out they must leave their father and fight for their mother's tribe, even against their own parent if need so be." Similar statements have been made with reference to a few matrilineal peoples in other parts of the world, but they are quite exceptional and even of doubtful accuracy; hence it would have been

well if the author had confirmed his assertion by actual cases in which Tuareg have been at war with their fathers on account of their method of tracing descent through the mother. He maintains that the frequency of monogamy is connected with the 'matriarchate.' But his statement relating to the Tuareg of Air, that in practice "monogamy is more frequent than polygamy," is true of all Muhammadan nations and of nearly all other peoples who allow polygamy, and nobody has ever been able to show that patrilineal peoples are more addicted to it than matrilineal ones; indeed, the prevalence of mother-right has, on the contrary, been partly traced to the practice of polygamy. Monogamy may certainly be a result of the regard in which women are held; but the supposition that their position in general is influenced by the system of reckoning kinship is not past all doubt.

Mr. Rodd observes that the Tuareg women are respected by their men in a manner which has no parallel in his experience, and that their unveiled countenances are in keeping with the perfect freedom they enjoy—though, wisely enough, he does not attribute the veil worn by the men to female supremacy. There can be little doubt that the veiling of women found in many parts of the Muhammadan world is not merely due to masculine jealousy but serves the object of protecting them from the evil eye, and in early Arabia very handsome men for the same reason veiled their faces, particularly at feasts and fairs; but though the belief in the evil eye is known to exist among the Tuareg, it does not seem to have anything to do with the veiling of their men. The author criticises some theories as to the origin of this peculiar custom, and is of opinion that up to the present no reasonable theory has been advanced. I think, however, that he has made a little too light of the suggestion that the veil was assumed by raiders who wanted to conceal their faces in order to escape recognition; he argues that the veil would be of little use as a means of concealment. I have heard Moors who have come in contact with Tuareg express a very different opinion; and among the mountaineers of northern Morocco robbers blacken their faces so as not to be found out. The veil is not worn until some years have elapsed after the youth begins to carry a sword.

While Mr. Rodd gives us much minute and valuable information about the organisation, the social conditions, the mode of life, the trade and occupations, the architecture and art, and the history of the Tuareg of Air, he has much less to tell of their rites and beliefs. Only a few lines are devoted to their customs connected with childbirth, marriage, and death, which may not be so uninteresting as he assumes; and he modestly says that he was not sufficiently fluent in their language to learn much of their superstitions. "Such information," he rightly remarks, "can only be obtained after prolonged residence among a people." He believes that the frequent use of the cross in Tuareg ornamentation is due to early Christian influence. It may be so; but the cross is much older than Christianity, and cruciform devices occur among the tattoo-marks seen on Libyans represented on old Egyptian monuments.

Fig. 2.—Tuareg huts at Auderas. From "People of the Veil."

It should be added that Mr. Rodd's book is an important contribution not only to our knowledge of the Tuareg, but also to the study of certain problems relating to the history and ethnology of the Sahara and North Africa in general. The illustrations are excellent. Edward Westermarck.

Atomic Physics.

The Structure of the Atom. By Prof. E. N. da C. Andrade. Third edition, revised and enlarged. Pp. xviii+750. (London: G. Bell and Sons, Ltd., 1927.) 30*s*. net.

PROF. ANDRADE'S well-known introduction to atomic physics has been very largely rewritten for this (the third) edition, and the size of the work has been approximately doubled. Some of the discussions of the earlier editions have been amplified, but in the main the increase in size represents the introduction of new subject matter. As before, the book is divided into two parts, of which the first is nominally devoted to the nucleus. A great deal of extranuclear matter is, however, disposed of in this section, in order to clear the ground for the later discussion of the outlying portions of the atom.

After a brief historical introduction, pride of place is appropriately given to an admirable account of the passage of swift electrified particles through matter—the problem which primarily led to the enthronement of the nuclear theory of the atom. Rutherford's α-particle scattering is naturally dealt with in some detail, together with an outline of the rather less definite evidence obtained from β-particle scattering. There is also a (much too brief) reference to the fundamentally important observations of Ramsauer and others on the behaviour of inert gases towards slow cathode rays—observations now extended, with refined methods, to the more 'aggressive' gases.

Part I. is also distinguished by an excellent account of the remarkable work conducted by Rutherford and his school during the last eight years, on the effects of extremely close collisions between swift α-particles and the nuclei of light atoms—the 'artificial' disintegration of matter and the estimation of the 'size' of the nucleus. Other topics which are concisely but adequately presented are: positive rays (including Aston's work on isotopes), the evidence for 'energy levels' within the nucleus, the interpretation of β- and γ-ray spectra and the deduction therefrom of details of the process of radioactive disintegration. Separate chapters are devoted respectively to more speculative hypotheses on the structure of the nucleus, and to an excellent account of 'classical' X-ray work—including Moseley's establishment of the importance of the concept of atomic number, Barkla's application of the scattering formula to the determination of the number of extranuclear electrons, and W. L. Bragg's work on the average time-spatial distribution of these electrons. The necessary 'Digression' on optical spectra, which has been modified and enlarged, brings Part I. to a close.

Part II., which now occupies about three-fourths of the whole book, deals exclusively with the behaviour of the extranuclear electrons, and almost exclusively with the quantum explanations of this behaviour. A great deal of space is therefore allotted to the discussion of spectral series. This part of the discussion, which has been profoundly modified in the new edition, begins, inevitably, with the classical Bohr theory of the spectra of hydrogen and of ionised helium. This is followed by simplified expositions of Ehrenfest's adiabatic principle and Bohr's correspondence principle. The argument is then carried on to the case of 'hydrogen-like' atoms, in which two quantum conditions are required for the specification of the orbits, and to the problems of 'relativistic' fine structure, normal Zeeman- and first-order Stark effects. Examples are given of Sommerfeld's classical applications of the 'Sommerfeld–Wilson' quantising rules and of Bohr's use of the method of perturbations. After a preliminary attack on the spectrum of the general atom, with the evocation of selection rules and adoption of a third and fourth quantum number, the discussion of the spectroscopic evidence culminates in a remarkable chapter on multiplet theory and anomalous Zeeman effect. This chapter (xv.), which has been partially revised by Mr. R. H. Fowler, summarises some of the most eminent successes, and at the same time emphasises some of the most significant difficulties and inadequacies of the older quantum theory of line spectra.

Among other new chapters which enhance the value of the book, special reference must be made to an excellent summary of work on critical potentials. There is a particularly welcome account of Saha's theory—which is not always, even in astrophysical text-books, given the place it merits—and the extensions of Fowler and Milne. Klein and Rosseland's superelastic collisions, and resonance radiation (including quenching and 'sensitised fluorescence'), are briefly discussed.

The account of the evidence from X-ray spectra has been very considerably expanded, and now occupies a separate chapter. This chapter gives a useful account of measurements in 'soft' X-ray regions and of the transition from optical to X-ray spectra, and a brief discussion of the interesting dilemma of the 'relativity' doublets raised by the recent 'hot spark' work of Millikan and others.

The relation of the dynamical atom-model to

the periodic system of the elements is much more fully discussed than in the earlier editions. An account is given of the Stoner–Main Smith modification of Bohr's original scheme, and McLennan's new table of basic spectral terms is added in an appendix (v.).

The chief addition to the chapter on magnetism is the extended account of the beautiful experiments of Gerlach and Stern, which is supplemented by a particularly fine reproduction of some of the original photographs. There is, however, no discussion of Glaser's work on diamagnetic gases at low pressures.

The relative positions of wave theory and classical quantum theory are summarised in a new chapter, which deals with dispersion, the Bohr–Kramers–Slater discussion of radiation fields, and the Compton effect.

The book closes with a brief but suggestive statement of the present position, and an account of the salient features of the newer quantum theory —or what seems doomed to be known for the present as the 'Born–Jordan–Heisenberg–Pauli–Dirac–Schrödinger . . .' mechanics.

The above—necessarily imperfect—analysis of the subject matter is intended to indicate the scope of the work, which is in many respects complementary to that of Sommerfeld's well-known treatise. It should be obvious that the book is primarily addressed to the traditional 'serious student' of physics. The treatment is, however, so ordered that much of the text is accessible to readers who have a general rather than a professional interest in modern speculations on the structure of matter.

The general plan has been to give a lucid account of the essential features of each problem, and to supplement this by a judicious selection of references to original sources. Space is economised here and there by omitting details for which English readers would naturally turn to such standard treatises as those of the Braggs, Aston, or Siegbahn. The result of this plan has been the production of a book which is specially adapted to serve as a general guide for senior students of physics and for those who are preparing to embark upon independent work. There are also, unfortunately, many older experimenters whose employment leaves them little time to keep in touch with new work which does not bear obviously and directly upon the subjects of their own special studies: to these, too, Andrade's book will make a special appeal.

The appeal in many cases will be none the weaker because the treatment is throughout physical rather than mathematical; and although the greater part of the book is necessarily allocated to the theoretical superstructure, unusual attention and respect are paid to the experimental methods and observational data at the foundations. The information has not always been brought completely up-to-date—it is many months since X-ray spectroscopy stopped short at such puny wave-lengths as 14 Å.U., and it is no longer held to be established that the absorption edges of an element depend upon the allotropic form, though it has been shown that the effect of valency can be exhibited even in the X-ray emission spectra of compounds—but oversights of this nature are inevitable in so comprehensive a survey. Certain omissions—as that of any discussion of band spectra—were also inevitable, as is pointed out in the author's preface; perhaps one of the most regrettable is the absence of any detailed discussion of the outstanding problem of X-ray absorption. As the problem by its nature is rebellious to direct treatment by the correspondence principle, which is the key to so great a part of the book, this omission is not unnatural.

Even if, as the author forecasts, much of the book will need to be rewritten in terms of the new mechanics and the spinning electron, the work in its present form stands as a very valuable exposition of the existing state of our knowledge of atomic structure, and one which is not likely to be superseded in the near future. The advances made even as the book was passing through the press are sufficient to demonstrate the futility of any immediate attempt to assemble, in a work of this kind, more than the barest outlines of the new methods of attack. It is to be hoped, however, that in the next edition it will be possible to include an account of the newer physics which, as yet, is but dimly to be discerned, stirring lightly in the matrices of the new dynamics.

The book is well produced, and the new plates are worthy companions to the beautiful reproductions in the earlier editions. The price has been increased—one serious defect in a book which is in all other respects so well adapted to the needs of the experimental physicist—but no one appreciating the amount of new work incorporated in this edition, or familiar with the cost of production of scientific books, will maintain that the increase is unwarranted. There is an excellent index, of the type (combined author and subject) which ought to be made compulsory in all books on physics.

H. R.

Cell Division.

Das Problem der Zellteilung physiologisch betrachtet. Von Prof. Alexander Gurwitsch. (Monographien aus dem Gesamtgebiet der Physiologie der Pflanzen und der Tiere, Band 11.) Pp. vii + 221. (Berlin: Julius Springer, 1926.) 16·50 gold marks.

IN this monograph the professor of histology at the University of Moscow puts together the results of a series of researches, carried out in his laboratory, which are so novel in outlook and method of experimental approach that some time must elapse before biologists in general can be prepared to express an opinion upon them. In introductory chapters the problem of cell division is approached in a somewhat artificial semi-philosophical manner, leading up to the general conclusion that the process of cell division is very largely determined as the result of influences received at the surface of the cell.

As possible influences leading to cell division upon reception at the cell surface two are considered: (1) Haberlandt's necro-hormone, a generalised suggestion arising out of experiments which led Haberlandt to think that the meristem divisions giving rise to wound cork were initiated in part as the result of substance diffusing from the wounded cells; (2) the 'mitogenetic' radiations, upon which much work has been done in Gurwitsch's laboratory. The regular cell divisions in the apical meristem of the onion root suggest an influence, inducing cell division, centred within, and radiating from, the apical meristem itself.

Gurwistch then proceeds to test the influence of this 'mitogenetic' radiation, emanating from the root apex, in inducing cell division in the still meristematic region of another root, when the apex of the first root is pointed, at close range, toward the flank of the second root. Normally, in the region behind the apex, when a root is examined, the number of cells found in division on either side of a median line through a longitudinal section is approximately the same. But when, on one side of this median line, the cells have been exposed to this 'mitogenetic' influence of another root apex, many more cells are found in stages of division on this side of the root.

In the main, this general line of experimental evidence is the chief evidence brought forward in support of this very new idea of a mitogenetic radiation. Modifications of the experiment lead to the conclusions that the rays are reflected from a plane glass surface, penetrate quartz, and are probably ultra-violet rays of wave-length between 1900 Å.U. and 2000 Å.U.

A few experiments with root extracts are given as evidence that these rays are released as the result of the interaction of a substance, 'mitotin,' with an enzyme 'mitotase,' on analogy with the phosphorescence of 'luciferin' under enzyme action. The experimental basis given for this conclusion is not, however, very complete. These views of Gurwitsch are given general application to the phenomena of cell division in both animal and plant; it remains to be seen how they will stand the test of time.

Our Bookshelf.

From Tribe to Empire: Social Organisation among Primitives and in the Ancient East. By Prof. A. Moret and G. Davy. Translated by V. Gordon Childe. (The History of Civilisation Series.) Pp. xxx + 371. (London: Kegan Paul and Co., Ltd.; New York: Alfred A. Knopf, 1926.) 16*s.* net.

IN his foreword, Mr. Henri Berr emphasises the importance of the social factor in history, and points out that in the early volumes of this series, which deals with the evolution of humanity, it has been necessary repeatedly to refer to the problem to which it gives rise. This volume thus marks a critical point in the general scheme of the series. For here we 'come to grips' with the problem. The aim of the book is to introduce the social as such into historical explanation. We find, therefore, that it falls into two parts. In the first part, six chapters introduce the reader to what is known of primitive social development, the material being arranged in a progressive framework. After a statement of the problem, it starts with the totemic organisation in which the individual is lost in the totemic group, or, perhaps it might almost be put, the individual is a function of the totem. It then traces the gradual development of individualised power. This is in effect the centralisation of the magic of the totem, of the land and the community, in one individual, the king. In Part 2 the transition of the clan to the kingdom is considered. This is traced in the early civilisation of Egypt and Mesopotamia. Finally, the working out of the social factor is studied in the first empires of the Orient, and the reader is carried down to the Egypto-Hittite *entente* and the invasion of Egypt by the peoples of the sea in the Nineteenth Dynasty.

The application of primitive sociological data to the elucidation of archæological and historical problems is of course not new, but here it is conceived on a grand scale, and worked out in detail with much ingenuity. A word of caution may not be out of place. In this field much is uncertain, at any rate of early days. It is impossible, for example, to say how great was the

extent of the subordination of the individual to the whole. The large generalisations based upon the application of the prevalent analysis to what is often the merest outline, give rise to an uneasy feeling that the interpretation of the more obscure facts has had to square with theory rather than that it has evolved naturally from the facts themselves. In other words, the argument from analogy may have been unduly strained in its application to the internal conditions of Egypt and Mesopotamia.

The Indian Zoological Memoirs on Indian Animal Types. 1: *Pheretima* (*The Common Indian Earthworm*). By Prof. Karm Narayan Bahl. Pp. iv + 72. (Lucknow: The Methodist Publishing House, 1926.) 1.8 rupees.

A committee of zoologists in India has arranged for the preparation of a series of memoirs on the lines of the well-known memoirs published by the Liverpool Marine Biological Committee. Hitherto students of zoology in India, while dissecting Indian types of the various phyla, have had chiefly to use descriptions based on British representatives of those phyla. The present is the first of the series of memoirs on Indian animal types; others are contemplated on a leech, a starfish, a centipede, a scorpion, an ascidian, a dogfish, a catfish, and a lizard.

Prof. Bahl's account of the common Indian earthworm *Pheretima posthuma* sets a worthy standard for the series. The chapters deal successively with the habits and habitat, external features, body wall, cœlom, the alimentary canal, the vascular, excretory, nervous, and reproductive systems, and the development. A concluding chapter contains concise directions for practical work. As would be expected from the author's published papers, the accounts of the vascular and excretory systems are particularly full and well done; perhaps a little less detail in parts of the vascular system would have sufficed. In addition to the examination of the worm by dissection, due attention is devoted to the microscopic study of excised organs and tissues and of transverse sections. The volume is adequately illustrated by two half-tone plates and 29 line drawings in the text.

The author is to be congratulated upon his suggestion that memoirs on common Indian animals should be prepared, and upon his own excellent contribution to the series.

A Book of South African Flowers. By D. Barclay, H. M. L. Bolus and E. J. Steer. Pp. xviii + 174 (57 plates). (Capetown and Johannesburg: The Specialty Press of South Africa, Ltd.; London: L. Reeve and Co., Ltd., 1925.) 21*s.*

Since its discovery, visitors have been struck by the remarkable flora of Cape Colony, and especially of the particular region known to botanists as the "South-western Region." Here the landscape is often dominated by such unique types of plants as Protea, Leucadendron, Strelitzia, etc., which are found nowhere else in the world. In order to spread a wider knowledge of these interesting and beautiful plants "among those for whom the purely scientific botanical books have little or no meaning," the Wild Flower Protection Society has published a book with illustrations, accompanied by interesting biological notes suitable for the ordinary reader. Most of the plants described are those which were in danger of becoming extinct from various causes, mainly, however, the Capetown flower-seller, and are now protected by law from being destroyed. Thirty-two of these are illustrated by coloured plates, some of them good, some rather poor, and the remainder by photographs. The text has been written by Mrs. Bolus, the Curator of the Bolus Herbarium, Kirstenbosch, the drawings are by Miss Barclay, and the photographs by Mr. Steer. We feel sure not only that the authors' modest hope "that the book may prove useful in schools" will be fulfilled, but also that it will be just the thing for those interested in the Cape flora generally, and especially for the visitor with limited time who wishes to know something about the wild plants around him.

Practical Microscopy: an Introduction to Microscopical Methods. By Dr. F. Shillington Scales. Third edition. Pp. ix + 332. (London: Baillière, Tindall, and Cox, 1926.) 8*s.* 6*d.* net.

In this third edition the author (whom death has recently claimed) has revised the text and introduced much new matter, particularly in the chapters dealing with the design of the microscope, choice of an instrument, objectives and accessories, and many of the newest models and pieces of apparatus are illustrated. The chapter on the practical optics of the microscope is exceedingly good, and gives all the essentials of the subject in simple form. A chapter on photo-micrography is included. The section on microscopical technique gives an excellent summary of the essentials of the subject—fixing, hardening, section cutting, staining and mounting—and the budding microscopist will find that it will carry him a long way in his work. Tables, formulæ, and a useful bibliography are included in an appendix. R. T. H.

The Goodness of Gods. By Prof. Edward Westermarck. (The Forum Series.) Pp. vi + 58. (London: Watts and Co., 1926.) 1*s.* net.

Dr. Westermarck's contribution to the "Forum Series" consists of four chapters in which he follows up the development of the idea of god from its earliest beginnings among primitive peoples in the belief in supernatural beings, to its fully developed form in the higher religions, the religion of the ancient Egyptians, Zoroastrianism, the Vedic religion, Christianity, and Mohammedanism. In the final chapter, "The Betterment of the Gods," the author deals specifically with the ethical side of his theory. The treatment in so small a compass is necessarily concise, and the reader is referred for the data upon which Dr. Westermarck's views are based to his "Origin and Development of the Moral Idea."

Letters to the Editor.

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

The Scattering of Electrons by a Single Crystal of Nickel.

IN a series of experiments now in progress, we are directing a narrow beam of electrons normally against a target cut from a single crystal of nickel, and are measuring the intensity of scattering (number of electrons per unit solid angle with speeds near that of the bombarding electrons) in various directions in front of the target. The experimental arrangement is such that the intensity of scattering can be measured

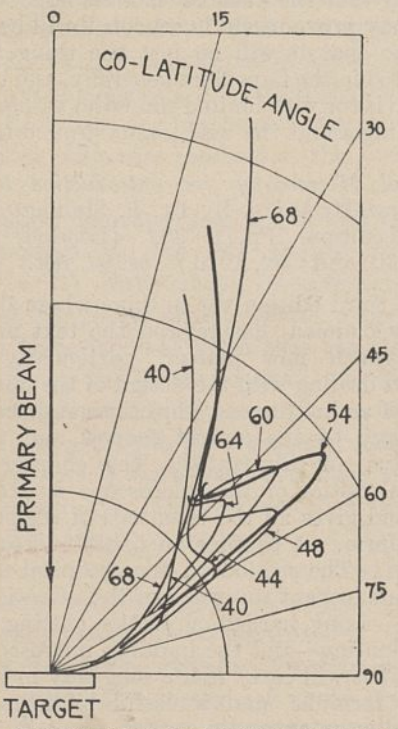

FIG. 1.—Intensity of electron scattering vs. co-latitude angle for various bombarding voltages—azimuth-{111}-330°.

in any latitude from the equator (plane of the target) to within 20° of the pole (incident beam) and in any azimuth.

The face of the target is cut parallel to a set of {111}-planes of the crystal lattice, and etching by vaporisation has been employed to develop its surface into {111}-facets. The bombardment covers an area of about 2 mm.^{2} and is normal to these facets.

As viewed along the incident beam the arrangement of atoms in the crystal exhibits a threefold symmetry. Three {100}-normals equally spaced in azimuth emerge from the crystal in latitude 35°, and, midway in azimuth between these, three {111}-normals emerge in latitude 20°. It will be convenient to refer to the azimuth of any one of the {100}-normals as a {100}-azimuth, and to that of any one of the {111}-normals as a {111}-azimuth. A third set of azimuths must also be specified; this bisects the dihedral angle between adjacent {100}- and {111}-azimuths and includes a {110}-normal lying in the plane of the target. There are six such azimuths, and any one of these will be referred to as a {110}-azimuth. It follows from considerations of symmetry that if the intensity of scattering exhibits a dependence upon azimuth as we pass from a {100}-azimuth to the next adjacent {111}-azimuth (60°), the same dependence must be exhibited in the reverse order as we continue on through 60° to the next following {100}-azimuth. Dependence on azimuth must be an even function of period $2\pi/3$.

In general, if bombarding potential and azimuth are fixed and exploration is made in latitude, nothing very striking is observed. The intensity of scattering increases continuously and regularly from zero in the plane of the target to a highest value in co-latitude 20°, the limit of observations. If bombarding potential and co-latitude are fixed and exploration is made in azimuth, a variation in the intensity of scattering of the type to be expected is always observed, but in general this variation is slight, amounting in some cases to not more than a few per cent. of the average intensity. This is the nature of the scattering for bombarding potentials in the range from 15 volts to near 40 volts.

At 40 volts a slight hump appears near 60° in the co-latitude curve for azimuth-{111}. This hump develops rapidly with increasing voltage into a strong spur, at the same time moving slowly upward toward the incident beam. It attains a maximum intensity in co-latitude 50° for a bombarding potential of 54 volts, then decreases in intensity, and disappears in co-latitude 45° at about 66 volts. The growth and decay of this spur are traced in Fig. 1.

A section in azimuth through this spur at its maximum (Fig. 2—Azimuth-330°) shows that it is sharp in azimuth as well as in latitude, and that it forms one of a set of three such spurs, as was to be expected. The width of these spurs both in latitude and in azimuth is almost completely accounted for by the low resolving power of the measuring device. *The spurs are due to beams of scattered electrons which are nearly if not quite as well defined as the primary beam.* The minor peaks occurring in the {100}-azimuth are sections of a similar set of spurs that attains its maximum development in co-latitude 44° for a bombarding potential of 65 volts.

Thirteen sets of beams similar to the one just described have been discovered in an exploration in the principal azimuths covering a voltage range from 15 volts to 200 volts. The data for these are set down on the left in Table I. (columns 1-4). Small corrections have been applied to the observed co-latitude angles to allow for the variation with angle of the 'background scattering,' and for a small angular displacement of the normal to the facets from the incident beam.

If the incident electron beam were replaced by a beam of monochromatic X-rays of adjustable wave-length, very similar phenomena would, of course, be observed. At particular values of wave-length, sets of three or of six diffraction beams would emerge from the incident side of the target. On the right in Table I. (columns 5, 6 and 7) are set down data for the ten sets of X-ray beams of longest wave-length which would occur within the angular range of our observations. Each of these first ten occurs in one of our three principal azimuths.

Several points of correlation will be noted between the two sets of data. Two points of difference will also be noted; the co-latitude angles of the electron beams are not those of the X-ray beams, and the three electron beams listed at the end of the Table appear to have no X-ray analogues.

The first of these differences is systematic and may

be summarised quantitatively in a simple manner. If the crystal were contracted in the direction of the incident beam by a factor 0·7, the X-ray beams would be shifted to the smaller co-latitude angles θ' (column 8), and would then agree in position fairly well with the observed electron beams—the average difference being 1·7°. Associated in this way there is a set of electron beams for each of the first ten sets of X-ray beams occurring in the range of observations, the electron beams for 110 volts alone being unaccounted for.

These results are highly suggestive, of course, of the ideas underlying the theory of wave mechanics, and we naturally inquire if the wave-length of the X-ray beam which we thus associate with a beam of electrons is in fact the h/mv of L. de Broglie. The comparison may be made, as it happens, without assuming a particular correspondence between X-ray and electron beams, and without use of the contraction factor. Quite independently of this factor, the wave-lengths of all possible X-ray beams satisfy the optical grating formula $n\lambda = d \sin \theta$, where d is the distance between lines or rows of atoms in the surface of the crystal—these lines being normal to the azimuth plane of the beam considered. For azimuths-{111} and -{100}, $d = 2{\cdot}15 \times 10^{-8}$ cm. and for azimuth-{110}, $d = 1{\cdot}24 \times 10^{-8}$ cm. We apply this formula to the electron beams without regard to the conditions which determine their distribution in co-latitude angle. The correlation obtained by this procedure between wave-length and electron speed v is set down in the last three columns of Table I.

In considering the computed values of $n(\lambda mv/h)$, listed in the last column, we should perhaps disregard those for the 110-volt beams at the bottom of the Table, as we have had reason already to regard these beams as in some way anomalous. The values for the other beams do, indeed, show a strong bias toward small integers, quite in agreement with the type of phenomenon suggested by the theory of wave mechanics. These integers, one and two, occur just as predicted upon the basis of the correlation between electron beams and X-ray beams obtained by use of

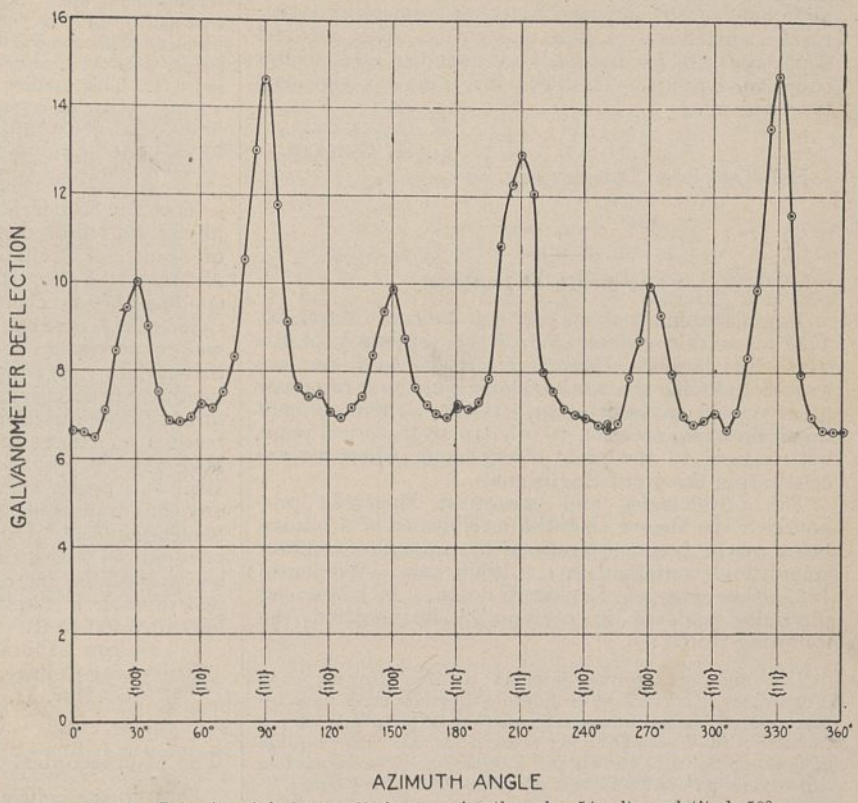

FIG. 2.—Intensity of electron scattering vs. azimuth angle—54 volts, co-latitude 50°.

TABLE I.

Azimuth.	Electron Beams.			X-ray Beams.						
	Bomb. Pot (volts).	Co-lat. θ.	Intensity.	Reflections.	$\lambda \times 10^8$ cm.	Co-lat. θ.	Co-lat. θ'.	$v \times 10^{-8}$ cm./sec.	$n\lambda \times 10^8$ cm.	$n\left\{\frac{\lambda mv}{h}\right\}$.
{111}	54	50°	0·5	{220}	2·03	70·5	52·7	4·36	1·65	0·99
	100	31	0·5	{331}	1·49	44·0	31·6	5·94	1·11	0·91
	174	21	0·9	{442}	1·13	31·6	22·4	7·84	0·77	0·83
	174	55	0·15	{440}	1·01	70·5	52·7	7·84	1·76	2(0·95)
{100}	65	44	0·5	{311}	1·84	59·0	43·2	4·79	1·49	0·98
	126	29	1·0	{422}	1·35	38·9	27·8	6·67	1·04	0·95
	190	20	1·0	{533}	1·04	28·8	20·4	8·19	0·74	0·83
	159	61	0·4	{511}	1·05	77·9	59·0	7·49	1·88	2(0·97)
{110}	138	59	0·07	{420}	1·22	78·5	59·5	6·98	1·06	1·02
	170	46	0·07	{531}	1·04	57·1	41·7	7·75	0·89	0·95
{111}	110	58	0·15	..	..	..	..	6·23	1·82	1·56
{100}	110	58	0·15	..	..	..	..	6·23	1·82	1·56
{110}	110	58	0·25	..	..	..	..	6·23	1·05	0·90

the contraction factor. The systematic character of the departures from integers may be significant. We believe, however, that this results from imperfect alignment of the incident beam, or from other structural deficiencies in the apparatus. The greatest departures are for beams lying near the limit of our co-latitude range. The data for these are the least trustworthy.

C. DAVISSON.
L. H. GERMER.

Bell Telephone Laboratories, Inc.,
New York, N.Y.,
Mar. 3.

The Brain of Laplace.

THE bicentenary of the death of Newton (March 20, 1727) is within a fortnight of the centenary of the death of Laplace (March 5, 1827), and no one acquainted with the work of both can think of one or other except in association. It may, therefore, not be an unfitting occasion to refer to an historical point with regard to the great Frenchman, when we are celebrating the great Englishman.

The physiologist and anatomist Magendie propounded the theory that the intelligence of a human being was in the inverse ratio of the amount of cerebro-spinal fluid contained in the brain case. Writing in 1827, the year of Laplace's death, his "Mémoire physiologique sur le cerveau,"[1] he inserted the following words:

"Je me suis trouvé dans la douloureuse nécessité d'examiner le cerveau d'un homme de génie mort dans un âge avancé, mais jouissant encore de la plénitude de ses facultés intellectuelles; la somme totale du liquide céphalo-spinal ne s'élevait pas à deux onces, et les cavités du cerveau en contenaient à peine un gros" [$=\frac{1}{8}$ once].

I have been unable so far to find any further reference in the writings of Magendie "to the brain of this man of genius who died at an advanced age" and in the fullness of his intellectual powers. Magendie appears to have given no further account of this brain; at least I have found none. Laplace died at the age of seventy-eight in the year Magendie wrote. I have also failed to discover any minute record of Laplace's death which would suggest that an autopsy was made or was a "douloureuse nécessité." I would venture, therefore, to ask those who may be better acquainted than I am with the circumstances of Laplace's death to let me know why his brain came into Magendie's possession and whether a full report on it was ever written. Magendie, indeed, mentions no name, and this might lead one to consider his investigation of the matter was confidential. However, I think the ascription is certain, for quite recently Miss Helen Hunter Baillie—a lady who combines the blood of other famous anatomists with that of a famous author,[2] placed in the hands of Miss Miriam Tildesley a letter of Joanna Baillie to her great niece Miss Sophy Milligan. This letter, dated Hampstead, Monday, 1834, contains the following important paragraph:

"MY DEAR SOPHY. . . . Dr. Somerville told us not long ago a whimsical circumstance regarding the head of La Place, the famous French astronomer. Some Ladies and Gentlemen went one day to the house of Majendie (sic!), the great anatomist, to see the brains of this Philosopher which they conjectured must be of a very ample size, and seeing a preparation on the table answering their expectation they were quite delighted. 'Ah! see what a superb brain, what organs, what developments! This accounts completely for all the astonishing power of his intellect, etc.' Majendie, who was behind them and overheard all this, stepped quietly forward and said: 'Yes, that is indeed a large brain, but it belonged to a poor Idiot, who when alive scarcely knew his right hand from his left. This, Ladies and Gentlemen' (handing to them a preparation of a remarkably small brain), 'this is the brain of La Place.' Dr. Somerville was told this anecdote by Majendie himself. . . .

Your affectionate Aunt, J. BAILLIE."

This Dr. Somerville can scarcely be other than the physician, fellow of the Royal Society, and husband of Mary Somerville, the learned lady who studied Newton's "Principia" in the original, was the correspondent of Laplace, and paraphrased his "Mécanique Céleste." There can thus be no doubt that Magendie was in possession of the brain of Laplace, and very little doubt that the passage in the "Mémoire physiologique sur le cerveau," written 1827, refers to that brain. The questions I would put to the French readers of NATURE are these: What became of Magendie's preparations? Have they, and with them Laplace's brain, survived until to-day? If so; has any one reported on it, or does any account by Magendie other than that I have cited, written or printed, exist? So few brains of great thinkers have been available for examination, that it would be a real disaster if Laplace's should have had only four lines devoted to it.

KARL PEARSON.

Galton Laboratory,
University College, London,
Mar. 31.

The Microscopical Examination of Flint Surfaces.

DURING the course of my work in the experimental fracture of flint by (*a*) human blows delivered by a hammer-stone, (*b*) unguided percussion, (*c*) unguided pressure, and (*d*) the application of heat, it became, in my opinion, possible, by a close examination of an extensive series of each of the differing types of flaking produced by these various methods of fracture, to differentiate between the work of man, and that of Nature ("Pre-Palæolithic Man," W. E. Harrison, publisher, Ipswich). While engaged upon this research I was much interested to notice that not only the type of flaking of the different series served to distinguish them from each other, but also that this difference appeared to find support, though in a less obtrusive manner, *in the appearance of the surface of the flints* broken by the methods above enumerated.

Most of those who are familiar with fractured flints of prehistoric date will have probably noticed the marked differences, often observable to the naked eye, between, for example, specimens broken by thermal effects and others fractured by human blows. The surfaces of the flake-scars of the former exhibit, generally, a much duller, less bright, surface than those of the latter. It occurred to me that this difference was caused possibly by the fact that these surfaces differed in texture, and had thus offered a differing resistance to the natural force, or forces, responsible for the imposition of 'polish,' or 'gloss,' upon the flake-scars of fractured flints. Further, it seemed highly probable that this difference in texture, if it existed, would have been most likely to have been produced by the two differing forms of fracture, and I compared, provisionally, the surfaces of a flint broken by thermal effects, to those of an apple which has been pulled in half with the hands and exhibits a rough surface, while I likened the surfaces of the

[1] Published by Magendie in his own *Journal de Physiologie expérimentale et pathologique*, Tome 8, p. 228; 1828.
[2] The mother of Joanna Baillie was sister of William and John Hunter.

flake-scars of the flint broken by human blows to the smooth surface of an apple cut in half by a knife.

In order to make some test of this theory, I procured examples of good, sound flint from the detritus-bed at the base of the Red Crag of Suffolk, and having fractured some by means of a hammer-stone,

Fig. 1.—Photo-micrograph of surface of flint fractured by human blows. (×100.)

and others by putting them into a fire, thus producing flake-scars by (*a*) human blows and (*b*) thermal effects, I had photo-micrographs taken of the two surfaces in order to see if they differed in appearance. A number of specimens were examined and photographed, and the surfaces here illustrated (Figs. 1 and 2) may, I think, be said with fairness to be typical. Fig. 1 shows the type of surface produced by human blows, while Fig. 2 illustrates the type of

Fig. 2.—Photo-micrograph of surface of flint fractured by thermal agency. (×100.)

surface produced by thermal fracturing. An examination of these illustrations will show that the two surfaces differ from each other, and that this difference takes the form of the greater or lesser number, and prominence, of the white markings visible on the photographs.

Though it is possible that these markings point to the 'thermal' surface being rougher than that produced by human blows, yet this is by no means certain. In fact, I am unable at present to say what these markings actually represent. But I believe that, though illustrating such a small area of the flint under examination, the photographs are representative of the two types of surface mentioned, and that the differences here indicated, plus the well-known other divergences between the flake-scars formed by human blows and thermal effects, now make it possible to differentiate, with confidence, between them.

I conceive that differences, though less easily observable, may exist between the surfaces of flints fractured by human blows and natural pressure, but so far I have not been able to establish this very important fact to my satisfaction. I believe, however, that this method of attempting to ascertain the manner in which a flint has been broken, though novel, has great possibilities before it, and will lead to very definite and valuable scientific results.

J. Reid Moir.

One House, Ipswich.

Haze.

With regard to the composition of the haze which often obstructs visibility in the summer, the following experiments may be of interest owing to the curious results and the make-shift methods which had to be used.

In August last, while staying on the coast of Norfolk, a well-marked haze appeared covering the whole country on Aug. 31 and Sept. 1. This had the characteristic bluish look often seen in summer haze. There was at the same time a strong wind blowing from the sea from north-west by north, which on Sept. 1 veered to nearly due north, the velocity being nearly 20 m.p.h. as measured by the flight of thistledown over a measured distance. The sea was rough, and the haze was such that the limit of visibility was about 5 miles.

Having no instruments with me with which to obtain samples of this haze, an instrument was improvised as shown on the sketch (Fig. 1). An empty peach tin 100 mm. diameter had a hole about 2 mm. diameter made in the centre of the bottom. The tin, A, was lashed to a piece of board with string, the bottom being brought up against a step, B, cut on the edge of the board; a microscope slide, C, was fixed opposite the hole in the bottom of the tin by means of a wedge, W, between it and the tin. This wedge also served the purpose of adjusting the distance between the slide and the hole to about 2 mm. The board carrying the tin was attached to a stake about 4 ft. 6 in. high, which was fixed in the ground with the mouth of the tin facing the wind.

A clean slide having been placed in position behind the tin, a definite patch became visible in 45 minutes on the glass opposite the hole, where the jet of air produced by the hole struck the slide. It was left in position for a little more than an hour, when the slide was removed and another put in its place which also received a patch visible to the naked eye. These patches, on examination under the microscope, were found to consist of a mixture of drops of liquid and crystals. The first consisted almost entirely of drops when examined, the relative humidity at the time being 82 per cent.

On warming gently all the drops dried, leaving crystals mostly of a skeletal form with branches at 90°, but some were cubical, while a few were thin rhomboidal plates, and these latter did not deliquesce as the others did when the slide cooled. The second

slide was similar, except that there were in the drops larger numbers of rhomboidal crystals which showed no tendency to deliquesce, while on warming the slide numbers of cubical crystals appeared, with sides up to 24 μ, clearly of common salt; also a number of

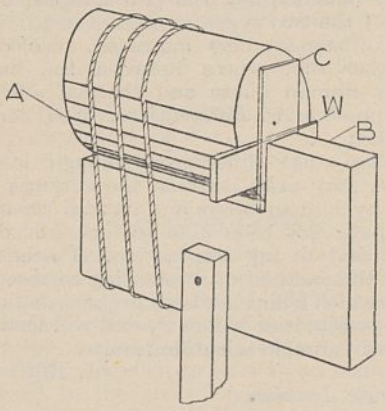

FIG. 1.

skeletal crystals with 90° arms (Fig. 2). It would appear, therefore, that this haze consisted almost entirely of crystalline salts, existing partly in the solid and partly in the deliquesced condition, and presumably mainly derived from sea spray, with

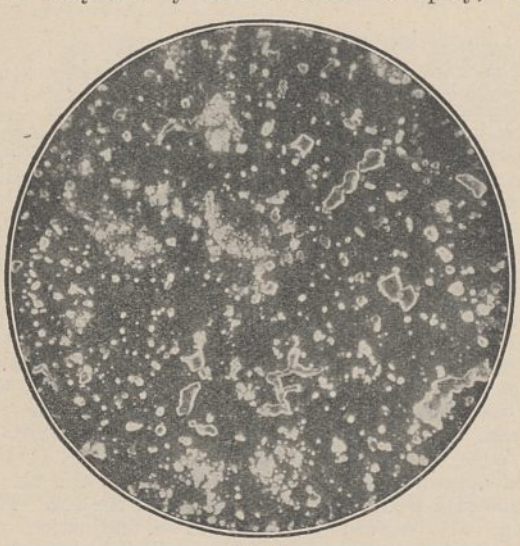

FIG. 2.

crystals, probably sulphates, derived from the smoke of cities on the north-east coast. With such a dense supply of hygroscopic crystalline matter in the air it would seem certain that a liquid fog would result from the deliquescence of the crystals present long before saturation, indeed probably in the neighbourhood of 70 per cent. relative humidity.

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Hereditary Choice of Food Plants in the Lepidoptera and its Evolutionary Significance.

MR. EDWARD MEYRICK, in his comments (NATURE, Mar. 12) upon my paper (*Proc. Roy. Soc.*, B, vol. 101, pp. 115-127) on the egg-laying instincts of *Pontania salicis*, so completely misses the point that it is difficult to deal with them seriously. The "new principle" to which he refers does not depend in the slightest upon the work he mentions, but is deduced from work described in an earlier paper (*Proc. Roy. Soc.*, B, vol. 99). It may be summed up in two sentences: (1) Chemical agencies acting through ingested food have been shown to act directly on the germ plasm so as to affect its potentialities; (2) Therefore any circumstance bringing about a change in the food ingested by an organism may affect its germ plasm so as to produce heritable variations.

Independently of this failure to appreciate the real foundation of the new principle, several other remarks of Mr. Meyrick require criticism. Amongst these is the statement that the only discrimination made by Salix-feeding Lepidoptera is in general between rough- and smooth-leaved species, and with this is coupled the remark that the influence determining the choice is touch rather than taste. Such views could not possibly emanate from one who has studied the matter in the field. I have recently been investigating the egg-laying habits of the moth *Ypsipetes ruberata*, which abounds here in a tangle of *Salix pentandra* and *S. aurita*. I can assure Mr. Meyrick that the females, when intent on egg-laying, never approach the *S. pentandra* to test the roughness of its foliage, but fly directly to the leaves of *S. aurita*. Moreover, I fail to see how their smoothness or the reverse can affect the choice of food-plant in the case of the lepidopterous *Xanthia flavago*, the coleopterous *Cryptorhynchus lapathi*, or the various Cecidomyids of the genus Rhabdophaga, which, with many other species, lepidopterous and otherwise, favour *S. aurita* in the same thicket but lay their eggs on the bark! The facts are, of course, that the two species of Salix support two very different faunas.

Further, Mr. Meyrick cannot really imagine that I think that the species employed as examples of allied pairs originated in Britain? I am quite well aware of their range outside our limits, but fail to grasp what this, or the exact locality in which they originated, has to do with the argument. Again, he seems to imply that I consider that a new species has been originated in three generations. No one ever claimed this; the experiments criticised dealt with only one point, that of egg-laying habits. Nevertheless, had Mr. Meyrick understood the principle, or the precise experiments upon which it was based, he would have realised, as is clearly stated in my paper but overlooked by him, that under its workings *Selenia bilunaria* diverged from the parent stock in wing colour and shape, length of larval life, and other features. These achievements may not, in Mr. Meyrick's eyes, go far to explain species-formation in the Lepidoptera, but still they do show how breaks from the original species arise which, in the end, may yield new species. One can expect little more in the lifetime of one worker!

Mr. Meyrick is correct in saying that entomologists have long noted that groups of related species feed on allied or associated plants and probably arose as phytophagous races. However, recognition of these facts is one thing, and an explanation on an experimental basis is another; this explanation I have endeavoured to supply.

As Mr. Meyrick speaks very definitely on the lack of variation, except in size, produced by food amongst the very variable, polyphagous British Caradrinidæ, he doubtless has access to experimental work bearing on the point. If so, these experiments are entirely unknown to me, and should be produced for the guidance of fellow-workers. The only pertinent researches on the Caradrinidæ with which I am acquainted are those of Hasebroek (*Zool. Jahrb., Abt. f. allg. Zool. u. Physiol.*, Bd. 37, 1919), and that

investigator gives a very definite correlation between the food and certain phases of variation.

In conclusion, I plead for one thing, and that is the removal of the tendency to surround the results of researches in experimental evolution in a cloud of words; what is wanted is not words, but more experiments—and then still more!

J. W. Heslop Harrison.

Armstrong College,
Newcastle-upon-Tyne.

Biological Fact and Theory.

It seems to me that all the facts of genetics must be accepted so far as they are supported by evidence, but the antagonism of some biologists is, I think, chiefly due to the complacency with which geneticists assume and assert that their discoveries explain all the important phenomena of biology, including the evolution of adaptations. Prof. T. H. Morgan believes that change of structure has been due to mutation, and that organisms have adapted their habits accordingly. I know of no case of mutation which is in any way parallel to the metamorphosis of the flat-fish or the frog.

The most crucial test, however, of the claims of genetics is the relation of sex-limited characters to the gonadial hormones. Prof. Morgan's view is that "supposing the testis hormone were the cause of strength and activity in the male which would be preserved and developed by natural selection, their secondary influence over other parts of the body would call for no other explanation." Obviously there is no suggestion here of any reason why the hormone should have a secondary influence over other parts of the body, or what determines the special result of the influence. The antlers of a stag have no essential relation to sex or reproduction at all, any more than its legs. Both legs and antlers are part of its hereditary constitution, but the latter depend for their normal development on the testis hormone, the former do not. Female secondary sexual characters, like the milk glands of mammals, are influenced by ovarian hormones. The only connexion with sex which such organs have is an external one, through function and habits. The antlers are only sexual in the use that is made of them in fighting between rival males. The testis hormone is much the same in all mammals; it is certain that there is nothing in the stag's hormone which would produce antlers in a horse or in a man. Why, then, should organs which have functions related to sexual habits be connected physiologically with the gonads or other reproductive organs?

There is nothing in all the facts of genetics or in the refinements of genetical theory, and nothing known about mutations, which throws light upon the relation of sex-limited characters to the sexual habits on one hand and to the gonads on the other.

J. T. Cunningham.

35 Wavendon Avenue, W.4,
Mar. 10.

The discussion in Nature under the above heading appears to me to be based in large measure upon failure to realise the character of scientific knowledge. Such misunderstanding is to be deprecated as being contrary to the interests of further progress in biology. I beg leave, therefore, to reiterate that scientific hypotheses, otherwise known as laws of Nature, are created by the mind of man for purposes of prediction and generalisation. They do not represent absolute truth, and are always liable to be superseded by new hypotheses which are more widely embracing. The Mendelian laws are no exception. So long as these laws fulfil the function of helping men of science to generalise and to predict they may be held to reflect definite degrees of reality. If, however, they fail to serve this purpose they have no logical justification.

Genes or factors, like atoms and molecules, are concepts invented by the human mind, but if their invention leads to increased complexity of thought rather than to simplification, it is both useless and unwarranted. I am not a geneticist, and to what extent, if any, such a perversion of sound scientific method is being made, it is not for me to say. Nevertheless, I suspect that much of the misunderstanding which has found expression concerning this subject would be resolved by a proper appreciation of the descriptive character of natural science and the limits of its domain.

F. H. A. Marshall.

Christ's College, Cambridge,
Mar. 27.

The Continuous Spectrum of β-Rays.

The continuous spectrum of the β-rays arising from radio-active bodies is a matter of great importance in the study of their disintegration. Two opposite views have been held about the origin of this continuous spectrum. It has been suggested that, as in the α-ray case, the nucleus, at each disintegration, emits an electron having a fixed characteristic energy, and that this process is identical for different atoms of the same body. The continuous spectrum given by these disintegration electrons is then explained as being due to secondary effects, into the nature of which we need not enter here. The alternative theory supposes that the process of emission of the electron is not the same for different atoms, and that the continuous spectrum is a fundamental characteristic of the type of atom disintegrating. Discussion of these views has hitherto been concerned with the problem of whether or not certain specified secondary effects could produce the observed heterogenity, and although no satisfactory explanation has yet been given by the assumption of secondary effects, it was most important to clear up the problem by a direct method.

There is a ready means of distinguishing between the two views, since in one case a given quantity of energy would be emitted at each disintegration equal to or greater than the maximum energy observed in the electrons escaping from the atom, whereas in the second case the average energy per disintegration would be expected to equal the average energy of the particles emitted. If we were to measure the total energy given out by a known amount of material, as, for example, by enclosing it in a thick-walled calorimeter, then in the first case the heating effect should lead to an average energy per disintegration equal to or greater than the fastest electron emitted, no matter in what way this energy was afterwards split up by secondary effects. Since on the second hypothesis no secondary effects are presumed to be present, the heating effect should correspond simply to the average kinetic energy of the particles forming the continuous spectrum.

To avoid complications due to α-rays or to γ-rays from parent or successive atoms, we measured the heating effect in a thick-walled calorimeter of a known quantity of radium E. This measurement proved difficult because of the small rate of evolution of heat, but by taking special precautions it has been possible to show that the average energy emitted at

each disintegration of radium E is 340,000±30,000 volts. This result is a striking confirmation of the hypothesis that the continuous spectrum is emitted as such from the nucleus, since the average energy of the particles as determined by ionisation measurements over the whole spectrum gives a value about 390,000 volts, whereas if the energy emitted per disintegration were equal to that of the fastest β-rays, the corresponding value of the heating would be three times as large—in fact, 1,050,000 volts.

Many interesting points are raised by the question of how a nucleus, otherwise quantised, can emit electrons with velocities varying over a wide range, but consideration of these will be deferred until the publication of the full results.

C. D. ELLIS.
W. A. WOOSTER.

Cavendish Laboratory,
Cambridge, Mar. 23.

The Coefficient of Ionisation of a Fused Salt.

IT is now forty years since Arrhenius and Van't Hoff put forward two independent methods for calculating the 'coefficient of ionisation' of a dissolved salt. The general concordance of their results provided a firm foundation for Arrhenius's theory of electrolytic dissociation, whilst the smaller discordances have provided material for the development of the later theory of complete ionisation. Since neither of the above methods could be used to determine the coefficient of ionisation of a fused salt, it has been supposed that the problem of determining this coefficient was insoluble. All the data that are required for a formal solution are, however, available for silver chloride at 600°, namely, molecular weight $M = 143{\cdot}34$, density $\delta = 5{\cdot}267 - 0{\cdot}00092\,t = 4{\cdot}715$, specific conductivity $\kappa = 4{\cdot}48$, viscosity $\eta = 0{\cdot}01606$ (at 603°).

The normality of the fused salt is $4715 \div 143{\cdot}34 = 32{\cdot}9\,N$; and the equivalent conductivity $\Lambda = 4{\cdot}48 \div 0{\cdot}0329 = 136$. A value for the equivalent conductivity, Λ_∞, of the completely ionised salt, can be deduced from the value in aqueous solutions, for which $\Lambda_\infty^{18} = 54 + 65 = 119$, by making a proportional correction for the increase of viscosity from 0·01056 to 0·01606; the value thus deduced is 78. Since, however, aqueous solutions are often abnormal, more importance attaches to a value deduced from Walden's relation, $\Lambda_\infty \eta_\infty \sqrt{M} = 11{\cdot}15$, which has been verified for six salts in 29 non-aqueous solvents, as well as for two 'anhydrous' salts in aqueous solution. For silver chloride, $\Lambda_\infty = 11{\cdot}15 \div 0{\cdot}01606 \div 12 = 58$. The formal values for $\alpha = \Lambda/\Lambda_\infty$ are then $136 \div 78 = 1{\cdot}74$ and $136 \div 58 = 2{\cdot}35$.

Results such as these, indicating an ionisation of about 200 per cent., have perhaps been deduced before, but have been thought to be too absurd to justify publication. They represent, however, an anomaly which merits consideration. The view that *the ions of the solvent* exhibit an exceptionally great mobility may be true of water, but is certainly not true of other solvents, and cannot therefore be used as a general explanation of the high conductivity which is characteristic of many fused salts. It is therefore more plausible to attribute this effect to the presence of multiply-charged ionic aggregates, resembling the 'ionic micelle' of a colloidal electrolyte, since these would increase both the viscosity and the conductivity of the liquid.

T. M. LOWRY.

University Chemical Laboratory,
Cambridge.

Larger Aspects of Natural Selection.

THE brilliant researches of Harrison and Garrett, wherein they succeeded in producing heritable modifications in geometrid moths by the use of lead nitrate and manganese sulphate, suggest some reflections on the relation of these phenomena to natural selection. In 1908 I wrote (*Popular Science Monthly*, Dec. 1908, p. 547): "Speaking philosophically, progressive or orthogenetic evolution—the existence of which no naturalist has any ground for doubting—must have a cause external to itself. All probability favours the idea that this did not operate once for all, but has continued in action throughout the ages. It may be found, perhaps, in the susceptibility of the hereditary mechanism to environmental influences of particular kinds, the nature of which remains for the present obscure. These reactions would fall under the operation of natural selection from the very beginning; thus a too susceptible organism would quickly be thrown out of gear and would perish; a too conservative one, unless adapted to practically unchanging types of life, would equally perish. There would be a certain optimum susceptibility, which would be preserved, and would differ for different groups. More than this, certain kinds of susceptibility would be favoured, and being once developed might, like bad habits, become harmful through the accumulation of results, resulting in extinction."

Suppose that we think of mutations as chemical changes induced by certain agents, there is apparently no reason why any of them should be adaptive, or, as we say, 'purposeful.' Yet if we think of millions of such changes, occurring during millions of years, it is evident that natural selection must operate to sort out those substances the reactions of which are more or less likely to be beneficial. This process would not go beyond a certain point, because from the viewpoint of natural selection, it is the race and not the individual that matters. If once in a hundred or a thousand times a favourable reaction occurred, that might suffice; but if it never occurred, the line would probably eventually die out. There is thus some reason for expecting a higher percentage of favourable variations than would be expected on purely chemical grounds.

T. D. A. COCKERELL.

University of Colorado, Feb. 18.

The Control of the Beat of the Fan Segments in *Chætopterus variopedatus*.

WHILE studying regeneration in the tubiculous polychæt *Chætopterus variopedatus* (Renier), some observations were made of a different nature on the rhythmically beating fan segments.

In this worm there are three such segments which beat in a co-ordinated manner, producing a strong current through its tube. The most anterior seems to act as the pacemaker and half accomplishes its beat before the middle fan starts, and this in turn is similarly in advance of the posterior fan. This sequence persists even when the three segments are together isolated from the rest of the worm, but when isolated from each other they beat independently.

In each segment the ganglion is bilobed and the system of muscles, radial and circular, is bilaterally arranged. The intersegmental tissue is greatly constricted and the segments may readily be isolated with little injury, while the ganglion may be extirpated with a needle entirely or on one side only. When destroyed on both sides the contractions cease, but if on one side, the contractions of that side only

are stopped, the other side continuing to beat in a relatively normal manner.

The anatomy of these structures has been described in detail by Joyeux-Laffuie (*Arch. Zool. exp. et gén.*, 8, p. 244; 1890). Thus each half of a fan segment acts as a single nerve muscle system under the control of the corresponding half of the ganglion, the action of which, however, is synchronised with that of the other, while the whole is subordinated, in the case of two out of three, to the influence of the segment immediately in front of it.

A further point of interest is that such isolated fan segments may readily be kept alive and beating in a stream of well-aerated sea water for four or five weeks, and so form promising material for further experimental work.

N. J. Berrill.

Zoological Department,
University College, London.

Numerical Solution of Algebraic Equations.

In his account of Newton's work in pure mathematics (Nature, Mar. 26, Suppt. p. 42), Prof. Mordell directs attention to the method of solving the cubic equation introduced by him. This method is in principle precisely that usually attributed to Horner; but the form quoted by Prof. Mordell is much more convenient in application than that given in most modern works on algebra. In the original form of the method, when we want to reduce the equation by 2, we replace y by $p+2$, and rearrange in powers of p. In the usual form we divide three times by $y-2$; thus in finding the coefficient of the second term we add 2 to the original coefficient three times instead of simply adding 6. The introduction of division resulted in a great increase in labour instead of a reduction. If there is any doubt, try it both ways and see!

The device of multiplying the roots by 10 is also, I think, undesirable, but less so. I have found it easier to dispense with it, noticing when the highest term has become too small to affect the answer. The whole equation should be multiplied by a power of 10 at intervals, so as to keep the coefficient of the *first* power of the unknown between 1 and 10.

Last year I had occasion to mark a number of solutions of a cubic equation produced in an examination. They included, to my surprise, a number by Tartaglia's method, which were almost as short as those obtained by the Newton-Horner method at its best. Tartaglia's method, of course, replaces the problem of solving the cubic by that of finding two cube roots, and in the absence of tables the extraction of one cube root is as difficult as the solution of the original equation. But tables of logarithms avoid this difficulty. For numerical work the disadvantages of Tartaglia's method, using tables, are first, that it does not work in the "irreducible case," and second, that it is not a particular case of a general method applicable to equations of all degrees.

Harold Jeffreys.

St. John's College, Cambridge.

Behind the Divining Rod.

I do not quite understand why Dr. Mill should assume (Nature, Mar. 26, p. 458) that the dowsers of my acquaintance are 'ignorant charlatans,' and they certainly have never 'impudently challenged' my studies, scientific or not. For my own part I regard these honest folk simply as self-deluded enthusiasts, and trust that no one will see in this a euphemistic equivalent; I am quite sure that at least one of my scientific friends would feel hurt if the term 'ignorant charlatan' were applied to his pet dowser.

It is fortunate that Dr. Mill knows an honest man of whose powers he is convinced. Here there is good material for serious investigation. Experiments might be devised to determine whether the subject responded to the influence of flowing water, but fortunately stationary metals, such as gold or silver, could be substituted for flowing water. This would simplify the procedure. I would suggest that a handful of similar coins, say French francs, which resemble gold, and English sovereigns, should be shuffled and then distributed into wooden boxes, all of the same size and outward appearance. The whole operation to be so conducted that the investigator himself should be ignorant of the location of the genuine noble metal and its simulacrum. This would exclude any telepathic influence. Should the dowser by 'spotting' the sovereigns emerge successfully from this test, there would then be good grounds for extended inquiry.

I may add that I am familiar with the one-sided presentation of the question which we owe to the advocacy of the late Sir William Barrett, and am unable to regard its evidence as convincing.

W. J. Sollas.

University Museum, Oxford,
Mar. 27.

Prof. Carl Runge.

Many of those who attended the meeting of Section A of the British Association at Oxford last August, distinguished as it was by the presence of so many spectroscopists and atomic theorists from various countries, will remember the peculiar pleasure, and one might say affection, roused by a really beautiful speech from that veteran mathematical spectroscopist, Prof. Runge; in which he expressed gratification at the brilliant results which were pouring forth on all sides as the outcome of earlier work in which he and some German colleagues had taken a leading part. In the peroration of that speech he pronounced on himself a touching *Nunc Dimittis*, which, alas, only five months later has been justified, though, as we learn from the obituary notice in Nature of April 9, p. 533, he had attained only seventy-one years of age.

Surely Runge felt the welcome which we gave him; and I will only quote, without comment, the concluding words of that obituary notice: "His son was killed early in the War."

Oliver Lodge.

April 9.

The Behaviour of Cultures of *Leishmania* sp. in *Phlebotomus papatasii*.

We must apologise for two errors in the note on the behaviour of cultures of Leishmania in *P. papatasii* (Nature, Jan. 8, p. 48). Sandfly No. 172 was not laboratory bred but was caught in Jerusalem, but as the infection rate in sandflies in Jerusalem is either nil or so small as to be negligible (not a single example of an infection was found during two years' dissection), this makes no difference to the conclusions deduced from the experiment. The inoculation was performed on Sept. 20, and not Sept. 26.

S. Adler.
O. Theodor.

Microbiological Institute,
Hebrew University,
Jerusalem, Feb. 14.

Philosophical Foundations of Quantum Theory.[1]

By Dr. P. JORDAN, University of Göttingen.

THE development of physics in the last decades has repeatedly raised epistemological questions of fundamental importance. Thus in the theory of relativity the problem of space and time received at least a temporary clarification. New questions have arisen in connexion with the quantum theory, and particularly the question of the existence of causal laws in elementary physical processes. Is the condition of an atomic system completely determined, or are there gaps in its determination?

Physicists no longer doubt that this question of the existence of a complete causal determination can only be settled by experience, and that causality is not an *a priori* necessity of thought. Certainly some degree of determinism is an essential condition for the possibility of physical science, as it is for any ordered and intelligible existence; and fortunately we have, if we confine ourselves to macroscopic phenomena, an apparently universal and trustworthy determinism. But for atomic phenomena this implies only a statistical determinism. The question of the causal necessity of the laws of an individual atom thus remains.

Before we attack this point it will be useful to give the notion of determinism a more precise consideration. The physicist cannot be satisfied with the approximate idea that we have of the meaning of this word. Nor is he interested in the metaphysical significance that some philosophers give it. For the physicist the definition of causality or determinism means the specification of conditions by which its existence may be experimentally established. This shows that the physical definition must continually change in accordance with the basis of our theories and facts and experimental methods. Let us consider first the rôle of causality in the classical physics of the field.

The contention of this classical physics is that the physical world may be described—and we use the word describe in a more or less purely geographical sense—by the specification of certain measurable quantities—fields, potentials, etc.—for every point of a four-dimensional region of space-time; and then the causal determinism consists in this. Let us consider a bounded volume of the space—say a parallelepiped. We shall not consider what modifications would be introduced into these considerations by taking complete account of the relativistic relations of space and time; but this would, of course, raise no difficulty. At a certain time—for example, at eleven o'clock—let the physical conditions inside the box be completely known and measured. Further, let the physical conditions of the entire surface of the box be specified from eleven until twelve o'clock. The physical phenomena in the whole box will then be uniquely determined from eleven to twelve o'clock. Thus, if we at any other time and place repeated the experiment, with the same initial conditions and the same course for the surface conditions, all of the phenomena inside the box would automatically be reproduced. Within a certain period of time—of the order of magnitude of the dimensions of the box divided by the velocity of light—the phenomena inside the box are independent of those on the surface.

These assertions are susceptible of experimental proof. Of course, we have to suppose at the beginning that the initial state within the box is not so complicated that its complete physical investigation would be entirely impossible. Thus we should have to exclude the case that there is a living organism in the box; for the notion that one could measure exactly the physical conditions is in this case not in accord with the experimental practicability. Thus the notion of determinism must be formulated differently for biology and for physics.

Let us therefore confine ourselves to a consideration of physical determinism. We may remark that this determinism is of an extraordinary kind; it is not at all equivalent to the mere existence of physical laws—the existence of mathematical relations between physical quantities. Moreover, we have here a peculiar asymmetry between the special and temporal co-ordinates; by this principle of determinism two temporally separate regions may influence each other physically; two spatially separated regions cannot.

The theoretical justification of this determinism arises from two circumstances. We shall mention these here without entering upon a mathematical proof that they really furnish this justification. In the first place, the physical laws—that is, the mathematical relations between the components of the field—are differential equations, and, in fact, to a first approximation, principally linear partial differential equations of the second order. In the second place, for the simplest four-dimensional geometry, in which the Pythagorean theorem remains valid, one must use, not the time itself, but the imaginary time, as fourth co-ordinate. If, instead of this, the four-dimensional manifold had four real dimensions, and the differential equation of physics remained unchanged, then we should have a much more complete determinism: one would then be able to deduce the state of any region of space-time from an accurate knowledge of any other specific region. If, on the other hand, the world had two real and two imaginary dimensions, there would be no determinism left. For in this case it would be possible for new motions suddenly to arise inside a box, even though there were no cause for them either within the box or at the boundary. This, then, is the significance of determinism for the physics of the field. It is not itself

[1] *Habilitationsvortrag* at the University of Göttingen. Translated by Mr. Robert Oppenheimer. The author is very much obliged to Mr. Oppenheimer for his careful translation.

a natural law ; the natural laws are the differential equations that lie at the basis of the physical field. It is a mathematical conclusion from these natural laws, a theorem from the mathematical theory of hyperbolic differential equations which has been applied to the laws of physics.

It is on this account that one must be prepared to lose this determinism in the transition from classical physics to the quantum theory. For just those physical assumptions are here discarded which we have noted as theoretical support for the existence of determinism. Even the *description* of 'physical reality' cannot, as we now know, be given in terms taken from classical physics. Physical quantities are *not* continuously propagated through space ; physical motions are not invariably continuous ; there are elementary discontinuities, there are *quantum jumps*. What remains of determinism is not necessarily more than statistical. If we work with a great many similar atoms, or repeat very often experiments with a few, then we always get a result in agreement with the principle of determinism. We have seen before that physical determinism and physical laws were not co-extensive. We must, therefore, remark that in this case what we have said for determinism holds also for all physical laws. All we know at present are laws that are essentially statistical.

In recent times important advances have been made in the discovery of these laws. One can now, for example, compute (in principle) the spectrum connected with the motion of electrons in an atom with the same assurance as, on classical dynamics, one could calculate the motions of the planets. But in spite of the analogy between the calculations, there is an important difference in the interpretation of their results. The classical calculation gives us information about our specific system of planets. The quantum theoretical calculation does not, in general, tell us anything about a single atom, but only about the mean properties of an assembly of similar atoms. One can, it is true, calculate the energy of a single atom in a certain state on the quantum theory. But that is only because the energy is the same for all atoms in this state, and the individual energy coincides with the mean. But if we consider the behaviour of the atom under external influences—*e.g.* incident light or electronic collision—we get a result that cannot be interpreted as showing that, for specific values of the phases, specific phenomena occur. We can only interpret the results of the calculation as follows : there is an assignable probability that the atom will do one thing, and an assignable probability that it will do any other.

We have a similar situation in optics. Classical optical theory yields, it is true, all interference phenomena in perfect accord with experiment. But the calculated intensity of light at a given point does not represent the actual intensity. The classical wave-field clearly only gives the probability that a quantum will reach the point. Moreover, one can find waves accompanying a material corpuscular beam which in some respects bear the same relation to the corpuscles as the light waves to the quanta. Here again we see the purely statistical nature of the present quantum theoretical laws.

We shall therefore direct our attention, not to the discrete, discontinuous details, but to the corresponding probabilities. The introduction of these probabilities brings us formally back to continuous variables, and thus, in a very important respect, to classical terms. We are therefore led to suppose that there is a principle of determinism for these continuous probabilities which is not very different from the classical principle. This is, in fact, the case, but in a somewhat more abstract way than in the classical theory.

It is known that Schrödinger, independently and by methods of his own, was able to give a formulation of the quantum theory which turned out to be mathematically equivalent to the matrix theory based on Heisenberg's ideas. He thus discovered mathematical relationships in the quantum theory, which had not before been explicitly developed. These were, it is true, implicitly involved in the matrix theory ; but their formulation represents an important addition to quantum mechanics.

In connexion with these formulæ, Schrödinger also tried to develop a new physical basis for the quantum theory. His interpretation differs fundamentally from that of Planck, Bohr, and Einstein, from the classical quantum theory based on stationary states and quantum jumps. In it he tried to return to quasi-classical conceptions, in which there were no longer any discontinuities, and in which, therefore, the classical principle of determinism was still valid. All other scientific workers, however, who had taken part in the development of quantum mechanics, were unable to accept these speculations of Schrödinger. They were sure that the new conceptions would have to be interpreted physically in close analogy with the older notions of stationary states and quantum jumps, and with Heisenberg's theory ; and that Schrödinger's relations would, like those of the matrix theory, have to be interpreted statistically. A particularly clear and satisfactory formulation of the statistical interpretation of Schrödinger's theory has been given by Born, and in what follows I shall base my argument on this.

The essential purport of Schrödinger's theory is this : that quantum mechanical laws, which were given in the matrix theory as a system of infinitely many equations with infinitely many unknowns, can instead be expressed by quite ordinary differential equations. Formally, this takes us back very close to the classical theory. Born's answer to the question as to how it is possible to represent anything in the discontinuous confusion of quantised atomic processes by differential equations, is that the function which is to satisfy the differential equation is a probability.

We shall now consider more closely this probability function, and try to make clear the analogy with the classical situation. Consider a mechanical system of two particles and six degrees of freedom ; let the continuous co-ordinates of the particles be x_1, x_2 to z_1, z_2. We now construct a space more or

less like the classical phase space, but with only half as many dimensions: a configuration space. In our example it is a six-dimensional space with the co-ordinates x_1 to z_2. We can represent the state of the system when it has specified co-ordinates and arbitrary momenta by a point in this space, which we shall call the system-point. Classically the system-point would describe a certain trajectory. But we cannot know beforehand, if we observe it at a given time at a given place in the space, how it will move, for the system-point only tells us the co-ordinates, not the momenta, of the two particles. All one can determine is the probability that the point will move in a given direction.

In the classical theory we can translate this statistical prediction into an exact one, since we can observe not merely the position but also the velocity of the system-point. But, according to Pauli, this is just the point where quantum and classical theory differ. If we can observe the co-ordinates of a quantum mechanical system—and here we use *co-ordinate* in a generalised sense, so as to include, say, the energy or the quantum numbers—then the momenta conjugate to these co-ordinates are intrinsically not observable. All we can do, therefore, is to take over the statistical problem from classical mechanics, and probably derive the solution from Schrödinger's differential equation. I say *probably*, because considerations which follow out these speculations are not yet completed.

The following question, however, which is closely connected with the one we have been considering, *can* be regarded as solved by the work of Born and Pauli. Suppose we know the energy and quantum numbers of our system—or, more generally, suppose we know the probability that the system is in any of the stationary states; what is the probability that the system-point is at a given place in the configuration space? We can answer this question at once if we know the Schrödinger wave function.

This Schrödinger function—a function of the six variables x_1 to z_2 and the time—satisfies Schrödinger's fundamental differential equation. For this probability function we can again formulate a principle of determinism. For this, of course, we have to take a box, not in ordinary space, but in the six-dimensional configuration space. Then the principle is precisely the same as in the classical theory, except that in place of the measurement of the field inside and on the boundary of the box we must now write the measurement of the Schrödinger probability function.

To recapitulate: classical physics described the world in terms of quantities continuously propagated in space and time. The quantum theory describes the world in terms of an abstract, many-dimensional configuration space, and the number of dimensions is proportional to the total number of particles in the world. In this abstract space we have again the propagation of continuous quantities; but these no longer tell us directly about the single atomic phenomenon, but rather about the probabilities of quantum processes. Determinism—not as a metaphysical distinction from chance, but in the physical sense explained above—has the same formal validity in both theories.

Of course, one can transform the quantum theoretical laws back to ordinary space, but their form is then very complicated, for the abstract space leads to the most suitable formulation of the problem. But one can still say that the complicated 3-dimensional predictions justify, roughly, what I said before—that in the mean the old 3-dimensional determinism still holds.

We have seen how it is possible, by the use of averages and probabilities, to eliminate the elementary discontinuities in physical processes, and to find relations which can be formulated mathematically by the customary methods of classical physics, methods adapted to the study of intrinsically continuous quantities. In this respect quantum mechanics constitutes a more precise version of Bohr's correspondence principle. Bohr always (it will be remembered), even in the zenith of our belief in integers, insisted that we try to establish a formal analogy with classical theory by a consideration of mean values.

Now, however, we shall return to the problem of the discontinuous elementary phenomena; we shall consider the question of how much we can say about these phenomena, granted that we can find the solution of any problem in averages, whatever their formulation. The answer to this question is not nearly so simple as one might expect; and I should be guilty of a very superficial treatment of my subject if I were not at least to point out some of the difficulties that occur in connexion with it.

Let us first of all examine the matter from the empirical point of view. One might suppose that experiments would in no case give us anything but average values. An interesting lecture given by Prof. Zernicke last summer on the Brownian movement, and in particular on the researches of Ising in Sweden, showed clearly the impassable limits to an improvement of the technique of physical measurement. It is impossible to increase the accuracy of a galvanometer, for example, beyond a certain assignable limit; it is impossible because of the Brownian movement in all parts of the apparatus. The needle, the fibres, the housing, the surrounding air, all consist of atoms in irregular thermal agitation; and the current that passes through the galvanometer consists of electrons, and therefore shows irregular variations of intensities, which can only be statistically computed and limit the efficiency of the instrument in an analogous way. When we remember that this is the case with all our apparatus, and that it all 'rattles about' in this way, we may be tempted to think that the experimentalist is quite as incapable of observing elementary processes as the quantum theorist is of predicting them. But there is a drastic method of avoiding Brownian movement. The theorist gives

the simple recipe: make the experiments at the absolute zero. Luckily, experimentalists have discovered an equivalent but less uncomfortable way. By working with particles which have a vast store of energy, *e.g.* a fast α-particle, they make the thermal agitation of the atoms negligible. And we can, in fact, largely because of the work of C. T. R. Wilson, actually observe the fate of a single α-particle, follow its trajectory, and determine the moment when the trajectory ends in a quantum jump.

The time of a single quantum jump is thus under certain conditions a measurable quantity. What predictions can our theory make on this point? The most obvious answer is that the theory only gives averages, and can tell us, on the average, how many quantum jumps will occur in any interval of time. Thus, we must conclude, the theory gives the probability that a jump will occur at a given moment; and thus, so we might be led to conclude, the exact moment is indeterminate, and all we have is a probability for the jump. But this last conclusion does not necessarily follow from the preceding one; it is an additional hypothesis. It is this hypothesis which Bohr, Kramers, and Slater tried to carry out in their theory of radiation. They realised quite clearly that this hypothesis must leave the conservation of energy as only a statistical theorem. This conclusion, of course, was disproved by the beautiful experiments of Geiger and Bothe and of Compton. We can now assert that if an atom emits light, and that if this light is propagated, unhindered by interference, to another atom, where it is absorbed, then the quantum jump of the absorbing atom occurs after a time which corresponds exactly to the distance between the atoms. Thus we see that, in some cases at least, the time of a quantum jump is determined.

One might be tempted to say: the time is determined in so far as its determination is required for conservation of energy—and no further. But this two-sided explanation is too indefinite to be of any use in complicated cases, *e.g.* where interference occurs. Another method of overcoming this difficulty was tried some time ago by Wentzel: since in our example the absorption is fully determined by the preceding emission, we could regard the two processes together as a single quantum process, and then hope that such processes would be statistically independent of each other. But this way, too, does not seem to lead to any simple formulation.

It is thus very significant that in Pauli's above-mentioned formulation nothing is said about the probability of a transition—for we saw that this could not lead to independent probabilities. What the theory does specify is the probability that the system-point be at a given place in the configuration space. One might therefore hope that these considerations would lead us to independent elementary physical probabilities.

Although we can in principle compute all probabilities on the quantum theory, a very serious problem still remains unsolved. For definiteness let us take a simple example. Let us throw two dice; and let us observe empirically that a 1 and a 3 occur together just as often as a 4 and a 5, and twice as often as two 2's, and so on. Now if we had a theory which made it possible to compute these probabilities in some very complicated and abstract way, we might be satisfied. But we are really only satisfied when we can reduce the theory to this form; for each die each of the six faces is equally probable; and the dice are statistically independent. Only when we see this do we feel that we really understand the matter.

Now, for the dice we clearly should never think of using any other theory than the one just given. But in the quantum theory the matter is different: we can at present compute all probabilities; but we cannot understand any of them. We could only say that we understood them if we had translated the calculations in configuration space into the following terms: In some cases there is no condition on what happens; either this or that can happen; they are equally likely, and what happens in one case has nothing to do with what happens in others.

In other words, we must reduce the quantum theoretical probabilities to independent elementary probabilities. Only then can we say that we really understand the laws; and only then can we tell under what conditions the time of a transition is determined. Only then can we know exactly what is causally determined, and what is left to chance.

In conclusion, let me try to bring out one more point. We have just been taking for granted that the future analysis of quantum theoretical probabilities would lead to the result that certain elementary processes were not determinate, and could happen equally probably in a variety of ways. But in fact that is not at all self-evident. The circumstance that quantum laws are laws of averages, and can only be applied statistically to specific elementary processes, is not a conclusive proof that the elementary laws themselves can only be put in terms of probability.

We can thus put in this final form our question, "Does modern physics recognise any complete determinism?"—a question which we have seen to split up into several distinct ones. Will the elementary laws for which we are looking be laws of determinism or of probability? Will it ever happen that the time of a quantum jump is undetermined?

Probably we shall find that an incomplete determinism, a certain element of pure chance, is intrinsic in these elementary physical laws. But, as I have said, a trustworthy decision will only be possible after a further analysis of quantum mechanics on the lines laid down by Born and Pauli. Perhaps I might add that pertinent considerations have been recently carried through in Copenhagen, and here in Göttingen, in what, I think, is a very promising way.

The Lister Centenary Celebrations in London.

ON April 5, 1827, there was born at Upton, in Essex, one who was destined to achieve more for the happiness of mankind than was vouchsafed to almost any other human being. Joseph Lister was the fourth child and second son of Joseph Jackson Lister, a prosperous wine merchant and also an eminent scientific worker, and fellow of the Royal Society, to whom we owe the production of the achromatic lens. He studied medicine at University College, London, and in 1852 took the M.B. degree and became also a fellow of the Royal College of Surgeons.

Acting on Prof. Sharpey's advice, Lister then went to Edinburgh, where he became closely associated with the famous surgeon James Syme, and in 1856 he married Agnes, Syme's eldest daughter. In 1860 he was appointed professor of surgery in the University of Glasgow, a post which he held for nine years, only leaving when he was elected to the Edinburgh professorship. In 1877 he was appointed to the chair of clinical surgery at King's College, London, and held this post until 1893. In 1883 he was made a baronet. In 1895 he became president of the Royal Society, and during his tenure of this office, was created a peer, on the occasion of Queen Victoria's second jubilee. At the time of King Edward's coronation he became a member of the Order of Merit. In 1908 he retired to the small seaside town of Walmer, in Kent, where four years later, on Feb. 10, he passed peacefully away, at the age of eighty-four. Lady Lister had predeceased him by some nineteen years.

This bald sketch of Lister's life will enable readers to follow more clearly the account which follows of the celebrations during the Lister centenary week in London, in which the speakers dealt with the various aspects of his life and work. For further details those interested may be referred to the chapter on the Life of Lord Lister in the Handbook of the Lister Centenary Exhibition at the Wellcome Historical Medical Museum.[1] The Glasgow period is dealt with by Sir Hector Clare Cameron,[2] and in the centenary contribution entitled "Lister and the Lister Ward in the Royal Infirmary of Glasgow,"[3] wherein accounts are given of the beginnings of antiseptic surgery and of the fruitless efforts made by scientific men the world over to save the Lister ward from demolition: the Edinburgh period is described in interesting detail by Dr. J. R. Leeson.[4]

The centenary celebrations commenced in London on Monday, April 4, when about a hundred delegates from all parts of the world were received by the King at Buckingham Palace. An address was presented by Sir Ernest Rutherford, president of the Royal Society, to which His Majesty replied. In the afternoon the Listerian Society held a meeting at King's College Hospital, with Mr. Arthur Cheatle in the chair. Sir Watson Cheyne, in the course of his address, said that the outcome of Lister's work was perhaps more widespread than that of any of the great statesmen, generals, philosophers or religious teachers, and its influence on mankind was not limited to any country or race. Sir Watson described how he himself, with a few other chosen associates, accompanied Lister from Edinburgh to King's College Hospital as apostles of the new methods in surgery. Like all pioneers, Lister met with much opposition in promulgating his views, and London was probably one of the last places in the world to accept them. The speaker referred also to Lister's conscientiousness, both in the treatment of his patients and in his lectures: for the latter he endeavoured, by his own experiments, to prove any points which appeared to him doubtful. The difficulties in advising treatment were greatly enhanced by the fact that only some surgeons practised antisepsis; thus an operation which might be justifiable, performed antiseptically, would be contra-indicated if the additional risk of sepsis had to be run.

In the evening a reception was held at the Royal Society of Medicine, when Sir St. Clair Thomson gave an address entitled "A House Surgeon's Memories." He said that Lister achieved more for mankind than all the surgeons from the beginning of history. For centuries the results of surgical wounds had scarcely improved at all: but Lister's teaching has saved more lives than all the military heroes of all the ages have destroyed. Sir St. Clair was associated with Lister at King's College Hospital; at his inaugural lecture he described experiments showing that neither milk nor blood had any inherent tendency to putrefaction, and if drawn under what we should call 'sterile' conditions, would remain free from putrefaction indefinitely. Lister's classes were strangely neglected by the students, probably owing to the fact that his work did not find favour with the examiners of the period, so that his teaching was of little use in helping a man to pass his examination. London was not backward in demonstrating that a prophet was not without honour except in his own country. But in ten years' time, with a new generation of surgeons springing up, Lister's technique had become widely followed. Sir St. Clair referred also to his scientific spirit. In 1875, Queen Victoria, to whom only one side of the question had been presented, wrote to Lister asking him to take action to suppress vivisection. Lister wrote to the private secretary as follows: "I should deeply regret that I cannot see my way to comply with this request, were I not persuaded that my duty so would not promote the real good of the community, which I know to be Her Majesty's only object in the matter."

On Tuesday, April 6, the delegates to the centenary celebrations were received by the Prime Minister in the Great Hall of the British Medical

[1] Lister Centenary Exhibition at the Wellcome Historical Medical Museum: Handbook, 1927. (The Wellcome Foundation, Ltd., London.)
[2] "Centenary of Lord Lister, 1827-1927. Reminiscences of Lister and of his Work in the Wards of the Glasgow Royal Infirmary, 1860-1869. By Sir Hector Clare Cameron. (Glasgow University Publications, 6.) Pp. 45+3 plates. (Glasgow: Jackson, Wylie and Co., 1927.) 1s. net.
[3] "Lister and the Lister Ward in the Royal Infirmary of Glasgow: a Centenary Contribution." Pp. xvi+132+28 plates. (Glasgow: Jackson, Wylie and Co., 1927.) 12s. 6d. net.
[4] "Lister as I knew Him." By Dr. John Rudd Leeson. Pp. xii+12+7 plates. (London: Baillière, Tindall and Cox, 1927.) 8s. 6d. net.

Association, Tavistock Square. Sir Ernest Rutherford was in the chair and was accompanied by Mr. R. G. Hogarth, president of the British Medical Association. Sir Ernest, in the course of a few introductory remarks, said that it was not necessary to be a specialist to recognise the debt the whole world owes to Lister's discoveries and his single-minded devotion to the cause of suffering humanity. Mr. Baldwin recalled that it was two years after Lister came to London, and before he had obtained that recognition which was afterwards lavished upon him, that at an international congress in Amsterdam, he was greeted by the chairman in these words: "Prof. Lister, it is not only our admiration which we offer you; it is our gratitude and that of the nations to which we belong." These words were echoed years later, not by an Englishman but by an American, at a dinner of the Royal Society, when Mr. Bayard, the American Ambassador, in proposing Lister's health, said: "My lord, it is not a profession, it is not a nation, it is humanity itself which with uncovered head salutes you." The Prime Minister said that they had come to greet the memory of a great master workman in his own craft, the man who pursued his science empirically and who also, by applying newly discovered knowledge to practical problems throughout his life, brought more relief and comfort to the human race than almost any man who has lived. At the same time, as a statesman he (Mr. Baldwin) felt he could pay tribute to Lister's character, his wonderful simplicity and integrity, for he was a man who loved the truth, gentle and filled with charity and self-devotion, a man with never a mean thought.

After the Prime Minister had greeted each delegate, Prof. Henri Hartmann of Paris and Prof. Max Ritter von Gruber, of Munich, spoke on the influence Lister's practice had on pathological and surgical science and practice in their own countries.

On Wednesday, April 6, a thanksgiving service was held in Westminster Abbey, in the morning, which was attended by the delegates, and by representatives of the Royal Society and of the Royal Colleges of Surgeons and Physicians. The service was conducted by Canon Nixon, and the Bishop of Birmingham, Dr. E. W. Barnes, delivered an address. He said that Lister owed much to his Quaker ancestry, and perhaps it was not fanciful to see in the ability of his father, and in a touch of Celtic imagination derived from his mother, the source of his genius. He certainly received in his home life influences which made his character the worthy servant of his genius. Throughout his life he retained the Christian faith of his childhood: at the time of his marriage he ceased to belong to the Society of Friends and became, like his wife, a member of the Scottish Episcopal Church. He combined the hope of personal immortality with faith in the goodness of the Creator, and when his life was drawing to a close, he publicly expressed his conviction that "there is no antagonism between the religion of Jesus Christ and any fact scientifically established." He was convinced of the power of goodness and was a loyal servant of the truth. Dr. Barnes continued by saying that man differs from all other animals in possessing a soul. Is it possible that, by virtue of the mental powers which set man apart, he will conquer disease and pain and thus, in the end, prepare the way for a Kingdom of God upon earth? Will medical and moral victories combine to make human life equal to human hopes? The achievements of great men give substance to our hopes, and we thank God, he said, for the example of a single-minded devotion to science which will inspire others to work for the welfare of the human race.

In the afternoon a meeting was held at the rooms of the Royal Society of Medicine, at which tributes were paid to Lister as physiologist, bacteriologist, and surgeon. Sir Ernest Rutherford was again in the chair.

Sir Charles Sherrington spoke on Lister as a physiologist. He said that Lister's first paper, published when he was twenty-five years of age, was on the "Contractile Tissue of the Iris," done with the microscope, which he used for the study of function rather than of form alone. It was only natural, considering the interest his father took in optical science, that young Lister should employ the microscope in his first research. His second paper was on the involuntary muscle cells of the skin, and it is of interest to note, in connexion with his later characteristics, certain expressions used in these papers, such as "the grand discovery of plain muscle cells" and "the beautiful muscle of the iris." These phrases throw light on the eagerness with which he threw himself into research. These papers reveal points in Lister's original nature: a catholic enthusiasm for research and a restless testing of authority by observed fact: in short, a fear of nothing except of missing the truth. Four years later, a further paper on involuntary muscle appeared, in which Lister proved, once again, its cellular nature; but this was the last on this particular theme: his interests had turned to surgery and pathology and his physiological research became merely collateral to the pathological studies engaging his main thoughts. His earlier work in this field was related to the problems of inflammation, and dealt with the nervous control of arteries and the inhibitory nature of certain visceral nerves; but after the year 1859 none of his work was directly related to physiology. Yet by means of his work on antisepsis and by the development of his surgical technique he enriched physiology with the contribution of enhanced means towards its own cherished aims. Without Lister's surgical principles, how could Pavlov have achieved his epoch-opening study of the digestive processes, or Ferrier initiated his work on localisation of cerebral function? How could the Toronto physiologists, barely four years ago, have bestowed upon diabetic sufferers that merciful remedy insulin? The experimentalist indeed owes to Lister an instrument of research the beneficent future of which the boldest imagination may well halt to set limit to. At the same time, while

helping man to mastery over disease alike for animal and man, he contributed to free that necessary experimentation from the infliction of pain. Thus it is that through the years to come, after indeed the actual physiological papers may have become matter chiefly for the historian and antiquarian, Lister will still receive his meed of commemoration from the physiologist and experimentalist. It is therefore with peculiar gratitude that the physiologist brings his tribute of admiration and veneration to the memory of one great even among the greatest of the benefactors of humanity, Joseph Lister.

Prof. William Bulloch then gave an account of Lister as a pathologist and bacteriologist. The main part of the address covered the same ground as that of the article entitled "Some Aspects of Lister's Scientific Work," which Prof. Bulloch contributed to our issue on April 9, p. 531.

In the third and final address Sir Berkeley Moynihan paid an eloquent tribute to Lister as a surgeon. He said that seldom is a great discovery the product of one man's mind: in the work of other men it has ancestors—forerunners possessing one or more attributes the final and felicitous association of which within new work constitutes new truth. The claim may then arise that those who have revealed isolated and antecedent truths have priority in the final discovery. Such truths are, however, only progenitors, with no claim to be regarded as their own descendant—the new truth itself. Lister did for the craft of surgery what John Hunter had done for its science. When he first began his work, operations were few owing to the danger of putrefaction in the wound, followed in almost all cases by death. Even the simplest operation was a great anxiety to the surgeon, from the ever-present fear of suppuration developing. Lister's discovery was very gradual. His earliest surgical inquiries dealt with inflammation and the coagulation of the blood, but his chief interest lay always in the problem of the healing of wounds. He had arrived at the conclusion that the essential cause of suppuration in wounds was decomposition brought about by the atmosphere acting upon blood and serum retained in them, or upon portions of destroyed tissues, but since oxygen was considered to be the agent causing this putrefaction, it appeared hopeless to devise a method by which suppuration might be prevented. But when Pasteur had shown that putrefaction was caused by minute organisms suspended in the air, a method of prevention at once came to his mind, to apply to the wound some substance which would destroy the micro-organisms without injuring the body tissues. Still later he developed a method by which the organisms might be destroyed before they had even entered the wound. Around every step of his advance fierce controversy raged; the scepticism of early contemporaries was stupid, unimaginative, and petty. But the history of science frequently discloses this bitter opposition to new truths, as in the case of Harvey and Pasteur and other famous men. Lister's answer was unfaltering continuance in inquiry and experiment, with demonstration of his results. The heavily infected wounds seen during the War has enabled us to realise much more acutely the problems which confronted Lister at the beginning of his work, and has increased our admiration for the way he overcame them. Although Lister sought to destroy the organisms which might enter a wound, yet he was not blind to the natural resistance of the body's cells to infection, so that a natural step was the development of aseptic surgery in which organisms are prevented from entering a wound so far as possible, and any that do can then be dealt with by the body's own bactericidal forces. There is no real clash between 'antiseptic' and 'aseptic' methods, for no surgeon ever practised with success a method which omitted the use of agents for the destruction of organisms. The consequences of Lister's work were many and far-reaching: when the few operations which were practised in those days became safe it was obvious that others might be attempted, and thus has grown up the science and art of modern surgery. Ovariotomy was one of the first operations to be made safe; and once it was found that the abdomen could be safely opened, a vast field of usefulness was before the surgeon. The cranial and thoracic cavities then became accessible to surgical methods of treatment, so that nowadays almost all parts of the body can be safely submitted to surgical operation. Not the least of the debts we owe to Lister is the curability of cancer if complete surgical removal is practised in the early stages of the disease. We may almost claim that the full effect of Lister's work is now accomplished. The art of surgery is far in advance of the sciences on which its future progress depends. The great search must be for methods of applying new discoveries in other sciences to the study of disease.

To the honoured dead we raise our monuments; but Lister's living and enduring memorial is a great and even greater multitude of men, women, and children of every nation, of every race, of every creed, through his mercy and by the skill of his most gentle hand relieved from infirmity and suffering and sorrow and made for a time triumphant over death itself. It is immortal Lister we salute to-day, the supreme benefactor of mankind.

In concluding, attention must be directed to the Lister Centenary Exhibition at the Wellcome Historical Medical Museum in Wigmore Street. The collection was opened by Sir W. Watson Cheyne, in the absence of Mr. Wellcome, on the evening of Thursday, April 7. The most striking exhibit is probably the section of the old Lister Ward from the Glasgow Royal Infirmary, in which Lister practised his antiseptic system of surgery between 1861 and 1869. The furniture and fittings are from the Ward when it was demolished in 1924. The collection comprises an extensive and highly interesting series of exhibits relating to all aspects of Lister's life and work, including instruments and apparatus used by him, reproductions of various experiments performed by him, his diplomas and certificates, and photographs of those associated with him in his work.

Obituary.

Dr. F. B. Power.

During his stay in Great Britain, Dr. Frederick Belding Power made many friends among chemists, who will regret to learn of his death from heart failure in Washington on Mar. 30. He was born at Hudson, in New York State, in 1853, and at the early age of thirteen years was apprenticed to a local pharmacist. This direct connexion with pharmacy was continued up to 1874, when, after securing his diploma at the Philadelphia College of Pharmacy, Power went to Strasbourg, where he took his Ph.D. in 1880. Returning to the United States, he held, among other teaching appointments, the professorship of materia medica and pharmacy at Wisconsin University.

Among his fellow-students at the Philadelphia College of Pharmacy was Mr. Henry S. Wellcome, and when the latter established the Wellcome Chemical Research Laboratories in 1896, he invited Dr. Power to become the first director. From 1896 until 1914, Power and his assistants maintained a remarkable output of papers dealing mainly with the constituents of plants. Fellows of the Chemical Society will remember the occasions on which these papers were read, for the lecture table was always decorated with an extensive series of small glass bottles, each containing a specimen of one of the constituents isolated from the plant under discussion. Each bottle was labelled in Power's meticulously careful caligraphy, and the bottles were always arranged in the precise order in which the author would describe their contents. These ranged from simple fatty acids to the most complex of glucosides or alkaloids and all the solids were beautifully crystallised. Power belonged to the generation of chemists who were primarily interested in the isolation of the constituents of plants in a pure state, and his papers devote little or no attention to speculation on the origin of these substances or to their possible bearing on biological relationships, but they form a mine of information, upon which in due course bio-chemists interested in these things will be able to draw.

The work of Power and his collaborators, among whom Mr. Tutin and Mr. Barrowcliffe should be specially mentioned, has already borne fruit in at least one direction, for it is upon the results of their researches on the peculiar acids of chaulmoogra and hydnocarpus oils that the whole of the modern treatment of leprosy is based. Similarly, they did much to extend our knowledge of the distribution of sterols in plants, and in view of the recent discovery of the connexion between certain types of sterols and vitamin D, this work may prove of considerable scientific interest.

In 1914, Power returned to the United States, where he carried on similar work in the phytochemical laboratory of the United States Department of Agriculture. In the previous year he had been awarded the Hanbury Medal by a joint committee of the Chemical, Linnean, and Pharmaceutical Societies of Great Britain, an award peculiarly fitting for so untiring a pioneer in plant chemistry, and one which he regarded as not the least among the many of which he was the recipient.

Dr. John Brownlee.

The unexpected death of Dr. John Brownlee, after an illness of little more than two days, has removed one of the very few highly trained research workers in the field of biological and medical statistics. Dr. Brownlee, who was in his sixtieth year, had been, since 1914, Statistician to the Medical Research Council and Director of the Council's Statistical Department at the National Institute of Medical Research. He was a graduate in arts, science, and medicine of the University of Glasgow, and obtained first-class honours in mathematics and natural philosophy. Before his appointment by the Medical Research Council he had held several important medical posts and successfully directed two large hospitals for infectious diseases.

Brownlee's scientific output was very large; he was the author of more than eighty separate papers. He was particularly interested in the study of periodicity in epidemic disease and, in a series of memoirs, applied the method of periodogram analysis to the data of all the important infectious diseases. Perhaps the most complete of these memoirs was that dealing with measles, which was published in the *Philosophical Transactions of the Royal Society* (Ser. B, vol. 208 and 209, 1917 and 1918). He was also intensely interested in the application to the phenomena of human physiology of physico-chemical laws; his numerous papers on this topic, and the zeal with which he sought to apply physico-chemical equations, led his very numerous friends to rally him on holding that the general law of life was a geometrical progression.

These subjects, however, by no means exhausted Brownlee's energies. Within the medical field his work on the epidemiology of phthisis and various more specialised papers upon infectious disease were important, while his contributions to the study of Scottish anthropology and archæology are noteworthy. His range of scholarship was extremely wide and his outlook philosophical. Valuable as have been his individual contributions to science, it is regrettable that he never carried out an intention he once formed of preparing a comprehensive treatise which would have given full scope for his powers. Dr. Brownlee has left a gap which it is impossible to fill, for he combined technical knowledge and wide intellectual culture in a way which is unfortunately rare in the younger generation of investigators.

News and Views.

THE Imperial Conference of last year, at which the self-governing Dominions and India were represented, is to be followed by a Conference—the first of its kind—called by the Colonial Office, which will be attended by representatives of the non-self-governing Colonies, Protectorates, and Mandated Territories. Most of these dependencies will be represented by their governors or by a senior official, and officers of the specialised services who are on leave will be invited to be present at discussions of papers and addresses dealing with matters of particular concern to their several departments. The Conference will hold its first meeting on May 10. Its main object will be to secure more effective co-operation between the various Colonial governments in matters of general interest. The items for the agenda are grouped under the headings: (*a*) Questions of general administration; (*b*) economic questions covering trade and communications; (*c*) problems of technical services. In each of the three sections matters of particular interest to scientific and technical workers are down for discussion. Under (*a*) there should be an interesting interchange of views on "the relation of technical to administrative services," which is to follow a subject of particular significance to the Colonial services, the recruiting and training of Colonial civil servants. It would be a healthy sign if consideration of this subject were to embrace the principles governing the selection of Colonial governors themselves. Far too many men of high rank in the Navy or Army have been made governors of the dependencies of the Crown as a reward for past services of a character which often unfitted them for the essentially creative work of controlling the destinies of backward peoples.

IT is to be hoped that due publicity will be given to the proceedings of this Conference. The papers dealing with such matters as "Recent Developments in Mechanical Transport," where the results of experiments with various types of trackless mechanical vehicles will be given; the progress and possibilities of "Civil Air Development" as affecting the various territories; and "Wireless Communications," should contain much information of value to technicians at home who are interested in these matters, apart altogether from their particular interest to home traders and manufacturers. Under "Problems of Technical Services" special emphasis is to be put upon the need and the means whereby to effect co-operation and exchange of information in research and technical matters. This subject, it will be remembered, assumed great importance at the last Imperial Conference. Most of the activities of the specialised services, health, agriculture, forestry, education, are to be dealt with, but it is to be regretted that no specific mention is made of the geological surveys or of the departments of mines. The number of Crown Colonies which maintain such surveys may not be large, but the activities of the existing surveys are sufficiently important to be brought to the notice of the Conference.

THE new radio beam service to Australia was opened to the public on Friday, April 8. The messages are dispatched in London by the ordinary Wheatstone machines and pass automatically by land line to the sending station at Grimsby. They are then sent by a beam of radio waves on their 10,000-mile journey to the Australian receiving station at Rockbank. Finally they travel by land line into the receiving office at Melbourne. The messages coming from Australia to Great Britain pass from Melbourne to Ballan, a distance of 55 miles; then from Ballan to Skegness, and finally to London by land line. It is interesting to learn that it is possible to direct the beam either eastward over Europe and Asia, or westward over America and the Pacific. In the reverse direction this can also be done from Melbourne. The route is chosen according to the time of day. It is found that radio signals travel better at night, and so the darker of the two paths is chosen. The signals take one-eighteenth of a second to travel from the transmitter on the one continent to the receiver on the other. The speed of transmission is governed only by the limitations of the transmitting and recording instruments used. The Marconi Company contracted to provide a system which would work at the rate of 100 words per minute, in both directions at once, for seven hours a day. The performance largely exceeds the minimum specified. The working has been carried out for 18 hours out of the 24, and for several hours the speed has been at the rate of 200 words a minute. On test also the speed was worked up to 325 words a minute. It is stated that the Indian and South African radio beam links will be ready for tests in a few weeks' time. The Canadian beam link has been working since last October.

MR. H. FRANKFORT'S preliminary summary of the results obtained from excavations carried out by the Egypt Exploration Society during the past winter at Tell el-Amarna, which appeared in the *Morning Post* of April 4 and 5, suggests that his report, when published in full, will prove of exceptional interest in the light it will throw on the everyday life of the ordinary individual. One part of the work has been directed to the investigation of a suburb of the city founded by Aken-aten, which was populated, not to say over-populated, by members of the middle and lower classes. It has revealed the plan and domestic economy of private residences ranging in size from the 'comfortable' down to the mere hovel. It has been found, for example, that in the larger houses the kitchen was situated at some distance away from the main structure; in the smaller it was erected against the wall of the building, and access to the dining-room was provided by means of an entrance from one of the loggias, which were a characteristic of these residences to secure coolness. Some interesting and instructive examples of bed- and bath-rooms were found in a state of good preservation. In houses even of this size the domestic

apartments were shut off from the public or official reception room, with which they communicated by a corridor. It is interesting to note that notwithstanding the prevalence of the official *aton* or sun-disc worship, as shown by the numerous shrines found in courtyards or by the wayside, the population of this suburb still clung to its belief in the efficacy of amuletic deities, such as Bes, the cow-eared Hathor and Tauert. One of the shrines produced a small red crystalline sandstone head of one of the youngest daughters of Aken-aten. Its peculiar conformation recalls that of the head of her father, and lends further support to the view that this shape was not due to disease, but was congenital and possibly a family characteristic. It was found to occur in the head of Tut-ank-amen when his mummy was unwrapped, and has given rise to the suggestion that he was the son as well as the son-in-law of the Heretic King.

Another discovery which is of considerable interest in relation to the court life and organisation of early Egypt is announced in the *Times* of April 7. The expedition of the Vienna Academy of Sciences has discovered on its concession near Giza, among sun-brick tombs of the Sixth Dynasty, a quadrangular room roofed with a well-preserved brick dome with corbels. Such domes hitherto were not known before Roman times, but are thus proved to go back so far as 3000 B.C. In a statue room adjoining the false door of the *mastaba* is a closed stone coffin with two slit-shaped openings, in one of which is a very fine group of painted limestone representing the owner, Senab, and his wife and children. Here and in the paintings and inscriptions of a votive offering table, Senab is shown as a dwarf. He was superintendent of the dwarfs in charge of the king's wardrobe, and it is clear from the inscriptions that he was possessed of considerable wealth. It is remarkable, and at the same time significant, that while he is depicted in such a way as to suggest a lowly origin, his wife was a princess. The question of the origin, character, and position of dwarfs at the royal court of Egypt is one of considerable interest. A connexion with pygmy races has been suggested; but in all probability they were pathological. A number of cases of pathological dwarfism have been recorded from Africa.

Although several centenary celebrations are being held this year, bicentenary celebrations are, comparatively speaking, very rare. All such celebrations are by their very nature apt to be ephemeral in their appeal to the public interest, but efforts are being made to mark in some fruitful way and locally the recent bicentenary of Isaac Newton, who received his early schooling at the old King's School at Grantham in Lincolnshire. A scheme has been inaugurated by the Mayor of Grantham to raise a fund to found an Isaac Newton scholarship in natural science and mathematics for the benefit of the boys of Newton's old school. Locally about £1500 has already been raised towards the £5000 or £6000 which is required. Such a scholarship would be a strong incentive to the boys of his own native place to develop the scientific side of their education, and would surely be a fitting memorial of Newton's great genius. The success of the scheme will ensure that no boy from Newton's own countryside and town, with real scientific talents, will be prevented by lack of means from receiving the benefits of a university education. Donations to the fund should be sent to the Mayor, The Mayor's Parlour, Grantham, Lincs.

In a paper read to the Institution of Electrical Engineers on Mar. 31, W. McClelland, the director of electrical engineering to the Admiralty, discussed the applications of electricity in warships. He pointed out that the Washington Treaty has made naval superiority by means of large warships impossible. There has therefore been intense concentration on improving the efficiency of the unit and on improving its design. The weight and size of every piece of apparatus has to be reduced to the minimum and everything superfluous has to be eliminated. The Treaty has therefore forced on naval designers very exacting problems. He stated that the two new aircraft carriers of the U.S. Navy have a speed of about 35 knots and each develop 180,000 shaft horse power; that is, their output is equal to that of a modern super-power electric station. Electric propulsion of ships has not yet been largely adopted in Great Britain, possibly because at full load the efficiency of turbo-electric transmission is somewhat less than that of the geared turbine. The development of radio communication enables a navy board to keep in touch with fleets dispersed throughout the world. In a battleship there are some 700 telephones, including loud-speaking telephones for use in noisy compartments and for broadcasting. It is interesting to note that in the motor boats of the fleet, electric starting and lighting sets working at 12 volts, and very similar to an ordinary motor-car starting and lighting equipment, are used.

The first Empire Mining and Metallurgical Congress was inaugurated at Wembley in 1924, when it was decided to arrange for a triennial meeting. The invitation for the second congress came from Canada, where the opening session will be held in Montreal on Aug. 22 next. There will also be sessions in Toronto, Winnipeg, and Vancouver, and the full programme, which includes visits to most of the principal mining centres, metallurgical works, and places of scenic interest, will occupy about six weeks. The Canadian Institute of Mining and Metallurgy is the convening body on this occasion, the other constituent organisations being the Institute of Metals, the Institutions of Mining Engineers, Mining and Metallurgy and Petroleum Technologists, and the Iron and Steel Institute (all of London); the Chemical, Metallurgical and Mining Society of South Africa, the South African Institution of Engineers, the Australian Institute of Mining and Metallurgy, and the Mining and Geological Institute of India. A large attendance is now certain; members are expected from all parts of the Empire, and there will be representatives from nearly every civilised country.

About 300 are going from Great Britain, including more than 100 ladies. The business side of the Congress includes the consideration of papers giving valuable information on the mining and metallurgical conditions in the scattered units of the Empire; there will also be under discussion certain broad problems of Empire policy in relation to metals and minerals. No efforts are being spared by the organisers to make the Congress a most valuable educational opportunity. A magnificent round tour has been arranged from Montreal to Vancouver and back, approximating 7500 miles, and a rather shorter tour has been planned in eastern Canada and Newfoundland. Elaborate arrangements are being made for the comfort and entertainment of the visitors. Communications should be sent to the Secretary-General of the Congress, 225 City Road, E.C.1.

THE first number of a new quarterly review devoted to archæology made its appearance on Mar. 15. The title is *Antiquity*, and its editor is Mr. O. G. S. Crawford. In his editorial notes Mr. Crawford describes the aim of the new publication, which will be to attempt to summarise and criticise the work of those who are revealing the past. As he rightly says: "Here and there attempts are made to summarise a period or interpret a group of facts; but they seldom reach the general public, and remain buried in obscure publications." The editor has secured the co-operation of a distinguished body of archæologists, who will contribute first-hand information about their own researches. The field is world-wide and the subjects are of the most varied character. The review will not confine itself too rigidly to the past. "The past often lives on in the present. We cannot see the men who built and defended the hill-top settlements of Wessex; but we can learn much from living people who inhabit similar sites to-day in Algeria."

THE first number of this review abundantly justifies its promise, as a list of the articles and authors will show. We have first an article on "Lyonesse," by the editor; then "The Roman Frontier in Britain," by Mr. R. G. Collingwood; "Orientation," by Admiral Boyle-Somerville; "Stonehenge as an Astronomical Testament," by Mr. A. P. Trotter; "Prehistoric Ways," by Mr. R. C. C. Clay; "Maori Hill-Forts," by Mr. Raymond Firth; "The Danube Thoroughfare," by Prof. V. G. Childe; and last but not least, "Prehistoric Timber Circles," by Mrs. Cunnington. These articles are followed by notes and news and some valuable indications of forthcoming excavations, with nearly twenty pages of reviews of recent publications. If we were to select one article for mention it would be, perhaps, Mrs. Cunnington's on "Prehistoric Timber Circles," in which an authoritative account is given of the excavation of a monument of a type hitherto undiscovered in Great Britain, which, so far as is at present known, has only one parallel—in Holland. The discovery of this circle, called appropriately "Woodhenge," was originally made by Squadron Leader Insall, V.C., whilst flying near Stonehenge on Dec. 12, 1925, but its true nature was not ascertained by him until flying in July 1926, when the wheat was well over the site. His photographs, taken on the latter occasion, are reproduced and show ring shadows and concentric rings of dots, caused by irregularity in the growth of the wheat, due to the ancient excavations. But *Antiquity* is full of such good things, written in a way to interest the general public as well as those who are more immediately concerned with archæology. We welcome its appearance, and we congratulate all those connected with its publication. All communications should be addressed to Mr. Crawford, Ordnance Survey Office, Southampton.

THE annual report of the Rockefeller Foundation for 1925 has recently been issued, and the year's work is reviewed by the president, Dr. George E. Vincent. Through its departmental agencies somewhat more than 9,000,000 dollars were expended. The governments of eighteen countries were aided to combat hookworm disease. Rural health services were helped in American States and in Brazil, Poland, Czechoslovakia, Austria, and France. Precautionary measures were instituted against yellow fever in the Central American States and in Brazil, and a yellow-fever commission was sent to West Africa. Contributions were made to the League of Nations' international study tours. Malaria control was demonstrated or aided in American States and in Brazil, Argentina, and Italy. Contributions were made to public health teaching and medical education in a number of cities and countries, including Cambridge, Edinburgh, and Montreal. Nursing education, mental hygiene, and biological research were also assisted. This list by no means exhausts the activities of the Foundation, and 350,000 dollars, to be spread over ten years, have been allocated towards the cost of a journal of biological abstracts on an international basis.

AFTER nearly thirty-five years of activity, during which it has done so much admirable work, the Imperial Earthquake Investigation Committee in Japan has been replaced by a new body, the Earthquake Research Institute, with wider aims. The Investigation Committee, founded shortly after the great Mino-Owari earthquake of 1891, was designed for practical purposes, though the Committee has always given a liberal interpretation to its instructions, and most of its contributions have been in the domain of pure seismology. The new Institute has its headquarters in the Imperial University of Tokyo, and its sole object is to be scientific research, the practical work of the old Committee being continued by the Earthquake Advisory Council in the Department of Public Instructions. The staff of the Institute includes all the leading seismologists of Japan, the director being Prof. K. Suyehiro. The *Bulletin* issued by it is an expansion of that published by the Investigation Committee, though, unfortunately for European readers, all the papers in the first number are written in Japanese instead of in English. They are, however, preceded by very brief summaries either in French or English.

THE Mellon Institute of Industrial Research, University of Pittsburgh, is primarily a technological experiment station, but the need for fundamental scientific research as a background and source of stimulus for research on behalf of industry has always been recognised. During the past five years the Institute has been giving an increasing amount of attention to the encouragement and support of research in pure chemistry, and has been progressively successful in arranging for funds for investigations not suggested by industry, but planned within the Institute for the study of basic problems. Since 1922 Dr. Leonard H. Cretcher has been in charge of the Institute's research in pure chemistry, and has contributed a number of papers to the literature. Hitherto these investigations have been conducted in accordance with the Institute's fellowship system, but the Director, Dr. E. R. Weidlein, has recently announced the establishment of a definite department of research in pure chemistry, with Dr. Cretcher as its head. Dr. Cretcher will supervise all the Institute's purely scientific studies in chemistry, and will also act as an adviser to those holders of industrial fellowships who are carrying on research on specific problems in synthetic organic chemistry. The new department will be operated as an integral part of the Institute and will be sustained by institutional subsidy. Dr. Cretcher will be assisted by Dr. William L. Nelson as fellow in pure chemistry. Dr. Nelson was formerly a member of the staff of the department of chemistry of the University of Pittsburgh.

OPINIONS 91-97 rendered by the International Commission on Zoological Nomenclature have been published by the Smithsonian Institution in its Miscellaneous Collections. To the Official List of stable generic names there have been added, as fulfilling all requirements of the rules, the names of 35 Mammalia, 9 Reptilia, 3 Amphibia, 4 Pisces, 5 Tunicata, 17 Mollusca, and 2 Protozoa. The following 12 names of Pisces, now current, have been added to the same list by suspension of the rules (as *fiat* names), with the genotypes as given in parentheses: *Conger* Cuv., 1817 (*Muræna conger* L.); *Coregonus Linn.*, 1758 (*Salmo lavaretus* L.); *Electris* Bloch and Schneider, 1801 (*gyrinus* Cuv. and Val.); *Epinephelus* Bloch, 1792 (*marginalis* Bloch); *Gymnothorax* Bloch, 1795 (*reticularis* Bloch); *Malapterurus* Lacépède, 1803 (*Silurus electricus* L.); *Mustelus* Linck, 1790 (*Squalus mustelus* L. [= *Mustelus lævis*]); *Polynemus* Linn., 1758 (*paradiseus* L.); *Sciæna* Linn., 1758 (*umbra* L. = *Cheilodipterus aquila* Lacép. restr. Cuv. 1815); *Serranus* Cuv. (*Perca cabrilla* L.); *Stolephorus* Lacép., 1803 (*commersonianus* Lacép.); *Teuthis* Linn., 1766 (*javus* L.). Conchologists will be delighted or dismayed to learn that the *Museum Boltenianum* (1798) is accepted as nomenclatorially available. With like diversity of feeling entomologists will take note that the "generic" (?) names in Hübner's "Tentamen" (1806) are ruled out—first, as not published; secondly, as *nomina nuda*. At any rate it is good to have these long-controverted questions authoritatively settled.

IN the *Quarterly Review of Biology*, vol. 1, No. 4, Dr. Raymond Pearl publishes an interesting comparison of the prices charged for scientific books, as received in the United States from various countries. The most expensive are books first manufactured and published in Great Britain and then published in the United States by an American branch of the original firm. Next come those published in various unnamed countries, and then the books published in England and directly imported into the United States. It appears that the cost of running a branch in America adds 20 per cent. to the price of an English book; but this includes duty. American books published in the United States are only 12½ per cent. cheaper than books published in England; but German books are 10 per cent. less, and this is rather surprising in view of recent complaints that certain German publishers have been making a corner and forcing up prices. French books, thanks to the failure of their publishers to keep pace with the franc, have averaged little more than a quarter the price of English books. In comparing French and German books with English and American, it should be remembered that the former are generally in paper wrappers and the latter generally cased.

JOHN E. TEEPLE, consulting engineer, New York City, has been awarded the Perkin medal by the American Section of the Society of Chemical Industry for "significant scientific, technical and administrative achievements, particularly the economic development of an American potassium industry at Searles Lake, California." This medal is awarded "annually to the American chemist who has most distinguished himself by his services to applied chemistry," and was founded in 1906 at the time of the fiftieth anniversary of the coal-tar discoveries, the first medal being awarded to Sir William H. Perkin himself.

MR. HUGH C. SAMPSON, formerly Director of Agriculture, Madras, has been appointed economic botanist at the Royal Botanic Gardens, Kew. This appointment has been made possible by a grant of £4000 for five years from the Empire Marketing Board, through the Ministry of Agriculture and Fisheries. The object of the grant is to promote that co-operation of Kew with the Dominions and Colonies which has already proved of great value in the introduction of new staples and the development of natural vegetable resources in new territory. Part of the grant will be available for sending out botanical collecting expeditions. Since his retirement, Mr. Sampson has been engaged in research on cotton and other economic products in Nyasaland under the Empire Cotton Growing Association.

THE fourth International Congress of Theoretical and Applied Limnology is to be held at Rome in September 1927; the exact dates and details of the programme are to be published later. It is proposed to organise limnological excursions around Rome and the regions of central and northern Italy and Naples, while a Limnological Exhibition will be held in Rome and a Fishery Exhibition in Como. Intention to be

present and titles of papers proposed to be presented should be communicated without delay to the Organising Committee of the Congress, R. Laboratorio Centrale di Idrobiologia, Via Tiburtina, Roma 38.

A YEAR ago the "Sanitation Supplements" issued with the *Tropical Diseases Bulletin* were discontinued and replaced by a monthly *Bulletin of Hygiene*, for the review of the literature of public health and preventive medicine, of which we have received No. 1 of vol. 2, 1927. It contains summaries and reviews of publications on all branches of public health and preventive medicine, and is intended to meet more particularly the needs of Britain overseas. The Bulletin is issued by the Bureau of Hygiene and Tropical Diseases, 23 Endsleigh Gardens, W.C.1, at the subscription price of 21*s*. per annum.

THE latest catalogue (No. 493) of Mr. F. Edwards, 83A High Street, W.1, is devoted to works relating to Canada and Arctic discovery. Particulars of nearly 600 volumes, maps, drawings, etc., are given. The catalogue is to be had free upon application.

WE have just received from Messrs. Bernard Quaritch, Ltd. (11 Grafton Street, London, W.1), a copy of Catalogue (No. 407) of upwards of 1900 works on zoology, geology, and palæontology. The list should be of very great interest to librarians and others, seeing that it gives particulars of important publications many of which are of extreme rarity.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An analyst at the Building Research Station of the Department of Scientific and Industrial Research—The Director, Building Research Station, Bucknall's Lane, Garston, nr. Watford (April 25). An advisory officer on farm economics under the Board of Agriculture for Scotland—The Secretary, Board of Agriculture for Scotland, York Buildings, Queen Street, Edinburgh (April 30). A bio-chemist at the General Hospital, Birmingham—The House Governor of the Hospital (May 2). An assistant demonstrator in physics (woman) at the Royal Holloway College—The Principal, Royal Holloway College, Englefield Green, Surrey (May 7). A laboratory assistant in connexion with the Imperial Bureau of Entomology, for work relating to living insects—The Assistant Director of the Bureau, 41 Queen's Gate, S.W.7. A laboratory attendant in histology at University College—Prof. J. P. Hill, University College, Gower Street, W.C.1. A woman lecturer in geography and science at the Truro Diocesan Training College—The Principal. A lecturer in geography at St. Mary's Training College, Strawberry Hill, Middlesex—The Principal. A male laboratory assistant for a biochemical laboratory—The Wellcome Physiological Research Laboratories, Beckenham. A professor of agriculture, and lecturer in dairy bacteriology, dairy technology, dairy chemistry, dairy engineering, and dairy accountancy and economics at the University College, Cork—The Secretary.

Our Astronomical Column.

COMETS.—Comet Comas Sola, 1926*f*, is still well placed in the evening sky. Several observers have noticed a short tail.

The following photographic observation is by F. J. Hargreaves, measured by G. Merton:

U.T.	R.A. 1927·0.	N. Decl.	Mag.
Mar. 23·8729	$4^h\ 36^m\ 26{\cdot}67^s$	$30°\ 27'\ 45{\cdot}5''$	12·5

It had a central condensation, 5″ in diameter; ephemeris for 0^h:

	R.A.	N. Decl.	log Δ.
Apr. 14.	$5^h\ 36^m\ 6^s$	32° 41′	0·305
22.	5 59 56	33 3	0·319
30.	6 24 6	33 14	0·332

Mr. B. Strömgren has revised the orbit of Stearns's comet, using observations until Mar. 31, and obtains:

T	1927 Mar. 20·2338 U.T.	
ω	10° 38′·63	1927·0
Ω	214 36 ·67	
i	87 33 ·38	
log *q*	0·56631	

It has the fourth largest perihelion distance known.

EPHEMERIS FOR 0^h.

	R.A.	N. Decl.
Apr. 13.	$14^h\ 57^m\ 9^s$	4° 41′
21.	14 49 59	7 42
29.	14 42 20	10 37
May 7.	14 34 31	13 18

THE DETONATING METEOR OF OCT. 2, 1926.—In a reprint from the *Meteorological Magazine* (Dec. 1926 and Jan. 1927), Mr. F. J. Whipple has detailed observations made to investigate the velocity of sound transmission from meteor observations, as it seems possible that the temperature of the air may materially affect the rate of motion of sound waves.

The great Yorkshire meteor of Sept. 6, 1926, which gave a loud detonation, promised an opportunity for such inquiries, but unfortunately the observations were not of desirable accuracy.

Another fireball appeared on Oct. 2 moving up from south to north over the Channel, west of London, and on to Hertford. An appeal for data was made through the medium of the Air Ministry, and 700 responses were received at the Kew Observatory.

The evidence from the Yorkshire meteor convinced Mr. Whipple that the thunder-like noise was produced by the mere passage of the meteor through the air. The sharp detonation of the meteor of Oct. 2 had a similar origin. Mr. Whipple remarks that Dr. Wegener had previously formed these conclusions from his study of the fireball of April 3, 1916. "Wegener points out the analogy with the noise produced by the passage of a shell fired from a big gun. It is well known that a projectile moving through the air with a velocity exceeding that of sound makes a wave like the bow-wave from a ship. This wave when it reaches an observer is heard as a sharp crack. The crack is followed by a rumbling noise which may be attributed to the irregularities in the aerial disturbance. The nature of these ballistic waves is expounded at length in a recent work by Prof. Ernest Esclangon, the pioneer of sound-ranging."

"As the meteor of Oct. 2 was moving about 70 times as fast as sound, the ballistic wave must have taken the form of a very sharp cone, nearly a cylinder. That sound was not heard beyond the end of the meteor's track may be analogous to the fact that the ballistic wave from a shell is not heard behind the gun."

Research Items.

Niue (Savage Island).—As the result of seven months' field work in Niue, Mr. Edwin M. Loeb has collected evidence relating to the ancient customs, history, and traditions of the island which has been published as Bulletin 32 of the Bernice P. Bishop Museum, Honolulu. The population of Niue has been decreasing steadily since early missionary days, but the decline is now said to have run its course. During the year 1922 the deaths were 21·69 per thousand; the births 26·18. One of the prominent features of its culture is the division of the island into endogamous hostile moieties—a division which it is fairly safe to conclude is due to separate migrations. Historical traditions record three such migrations; minor differences of language, mythology, and physique still appear between the two ends of the island, and these were probably much greater in prehistoric times. The most important piece of evidence, however, is the difference in physique between the inhabitants of Motu and Tafiti. The people are undoubtedly of Polynesian stock. They lived under very primitive conditions, *i.e.* their political and social organisation was far less highly differentiated than that of other Polynesian peoples. Not only was a well-developed system of government lacking; but also the people themselves were not grouped according to crafts and occupations. There was no actual priestly class, and to the lack of power in the priestly class may be due the absence of the attribution of divinity to the ruling classes, of the taboo on women, and of the caste system imposed on the common people—features of Polynesian culture which developed at a relatively late date. There is also a lack of lengthy genealogies and of a well-developed stock of mythologies. Probably Niue was settled at an early date and, owing to its isolation, preserved its primitive institutions long after its neighbours had been converted to theocratic rule. It perhaps represents an archaic type of social organisation once common to all Polynesian peoples.

Middle American Archæological Research.—In Year Book No. 25 of the Carnegie Institution of Washington, which covers the year 1925–26, Dr. Sylvanus G. Morley reports on the work of archæological exploration in Central America which is being carried on under the Institution. This is becoming of increasing importance as the excavation and preservation of the Maya site of Chichen Itza progresses. This work is fully described by Dr. Morley and Mr. E. H. Morris in dealing with the Temple of the Warriors and the North-west Colonnade. Among a further number of noteworthy examples of Maya art, special mention is made of examples of painting in which the colours, having been shielded from light and air, have been preserved in a remarkable manner. These, with others which have come to light, serve to show the importance of colour rather than of relief in these examples of Maya artistic technique. Important as this work is, it is overshadowed by the interest of the expedition of the Institution to Coba and also to Chetumal Bay in Yucatan, where the date inscription discovered by Dr. T. W. Gann, and giving the date A.D. 333, was examined. At Coba, the discovery of the site Macanxoc with eight Initial Series on May 24 constitutes one of the most important contributions to Central American archæology of the last five years. It practically trebles the Initial Series known from the Peninsula of Yucatan, and promises to throw a flood of light on the early history of the country. The dates of these series run in ten-year periods from A.D. 354 to A.D. 413. Two other monuments of which the inscriptions are illegible probably completed the sequence. The significance of Macanxoc lies in the fact that the latest date antedates the earliest date at Chichen Itza by more than two centuries, and pushes back the discovery of Yucatan a century earlier than the date for that event given in the Books of Chilan Balam.

Freshwater Eels in Java.—An interesting addition to our knowledge of the distribution of freshwater eels has been made by Dr. H. C. Delsman in Java (*Treubia*, vol. 9, 4; 1926, and *De Tropische Natuur*, No. 10; 1926). The work was undertaken in response to a suggestion of Dr Johs. Schmidt in his recent survey of the freshwater eels of the Indo-Pacific Region, that if zoologists in Java would study the distribution there, much light would be thrown on the problem. In the Indo-Malayan area, *i.e.* the shallow sea surrounded by the Malay Peninsula, Cochin China, and the islands of Sumatra, Borneo, and Java, Dr. Schmidt noted the scarcity or absence of these eels, whereas they were abundant all round this region. He assumed that the larvæ of the Pacific species of Anguilla are inferior in migratory power to the Atlantic species and that they are unable to migrate through shallow water, and so are only found in numbers on the coasts facing deep water. Dr. Delsman's investigations resulted in a complete confirmation of Dr. Schmidt's conclusions. He found two species of freshwater eel common in Java, the mottled *Anguilla mauritiana* and the smooth *A. bicolor*, called 'dog-eel' by the natives and considered by them 'unclean' for food. They were present in all the rivers of the south coast and on the east and west as well, but were absent from the rivers of by far the largest part of the north coast. The suggestion is made that the development of the tropical species is accelerated by the higher temperature, so that the distance covered by the larvæ during their migration must be shorter than in the cooler seas. An excellent map of Java is given showing the extent and results of the survey.

The Insect Fauna of the lesser-known Hawaiian Islands.—Changes in the fauna of the Hawaiian Islands through the demolition of native forests and the extension of cultivation have resulted in the extermination of certain of the endemic insects. At the same time, the maritime importance of Honolulu as 'the cross roads' of the Pacific has facilitated the entry through commerce of many alien species. In view of this process of subtraction and addition that is still altering the indigenous fauna to-day, the foresight of those Englishmen who inaugurated the "Fauna Hawaiiensis," and saw it through to completion, becomes increasingly evident. This work is the scientific basis for all subsequent progress in Hawaiian entomology but, at the time of its completion, the fauna of certain of the small outlying islets, north-west of the Island of Kauai, was little known. In 1923 the *Tanager* expedition made a biological survey of these remote areas and also of the still more distant Johnston and Wake Islands. A report on the insects by Mr. E. H. Bryan, jun., and collaborators, has recently appeared as Bulletin 31 of the Bernice P. Bishop Museum, Honolulu (1926). Many of these islets betray evidences of the landing of man thereon, in the occurrence of cosmopolitan insects. Perhaps the most unexpected record is the presence of the Diamond back moth (*Plutella maculipennis*) on most of the areas surveyed, including the remote Wake Island. The establishment of a cable station on Sand Island explains the presence of certain insects un-

doubtedly introduced from Honolulu. Of the two truly indigenous butterflies found in the larger Hawaiian Islands, *Lycæna bætica* occurs only on Necker Island among the islets fringing the archipelago, while the migrant *Hypolimnas bolina* was only met with on Wake Island. Among the new species described in this bulletin, nine are parasitic Hymenoptera, sixteen are Coleoptera, and five are Lepidoptera.

A NEW SPECIES OF PARAGONIMUS.—A. Gulati (*Mem. Dept. Agr. India*, Veterinary Series, vol. 3, No. 8, 1926) describes a new species of Paragonimus (*P. edwardsi*) from the lung of a palm civet (*Paradoxurus grayi*). Eight cysts were found in the lungs and in each were two flukes, the principal organs of which are described, but the accompanying illustrations are somewhat crude.

STUDIES ON SANGUINICOLA.—Dr. L. Ejsmont describes (*Bull. Acad. Polon. Sci. et Lettres*, Ser. B, 1925, pp. 877-966 + 4 pls.) the structure and development of three species of the trematode Sanguinicola. The majority of the worms were obtained from the heart and bulbus arteriosus of tench and carp (*Cyprinus carpio* and *Carassius carassius*). The largest number of worms (which are usually 0·6 mm. to 1 mm. long) found in any one heart was thirty. The distinctive characters of the genus and of the three species are given in detail. *S. armata* occurs only in tench; *S. inermis* was found exclusively in *Cyprinus carpio*, and *S. intermedia* n.sp. in Carassius. The author has found sporocysts and two species of cercariæ of Sanguinicola in *Limnaea stagnalis* and *Bithynia leachi*, and suggests that the smaller cercaria from Limnæa belongs to *Sanguinicola intermedia*, and the larger one from Bithynia to *S. armata*. A table is given showing the characters of other blood-inhabiting trematodes.

PRESERVATION OF WILD NATURE IN CRIMEA.—The flora and fauna of the Crimea are of special interest since these include a large number of typically Mediterranean elements and a considerable percentage of truly endemic forms. With the view of preserving natural conditions in their virgin state, a national reservation was recently formed stretching over 23,000 hectares (*Priroda*, No. 2, 1927), and comprising uplands rising to 1500 metres, covered with forests of Crimean beech (*Fagus taurica*) and oaks (three species). Amongst other interesting plants are large juniper trees (*Juniperus foetidissima*), some of which are 500 years old; trees of *Taxus baccata*, which species is dying out in Crimea; and white birch, which occurs here only in single specimens, as a relict of a colder age. Mammals occurring in the preserved area include the local race of deer, an endemic species of marten (*Martes rosanovi*), and others, while birds are also represented by local species and races. Since 1925 a biological and a meteorological station have been organised; the latter is specially engaged in a study of the importance of mountain forests for condensation and preservation of moisture, this being a very important economic problem in the Crimea, where deforestation of mountains resulted, as in many other countries, in diminution of the mountain streams necessary for irrigation of lower-lying parts of the country. In 1926 a small local museum was established.

POISONOUS PLANTS OF SOUTH AFRICA.—The problem of stock-raising in a comparatively new country is often complicated by the rôle played by the poisonous plants of the region, and it takes many years of the trial and error method before the poisonous forms can be definitely separated from the harmless species. In this connexion the Botanical Survey of South Africa has performed a useful service to the agricultural community in publishing Memoir 9, "A Preliminary List of the Known Poisonous Plants Found in S. Africa." The knowledge incorporated in this work is mainly due to the researches carried out by the Division of Veterinary Education and Research, and while the information is yet incomplete, sufficient data have been collected to warrant a botanical description of such species as have been definitely proved poisonous. The fifty-one species of plants included have been shown by experimental feeding tests to be injurious to stock, or by chemical analyses to contain poisonous substances. A brief description of each plant is given, and a key to the genera facilitates identification of the various forms, which are illustrated by twenty coloured plates. In addition, notes on the symptoms and diseases produced are appended for each species.

ELECTRIC CURRENTS AND PLANT TISSUES.—Prof. H. H. Dixon and T. A. Bennet-Clark have investigated the responses of plant tissues to electric currents for the purpose of establishing some quantitative relation between stimulus and response, and their results shed some light on the mechanism of control of permeability (*Scientific Proceedings of Royal Dublin Society*, vol. 18 (N.S.), No. 29, Feb. 1927). By observing the response in the actual stimulated cells themselves, the uncertainties connected with the propagation of the stimulus, and the conversion of the propagated stimulus into response, are eliminated. The authors find that the passage of an electrical current through a tissue leads to a change in the electrical resistance and the permeability of the tissue. Pieces of *Hedera helix* cut 1 cm. square were used. A moderate stimulus (120 volts for 0·1 sec.) is immediately followed by a very rapid fall in resistance, the rate of which becomes less rapid. After a few slight undulations, recovery takes place in about an hour, and resistance becomes the same as before stimulation. It is found that response to a stimulus does not develop instantaneously, and maximum change in permeability is only attained 5 min.-10 min. after stimulation. This seems to indicate that the change cannot be entirely due to concentration of ions in the vicinity of the membrane, and it seems probable that the change in concentration of ions produced by stimulation initiates a secondary colloidal change, taking time to reach its maximum and affecting the structure of the semi-permeable membrane. It is supposed that the ability of a current to stimulate a cell is determined by the potential difference across the membrane of the cell.

REVERSAL OF MAGNETIC DIP IN GEOLOGICAL TIME.—Perhaps the most interesting feature of the December issue of *Terrestrial Magnetism and Atmospheric Electricity* is a letter by P. L. Mercanton on a possible inversion of magnetic dip in the course of geological ages. Volcanic lavas in cooling are found to take up a feeble degree of magnetisation, which is very stable and is along the direction and proportional to the intensity of the magnetic field at the point; this occurs after the lava has ceased to be capable of much change of form, and therefore the direction of magnetisation as now observed indicates the direction of the earth's field at the time of setting of the lava, except for any later tilting of the whole lava layer. It is found that the magnetisation of lava specimens is unaffected by considerable artificial impacts. In view of these facts, it is of extreme interest that specimens of lava from Spitsbergen, Greenland, and Jan Mayen indicated almost without exception a magnetic dip of sign contrary to that now existing in Arctic regions. The lava was of tertiary epoch.

More recently, specimens have been obtained, through Sir Edgeworth David and others, of lava from Queensland and New South Wales; they also appear to show a reversal of magnetic dip in the southern hemisphere in permocarboniferous times. These results are so astonishing and of such great significance for any theory of the origin of the earth's magnetic field that it is to be hoped that they will impel other investigators to make similar measurements on specimens from other parts of the globe.

COALFIELDS OF WALES.—The National Museum of Wales has published a pamphlet by Dr. F. J. North: "Coal and the Coalfields in Wales" (Cardiff: National Museum of Wales; London: Oxford University Press; 1*s.*) in order to make the Museum exhibits relating to the coalfields of Wales more readily intelligible. The work consists of a description of coal and its constitution, of the manner in which coal is produced, and of the general geological condition under which it was deposited. There is also a brief description of the animal and vegetable life of the Coal Measure period. The South Wales coalfield and the coalfields of North Wales are each described in some detail, the useful mineral products other than coal which are obtainable from the rocks of the Carboniferous period are briefly discussed, and the work terminates with a bibliography in which all the works referred to in the present publication are catalogued. The little work is written in a simple and straightforward style, and should answer quite satisfactorily its purpose of giving a clear idea of the origin and nature of coal to the general reader. It has been carefully done, and few errors have been noted.

ELECTRON SCATTERING IN HELIUM.—The March number of the *Physical Review* contains a full account of Dr. E. G. Dymond's work on the scattering of electrons by helium atoms. A preliminary account of these difficult experiments was given in NATURE a short while ago (Sept. 4, 1926, p. 336). Differential pumping has to be utilised to maintain a very low pressure in the analysing chamber, and yet have the necessarily higher pressure of about 0·05 mm. in the attached collision chamber. In the latter, the magnetic field of the analysing coils has to be neutralised by means of an auxiliary solenoid, whilst the electron currents are so small that it is frequently necessary to use a Compton electrometer with a sensitivity of 25,000 mm. per volt in order to measure them. The principal loss of energy for the slower electrons is due to excitation of the 2^1S state (20·5 volts); for faster incident pencils there is an increasingly larger number of electrons which suffer retardation over a continuous range between 22 volts and several hundred volts. The angular distribution curve of electrons which have lost energy equivalent to 20·5 volts is a rosette pattern with a number of maxima, the main one being in the forward direction. As is pointed out by Dr. Dymond, the complete investigation will take a considerable time, because of the presence of three variables, the initial velocity of the electrons, their velocity after collision, and the angle of scattering. The field which has been opened up is, however, very wide, and future results may be expected to have an important bearing on the development of atomic theory.

THE PROPAGATION OF FLAME.—The observations of Mason and Wheeler on the propagation of flame in inflammable gas mixtures have raised the question as to whether the conduction of heat is one of the factors which determine flame speeds. A comparison of the speeds of flame in mixtures of different thermal conductivity should test the mechanism of flame propagation. For this reason H. F. Coward and G. W. Jones have determined the speed of uniform movement of flame in mixtures of methane with air, and with artificial atmospheres of oxygen with argon or helium. The results are reported in the *Journal of the American Chemical Society* (Feb. 1927), and they show that the transference of energy, whether by conduction or radiation, is so rapid that little change in the flame speed is observed. It is evident that the most important factors are the amount of heat developed, the heat capacities of the constituents, and the rate of reaction.

FATIGUE OF METALS IN THE PRESENCE OF CHEMICALS.—Reports and Memoranda No. 1054 of the Aeronautical Research Committee (London: H.M.S.O. 1*s.* net), by G. D. Lehmann, discusses "The Variation in the Fatigue Strength of Metals when tested in the Presence of Different Liquids." Some work has previously been done on similar lines by Haigh, J. A. Jones, G. Slater, S. C. Langdon, and others. The present experiments concern researches carried out in the engineering laboratories at Oxford on the suggestion of the Elasticity and Fatigue Sub-Committee of the Aeronautical Research Committee. The most unusual result found is the increase of the fatigue limit by 6 per cent. when the steel was tested in the presence of common salt. Wöhler fatigue tests have been made on standard steels in the presence of hot aqueous solutions of sodium nitrate, in sodium or ammonium chloride, in water, after the steel had been pickled in sulphuric acid, and in oil. Control tests were made in hot water and in air at the atmospheric temperature. The results show that oil has no effect, while ammonium chloride reduced the fatigue strength 16 per cent., and sodium chloride *raised* it by 6 per cent. Sodium nitrate produced no effect on a steel with 0·33 per cent. carbon, but lowered the fatigue limit of 0·13 per cent. carbon steel by 4 per cent. Pickling reduced the fatigue strength by about 8 per cent.

ACTIVITY COEFFICIENTS OF ELECTROLYTES.—The *Journal of the American Chemical Society* (Feb. 1927) contains two interesting papers on the activity coefficients of electrolytes determined by the solubility method. The first paper, by V. K. La Mer, C. V. King, and C. F. Mason, describes measurements made to test the validity of the Debye-Hückel limiting law when applied to salts of high symmetric valence type. Luteo-cobaltammine ferricyanide is a very suitable salt for this purpose, and its solubility was determined in solutions of potassium nitrate, magnesium sulphate, and sodium chloride. The results obtained for the first two solutions are in excellent agreement with the law, but with sodium chloride there are noticeable discrepancies. Nevertheless, the data are interpreted as substantiating the limiting law, at least in its broader aspects. The second paper, by La Mer and Mason, concerns the activity coefficients of salts of high unsymmetric valence type, in this case two cobaltammine salts with the luteo ion as cation. The limiting law was confirmed for a number of solvent salts containing univalent anions, but with solvent salts having anions of higher valency, marked discrepancies were noticed. It is believed that these deviations are due to the fact that the higher terms in the Debye-Hückel expression for the density of electricity have been neglected, factors which become most pronounced for solutions of this type. Qualitative agreement is obtained when these terms are taken into account, and further experiments are in progress to test the truth of the modified principles when applied to examples in which the present form of theory fails.

James Hutton: Father of Modern Geology, 1726–1797.[1]

JAMES HUTTON has been justly claimed by Sir Archibald Geikie as the 'father of modern geology.' He was born and bred in Edinburgh, where his father had held the post of City Treasurer. From the High School he went to the University. A chance reference to the potency of *aqua regia*, introduced by way of illustration in a lecture on logic, turned his young fancy to thoughts of chemistry. He followed up the subject in a lexicon; and, when presently apprenticed to a lawyer, he spent his time in making chemical experiments rather than in copying papers. "With much good sense and kindness," Playfair naïvely remarks, his employer "released him from his obligations." Medicine now seemed the only refuge. Hutton studied in Edinburgh, Paris, and Leyden, where he graduated; but he never practised. His chemical experiments, wonderful to relate, found commercial application; and, with an income in prospect, he turned to agriculture. For experience he went to Norfolk, and it was in England that he first developed an interest in geology.

It is impossible to follow Hutton in detail as Berwickshire farmer and Edinburgh man of science. He travelled considerably, he experimented, he read, and he conversed. He inspired enthusiasm in his circle; and it is mainly through his friends, and after his death, that he exercised an influence upon the course of geology. Playfair's "Illustrations of the Huttonian Theory of the Earth" appeared in 1802 and supplied the foundations upon which Lyell in 1830 reared his "Principles of Geology." Hutton himself was one of those great men who write badly. His "Theory of the Earth," whether we turn to it in the first volume of the *Transactions of the Edinburgh Royal Society*, or in its later expanded book form, is almost unreadable.

Hutton made his mistakes, and in his more important discoveries he was sometimes in part anticipated. This much must be taken almost for granted in presenting a brief account of his achievements. There is, however, one failing that must be mentioned for fear that readers, discovering it for themselves, may be unduly alarmed. Hutton continually explains geological phenomena on the basis of design—"the purpose of this earth," he assures us, "is evidently to maintain vegetable and animal life." Most readers will consider this mode of expression unscientific; but they must always remember that Hutton has righted himself, not only in practice, but also in words. "In the use of means," he explains, "we are not to prescribe to Nature those alone which we think suitable for the purpose, in our narrow view. It is our business to learn of Nature (that is by observation) the ways and means which in her wisdom are adopted."

Hutton's comprehensive contribution to geology is that the past should be, so far as possible, interpreted in the light of the present. His individual discoveries may be enumerated under five headings as follows:

(1) IGNEOUS ROCKS.—Hutton recognised basalt, porphyry, and granite as igneous rocks. The ideas which led him to look for igneous rocks are open to criticism; but the criteria of character and behaviour which he adopted for distinguishing these rocks from sediments have proved trustworthy in most of their applications. Verification of scientific prophecy is always pleasant. Hutton foretold the intrusive relations of granite from inspection of its unstratified crystalline appearance. He confirmed his expectations by visiting Glen Tilt and Arran.

Without going into detail we may recall that Hutton would not admit that any of the Scottish igneous rocks had reached the surface; all were, for him, "subterraneous lavas." The credit of recognising ancient surface lavas belongs to Hutton's contemporaries, Arduino and Desmarest, working in recently extinct volcanic tracts of southern Europe.

(2) ELEVATION.—Hutton claimed that the ancient consolidated sediments now so widely exposed to view have been elevated. Most other geologists had withdrawn the sea, instead of elevating the sediments. Hutton, however, emphasised the folded and fractured nature of the upheaved sediments. He also looked for, and found, *unconformities*, which proved to his satisfaction that cycles of elevation and erosion are followed by cycles of depression and sedimentation.

(3) EROSION.—Hutton's conception of the connexion of landscape with commonplace erosion is strikingly modern in its more essential features. It is true that in this great matter he was anticipated by Desmarest—so far as publication is concerned; but there can be no question of the originality of his views, and of the influence they had upon the development of science. "From the top of the decaying pyramids to the sea," he says, in summarising his arguments, "throughout the whole of this long course, we may see some part of the mountain moving some part of the way. What more can we wish? Nothing but time."

(4) GEOLOGICAL TIME.—Hutton realised to the full the immensity of geological time. He had satisfied himself that the various processes of erosion are observable realities, and that they stand in causal relationship to the details of landscape. He was undeterred by the fact that Roman roads can still be traced across the hills of Britain, and that one of their sea-baths cut into the rocks of the Mediterranean shore remains unspoilt. His deduction is confident. The antiquity of history is but the yesterday of geology. In geology itself he saw "no vestige of a beginning—no prospect of an end."

(5) GLACIERS.—Although Hutton was often puzzled by the transport of boulders in his native land, he did not conjure up Scottish glaciers to do the work. On the other hand, he did propose a former vast extension of existent Swiss glaciers to account for the distribution of Mont Blanc boulders which de Saussure had ascribed to deluges. "Let us now consider," he says, "the height of the Alps, in general, to have been much greater than it is at present; and this is a supposition of which we have no reason to suspect the fallacy, for the wasted summits of those mountains attest its truth. There would then have been immense valleys of ice sliding down in all directions towards the lower country, and carrying large blocks of granite to a great distance, where they would be variously deposited, and many of them remain an object of admiration to after ages, conjecturing from whence or how they came."

After perusing Hutton's "Theory of the Earth," the reader may well inquire whether there is any fundamental geological conception to which the author has not contributed. There is one. Hutton used fossils as an indication of ancient conditions of deposit and as evidence of upheaval. He did not recognise the succession of life which they record. Scottish fossils are not as a rule so unlike modern forms as are the ammonites of England. It was natural for Newton's contemporary Hooke (1635–1703) to surmise on the extinction of ancient organisms; and for Hutton's contemporary, William Smith (1769–1839), to establish that "strata" can be "identified by their organised fossils." No Scottish geologist need grudge these laurels to the Southerner.

[1] From the bicentenary address, delivered on Feb. 16 by E. B. Bailey, to the Edinburgh Geological Society.

The Morphology of Filterable Viruses.

THREE brief papers in the December number of the *Journal of the Royal Microscopical Society* by J. E. Barnard, J. Smiles, and F. V. Welch, discuss the great difficulties of determining the outward forms of the filterable viruses, and some contribution is made towards improved methods of attack. Mr. Barnard states that all ordinary bacteria may be stained and their size and form demonstrated if they are not less than 0·2 μ in diameter. The virus of bovine pleuro-pneumonia, which can be definitely and readily grown in artificial media, comes within this limit, but its minute size has precluded any satisfactory knowledge of its real appearance and of any possible phases through which it may pass in its growth cycle. Staining processes, moreover, have not helped matters.

Mr. Smiles has, by the aid of a dark-ground illuminator and an unstopped oil-immersion objective of 2 mm. focal length and 1·20 N.A., attempted to follow the changes in shape which occur in the virus bodies growing in fluid medium. Drawings of the observed changes are given, and it would appear that, in young culture, grouping of the organism is the chief feature. These groups consist of spherical, aspherical, and granular forms with occasional elliptical and cylindrical masses. These may be so closely apposed to each other as to render difficult the definition of connecting links. Short connecting filaments of low visibility have, however, been detected. As the culture ages, the number of organisms per group diminishes, and finally the culture shows merely single spheres, some with attached granules and some without, and also free granules. Mr. Smiles suggests that in growth the initial spherical form elongates to form the cylindrical type, and this latter breaks up again into two or three small spherical or granular forms. After 48 hours' incubation the cylindrical form may again break up into a chain of four or five granules which finally assume spherical form.

In the course of his work Mr. Smiles has also made use of pleuro-pneumonia cultures grown on thin films of media on ordinary microscopic slips as described by Mr. F. V. Welch. The method employed by him is eminently suitable for the object in view. It should not, however, be described as a new method, but only as one of many modifications of an old and extremely useful method for studying cultural growth *in situ* both in the fresh and in the fixed and stained condition.

University and Educational Intelligence.

THE annual conference of the Association of Teachers in Technical Institutions will be held this year at Plymouth on Friday, June 3–Tuesday, June 7. The provisional programme includes, in addition to the business of the Conference, a number of excursions. Arrangements are being made to visit, amongst other places, the Seale Hayne Agricultural College and the Marine Biological Laboratory, Plymouth. An important feature will be an educational and industrial exhibition in the Guildhall on June 4–10.

APPLICATIONS are invited for the Astley Cooper Studentship at Guy's Hospital, value £150 per annum, plus an additional sum of £50 for expenses. The studentship is tenable for three years. By the terms of the will of the founder, the studentship may not be awarded to any member of the staff of Guy's or St. Thomas's Hospitals, or to any one related by blood or affinity to them. Particulars may be obtained from Mr. C. H. Fagge, Guy's Hospital, S.E.1. The latest date for the receipt of applications for the studentship is May 31.

THE Charles Lathrop Pack Forestry Trust, founded by Mr. Charles Lathrop Pack, president of the American Tree Association, has given 130,000 dollars for the endowment of a research professorship in forest soils in Cornell University. Generous provision has also been made for the expenses of the advanced investigations to be undertaken, which will be done in the New York State College of Agriculture. The proposed work is a new development in forest research in the United States. Mr. Pack has made other large gifts for the promotion and support of education in forestry. Recently announcement was made concerning the Charles Lathrop Pack Demonstration Forest, 2500 acres of white-pine land on the main Adirondack highway near Lake George; and he has given land or endowments to other American forestry schools, including the New York State College of Forestry, the Yale Forest School, and the University of Washington.

THE fifth Pan-American Child Congress is to be held at Havana in Cuba with the official support of the Government. Owing to difficulties arising from the hurricane the date has been postponed until December 1927. An international exhibition on child hygiene will be held in connexion with the meeting. The Congress will be divided into six sections, dealing with medicine, hygiene, sociology, education, psychology and legislation, and the languages admitted will be Spanish, English, Portuguese, and French. There will be two governmental sessions, for official delegates only; at these, resolutions prepared by the committee will be put to the vote. A draft programme has been prepared with twelve leading topics for each section. As compared with other educational conferences it is interesting to note the great stress on the medical aspects of our problems. The Secretary-General is Dr. Felix Hurtado, Circulo Medico (Malecon 15), Habana. Some information in English typescript has also been circulated by the Commissioner of Education, United States Department of the Interior, Bureau of Education, Washington.

AFTER an experimental period of five years, a record of which is given in the Report of the Central Scholarships Committee of the Ministry of Agriculture and Fisheries (London: H.M.S.O.), the Government has decided to continue the awards of scholarships for the sons and daughters of agricultural workers under a slightly modified scheme. Junior scholarships are provided for short courses in agriculture, horticulture, dairying or poultry-keeping at farm institutes, while senior scholarships are intended for diploma or degree courses in agricultural, veterinary, or allied sciences at universities or appropriate colleges. The senior grade is normally reached after passing through the junior grade, but certain exceptions may be made. All scholarships will allow of attendance at the courses free of cost to the parents. Candidates must be either *bona fide* workers in agriculture or sons or daughters of agricultural or rural workmen, or of working bailiffs and smallholders whose means are comparable with those of agricultural workmen. Provided that a sufficient number of suitable applications are received, about one hundred and twenty junior, ten extended junior, and ten senior scholarships will be awarded this year. Forms of application, to be returned before April 30, and full particulars may be obtained from the Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, London, S.W.1, or locally from the offices of County Councils.

Calendar of Discovery and Invention.

April 17, 1823.—Though Dalton in 1801 had remarked, "There can scarcely be a doubt entertained respecting the reducibility of all elastic fluids of whatever kind into liquids, and we ought not to despair of effecting it in low temperatures and by strong pressures exerted on the unmixed gases," it was not until 1823 that the question was submitted to systematic experiment. Faraday then first obtained liquid chloride and afterwards liquid carbonic acid, ammonia, etc. The details of this work were given to the Royal Society by Faraday in two papers dated Mar. 13 and April 10, and on April 17, Davy in another paper suggested the employment of some of these substances as mechanical agents.

April 17, 1891.—Mechanical traction on common roads long met with opposition from the authorities, and it was an important gain when on April 17, 1891, Leon Serpollet received authorisation to place his steam cars on the streets of Paris.

April 19, 1758.—On this day John Dollond obtained a patent for his achromatic telescope, and that same year he received the Copley Medal "for his curious experiments and discoveries concerning the different refrangibility of the rays of light," communicated to the Royal Society.

April 21, 1686.—As is well known, the publication of Newton's "Principia" was mainly due to Halley. On April 21, 1686, Halley read "A Discourse concerning Gravity" to the Royal Society as preparation for the "incomparable treatise of motion almost ready for the press"; six days later, Dr. Vincent presented to the Society the manuscript of the first book of the "Principia," and on May 19 the Society resolved that "Mr. Newton's Philosophiæ Naturalis Principia Mathematica be printed forthwith in quarto, in a fair letter."

April 21, 1783.—One of the great scientific controversies of the eighteenth century concerned the discovery of the composition of water. The experiments of Cavendish were described in a paper in January 1784, but Watt, so early as April 21, 1783, had written to Black, "In the deflagration of inflammable and dephlogisticated airs, the airs unite with violence—become red hot,—and on cooling totally disappear. The only fixed matter which remains is water, and water, light, and heat are all the products. Are we not then authorised to conclude that water is composed of dephlogisticated and inflammable air?"

April 22, 1663.—The first Charter of Incorporation of the Royal Society was granted in 1661, but it having been found that this failed to give the Society certain privileges essential to its welfare, a second charter was obtained, the patent for which was dated April 22, 1663.

April 23, 1868.—In a paper read to the Royal Society on April 23, 1868, Huggins described the first successful investigation of the motion of the stars in the line of sight by the application of Doppler's principle, announced in 1842.

April 23, 1884.—It is estimated that the development of the steam turbine has halved the cost of the generation of electricity. Though there had been many earlier inventions, no advance was made until 1884, when de Laval and Sir Charles Parsons secured their patents. The patents of Parsons, Nos. 6734 and 6735, taken out on April 23, 1884, were for "improvements in electric generators and in working them by fluid pressure" and for "improvements in rotary motors actuated by elastic fluid pressure, and applicable also as pumps."

E. C. S.

Societies and Academies.

LONDON.

Institute of Metals (Annual General Meeting), Mar. 9.—D. **Hanson** and Grace W. **Ford**: Investigation of the effects of impurities on copper. Pt. v.—The effect of bismuth on copper. Experiments on copper containing up to 0·1 per cent. of bismuth confirm the great embrittling effect of bismuth, and indicate that when more than a trace of bismuth alone is present in copper, the working properties, particularly the cold-working properties, are seriously affected. The solid solubility of bismuth in copper has also been investigated.—Clement **Blazey**: Brittleness in arsenical copper. A description is given of a type of brittleness in arsenical copper tubing developed by annealing in the temperature range 450° to about 650° C. The susceptibility to brittleness was inherent in the 'as cast' billets from which the tubes were made, and no alteration in hot and cold working methods could eliminate it. The degree of susceptibility varied from billet to billet, but the variation could not be connected with chemical composition. After remelting, no trace of brittleness could be developed. Over a period of several years the brittleness was encountered in a certain mill on three occasions, and appeared to be connected with the composition of the refinery charges and with melting operations.

Mar. 10.—R. **Genders**: The penetration of mild steel by brazing solder and other metals. The cracking of mild steel under slight stress when heated and wetted with brazing solder is due to rapid intercrystalline penetration of the steel by the brass. Copper behaves similarly to brass, but zinc, tin, and lead-tin solder have no perceptible action. The phenomenon of intercrystalline penetration is in many cases of a complex character, involving a third factor.—H. J. **Miller**: The penetration of brass by tin and solder, with a few notes on the copper-tin equilibrium diagram. The cracking of stressed brass articles by a process of intercrystalline penetration when in contact with molten solder of the tin-lead variety is associated with the phenomenon of 'season-cracking' and the penetration of mercury into brass. Tensile tests upon brass test-pieces surrounded by various molten metals and solders indicate that the stress required for penetration to take place is much higher than that required for the penetration of mercury. The eutectic composition of the series copper-tin alloys occurs with about 0·7 per cent. of copper as against 1 per cent. by Heycock and Neville, 2 per cent. by Guertler, Shepherd, and Blough, and 5 per cent. by Giolitti and Tavanti.—Harold J. **Hartley**: The attack of molten metals on certain non-ferrous metals and alloys. Penetration of the molten into the solid material occurs when the latter is stressed in tension. Fully annealed materials are attacked at very low stresses with ultimate breakdown.—H. **Moore** and S. **Beckinsale**: Notes on the manufacture and properties of hairsprings. To raise the elastic limit to the required degree, hardening by heat-treatment or by cold-working is necessary, but all hardening operations are liable to produce a state of imperfect elasticity detrimental to the spring. The use of low-temperature heat-treatments to restore elasticity after cold-working (drawing, rolling, and the coiling of the spring) is described. Steel hairsprings are subject to corrosion, but elinvar is highly resistant.—F. **Hargreaves**: (1) The application of strain methods to the investigation of the structure of eutectic alloys. Investigation of the lead-tin, tin-zinc, and copper-silver eutectics shows that straining by suitable methods results in markings due to slip,

similar to those which occur in the case of pure metals. The orientation of the lead-tin eutectic is apparently determined by that of the tin. (2) Note on the crystallisation of the lead-tin eutectic. Straining and etching methods applied to a 30-lb. ingot of lead-tin eutectic show the exterior to possess the largest crystal size with absence of distinct colonies. The middle consists of much smaller crystal units in the form of distinct colonies of coarser eutectic structure.—J. D. Grogan: The influence of calcium on aluminium containing silicon. With an appendix on the estimation of calcium in aluminium alloys by P. G. Ward. Calcium combines with the silicon present in commercial aluminium, forming a compound, probably $CaSi_2$, which is almost insoluble in solid aluminium at all temperatures and exerts no age-hardening influence. By removing silicon from solid solution in aluminium, calcium improves the electrical conductivity of the latter.—M. Hansen: Note on the magnesium-rich magnesium-copper alloys. Some indication of the phase boundary of the solid solution of magnesium with copper has been obtained. The quenched alloys show no perceptible hardening by ageing.—R. Genders: The mechanism of inverse segregation in alloys. With an appendix on the accurate determination of copper in bronze by electrolysis by R. A. F. Hammond. None of the hypotheses which has been put forward to account for the occurrence of inverse segregation in alloys is fully in accordance with experimental fact. Some further factor must be taken into consideration. In extreme cases of inverse segregation, exudation at the surface of the casting occurs simultaneously with the escape of evolved gases. The variation of composition in chill-cast slabs of bronze containing 5 per cent. tin made by various methods of casting were determined. Considering the flow taking place in the mould during the formation of the ingot in relation to these results, a general theory of inverse segregation is advanced, in which the gas constituent in alloys is considered as part of the system. The evolution of gas from solution in the metal is regarded as of primary importance in determining variations in composition in the solid casting.—K. Honda and H. Endo: Magnetic analysis as a means of studying the structure of non-magnetic alloys. The present investigation is to show by means of examples that magnetic analysis applied to the case of non-magnetic elements, which are paramagnetic or diamagnetic, affords a convenient method of studying the equilibrium diagram for the alloys consisting of these elements. Not only is the melting point or the transformation point of an element given by a sharp discontinuity of the susceptibility-temperature curve, but the liquidus and the solidus of an alloy are also marked by a sharp break or bend. In some cases, small solubility is marked by a very large abrupt diminution of the diamagnetic susceptibility of one component on adding a small quantity of the other. Magnetic analysis is also convenient for the study of the actual state of an alloy when above its melting point, that is, in detecting the existence of an intermetallic compound in the liquid phase, the degree of dissociation of the compound with the rise of temperature, etc.—J. Newton Friend and W. E. Thorneycroft: Note on the silver contents of Roman lead from Folkestone and Richboro' Castle. Specimens of Roman lead from Folkestone and Richboro' Castle contained 0·0072 and 0·0078 per cent. respectively of silver.

Geological Society, Mar. 9.—L. J. Chubb and W. Campbell Smith: The geology of Maiao (Society Islands). Maiao, or Tubai Manu, which lies some 50 miles west of Tahiti, consists of a small volcanic island about a mile long and 800 feet high, encircled by a barrier-reef six miles in diameter. The volcanic rocks collected from the central island include a basalt with numerous phenocrysts of olivine and augite, of the type known to be abundant in Tahiti and the Austral Islands, a phonolitoid nepheline-tephrite, and an olivine-bearing basaltoid nepheline-tephrite somewhat similar to those described from Rurutu.—C. I. Gardiner: The Silurian inlier of Woolhope; with palæontological notes by F. R. C. Reed. The beds seen in the inlier are those between the Llandovery and the Downtonian. The uppermost beds frequently show a slightly eroded surface, and on this rests a conglomerate of clay-pebbles or limestone fragments full of fish remains, forming the base of the Downtonian. Higher up come false-bedded sandstones and shales, and the highest beds seen are sandstones yielding *Lingula cornea*. The inlier has been affected by pressures in two directions. One from the south-west has markedly affected the southern portion of the inlier, at places bringing Downtonian deposits into contact with the Wenlock Limestone. The main result was the bending of the Silurian rocks into an anticline. Pressure also produced an anticline, the axis of which runs north-north-east and south-south-west. The two pressures have produced a more or less dome-like arrangement of the beds, but much faulting has gone on in parts of the area near Sollers Hope, Old Sufton, and Woolhope Cockshoot. Dr. F. R. C. Reed describes fourteen new species and five new varieties of brachiopods, lamellibranchs, gasteropods, and trilobites.

Optical Society, Mar. 10.—Basil Graves: Microscopy of the living eye. The uses and advantages are illustrated of using a narrow beam of light for illumination and arranging that the axis of observation is so positioned as to place the object under view in the most favourable condition for observation, against a bright or dark background as the case may be. The non-coincidence of the observing and illuminating axes also enables troublesome specular reflections from the corneal and lens surfaces to be eliminated. Illumination by means of the reflection of the narrow beam from the iris, termed by the author 'retro-illumination,' is described. The rendering visible of the track of the light beam through the ocular media is explained and a term 'relucency' suggested for this property. As the result of continued observation over a period of years, the probable duration of certain conditions, in the crystalline lens for example, is capable of estimation.

Physical Society, Mar. 11.—G. M. B. Dobson and I. O. Griffith: Measurements of absorption coefficients of light filters. A portion of the slit of a spectograph is covered by the absorbing medium, and in front of the photographic plate or of the slit a neutral wedge is placed. The resulting spectogram consists of two parts, one due to light which has passed through the filter and the wedge, the other to light which has traversed the wedge only. From a knowledge of the distance between two points, one in each part of the spectogram, which are of the same density, the absorption coefficient of the filter at any wave-length may be determined. The source of light need not be constant.—T. L. Ibbs and L. Underwood: A comparison of the behaviour in thermal diffusion of nitrogen and carbon monoxide, and of nitrous oxide and carbon dioxide. The gas analysis required in the measurement of the effect is made by means of the Shakespear katharometer. The behaviour of nitrogen is similar to that of carbon monoxide. The effect given by carbon dioxide is generally a little greater than that given by nitrous oxide. The pairs of gases

examined provide a special case for the application of the Enskog-Chapman theory, as in each pair the molecular weights and mean collision areas are the same. It can thus be deduced that the molecular field of nitrogen is similar to that of carbon monoxide, and that the field of carbon dioxide differs little from that of nitrous oxide.—Robert R. **Nimmo**: Relighting of a neon lamp when momentarily extinguished at voltages below the striking potential. The time for which the continuous discharge of a neon lamp may be interpreted without putting out the lamp is of the order of 50 micro-seconds and depends on the voltage across the lamp and on the current passing through it.—G. B. **Deodhar**: Electricity of dust clouds. The factors governing the phenomena of electricity of dust storms are: (1) Material of the dust; (2) its size; (3) the gas raising the cloud; (4) the velocity of the gas; (5) the temperature. The first two factors are discussed. The electricity developed is of frictional nature. Some quantitative estimates of electrification of chlorides and nitrates of sodium and potassium are made, showing that chlorides of sodium and potassium are equally efficacious, whilst sodium nitrate is about $4\frac{1}{2}$ times as efficacious as potassium nitrate. Using prepared and graded dusts, it is shown graphically that, other things being the same, the number of volts developed by blowing increases very rapidly as the size grows less.

Mineralogical Society, Mar. 15.—C. E. **Tilley**: A melilite - spurrite - Ca_2SiO_4 assemblage from Larne (Antrim). This contact metamorphic assemblage, together with merwinite, perovskite, wollastonite, ægirine, and other minerals, occurs at the borders of Cretaceous limestone and a Tertiary dolerite near Larne. The rocks give evidence of considerable chemical interchange during metamorphism.—G. T. **Prior**: Alkaline rocks from Nimrud volcano, Armenia. Nimrud was a centre of eruption of alkali rocks similar to those of the Rift Valley, East Africa. The lava forming the main mass of the rim and the floor of the crater is a soda-rhyolite (comendite) containing anorthoclase felspar and the soda-pyroxenes and soda-amphiboles ægirine, cossyrite, and riebeckite. More basic lavas overlying the soda-rhyolites resemble the kenytes of East Africa in containing numerous corroded phenocrysts of anorthoclase. Ordinary olivine-basalts with phenocrysts of labradorite also occur.—G. **Greenwood**: Rotating crystal X-ray photographs. The first part of the paper deals with this method of crystal analysis as used in the German laboratories, where it was studied by the author. Two substances, tetramethylammonium iodide $N(CH_3)_4I$ and tetraethylammonium iodide $N(C_2H_5)_4I$ were investigated. The unit cell of $N(CH_3)_4I$ is a tetragonal unit of dimensions $a=8{\cdot}05$ Å.U. and $c=5{\cdot}75$ Å.U., and the space group is either D_4^2 or V_4^2, most probably the latter. Hence the crystal class is not the holohedral one proposed by L. Vegard. The unit cell of $N(C_2H_5)_4I$ has dimensions $a=12{\cdot}29$ Å.U., $c=6{\cdot}82$ Å.U. when referred to the axes demanded by the scalenohedral space group V_d^5 to which the substance belongs. A smaller unit can be found, using as a axis half the base-diagonal; the cell then has $a=8{\cdot}86$ Å.U. and $c=6{\cdot}82$ Å.U. The nitrogen and the iodine atoms in both substances are crystallographically identical, but the methyl and ethyl radicles may be half of one kind and half of another. The hypothetical structures suggested for these substances by Groth, as deduced from topic axes, are also discussed.—L. J. **Spencer**: Biographical notices of mineralogists recently deceased (third series). The average age of the forty lives described was sixty-eight years.

Royal Meteorological Society, Mar. 16.—G. I. **Taylor**: Turbulence (Symons Memorial Lecture). Turbulence is a condition of motion in a stream of fluid which occurs when it flows past solid surfaces or when two layers of fluid flow over one another. Turbulence increases the diffusing power of air until it is 100,000 times as great as that of air at rest. So great is this effect that in the case of tidal motions in the sea it is possible to prove that turbulence is responsible for the gradual slowing down of the earth's rotation, and consequent lengthening of the day which astronomers have been able to observe. Some observations of the details of turbulence show that eddying motion in the atmosphere is spread out equally in all directions in space.

DUBLIN.

Royal Dublin Society, Feb. 22.—E. J. **Sheehy**: The correlation of nutritive value with dry matter content of pastures. Two pastures, in which the nutritive value or stock-carrying capacity was in the ratio of about 3 to 1, were compared. The chemical analysis of the dry matter of the herbage—total nitrogen, ether extract, crude fibre, nitrogen-free extract, and total ash—showed no material difference, nor did the digestibility of the herbage from the two pastures differ. A difference in dry-matter content, which amounted to about 25 per cent. in favour of the richer pasture, was revealed; and a correlation was established between the dry-matter content and the proportions of grasses, clovers, and broad-leaved miscellaneous plants (weeds) present.—J. **Wilson**: The maintenance requirements of cattle on different kinds of rations and at different rates of production. Contrary to Kellner's and Armsby's assumption, it has been shown that maintenance not only rises with the rate of production, but that the rise is accelerated as the rate of production rises. The present paper discusses 'dynamic action' and suggests that such action is really a part of the digestive process, and the heat set free a result of the work done.

PARIS.

Academy of Sciences, Mar. 7.—The president announced the death of Charles Graebe, *correspondant* for the Section of Chemistry.—**Mesnager**: The rectangular beam loaded at a point. Angle under the charge when it becomes infinitely long. Consequences for plates.—André **Blondel**: Methods for position-finding by Hertzian waves.—E. **Mathias**: Contribution to the study of fulminating material (lightning): examples of spontaneous decomposition.—M. **Potron**: The distribution of a system of integers in groups of given sums.—Beniamino **Segre**: The diagrams of probability.—Paul **Alexandroff**: A new generalisation of the Phragmén-Brouwer theorem.—**Jacques**: Networks the tangents of which belong to linear complexes.—G. **Pólya**: A theorem of Hadamard relating to the multiplication of singularities.—**Hadamard**: Remarks on the preceding communication.—P. **Tzitzéica**: A certain system of partial differential equations.—D. **Riabouchinsky**: Some cases of cavitation.—Raoul **Ferrier**: Planck's oscillator.—Nicolas **Kryloff**: The approximate integration of some partial differential equations of mathematical physics.—Léon **Brillouin**: The statistics of light quanta (photons).—H. **Pélabon**: Rectifying contacts.—S. **Piña de Rubies**: The arc spectrum of gadolinium. Measurements made at the normal pressure, between λ3100 and λ2200.—H. **Jedrzejowski**: The ionising powers of RaB and RaC.—F. **Bourion** and E. **Rouyer**: The determination, by the boiling-point method, of the affinity relative to the formation of complex com-

pounds between cadmium halides and the alkaline halides.—H. Devaux and E. Aubel: The absorption of ions by glass. The surface of glass (glass wool) is capable of absorbing the ions Ca, H, K, Na, NH_4, quinine, and the action is reversible. Glass behaves as a gel, since adsorption takes place not only at its surface but also in its mass.—J. E. Verschaffelt: The specific heats of a sufficiently cooled condensed phase. An adverse criticism of a recent communication under the same title by M. Perrakins.—Henri Marcelet: The heats of combustion of some oils of marine animals. Data are given for eight samples of oil, ranging from 8700 cal. to 10,790 cal. per gram.—A. Travers and Jouot: The iodometric estimation of the antimonic ion. The reaction between antimonic salts and potassium iodide is complete in the presence of a considerable proportion of concentrated hydrochloric acid.—Ch. Courtot and C. Vignati: Researches in the fluorene series.—André Meyer: The sulphonation of anthraquinone in the presence of mercury.—Ch. Maurain: The distribution of earthquakes in latitude. A statistical study shows that the frequency of earthquakes is greater the smaller the latitude.—D. Faucher and E. Rougetot: Contribution to the study of the mistral.—P. Martens: The vital structure of the nucleus and the action of fixing reagents.—A. Guilliermond: Cytological and taxinomic observations on yeasts of the group of the Sporobolomyces.—J. Szymanek: Some observations on the morphology of the mycelium and suckers of *Phytophthora infestans* in the tubercle of the potato.—Boodan Varitchak: The development of the perithecium in *Cordyceps militaris*.—P. Cappe de Baillon: The descendance of double monsters of phasmids.—Maurice Fontaine: The comparative compressibility of the serum and the blood globules of the horse. The blood serum of the horse is less compressible than an isotonic solution of common salt. The complete blood is less compressible than the serum of the same blood.—Roger Douris and Georges Giquel: A method of differentiation of pathological sera (cancer, syphilis, tuberculosis). The characters of cancer serum. The turbidity produced by the addition of varying quantities of distilled water to the serum is compared with the same serum diluted with 0·9 per cent. sodium chloride solution. The difference in the optical density of the two tubes is determined in the Yvon photometer. The differences observed with normal sera are given by numbers between 0 and 3, for syphilitic sera, numbers between 3 and 10. If the number is higher than 10, under the experimental conditions described, the diagnosis is in favour of cancer.—Y. Manouelian and J. Viala: *Encephalitozoon Negrii*, the parasite of encephalomyelitis in young dogs.—A. Borrel: The verminous etiology of certain cancers.

GENEVA

Physical and Natural History Society, Mar. 3.—F. Chodat: The importance of isoelectric points in the preparation and activity of ferments. The author has studied the mother-liquors of the following ferments: saccharogenase, prunase, catalase, tyrosinase. In most cases several minima of dispersion occur in hydro-alcoholic media which are considered as indices of isoelectric points, each minimum corresponding to one of the amphoteric electrolytic colloids which are dispersed in the extract.—S. C. Guha: The preferential electric conductivity of the pistil of some plants. The pistil of the plants studied shows a basipetal preferential conductivity for the incident current, a difference which disappears after pollination.—E. Briner and A. Schidlof: The ebullioscopic paradox. It is established by calculation that external work is effected by the atmospheric pressure during the condensation of the vapour, and that this work is much higher than the compensating work, evaluated on the basis of a reversible transformation.—E. Cherbuliez and P. Rosenberg: Researches on the silicates. Having applied the determination of electrical conductivity to kaolin, quartz, and orthose, and to their mixtures, the authors have proved that kaolin presents very large variations as a function of the time to reach a limiting value, and this for several values of the temperature. The phenomenon is irreversible and follows the law of a monomolecular reaction.—P. Balavoine: The refractometric estimation of alcohol in fermentation products. The refractive indices of wine distillates have been examined, and it is shown that the volatile acidity of these distillates (mainly due to acetic acid) modifies these indices in a manner not permitting the use of an empirical correction table. A table has been prepared, based on the experimental data, which agrees well with the pycnometric measurements.—R. Wavre: The stratification of the planets and Fredholm's equation. Fredholm's equation, to which the problem of the stratification of the planets may be reduced, possesses a symmetrisable nucleus.

VIENNA.

Academy of Sciences, Feb. 17.—A. Kieslinger: Second preliminary report on geological petrographic researches in the Southern Kor Alps of Styria. A survey of the Kor Alps district including Unterdrauburg and Deutschlandsberg-Wolfsberg. The present reports concern metamorphic rocks and a series of mineralogical peculiarities—destratification (*Entschieferung*), deformations (*Verwachsungen*), recrystallisation (*Umkrystallisieren*), rough injected mica schist (*Glimmerschiefer*). Between the textures of the injection-changed rocks emerge remains of still older textures (*Durchbewegungstexturen*). The lamelliform gneisses with streaky texture are clearly intrusive rocks.

Official Publications Received.

BRITISH.

Biological Reviews and Biological Proceedings of the Cambridge Philosophical Society. Edited by H. Munro Fox. Vol. 2, No. 2, March. Pp. 91-197. (Cambridge.) 12*s.* 6*d.* net.

Aeronautical Research Committee: Reports and Memoranda. No. 1054 (M. 48): The Variation in the Fatigue Strength of Metals when tested in the Presence of Different Liquids. By G. D. Lehmann. Work performed for the Engineering Research Board of the Department of Scientific and Industrial Research. (E.F. 184.) Pp. 13+14 plates. 1*s.* net. No. 1056 (Ae. 239): Algebraic Formulæ for the Performance of an Aircraft at Full Throttle. By R. S. Capon. (D.I. Special Technical Questions, 181.—T. 2296.) Pp. 13. 9*d.* net. (London: H.M. Stationery Office.)

Colony and Protectorate of Kenya. Agricultural Census: Seventh Annual Report, 1926. Pp. 34. (Nairobi: Department of Agriculture.)

The British Mycological Society. Transactions. Edited by Carleton Rea and J. Ramsbottom. Vol. 12, Part 1, March 23. Pp. 77+10 plates. (Cambridge: At the University Press.) 7*s.* 6*d.* net.

More Books to Read (1920-1926) on Social and Economic Subjects. A Supplement to "What to Read," containing Publications from December 1920 to December 1926. Pp. 30. (London: The Fabian Society.) 6*d.*

Proceedings of the Geologists' Association. Edited by A. K. Wells. Vol. 38, Part 1, March 21st. Pp. 144. (London: Edward Stanford, Ltd.) 5*s.*

Report on the Operations of the Department of Agriculture, Madras Presidency, for the Year 1925-26. Pp. ii+79+4+8 plates. (Madras: Government Press, 1926.) 12 annas.

Madras Agricultural Department. Year Book, 1925. Pp. ii+63+12 plates. (Madras: Government Press.) 1 rupee.

Astrographic Catalogue 1900.0. Sydney Section, Dec. −51° to −65°. From Photographs taken at the Sydney Observatory, New South Wales, Australia. Vol. 7. R.A. 12^h to 18^h, Dec. −52° to −54°, Plate Centres Dec. −53°. Pp. 65. Vol. 8. R.A. 18^h to 24^h, Dec. −52° to −54°, Plate Centres Dec. −53°. Pp. 32. (Sydney, N.S.W.: Alfred James Kent.)

Transactions of the Geological Society of South Africa. Vol. 29, containing the Papers read during 1926. Pp. iv+150+17 plates. 42*s.* Proceedings of the Geological Society of South Africa. Containing the Minutes of Meetings and the Discussions on Papers read during 1926; to Accompany Vol. 29 of the Transactions, January-December 1926. Pp. iii+xlix. (Johannesburg.)

Nyasaland Protectorate. Annual Report of the Geological Survey Department for the Year 1926. Pp. 6. (Zomba: Government Printer.)

Agricultural Research and Administration in the Non-Self-Governing Dependencies. Report of a Committee appointed by the Secretary of State for the Colonies. (Cmd. 2825.) Pp. 101. (London: H.M. Stationery Office.) 2s. net.

Papers from the Geological Department, Glasgow University. Vol. 10 (Quarto Papers of 1926). (Glasgow University Publications, 7.) Pp. iv +5 papers. Vol. 11 (Octavo Papers of 1926). (Glasgow University Publications, 8.) Pp. iv+12 papers. (Glasgow: Jackson, Wylie and Co.)

The Journal of the Royal Anthropological Institute of Great Britain and Ireland. Vol. 56, July to December 1926. Pp. xi+207-437+plates 16-52. (London.) 15s. net.

Royal Astronomical Society. List of Fellows and Associates. Pp. 52. (London.)

The Gravesend and District Scientific and Archæological Society. Proceedings, 1925-26, and Second Annual Report, April 1st 1925 to March 31st 1926, with Lists of Entomological Captures, and Flowering Plants of the District, and Descriptions of the Ancient Buildings in the Locality. Pp. 20. (Gravesend: The Borough Library.)

The National Physical Laboratory. Report for the Year 1926. Pp. 260. (London: H.M. Stationery Office.) 7s. 6d. net.

Proceedings of the Royal Society of Edinburgh, Session 1926-1927. Vol. 47, Part 1, No. 6: The Distribution of Anopheline Mosquitoes in Scotland. By Prof. J. H. Ashworth. Pp. 81-93. 1s. 6d. Vol. 47, Part 1, No. 7: A Study of the Fertilisation Membrane in the Echinoderms. By A. D. Hobson. Pp. 94-117. 2s. 3d. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Directory of Members of the Association of Tar Distillers. Pp. 15. (London: 166 Piccadilly.)

FOREIGN.

Zentralanstalt für Meteorologie und Geodynamik. Publikation Nr. 129: Jahrbücher der Zentralanstalt für Meteorologie und Geodynamik. Amtliche Veröffentlichung. Jahrgang 1923, Neue Folge, Band 60. Pp. xxiv+A42+B40+C42+D4. Publikation Nr. 130: Bericht über die 12 Versammlung des Internationalen Meteorologischen Komitees in Wien, September 1926. Pp. 54. (Wien.)

Department of Commerce: U.S. Coast and Geodetic Survey. Hydrography. Serial No. 317: Construction and Operation of the Wire Drag and Sweep. By Lt.-Comdr. J. H. Hawley. (Special Publication No. 118.) Pp. iii+64. (Washington, D.C.: Government Printing Office.) 10 cents.

Department of the Interior: Bureau of Education. Bulletin, 1926, No. 22: A Manual of Educational Legislation. Pp. v+67. (Washington, D.C.: Government Printing Office.) 15 cents.

Cornell University Agricultural Experiment Station. Bulletin 457: An Index Number of Farm Taxes in New York, and its Relation to various other Economic Factors. By M. Slade Kendrick. Pp. 47. Memoir 102: A Cytological Study of Two Types of Variegated Pericarp in Maize. By Fannie Rane Randolph. Pp. 14+2 plates. (Ithaca, N.Y.)

Methods and Problems of Medical Education. (Sixth Series.) Pp. iii +275. (New York: The Rockefeller Foundation.)

Diary of Societies.

MONDAY, APRIL 18.

INSTITUTION OF ELECTRICAL ENGINEERS (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.—Annual General Meeting.

CHEMICAL INDUSTRY CLUB.

WEDNESDAY, APRIL 20.

ROYAL METEOROLOGICAL SOCIETY, at 5.—First Report of the Committee on the Relation between Atmospherics and Weather, entitled The Range of Atmospherics. Opener of discussion, R. A. Watson Watt.

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (at 17 Fleet Street, E.C.), at 5.30.—F. Achard and L. Seguin: Marc Seguin and the Invention of the Tubular Boiler.

INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.—A. Tustin: Some Magnetic Problems.

FOLK-LORE SOCIETY (at University College), at 8.—Mrs. A. Morgoci: The Devil in Roumania.

THURSDAY, APRIL 21.

ROYAL SOCIETY OF MEDICINE, at 5.—Dr. Gordon Holmes: Local Epilepsy (Savill Memorial Oration).

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Prof. E. W. Marchant: High-Frequency Currents (Kelvin Lecture).

INSTITUTION OF AUTOMOBILE ENGINEERS (London Graduates' Meeting) (at Watergate House, Adelphi), at 7.30.—W. G. Ruggins: Repairs.

FRIDAY, APRIL 22.

FARADAY SOCIETY (in Department of Biochemistry, University Museum, Oxford), at 3.30 and 5.45.—General Discussion on The Theory of Strong Electrolytes. Part I. Mobilities of Ions.—P. Debye: Introductory Paper. Report on Conductivity of Strong Electrolytes in Dilute Solutions.—L. Onsager: Report on a Revision of the Conductivity Theory.—K. Fajans: Refractometric Evidence for the Existence of Undissociated Molecules and Complex Ions in Solutions of Strong Electrolytes.—H. Remy: Electrolytic Transference of Water, True Transference Numbers, Ionic Mobilities and Water Sheaths of the Ions.—H. Ulich: Ionic Mobilities in Non-aqueous Solvents.—H. Hartley and H. R. Raikes: The Mobilities of the Elementary Ions in Methyl Alcohol.—H. Hartley and R. P. Bell: Notes on the Debye-Hückel Theory.—D. A. MacInnes: The Ionisation of some typical Strong Electrolytes.—Prof. A. J. Allmand and L. J. Burrage: A Thermodynamical Study of the System Lead Chloride-Potassium Chloride-Water at 25° C.—Prof. A. J. Allmand: Note on the Occurrence of Points of Inflexion in the Concentration-Vapour Pressure Curve of Aqueous Solutions of certain Electrolytes.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—Major C. H. Douglas: The Engineering of Distribution, with special reference to Finance as a Form of Organisation.

PHOTOMICROGRAPHIC SOCIETY (at 4 Fetter Lane, E.C.), at 7.—Members' Evening.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30—C. D. Holland: Shock Absorber Units for Land Planes.

SATURDAY, APRIL 23.

FARADAY SOCIETY (in Department of Biochemistry, University Museum, Oxford), at 9.30 A.M., 11.30 A.M., and 2.15.—General Discussion on The Theory of Strong Electrolytes. Part II. Activity.—J. N. Brönsted: Introductory Paper. On the Activity of Electrolysis.—R. H. Fowler: Strong Electrolytes in Relation to Statistical Theory, in Particular the Pnase Integrals of Gibbs.—D. L. Chapman: Note on the Theory of Debye and Hückel.—N. Bjerrum: Anomalies in the Theory of Solutions of Strong Electrolytes.—G. Scatchard: Mixed Solutions of Electrolytes and Non-electrolytes.—H. S. Harned: On the Thermodynamic Properties of a few Concentrated Salt Solutions.—F. Foxton and W. J. Shutt: The Activity of Zinc Chloride in Concentrated Solution.—C. A. Kraus: Influence of Salts on Solubility in Non-aqueous Solvents.—J. H. Wolfenden, C. P. Wright, N. L. Ross-Kane, and P. S. Buckley: The Use of Amalgam Electrodes for determining Activities in Methyl Alcohol.—M. Randall: (*a*) The Significance of the Activity Coefficient; (*b*) Methods of Calculation of Activity Coefficient.—Prof. J. R. Partington: Electrochemical Properties of Non-aqueous Solution of Strong Electrolytes.—Prof. T. M. Lowry: The Definition and Characteristics of Strong Electrolytes.—H. Millet: The Activity of Hydrogen Ion in Mixed Solvents as a Function of Environment.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Eastern District Meeting) (at County Hall, Ipswich), at 10.45 A.M.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS, at 2.30.

MINING INSTITUTE OF SCOTLAND (at Royal Technical College, Glasgow).—Annual Meeting.

CONFERENCES.

APRIL 19 AND 20.

SOCIETY FOR EXPERIMENTAL BIOLOGY.

April 19 (in Physiological Institute, Cambridge).

At 2.15—
Prof. R. R. Gates: An Investigation of Quantitative Inheritance.
E. M. Delf: Effects of Ultra-violet Light on Plants.

At 3.45—
J. Gray, D. Bhatia, and H. Standfast: The Growth of the Trout.
Prof. H. Hartridge and F. J. Roughton: The Velocity of Certain Biological Reactions.
Miss Henderson and Miss Spenser: The Influence of the Corpuscle as such on the Phase of Hæmoglobin.
A. Walton and J. Hammond: Ovulation in the Rabbit.
J. B. S. Haldane: Some Effects of CO.

At 4.30—
Dr. G. V. Anrep: Inhibition as an Integral Part of Cortical Activities.
Dr. A. S. Parkes: The Relation of the Corpus Luteum to Oestrin.

April 20 (in Zoological Building, Cambridge).

At 10 A.M.—
J. B. S. Haldane, G. C. Robson, C. Diver, and Dr. F. A. E. Crew: Symposium: Evolution and Heredity.

At 2.15—
J. T. Saunders: Chemotaxis in Protozoa.
Dr. E. D. Adrian: The Investigation of the Sense Organs in Animals.

At 4.30—
J. Gray: The Effect of Gravity on Cell-division.
Prof. J. S. Huxley: Artificially Induced Metamorphosis in Echinus.

APRIL 20 TO 24.

JOURNÉES MÉDICALES MARSEILLAISES ET COLONIALES (at Marseilles).—Prof. Cantacuzène: The Rôle of the Streptococcus in the Etiology of Scarlet Fever.—Dr. Mayer: Recent Advances in the Treatment of Cancer.—Prof. Ottolenghi: Malaria.—Dr. N. Bernard: Beri-beri.—Prof. Imbert: Bone-grafting.

APRIL 25 TO 28.

GERMAN SOCIETY FOR INTERNAL MEDICINE (at Wiesbaden).—Discussions on Psychotherapy, introduced by Gaupp and Fleischmann; Results of Recent Functional Investigations of the Stomach and Duodenum, introduced by G. Katsch.—A joint meeting with the German Röntgen Society will be held on April 28, with a discussion on the Significance of Röntgen-ray Examination of the Lungs and Mediastinum for Internal Medicine (excluding Tuberculosis), introduced by Dietlen, Assmann, Haenisch and Lorey, and Fleischner.