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Psychology and Industry.

DURING the last fifty years there has developed a much closer association between scientific research and productive industry than was formerly the case ; as is well known, many firms now have excellently equipped laboratories, staffed by highly qualified scientific men and technicians, devoting the whole of their time to devising improvements in the means of production and in the commodity produced. These activities, however, are concerned primarily with the technical and mechanical aspects ; hitherto much less attention has been paid to the human factor in industry and commerce. It is very encouraging, therefore, to learn from the ninth annual report[1] of the National Institute of Industrial Psychology, just issued, that large employers of labour are now recognising to an ever-increasing extent the value of the study of human 'behaviour' and 'endeavour', in relation to manufacturing processes and business organisation—that is, the application of psychology in the factory, workshop, and office.

This appreciation is by no means confined to the employers who benefit by increased production. The workpeople in the various establishments in which the Institute has conducted investigations have invariably extended their whole-hearted cooperation in the experimental work, and acknowledged the variety of advantages—lessening of strain, irritation, worry and boredom, and increase of earnings, etc.—derived from the adoption of the suggestions put forward by the industrial psychologist.

Merely to state that the purpose of the Institute is the application of the principles of psychology and physiology in industry and commerce, is to indicate at once the variety of problems with which it is concerned and the wide field to be covered. Members of the Institute's staff have been engaged in investigating the best methods of applying human energy in factories, offices, etc., especially in regard to the elimination of unnecessary movements, the most advantageous distribution of periods of rest and work, and the determination and realisation of other conditions which tend to the maximal health, comfort, and well-being of the worker. They have also been concerned in the planning of the lay-out of plant, the co-ordination of processes in production, and the reduction of monotony. There has been considerable develop-

[1] Obtainable from the Secretary to the Institute, Aldwych House, London, W.C.2.

ment in the application of suitable methods so as to secure more efficient and scientific selection of workers and enabling trustworthy guidance to be given to adolescents when choosing their life's work. The educational activities of the Institute include the provision of training courses for managers, foremen, investigators, etc., lectures for employers and workers, and the publication of the facts established by its research work.

The research work undertaken by the Institute, mainly by grants from the Rockefeller Trust, forms an important complement to the valuable researches carried out by the corresponding Government body, the Industrial Health Research Board, which is under the direction of the Medical Research Council. The Institute's investigations in the field are of course largely dependent on the knowledge derived from such research.

Industrial processes are so numerous, the conditions which obtain in factories, workshops, and commercial undertakings differ so much, and the types of workpeople and staffs are so varied, that only actual investigation in the establishments themselves can be expected to provide solutions to the many difficulties confronting the employers and the workers engaged in them. The best evidence of the value of these investigations is that firms which have engaged the Institute's services have given ' repeat orders ' for the extension of the work to other departments of their businesses. Again, these investigations have been carried on in all kinds of industries, differing largely in their methods of organisation for production and distribution; but in all cases it has been possible, after a close examination of the situation by an expert in industrial psychology, to effect improvements in the conditions under which the operatives work or in the manufacturing processes and, generally, in both directions concurrently.

In the safety razor blade department of a cutlery factory, the Institute's investigator recommended the installation of various mechanical devices to limit non-productive time (which in certain processes occupied as much as 53 per cent of the working period) and to minimise waste. In ' piercing ' alone, it was calculated that an annual saving of £200 would be effected on £2000 worth of material. The improved organisation in the polishing and stropping shops led to increases in output of 78 per cent and 23 per cent respectively. Rest pauses were introduced in the grinding shop with good results, and movement studies led to the devising of better working methods of grinding and polishing. Also, suggestions were made for a new method of payment by progressive piece rates which would provide a more effective incentive to increased output.

Among many other investigations carried out during the year, the report mentions a spinning mill in which such varied subjects as illumination, analysis of sales and organising production with the view of reducing costs of manufacture, and planning of work ahead were considered; a fancy goods factory where an annual saving of £1400 will be effected by the reorganisation of the gangs working the presses; and a railway service for which the lay-out of the iron foundry in the locomotive works was re-planned, including the mechanisation of certain heavy operations resulting in the expenditure of less physical energy on the part of the workmen. The report also gives interesting details of investigations into such varied businesses as a gas works, a chemical works, a number of radio manufactures, telephone and cable factories, textile machinery, a departmental store, engineering works, offices, and the General Post Office. In all such investigations it not infrequently happens that the psychologist discovers factors which, although individually of apparently minor importance, have a cumulative detrimental effect upon the workers, with a consequential effect upon the nature and the amount of work performed.

The need for assistance to a boy or girl in the choice of a career on leaving school is becoming more and more recognised, and in its vocational guidance and selection departments the Institute has conducted a large amount of research work and shown the definite value of psychological tests. In 1922 it carried out a joint experiment with the Industrial Health Research Board. In 1924 it began an experiment on a larger scale in the course of which the careers of 1200 London boys and girls have been closely examined. Psychological tests were applied to 600, upon the results of which they were advised in the choice of an occupation; while the other 600 (regarded as a ' control ' group) received the advice normally given by one of the Juvenile Advisory Committees of the Ministry of Labour.

This experiment has been made possible by grants from the Carnegie United Kingdom Trusts, by the co-operation of the London County Council in enabling the tests to be carried out during the pupil's last term at school, and by the Ministry of Labour in the finding of suitable employment for the boys and girls after leaving school. The completed results of this experiment are likely to be published during this year, but the information already received indicates clearly that psychological examination with advice based upon scientific research must have in future a definite place in our system of vocational guidance and selection. Other experiments of this nature with which the Institute is closely concerned are being conducted in conjunction with the Birmingham Education Committee and with the Fife Education Authority.

This branch of the Institute's activity is not confined to school leavers. Similar work has been successfully accomplished in connexion with higher administrative posts in businesses and in the selection of overseers, foremen, etc., in manufacturing establishments. As a consequence of the introduction of these methods in a textile mill, the *total* labour turnover *due to dismissals* has fallen from 9·5 to 6·2 per cent since the adoption of the Institute's recommendations. A large engineering firm reports that it has definitely proved that "the test gives us within an hour the measure of the boy's suitability which it would take three to six months to obtain in the works under the control of a foreman".

The Institute, of which the late Earl of Balfour was president until his death, is to be congratulated upon a very successful year of work—work of national importance which affects the community in a variety of ways, all tending towards the improvement of the conditions in which we work and live. Its aim, like that of a hospital medical school, is to combine practice, training, and research. The cost of the factory investigations of the Institute is met by the fees paid by the employers; but large numbers of applicants for vocational guidance must be turned away owing to their inability to pay for its expense. Not only the vocational guidance work, but also the training and research sections of the Institute need endowment. Indeed, as the Prime Minister recently said at the annual dinner of the Institute, "If you were endowed with something like a million a year, you could spend it in such a way that not a farthing of your endowment would be wasted". The Institute now possesses laboratories, research rooms, a library, and a lecture room. It is performing services of unique national importance, welcomed by all classes of the nation. It is appealing for an endowment fund of £100,000 in order to set its work on a permanent footing; and we cordially commend the appeal to trusts and generous benefactors desirous of promoting close contacts between the material and human factors of progressive life.

The Beginnings of Entomology.

Materialien zur Geschichte der Entomologie bis Linné. Von Dr. F. S. Bodenheimer. Band 2. Pp. vi + 486 + 4 Tafeln. (Berlin: W. Junk, 1929.) 2 vols., 100*s*.

THE issue of the second volume of this important work has speedily followed the publication of the first (reviewed in NATURE for June 22, 1929). The present instalment, as exact and thorough in its treatment as its predecessor, gives evidence of immense industry on the part of the author, Dr. F. S. Bodenheimer. Continuing the subject of the study of insects during the seventeenth and eighteenth centuries, the volume before us opens with a section on applied or economic entomology, with especial reference to agriculture, sericulture, and bee-keeping.

The treatises on these departments that appeared from 1600 onwards were both numerous and bulky. Besides precepts of some practical benefit, they were apt to contain a large quantity of valueless matter. Much attention, however, was paid to the protection of orchard and garden produce from the ravages of caterpillars. The migrations and depredations of locusts, more important to European husbandry in former days than at present, are noticed by the author at some length; much recent literature on the subject is quoted, and the recent researches of Uvarov are referred to with approval. Interesting chronological tables are given of the occurrence of locust swarms in various countries of Europe. Under the head of noxious insects, the author takes occasion to commend the remarkable observations of the Englishman, Robert Southall, recorded in his "Treatise on Buggs" (1730), and to regret that his remedial measures have not met with more recognition.

An important section of the work is devoted to the subject of learned societies and academies. To the influence of these institutions the author rightly attributes the wide diffusion of the spirit of inquiry which took its rise about the middle of the seventeenth century. As those most deserving the attention of entomologists he enumerates the Royal Society of London, the Academy of Schweinfurth in Franconia, and the Paris Academy of Sciences. The first named of these societies is, as the author truly declares, of more importance in the history of entomology than any of the continental associations. But here, for once, we catch Dr. Bodenheimer tripping. Perhaps even an English reader might fail to recognise under the style of "Christophus Wien" the architect of St. Paul's Cathedral. The misnomer is repeated on the same page, also in the index, and is accompanied by other orthographical curiosities of less importance. Moreover, in the list that he gives of histories of the Royal Society, we look in vain for the monumental work of Bishop Sprat.

Dr. Bodenheimer does full justice, however, to the admirable performance of the Royal Society in realising and promoting from the outset the international character of natural science; a task in which it continued to lead the way for at least the first hundred years of its existence. The *Philosophical Transactions* included from their first issue in 1665 entomological communications of considerable importance. The first volume contains notices of silk and cochineal culture, as well as of insect plagues in America and the Ukraine. On these speedily followed in later volumes the hitherto neglected work of Edmund King on the natural history and development of ants, physiological experiments on insects by Robert Boyle, Willughby's observations on the leaf-cutter bee, and, what is perhaps especially noticeable, a list of 'inquiries and directions' for the guidance in entomological research of residents in foreign countries. Much space is given by the author to the record of the early years of this Society, the efforts of which towards international co-operation in the cause of science merit and receive his warm approbation.

Excellent work from 1652 onward was produced by the members of the Schweinfurth Academy. Among these were Muralto, Mentzel, Heister, and Loeber, whose researches dealt with the anatomy and life-history of the mole-cricket, dragon-fly, breeze-fly, and locust respectively. A better-known name is that of Vallisnieri, who published in 1715 an illustrated account of the praying mantis with its portable egg-packet.

A remarkable item in the memoirs of the Paris Academy of Sciences is the first attempt at a natural classification of the Lepidoptera, based not only on the perfect insect, but also on the immature stages. This was the work of Guettard, and dates from 1749.

On the advent of journeys of exploration, there naturally followed an increasing knowledge of the forms of insect life. The interest excited in this department tended rather, as in an earlier period of inquiry, to centre in the utilitarian aspect of the subject; in such insects, for example, as were serviceable in providing material for drugs or dyes; or, on the other hand, were capable of inflicting annoyance or damage, such as the dreaded 'jigger'.

A genuine scientific spirit was shown by Marcgrave, who accumulated a large stock of entomological and other zoological observations in Brazil; unhappily, he died in 1644 at an early age. At a later period, good natural history work was done in the West Indies by our countrymen Sir Hans Sloane, Griffith Hughes, and Patrick Browne, all of whom devoted a great part of their attention to entomology.

In North America, also, the last half of the seventeenth and first of the eighteenth century produced many good observations on the insect fauna of that continent. It is interesting to note that several of these saw the light under the auspices of the Royal Society, which association was, as we have seen, indefatigable in encouraging the researches of its correspondents, whether native or foreign, in all parts of the world. In the eastern hemisphere, the same period was marked by the work of Hasselquist in Egypt, Syria, and Asia Minor, and of Adanson in Senegal, with a large number of other observant travellers. In connexion with the new interest in geographical distribution, the subject of the dissemination of noxious insects attracted attention; and their introduction into European countries by human agency was dealt with by Osbeck, Kalm, and Bartholini. On the gradual elucidation of the history of the cochineal and lac insects the author has much to say; the economic value of their products appealed strongly to the commercial spirit of the time.

Curious evidence of the superstitious dread awakened by unusual and unexplained occurrences is afforded by the consternation that followed the supposed descent of insects in snow (Hungary, 1672), and the sudden appearance of swarms of a wood-boring wasp (Prussia and Poland, 1679). The adaptation of insects to the changes of season, and the instincts that lead them to provide for their young, were dealt with, much on the lines afterwards developed by Paley, by William Derham, author of "Physico-Theology"; known also for his study on the death-watch beetle, communicated to the Royal Society.

A long list of popular works on entomology which appeared during the eighteenth century gives proof, says the author, that the foundation had been well laid for the great increase of interest in the study of insects which marks the following period. Similar testimony is afforded by the formation of entomological collections, which, first started by Aldrovandi and Gesner early in the seventeenth century, were continued on a large scale in the form both of private collections and public museums. Among the latter a conspicuous place was taken by the British Museum, which soon after its foundation in 1753 acquired the extensive entomological collection of Petiver. A photograph is given by the author of some of Petiver's Lepidoptera which are still preserved in the national collection. Linnæus's own collection was acquired after his death by the Society which bears his name in London. Both Oxford and Cambridge possessed large insect collections about the year 1750. In comparison with England, neither France nor Germany showed at this period much zeal in the formation of collections; Italy, however, established several museums in which entomology was to some extent represented.

With the publication in 1758 of the tenth edition of his "Systema Naturæ", Linnæus may be truly said to have laid a secure foundation for systematic entomology. The first edition (1735) made a fourfold division of insects into Coleoptera, Angioptera, Hemiptera, and Aptera. By 1748, the date of the sixth edition, this division had been amplified; and in the tenth edition we find seven orders for the most part equivalent to those at present recognised. The principal differences are that Linnæus's Coleoptera include the Orthoptera and Dermaptera; his Hemiptera include thrips; his Neuroptera have now been divided into five or more separate groups; his Aptera are also plainly heterogeneous. The genera ranked by Linnæus under his orders correspond fairly closely with present-day families. But the greatest achievement of this tenth edition must be allowed to be the establishment of the binary system of nomenclature, which for the first time made exact identification possible.

With a full, but not unduly copious estimate of the entomological work of Linnæus, Dr. Bodenheimer brings the historical part of his book to a close. There remains a carefully compiled series of tables in which is attempted an identification of all the species of insects mentioned by pre-Linnæan authors, from the Chinese writers onwards—a laborious task which few men, even with skilled assistance, would have had the courage to undertake. But painstaking thoroughness is the mark of Dr. Bodenheimer's enterprise from start to finish; and he has produced a work the value of which will be widely appreciated by all those whose tastes or avocations lead them to seek full and accurate information on the history of entomology.

F. A. D.

Our Nearest Living Relatives.

The Great Apes: a Study of Anthropoid Life. By Prof. Robert M. Yerkes and Ada W. Yerkes. (Published on the Louis Stern Memorial Fund.) Pp. xix + 652. (New Haven: Yale University Press; London: Oxford University Press, 1929.) 45*s*. net.

THIS stately book by Prof. and Mrs. Yerkes is an invaluable contribution to the study of the higher apes—gibbon, orang-utan, chimpanzee, and gorilla—and the historical part is so well done that it should never require elaboration. The account of personal observations on chimpanzee and gorilla is not less valuable, but it will, of course, be added to and possibly modified by the authors and others. In both functions of the book, the historical and the original, we recognise the critical acumen of the trained psychobiologist. In the historical sections there is a rigorous and much-needed separation of the wheat from the chaff; the record of personal observations is a model of sceptical carefulness.

We would say in general that this large and beautifully illustrated treatise is indispensable to those who would follow a line of investigation that has been characteristic of the last twenty years, the experimental and observational study of the higher apes. It may be noticed that the gibbon and the siamang stand so much apart from the others, that Prof. Yerkes would have omitted them altogether, which would have been a loss, had he been beginning his task afresh.

The book begins with a general historical introduction, telling of man's ancient knowledge of the anthropoid apes, its extension during the Middle Ages, and its gradual improvement during the seventeenth and eighteenth centuries. Thereafter a special part of the book is devoted to each of the four great types, and the method followed in each case may be indicated: (1) structural peculiarities, species, and habitat; (2) mode of life in natural conditions; (3) life in captivity; (4) affective behaviour—for example, expression of emotions, words, temperament; (4) nervous system, sense organs, and receptivity in general; and (5) perceptual processes and intelligence. The book ends with a comparative survey of the types and with a statement of conclusions. The whole survey is characterised by lucidity, vivacity, and a mood of active scepticism. In our judgment, the authors have steered their craft with shrewdness and courage between the Scylla of behaviourism and the Charybdis of anthropomorphism.

Very interesting is the careful comparison between the four anthropoid types as regards external characters, habits, life-history, sociality, emotionality and expressivity, vocalisation (which never rises to language in the strict sense) and sensory receptivity. The interest heightens when the authors come to the intelligence of apes, which they have no hesitation in rating high. They compare the four types with one another, with monkeys, and with man as regards curiosity, imitation, parental instruction, attention, adaptivity, memory, imagination, instrumentation, and effective adaptation of environment. The general result is to show that the orang-utan, chimpanzee, and gorilla are mentally further from the monkeys and nearer to man than has been until recently believed.

The book is a masterly piece of work, scholarly, careful, and non-sensational; it shows a rare combination of scepticism with sympathy; and it ends appropriately by indicating the lines of further investigation that are at present most urgent and most promising.

Medieval Maps.

Reproductions of Early Manuscript Maps. 1 : *The Portolan Chart of Angellino de Dalorto, MCCCXXV., in the Collection of Prince Corsini at Florence.* With a Note on the Surviving Charts and Atlases of the Fourteenth Century, by Arthur R. Hinks. Pp. 12, with Chart in 4 Sheets, 24 in. × 16½ in. (London: Royal Geographical Society, 1929.) 42*s.* net.

THE Royal Geographical Society has had placed at its disposal a fund for the reproduction of a series of selected manuscript maps, and the first issue of this series is the reproduction of the Portolan Chart of Angellino de Dalorto, which is in the collection of Prince Corsini at Florence. The reproduction is to full size, and is in colour; the work was carried out by the Fratelli Alinari of Florence, by the difficult method of half-tone colour plates—difficult, that is, for the registration of lettering and fine lines. The result is successful, however, and the lettering is, considering the character of such old maps, fairly clear, though it must be confessed that the red names are clearer than the black. It looks as if it would be desirable in future reproductions of this series to modify the process so far as concerns the black names. A comparison might be made with the full-scale reproduction of the Bodleian Map of Great Britain (*c.* A.D. 1300), which was carried out by the Ordnance Survey in 1870. The general appearance of this reproduction is not nearly so interesting as that of the Portolan Chart which we are discussing, but the brown names are easier to read than the black names on the chart.

The original chart is drawn on a single sheepskin, about 42 inches in extreme length, and 26 inches in breadth. The colours used were chiefly black, red, and green; but yellow or gold, purple and brown were also used. The outlines of the land are faint, but traceable in most parts of the map. As is the custom with such charts, the face of it is covered by rhumb lines, in various colours, radiating from about twenty different points; from each of these points thirty-two equally spaced, straight lines radiate. There is also, drawn across the face of the chart, a system of rectangles, the lines going north and south, and east and west, spaced a few inches apart. There is little or no fancy drawing, no fishes in the sea or monsters on land, though there are a few banners with arms, and the more important towns are marked by pictorial castles. In fact, the chart is, in the main, a business chart, meant for use.

The reproduction of the chart is accompanied by an admirable memoir by Mr. A. R. Hinks, secretary of the Royal Geographical Society. In this memoir Mr. Hinks explains that he was charged by the Society with the duty of inspecting the principal fourteenth century maps now existing in the libraries of Europe, with the view of deciding which were most worth reproducing. Of the eight Portolan charts of this century, or earlier, he was able to inspect seven, and chose the chart in question as being in the best style and in excellent condition; Prince Corsini readily gave his approval. Mr. Hinks adds brief, useful notes on the surviving Portolan charts, Catalan world maps and atlases of the fourteenth century.

There may be a slight difference of opinion as to the exact date of the chart. Mr. Hinks, in his memoir, says, " the date [is] almost certainly 1325, though it has been read 1330 ". The writer of this review took the reproduction to a scholar who is very familiar with fourteenth century Latin manuscripts, and this authority has little hesitation in reading 1330. The inscription then reads: " Hoc opus fecit Angellinus de dalerto anno dni m ccc xxx de mense martii conposuit hoc ".

As to the accuracy of the chart: A series of cross-sea measurements, made by the writer of this review, from points easily identifiable, gave a mean scale of 75 miles to the inch for the north-east sheet of the reproduction, 84 miles to the inch for the south-east sheet, 88 miles to the inch for the south-west, and very variable numbers for the north-west. That sort of thing would be expected, for the north-west of Europe was relatively little known to Mediterranean sailors. The mean scale of the better mapped region, that is, the Mediterranean, Black Sea, and western coasts of Spain and Portugal, is about 80 miles to the inch, or a little less than one to five million. An interesting feature is that there are four scales drawn for use in each of the four quarters of the chart. These scales are identical, showing that it was intended that the scale should be the same all over the chart. Each major division of the scale represents about 36 English miles, and each major division is divided into five minor divisions. The outlines of Scandinavia, Denmark, and Scotland are very faulty; but the same remark would apply to our own Bodleian map, so far as concerns Scotland.

The Bodleian map is about 46 inches long by 22 inches broad, on a single skin. Its date is about A.D. 1300. The scale, in the better mapped portion (England), is, as nearly as may be, 1 : 1 million, or five times the scale of the Portolan chart. The accuracy of this portion is very fair, and perhaps the map may serve to show the kind of material that was available in the better mapped regions when Angellino de Dalorto constructed his chart.

With regard to the method of construction, the rectangular grid appears to represent north-south and east-west lines, and to that extent, as Mr. Hinks remarks, the projection must tend towards a rough anticipation of Mercator. But, as mentioned above, the scale is undoubtedly meant to be the same all over the chart, so that there was an attempt to combine conflicting conditions. The main north-south line bears symbols for north and for south and is so marked; the main east-west line, at right angles to the former, bears symbols for east and west, and is so marked. There can be no doubt about these two lines, and, perhaps, we may look upon them as the chief construction lines. Perhaps, also, the various parts of the chart were fitted together in the manner of a jig-saw puzzle, from more detailed maps, many of which no doubt existed. As is usual with charts of this type, the Straits of Gibraltar are drawn considerably too far to the south, in comparison with the position of Alexandria, perhaps caused by a bending down of the western countries in the process of fitting.

These matters, however, are questions of mere frame-work. The chart deserves to be studied in detail. The names alone are full of interest; there is, for example, a wealth of place-names along the north coast of Africa. As was to be expected, the interior topography of the continents depends largely on hearsay. The Nile is made to rise a few hundred miles to the south of Tripoli; "hic surgit nil"; and above the place where it rises is a legend to the effect that in that neighbourhood there dwell dragons, serpents, basilisks, and other horrible beasts.

The anonymous benefactor, the Royal Geographical Society, and Mr. Hinks, have given all those who care for ancient cartography an excellent reproduction of an important fourteenth century map, and geographers must welcome the success of this first issue of what promises to be a valuable series of reproductions of early manuscript maps.

Our Bookshelf.

History of the Natural History Society of Northumberland, Durham and Newcastle-upon-Tyne, 1829–1929. By T. Russell Goddard. Pp. xvi + 195 + 12 plates. (Newcastle-upon-Tyne: Andrew Reid and Co., Ltd., 1929.) 7*s*. 6*d*. net.

The Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne attained its centenary on Aug. 19, 1929, and in order to commemorate the event the Council decided to publish a history of the Society and the Museum in which its collections are housed. The work has been carried out with meticulous care by the curator, Mr. T. Russell Goddard, who is to be congratulated on the production of a volume which will prove to be of great interest not only to local naturalists, but also to the wider circle of those who find in natural history—in the words of Lord Grey—a sure recreation and a refreshing pleasure.

The Society was founded by men who achieved permanent distinction, and many volumes of *Transactions* have been published since 1831, in which the fauna, flora, and geology of the two counties have been comprehensively dealt with. The Museum is an imposing and dignified structure of classic design situated in spacious grounds. It was John Hancock who made possible the erection of this beautiful building, which was completed and opened in 1884. Since 1891, a year after Hancock died, the museum has been known as the 'Hancock Museum'. Among the collections, the Hancock collection of British birds is known to ornithologists throughout the world. The Museum also contains the largest extant collection of drawings of birds by Thomas Bewick. The Hutton collection of Carboniferous plants is of unrivalled value and contains seventy-nine type and figured specimens. The geological department contains notable collections of Coal Measure fishes and amphibians, while the Permian collections, of both fishes and invertebrates, are the most extensive in Britain. Some of the specimens in the ethnographical department are of interest as having been brought from Oceania by Capt. Cook.

The book contains brief accounts of these and other collections of unusual scientific interest, together with lists of all the reference collections and of the new genera and species described in the *Transactions*. Fourteen bibliographical sketches of the old worthies associated with the development of the Society form an attractive addition. The membership of the Society has never been greater than it is at the present time, and though, like many other institutions that support museums, it has frequently been faced with grave financial difficulties, these have always been overcome, and a great tradition of public service and scientific responsibility has been developed.

The book is well printed and beautifully illustrated, and is a worthy monument to the vitality of the Society and the industry of the author.

Geologische Karte der Erde. Von Franz Beyschlag. Bearbeitet mit Unterstützung durch die Preussische Geologische Landesanstalt. 1 : 15,000,000. Lieferung 1, enthaltend die Blätter 1, 2, 3, 4. (Berlin: Gebrüder Borntraeger, 1929.) Subskriptionpreis der vollständigen Karte, 150 g.m.

A satisfactory geological map of the world is of so much help that we turn with interest to the first four sheets of this map, which is being prepared for the Prussian Geological Survey by Prof. Beyschlag and edited by Dr. W. Schriel. The map will consist of twelve sheets. The first section consists of the four northern sheets, which include Europe, northern Asia, and Canada, and the northern parts of the United States. The scale is 1 : 15,000,000, so that the map gives only a general survey of the main geological divisions. The colouring is clear and the primary geological structure is well shown. The largest areas left blank in these sheets are in Mongolia and along the Amur Valley: they are probably as well known as parts of north-eastern Siberia, which are fully coloured.

The map is difficult to judge without the colour sheet which is to be issued with the third part. The sheets published have therefore to be interpreted by the symbols on a sheet entitled "Explanation previous for the first delivery of the Geological Map of the Globe". Some countries, such as Japan and Sicily, are shown in many colours but in small areas; the initial letters are seldom given in such cases, and without the explanation of the colours the age of the rocks has to be guessed.

There are already good general geological maps both for Europe and North America, so that the sheets with the more difficult work are to come. The map, however, promises to be very useful. The table of formations suggests that the authors accept the existence of extensive areas of Palæozoic and Mesozoic metamorphic rocks.

Selected Readings in Pathology: from Hippocrates to Virchow. Edited by Prof. Esmond R. Long. Pp. xiv + 305 + 26 plates. (London: Baillière, Tindall and Cox, 1929.) 18*s*. net.

Prof. Long, whose excellent "History of Pathology" was referred to in these columns last year (Nature, Oct. 5, 1929, p. 543), has again laid the student of medical history under his obligation by the present volume, which contains selections from important but, to many, almost inaccessible works from the dawn of scientific medicine down to the present time. Antiquity is represented by Hippocrates, Galen, and Celsus, the Middle Ages by Paul of Ægina, Rhazes and William of Saliceto, the Renaissance by Antonio Benivieni, Fracastor, and Fernel, while the rest of the book contains passages from the leading British, French, Dutch, German, and American writers of the seventeenth, eighteenth, and nineteenth centuries, among whom British authors have a prominent place, as is shown by selections from Harvey, John Hunter, Baillie, Hodgson, Bright, Hodgkin, Corrigan, and Addison. In the passages from French writers, who are represented by Fernel, Astruc, Corvisart, Laennec, Louis, and Cruveilhier, we miss the inclusion of selections from the works on diphtheria and typhoid fever by Bretonneau, who in the estimation of his countrymen comes only second to Laennec as a pathologist as well as a clinician.

The selections from each writer are preceded by a short introduction giving an account of his significance in the history of pathology. Prof. Long himself has contributed the translations of the selections from the works of William of Saliceto, Antonio Benivieni, and Virchow. The other translations include several contemporary versions, as in the case of Astruc, Morgagni, Corvisart, Andral, and Rokitansky.

The text is interspersed with numerous portraits of the pathologists and illustrations from their works.

Railway and Seaport Freight Movement: with examples of British and American Practice. By George Bulkeley. Pp. xiv + 222. (London: Crosby Lockwood and Son, 1929.) 28*s*. net.

Students of that department of transport which is specially associated with the transfer and handling of goods at ports between rail and ship will find Mr. Bulkeley's manual an interesting and informative review of the conditions, written from the point of view of the man who is in charge of operations. It is full of practical hints gleaned from a long experience in railway and dock work, and should prove a serviceable guide, particularly to beginners. It is, in fact, designed as a textbook covering elementary principles, as well as being explanatory of the more complex features of port traffic organisation and operation.

The author describes various modern types of freight rolling stock and freight shipping, with a consideration in the former case of motive power and service control. The movement of traffic through shunting yards and sidings, to and from the quayside, is outlined and explained, and there is a description of various types of appliances for handling goods in and out of ships' holds. Finally, the author discusses the subject of statistics in regard to freight movement and shows the value of a reliable system of records for guidance in operation. The volume is profusely illustrated by photographs and diagrams, which form a useful adjunct to the text.

B. C.

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 Problem of Stellar Luminosity.

I ASK your permission to reply to the arguments brought forward by Prof. Milne (NATURE, Mar. 22) against my treatment of the problem of stellar luminosity. The outcome of my investigation is a formula which predicts the luminosity of a star of given mass and radius (or mass and effective temperature). I have followed the common procedure of first employing special assumptions to make the mathematical answer definite, and then removing the assumptions by calculating the effect of the greatest admissible variation from the conditions adopted as standard—thus obtaining what is equivalent to a probable error of the prediction. The calculations of luminosity must, of course, be considered in conjunction with these estimates of probable error. I think that the discussion in "Internal Constitution of the Stars" of all *known* sources of uncertainty is exhaustive; and I conclude that the error is not so great as to impair the practical value of the formula. I have shown that differentially the result agrees excellently with observation, but absolutely it makes all the stars about ten times too bright. In view of this remaining discordance, I have been as eager as my critics in searching for possible loopholes or complications. If Milne's scrutiny brought to light any new possibility I should be grateful; but his criticism is not of this type. He claims that there is a fundamental inadequacy in my method, so that not even a rough value can be computed in this way.

In my deduction I employ those laws and conclusions of pure physics which are generally accepted as trustworthy. I think that most physicists will assent to my including among these the conclusion that matter in the usual stellar conditions of temperature and density behaves as a perfect (or slightly superperfect) gas—notwithstanding the doubts of my friend Sir James Jeans. But there is one result that as yet ought only to be used tentatively, namely, the physical calculation giving the absorption coefficient or opacity of matter in stellar conditions. If we accept it, my formulæ determine the luminosity; if we mistrust it, the application of my formulæ is inverted, and we use the observed luminosity to determine the intrinsic opacity of the material in the interior. In the opening paragraph of his long *Monthly Notices R.A.S.* paper, Milne proclaims his main conclusion that it is not possible to infer from the observed masses, luminosities, and temperatures the value of the absorption coefficient for the stellar interior; and in his letter to NATURE he puts the same challenge in the converse form, denying the dependence of luminosity on internal opacity.

Now the greater part of Milne's letter is occupied with a problem which is only indirectly related to my investigation, namely, the problem of supplying energy (presumably from sub-atomic sources) at a suitable rate to maintain the star in an approximately steady state for vast periods of time. I think I was the first to insist on the difficulty of this regulation of supply (NATURE, Mar. 21, 1925, p, 419; May 1, 1926, Supp.). Many dilemmas similar to those touched on by Milne are collected and surveyed in "Internal Constitution of the Stars", Chap. xi. But these difficulties in reaching a satisfactory theory of evolution and in accounting, for example, for the Hertzsprung-Russell diagram, do not concern my investigation of luminosity, which depends only on the present equilibrium. Milne complains that my scheme of equations does not automatically provide that $L=\int\epsilon dM$ shall be satisfied. Of course, it does not. As well might he demand that the equations by which the flow of water in a main is calculated from the head of pressure should automatically control the machinery of the pumps. (It is not very clear whether in referring to contracting stars Milne takes ϵ to mean the actual rate of liberation of sub-atomic energy or the rate from a fictitious distribution of sources which he introduces in a formulation of the cooling problem; with the latter meaning $L=\int\epsilon dM$ is automatically fulfilled without reference to my equations.) My equations refer to ordinary equilibrium and they are indifferent as to whether the slow secular changes proceed with a time-scale of a million or a thousand million years.

Only at one point do considerations of evolution and energy-supply impinge on my theory of stellar luminosity. If fully known, they would enable us to assign an exact value to a certain factor (α in my formulæ, $\bar{\eta}$ in Milne's version), which depends on the relative distribution but not on the magnitude of the energy sources. As it is, we leave this factor undetermined within limits; the extreme range is about $2\frac{1}{2}:1$, and this is included in the uncertainty of prediction above-mentioned. Thus the one really vital sentence in Milne's letter is, "Similar considerations show that the luminosity of a star cannot be even roughly independent of the relative distribution of energy-sources". That is to say, α and $\bar{\eta}$ have unrestricted range. This throws over a conclusion on which Milne, Jeans ("Astronomy and Cosmogony", p. 101), and I had all reached agreement. Instead of following up this assertion with the expected justification, he proceeds to argue that the luminosity depends on the radius. (As this is what my formulæ assert, I have no need to dissent.) It is strange that Milne should leave his most essential assertion unsupported both in his letter and in his longer paper. It is strange that he should think it unnecessary to say why he rejects my calculation of the amount of dependence. Strangest of all, he treats with equal contempt his own paper on "Stellar Equilibrium and the Influence of the Distribution of Energy-production" (*Monthly Notices, R.A.S.*, vol. 87, p. 708).

Finally, I can scarcely agree that Prof. Milne has disproved my conclusion that the uranium model is unstable. His objection is that physically a star cannot "contract indefinitely"; sooner or later it must find a (contracted) configuration of equilibrium. By the same argument Humpty Dumpty's position on the wall was not unstable; ultimately he found a new configuration of equilibrium.

A. S. EDDINGTON.
Observatory, Cambridge,
Mar. 17.

The Relation of Fluidity of Liquids to Temperature.

NONE of the formulæ proposed for the effect of temperature upon the viscosity of liquids has secured general acceptance, in the sense of permitting satisfactory comparison of liquids.

In the shearing over unit area defining viscous resistance, we may suppose at any moment an equilibrium between undeformed and deformed molecules, to which the Boltzman distribution function applies. This leads to an expression relating fluidity to temperature of the form

$$\log \phi = -\frac{k}{T} + C,$$

where T is temperature absolute, and k and C are constants. This expression can only be a first approximation, since it assumes k and C independent of temperature. None the less, it was found to represent the relation of fluidity to temperature for every liquid so far tested—more than fifty—over a very wide range of temperature with an accuracy generally comparable with the experimental error. Deviations become considerable as the temperature approaches the freezing-point.

This result confirms Prof. A. W. Porter's observation that log ϕ plotted against log p, where p is vapour pressure, gives a straight line, and specialises his deduction that some function of ϕ should have the form $f(\phi) = \frac{k}{T} + C$ (*Phil. Mag.* [vi], **23**, 458 ; 1912).

From the derivation from the distribution function, it appears that k, the slope of the line, should be a work function involving the specific heat of the liquid. A simple work function which has given very interesting results is obtained as follows : The observed specific heat C_p—mean value over temperature range —refers to unit mass. Hence specific heat per unit volume is $C_p\delta$, where δ = density, mean value over temperature range. The heat per molar area is obtained as $C_p \times (M\delta)^{2/3}$, where M is the formula molecular weight, that is, uncorrected for possible association or dissociation.

It follows that to a first approximation, if k be the slope of the line log $\phi \propto 1/T$, the expression: $\frac{\text{Specific heat} \times (M\delta)^{2/3}}{k}$ should equal a constant K, the same for all normal liquids, while a relative indication of molecular association should be obtained as $\alpha = \left(\frac{K}{K'}\right)^{3/2}$ for deviating liquids.

The data available—principally the fundamental studies of Thorpe and Rodgers—give quite good confirmation of this relation. For liquids which have been previously deduced to be 'normal' by other methods (cf. W. E. S. Turner, "Molecular Association": Longmans Green and Co.) the values of the molar work function, in arbitrary units, ranged from 21·9 to 19·8. The values of the association factor α calculated for the abnormal liquids are generally of the right order of absolute magnitude, and place them in a relative order agreeing reasonably well with such orders as are obtained by other methods ; it is admitted that these are somewhat discordant. Thus the following values for α were obtained for typical cognate series of compounds :

Substance.	Formula.	α.
Water	H_2O	3·51
Methyl alcohol	$CH_3 . OH$	2·70
Ethyl alcohol	$C_2H_5 . OH$	3·15
Propyl alcohol	$C_3H_7 . OH$	3·04
Butyl alcohol	$C_4H_9 . OH$	2·95
Iso-butyl alcohol	$C_4H_9 . OH$	3·52
Formic acid	$H . COOH$	2·66
Acetic acid	$CH_3 . COOH$	1·64
Butyric acid	$C_3H_7 . COOH$	1·35
Iso-butyric acid	$C_3H_7 . COOH$	1·66

Except for methyl alcohol, the trend of these values is regular and plausible. The alcohols show a slow declination of association with increasing molecular weight, the fatty acids a more rapid one, while in both cases iso-bodies show increased association compared with normal bodies.

It is realised that the association factors found can be only relative, since the temperature variation is not allowed for. It may be remarked that on considering modifications of the formulæ to include this variation, it was found that the published data on the variation with temperature of the specific heats of liquids appear to be very sparse and discordant.

My thanks are due to Dr. R. C. Houck for essential assistance in testing the formulæ suggested. Should further applications give encouragement, a joint paper will be published in the *Journal of Rheology*.

S. E. SHEPPARD.

Research Laboratory,
Eastman Kodak Company,
Rochester, N.Y.,
Feb. 3.

Since my letter of Feb. 3, a further search of the literature has shown that the specific form of Porter's function,

$$f(\phi) = -\frac{k}{T} + C, \text{ putting } f(\phi) = \log \phi,$$

has been used before. The original application is by Señor J. de Guzman, "Relación entre la Fluidez y el Calor de Fusion" (*Anales de la Sociedad Española de Fisica y Quimica*, **11**, p. 353 ; 1913). The author refers to a future article to be published jointly with Prof. C. Drucker, of Leipzig, in whose laboratory he was then working. This article does not appear to have been published, so far as I can ascertain ; but in an article, "Untersuchungen über Fluidität" (*Zeit. phys. Chem.*, **92**, 287 ; 1918), Prof. Drucker recapitulates and expands the application of the formula, used as an integration between temperatures T_1, T_2 of its differential form

$$\frac{d \log \phi}{dT} = \frac{w}{RT^2}$$

to deduce the work function w, which, as previously stated by Señor de Guzman, is found to be nearly equal in many cases to the *molecular latent heat of fusion*.

On the other hand, the form of the work function suggested in my letter above appears correct, to an equal degree of approximation. Certain interesting consequences follow from this, with which I hope to deal more fully elsewhere.

I shall not regret having unwittingly assumed some novelty in the specialisation of Porter's formula, if so doing should help to affirm and extend the previous work of the authors cited. S. E. S.

Feb. 15.

[When Dr. Sheppard sent the above communication for publication, he was, of course, unaware that Prof. Andrade had recently been giving attention to the relation between temperature and the viscosity of liquids, and had stated preliminary results of his investigations in NATURE of Mar. 1. Since that letter was published, we have received several others discussing some points raised in it, and we hope to include these in an early issue, together with Prof. Andrade's remarks upon them.—Editor, NATURE.]

The Age of Iron Meteorites.

IF meteorites are scattered portions of our solar system, derived from some disintegrated planet or from the earth, then their age cannot be greater than that of the solar system. This is assumed to be about 3×10^9 years at the utmost. If, however, meteorites come from other stars, it is possible that the period of their solidification could date back some 10^{12} years. A determination of the age of meteorites can therefore bear on the question of their source.

Of the radioactive methods of age determination the lead method is here inapplicable; but Strutt's well-known helium method is practicable if the sensitivity of the measurements be suitably increased. In any event, it is essential not simply to heat the meteorite, but to bring it into complete solution. A description of an apparatus, such as is required for the performance of this operation under absolutely air-free conditions, was given two years ago, together with some results obtained (*Zeits. für Electrochemie*, **34**, 645; 1928; see also NATURE, **123**, 879; 1929, as well as the communication of Dubey and Holmes (NATURE, **123**, 794; 1929) concerning two helium measurements made in our laboratory).

At that time we confined ourselves to the determination of the helium content, and relied upon the meteorite-analysis of other investigators for the radium values. Owing to the fact that both measurements can vary somewhat in individual pieces of a meteorite, an element of uncertainty enters into the calculation. In the course of our research we have, therefore, so far improved our method that in one and the same sample both the helium and the radium content are ascertained. Our process of bringing the meteorite into solution remains essentially the same. The helium so freed is now, however, measured by means of a resistance manometer developed from that designed by Pirani and Stern; with this 10^{-7} c.c. of helium can be determined with a 2 per cent accuracy. (The limit of the qualitative test for helium by our method is of the order of 10^{-10} c.c.; see *Zeits. phys. Chem.*, **134**, 353; 1928.) The electrometric method employed for measuring the radium content permits an accuracy of about 10 per cent in measurements of 10^{-13} gm. of radium. All the reagents used in the solution process have been so freed from radium that their activity cannot occasion any error.

In the following table the results of our work are briefly summarised. In order to complete the series, we include four earlier determinations (in which we ascertained the helium, but other investigators the radium, value); and also the helium values of six meteorites, of which the radium still remains to be measured. These are added because the helium content is in itself of interest in the study of meteorites; it varies within very wide limits in meteorites of different source, and can therefore be used to test the common origin of fragments separately distributed on disintegration. (See, for example, the agreement of helium values for the two masses of Mukerop and Löwenfluss.) The only meteorite (Savik) in which both the helium and radium content is so abnormally low that we failed persistently to detect these elements qualitatively is also tabulated. All the age values which were calculated from helium and radium content ascertained in the same sample are indicated by a star.

It has generally been considered that the helium method gives only a minimum age estimate, on account of a possible helium leakage. This objection cannot be raised in the case of iron meteorites (to which we have therefore confined ourselves for the present) because we have demonstrated that even red-hot metals are not penetrable by the smallest amount of helium; even after palladium had been allowed to glow for several hours, the quantity remained under 10^{-10} c.c. (see *Zeits. phys. Chem.* (B), I, 253; 1928). As further evidence we heated Mount Ayliff, the meteorite richest in helium, for twelve hours at 800° C., and ascertained that less than 5 per cent of helium was released. This also explains why earlier workers who attempted to detect the helium content by mere heating found values far too low; Strutt found in Staunton Co. less than $1 \cdot 6 \times 10^{-6}$ c.c. per gm., although it contains nearly twelve times that amount. We do not believe, therefore, that our determinations of iron meteorites can be too low, owing to helium loss. A possible thorium content (probably, however, too small to effect appreciably the calculation) would still somewhat reduce the age value.

It will be noticed that some age values given in the table are higher than those found in any previous application of the radioactive methods. (The lead method gave a maximum of 1600 million years, the helium only of 570 million years.) Although our iron meteorite results range up to 2900 million years, nevertheless not one is found to be older than the age of the earth. The solidification date of all meteorites so far studied accords well, therefore, with the assumption that iron meteorites originate not from distant celestial bodies, but from our solar system.

Name.	Type.	He per gm. in 10^{-6} c.c.	Ra per gm. in 10^{-14} gm.	Age in Millions of Years.
Savik . . .	Om	<0·0002	<0·2	—*
,, . . .	Om	<0·0002	<0·4	—*
Mukerop, Farm Goamus . .	Of	0·43	1·3	100*
Mukerop, Farm Gröndorn . .	Of	0·49	—	—
Löwenfluss . .	Of	0·47	—	—
Toluca . . .	Om	1·2	21	16
Seeläsgen . .	Ogg	2·0	4·9	120
São Julião de Moreira . . .	Ogg	2·0	—	—
San Martin, Chile	—	2·13	1·4	420*
Santa Rosa, Columbia . .	Ob	3·02	—	—
El Inca . .	Om	4·0	2·0	550*
Augustinowka .	Off	5·21	—	—
Arispe . . .	Ogg	7·22	1·3	1500*
Mount Joy . .	Ogg	9·7	4·7	570
N'Goureyma .	Ob	13·91	2·9	1250*
Cocke Co. . .	Og	14	4·0	930
Hraschina . .	Om	14·9	2·6	1450*
Sacramento Mts.	Om	15·03	2·5	1550*
Crow Creek . .	Og	17·35	—	—
Staunton Co., Mass III . .	Om	18·82	2·1	2150*
Staunton Co., Mass V . .	Om	18·92	2·4	2000*
Independence Co.	Om	19·28	4·1	1200*
Burlington Co. .	Om	19·31	3·6	1400*
Nelson Co. . .	Ogg	20	1·8	2600
Thunda . . .	Om	28·57	2·3	2800*
Mount Ayliff .	Og	35·81	2·8	2900*
,, ,, .	Og	35·96	3·2	2600*

F. PANETH.
WM. D. URRY.
W. KOECK.

Chemisches Institut der Universität,
Königsberg i. Pr., Mar. 3.

The Planet discovered at Lowell Observatory.

LAST week I indicated the basis of Lowell's prediction of an unknown planet exterior to Neptune. Further consideration of Lowell's memoir leaves me of the opinion that the residuals in the motion of Uranus are too small for the orbit of a disturbing planet to be predicted with any certainty. It may be of interest to give the opinion of Newcomb, who, with his assistants, was responsible for the tables of all the major planets the positions of which are given in the *Nautical Almanac*. In the introduction to his tables of Uranus he wrote: "These tables of Uranus are based on elements derived from meridian observations of the planet from the time of its discovery by Herschel in 1781 to the opposition of 1898. The outstanding residuals between theory and observation, left in the solution of the equations, sometimes amount to one second of arc. It is not possible at the present time to decide whether these differences are real or whether they arise from the errors of the ephemeris of comparison, which, between 1830 and 1872, was that derived from Bouvard's tables. The observations since 1860 seem to be represented with great exactness." No great importance need be placed on the fact that Lowell used three normal places earlier than 1781 and that he included observations up to 1910. In justice to him, however, it should be stated that he made no claim to very great accuracy in the prediction.

It is impossible to deny the existence of unknown exterior planets, but it appears to me quite unwarranted to jump to the conclusion that the newly found object is a major planet with a mass between that of the earth and Neptune. It is not easy, on the other hand, to conjecture the nature of the body which for nearly two months has simulated in motion a planet distant more than 40 astronomical units. If we imagine a body in opposition distant 49 units from the sun, moving in a circular orbit, its path would be parallel to the earth's path, but its speed only one-seventh. Consequently, it would appear to retrograde about 60″ a day. After two months the earth's motion would be inclined at an angle of 60° to the direction of the planet and the apparent motion would be reduced to about half. The question is, What sort of body other than an exterior planet would appear to move in this way? It is quite easy to answer that no permanent member of the solar system inside the orbit of Uranus could behave in this way. The observations reveal that the object is distant. If it were 25 units away, it would require to move at about half the earth's speed to appear nearly stationary at twice its distance. But an object 25 units from the sun moving at half the speed of the earth would soon pass out of the solar system. The inevitable conclusion seems to be that the body is either moving in an approximately circular orbit at the distance announced, or in a nearer orbit with parabolic or hyperbolic velocity and near perihelion.

From all the information now available, the object is definitely a small planet, possibly comparable to the planet Mercury in size. No known comet would appear so bright at so great a distance.

From the newspaper reports it appears that the Lowell observers have spent a good deal of time during the past year in searching for the predicted planet, and that they have in the meantime discovered, as one would have expected, many minor planets which by their comparatively rapid motion have quickly shown their true character. The new object, whatever its real nature, will be of importance, for if only a comet, it will be no ordinary one. The comet which at present holds the record for greatest perihelion distance is 1927 *j*, which never approaches the sun nearer than 5·5 units and moves in an orbit which does not differ so very greatly from a circle. The fact that, of the five known comets with greatest perihelion distance, four were discovered so recently as 1914, 1925, 1927 (two) is surely significant. It looks as if long-exposure photographs are revealing a number of faint objects inside the solar system which would otherwise remain unknown, and possibly we may soon have better knowledge from which to judge the distribution of comets in our system.

With regard to comet 1927 *j*, it may be noted that the discoverers, Schwassmann and Wachmann, described it as of magnitude 13 to 14 with a well-defined nucleus and a circular coma about 2′ in diameter. It appears not unreasonable to believe that the new object, which is described as of magnitude 15 to 16, is a still more distant object. It is quite reasonable to expect that diligent search amongst the faintest objects we can photograph may reveal many faint comets at a great distance.

The stumbling-block in accepting the new object as the planet predicted by Lowell is its feeble luminosity. Lowell stated that his planet would have "a visibility of the 12-13 magnitude according to albedo; and a disc of more than 1″ in diameter". The magnitudes reported vary from 15 to 16·0—the latter being on the international photographic scale. A difference of three magnitudes in the brightness corresponds to a factor of 63 in the volume. It is difficult to explain this by low albedo and high density, as the mass, if wrong by a factor of more than 2, would make the prediction meaningless. The Lowell Observatory will in any case be congratulated on the discovery of what may be the most remote object ever observed in the solar system.

J. Jackson.

Royal Observatory,
Greenwich, S.E.10,
Mar. 23.

A Method of investigating Gas Exchanges of Living Tissues.

Few, if any, really simple methods have been proposed for the simultaneous estimation of the carbon dioxide evolution and oxygen uptake of living tissues in which it is possible to maintain the composition of the gas mixture surrounding the tissue constant, and at the same time detect a rapid change in rates of gas exchanges. The method outlined here has been found to be very simple, rapid, and trustworthy.

The principle of the method is as follows: a gas mixture circulates in a closed system over the material under investigation, and through a solution of barium hydroxide. Since the carbon dioxide is thus absorbed, there is a reduction in volume of the gas mixture due to the absorption of oxygen by the tissue. This causes the level of liquid to rise in a manometer placed between the closed respiration system and another closed volume of air (the compensator). The liquid is an electrolyte, and when it rises a small amount (about 1 mm.), it makes contact with an electrode from which oxygen starts to be evolved; further decrease in volume of the system due to absorption of oxygen is thus prevented by this automatic electrolytic addition of oxygen which takes place at the same rate as that at which the oxygen is absorbed by the tissue.

This rate is measured by measuring the current used in the course of the electrolysis by either finding the volume of hydrogen or weight of silver simultaneously set free.

The rate of carbon dioxide emission of the tissue is found by observing the change in electrical resistance of the barium hydroxide solution, which rapidly increases owing to the conversion of the hydroxide into insoluble barium carbonate.

It is essential that the platinum black electrodes should not remain long in contact with the baryta, more particularly while the gas stream is bubbling through it, as it is found that the barium carbonate precipitate tends to form on any solid surface placed in the solution. The electrodes thus become coated with barium carbonate and the 'cell constant' rises towards infinity. This is readily prevented by a simple device: the electrodes are kept in mercury at the base of the baryta tube in which the carbon dioxide is being absorbed. When it is desired to estimate the quantity of carbon dioxide which has been absorbed, the gas stream is stopped and the mercury is lowered and the baryta comes in contact with the electrodes, the conductivity is measured, and the electrodes are again covered with the mercury and the gas stream is started again.

The diagram of the apparatus is almost self-explanatory. Absorption of oxygen by the plants causes the solution in the manometer *CD* to rise into tube *C*, thus bringing the electrode *c* into electrolytic connexion

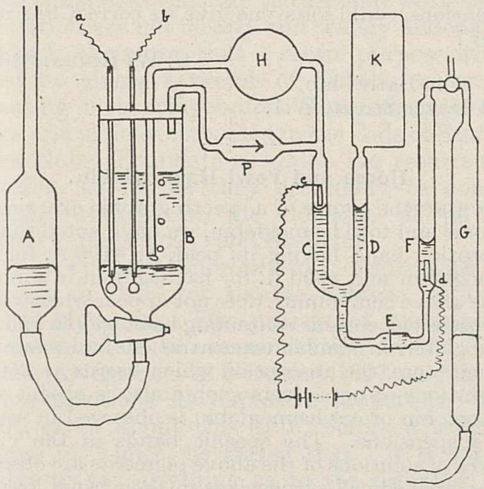

FIG. 1.—*A*, tube for altering level of mercury in *B*: *B*, carbon dioxide absorption tube: *CD*, manometer: *E*, parchment membrane: *G*, gas burette: *H*, plant chamber: *K*, compensator: *P*, circulating pump. Electrodes *a* and *b* are connected to a Wheatstone bridge.

with *d*. The parchment membrane *E* allows this movement of ions, but prevents changes in the gas pressure in the tube *F* from affecting the volume of the gas in the circulating system and compensator. The gas burette *G* serves to estimate the hydrogen evolved simultaneously with the oxygen.

The volume of the circulating gases fluctuates to an extent of about 0·07 c.c. on each side of the mean volume, and this defines the limit of accuracy with which the rate of oxygen intake can be estimated.

The relationship between the resistance of the baryta and the quantity of carbon dioxide which it has absorbed is most conveniently obtained by calibrating the apparatus with known amounts of carbon dioxide. The magnitude of the change in resistance for a given quantity of carbon dioxide increases as the process of absorption proceeds. Using $N/20$ baryta, 1 mgm. carbon dioxide brings about an increase in resistance of roughly 10 per cent.

It is hoped that full details both of the calibration and 'rapidity of response' of the apparatus will shortly be published.

It may be noted that the fact that the circulating gas-system is closed throughout the course of the experiment makes this method particularly accurate, and useful when gas mixtures other than air are used in the investigation. T. A. BENNET-CLARK.

School of Botany,
Trinity College, Dublin.
Feb. 28.

Crossed Connexion of the Cerebral Hemispheres with the Muscles and Sense Organs.

I WISH to thank Dr. Creed for his letter in NATURE of Mar. 1 with its references.

I am afraid that in my attempt to be brief I may have misled Dr. Creed in one or two details. I agree with him that the crossing of both afferent and efferent impulses seems a very clumsy arrangement, but my desire was to suggest a way in which this remarkable state of affairs might have been brought about.

I did not mean to suggest that the median eye is the forerunner of the two lateral eyes. In view of the number and variety of eye-like structures in invertebrates, it seems that such organs can be easily developed; in fact, in *Sphenodon* there are two lateral eyes as well as a single median one. The parapineal organ may be the remnant of the primitive median eye, and if so the well-developed structure in *Sphenodon*, even if it is not functional, is worthy of investigation. Perhaps some comparative anatomist can throw light on this possible relationship. I did not refer to *Sphenodon* previously because the crossed connexion occurs in fishes, hence the origin of that condition must have been in a more primitive organism. If the pineal eye of *Sphenodon* does represent the same structure as the eye of an ascidian larva, it is curious that the organ seems to have nearly disappeared in fishes.

I look upon the original crossing as efferent. There is no need in the ascidian larva for an afferent crossing, as the optical images would be formed on the crossed side. Where the crossing occurs and how many neurones are involved in the path to the muscles, I do not know, but in so far as the impulses are concerned with the production of movement they are efferent.

When the crossed connexion had been established, the parts growing from that region would all be crossed and the afferent impulses would have to cross in order to link up with the efferent paths. It is remarkable, however, that a new uncrossed system did not develop when lateral eyes became predominant. As pointed out by Dr. Creed, Ramón y Cajal's suggestion is out of harmony with the cortical distribution of the retinal areas in man.

H. E. ROAF.

London Hospital Medical College,
Mar. 10.

Indeterminacy in Physics.

THE Principle of Indeterminacy in physics, to the history of which Sir Joseph Larmor has directed attention in NATURE of Mar. 8, is sometimes referred to as though it might develop so as to dissolve all physical laws. It is well to point out its limitations. Its present phase is no more than the search among physical statements for their minimum content, rejecting repetition and superfluity. From this point of view it is the necessary continuation of the chapter of upheaval of ideas introduced by Relativity, which dissolved so much.

It is only by mathematics that superfluous statements, so subtle that they have hitherto evaded detection, can safely be analysed. But mathematics is a closed chain of argument that reveals nothing that is not put into the chain originally; and physics, upon which it works, has been so far explored, that apart from detail, we know what it is going to say. What it is going to say is, to attempt to describe the universe without Will or Purpose. It does so, not because anyone believes that to be possible, but because those things are unmanageable by mathematics and have, therefore, been left out expressly from the mathematical chain. Hence whenever physics attempts an ultimate picture, the result is jejune, or absurd, according to the writer's taste. In any case it is incredible. "I had rather believe all the fables in the Legend, and the Talmud, and the Alcoran, than that this universal frame was without a mind."

Physics, having excluded purpose from its view, when it has no more to say, presents a scheme which is purposeless and therefore meaningless, both in its beginning and its end. It is a self-consistent scheme, but it is in no sense satisfying. The conclusion to draw from it is, apparently, that we must try again upon a broader basis, little as we know how to do so. In the meantime, all searches aimed at weeding out unjustified precision in our statements of natural 'law' fall into a class of lower importance, an exercise merely technical, interesting to those that are interested in that kind of thing.

R. A. Sampson.

Royal Observatory,
Edinburgh, Mar. 8.

The Maladaptation of Trout Spermatozoa to Fresh Water.

A few years ago, when I was investigating sex-ratio in trout, some facts came to light which I intended to pursue further, but as there seems no opportunity at the moment of doing so, I feel it is worth putting them on record. Gray (*Jour. Physiol.*, **53**, 308; 1920) had already pointed out the remarkable fact that artificial insemination of trout eggs secured a much higher percentage of fertilised eggs than did natural fertilisation, and had shown that this was due to the extremely short time (1½-2½ minutes) for which the sperm remain active.

Struck by this observation, I made a few experiments with sperm in different solutions. I need not go into details: the salient point which emerged was that both sodium chloride and Ringer's solutions as well as somewhat diluted sea-water enormously prolonged the sperms' period of activity. Instead of about two minutes, it might run to ten or twenty minutes; and in sea-water diluted with three parts of tap-water, to half an hour or over. Undiluted sea-water was less favourable. Details of optimum salt composition, osmotic pressure, hydrogen ion concentration, or of possible antagonistic salt action remain to be determined.

The general fact emerges, however, that the trout is an animal which, though somatically fully adapted to fresh-water life, is very imperfectly so adapted in its reproduction, its sperms being many times more efficient in a medium intermediate between its present and its ancestral environment.

J. S. Huxley.

King's College, Strand,
London, W.C.2, Mar. 11.

Curling.

The letter on the flight of a curling stone by Messrs. Macaulay and Smith, in Nature of Mar. 15, seems to require a little filling out. As an old curler, and one who has been much 'in the house', I may perhaps be pardoned for taking part in a subject the mathematics of which are above my head. First, on good ice covered with ever so little frozen mist a stone 'borrows', bends, or curls far less than one passing over dry, clean ice, or very clean ice *just* on the thaw. The amount of spin (handle) put on one stone without effecting the curl of that stone may be too great for another stone, and cause it to keep its original direction. I have seen old stones, with the polish off them, take a lot of curl, even when played on the side with next to no cup. My own view is: a stone tends to turn on its outer edge and so to roll inwards; the spin of the stone when great reduces this outward turn; the tendency of the stone to follow the line of least resistance is slight, perhaps the 1 ft. 11 in. arrived at by Messrs. Macaulay and Smith.

Before leaving this interesting subject there is one more point worth consideration: Should a stone be delivered with the weight of the body behind it, as from the hack, or is it more economical in energy to swing it, as from the crampit? The finest exponent of the game I have seen of late years does both, but his swing, if not followed by a forward slide of his body, every once in a while, causes him to 'drop' his stone. If the flight is worth considering in one pair of dimensions, could some one give its correct line in the other?

C. W. Richardson.

The Bath Club,
34 Dover Street, W.1.

Horse and Fowl Hæmoglobin.

During the course of a spectrographic examination of horse and fowl hæmoglobin, we have noted that the absorption band having its peak at 4100 A. for oxyhæmoglobin and 4300 A. for hæmoglobin in solutions of the above compounds, does not appear when washed corpuscle suspensions containing hæmoglobin and oxyhæmoglobin in similar concentrations are examined. Furthermore, the absorption which begins at 2500 A. in solutions of horse hæmoglobin also is absent when hæmoglobin or oxyhæmoglobin is observed in washed cell suspensions. The specific bands in the visible regions of solutions of the above pigments are observed in the washed cell suspensions in their usual location.

Apparently there is, in the case of hæmoglobin in the cell, a possibility that it is in combination with some constituent of the corpuscle. This problem is one of several concerning the blood pigment for which we are attempting to find a solution.

A. Bruce Macallum.
R. C. Bradley.

Biochemical Department,
University of Western Ontario,
Medical School,
London, Canada.

An Anthropological Congress.

Through the courtesy of a friend, I have had the opportunity of seeing a copy of a circular of invitation, dated Paris, Feb. 15, 1930, to an anthropological congress described as *XVe Congrès Internationale d'Anthropologie et d'Archéologie Préhistorique: IVe Session de l'Institut International d'Anthropologie: Portugal, 1930.* This invitation is signed by the president and secretaries of the Institut International d'Anthropologie, and is issued from its address in Paris. Among the 'comité d'honneur' is one of the survivors of the 'permanent committee' of the *XIVe Congrès International* (Geneva, 1912); another represents Switzerland on a "comité international de préparation scientifique des sessions"; but there is no other apparent link with the older series of congresses.

In view of the leading article on these congresses in Nature of March 1, readers may be interested to have this further information.

John L. Myres.

Royal Anthropological Institute,
London, Mar. 15.

The Nobel Prizes for Research Work in Science.

HISTORY OF FOUNDATION AND CONSTITUTION OF COMMITTEES.

ALFRED BERNHARD NOBEL, engineer, chemist, inventor, industrialist, philanthropist, was born at Stockholm, Sweden, on Oct. 21, 1833 ; he died at San Remo, Italy, on Dec. 10, 1896, aged sixty-three years. The terms of his will, covering an immense capital sum, instituted an annual allocation of money prizes, of which the essential principle was their application for and towards the greatest benefit of mankind. From inquiries which reach us from time to time, and from comments made upon awards of the prizes, it appears that the nature and work of the Foundation are not clearly and widely understood. We think, therefore, that a useful purpose will be served by giving a sketch of Nobel's career and presenting in a compendious form, the main decisions and articles embodied in the Code of Statutes of the Nobel Foundation, which are recurrent in operation, so far as they are likely to concern scientific workers in the domains of physics, chemistry, physiology, and medicine.

The story may appropriately begin with the discovery in 1846, by Ascanio Sobrero, of Turin, of nitro-glycerine. The process of manufacture was described in a communication to the Turin Academy of Sciences in February 1847, and therein Sobrero mentions its explosive properties. In a lecture given about this date, before a scientific congress in Venice, he stated that " it is not yet possible to say anything as to the use that may one day be found for this liquid substance, which can be exploded by a shock ; future experience alone will show us ". Down to the early 'sixties, nitro-glycerine was regarded much in the aspect of a scientific curiosity, and its use as a powerful explosive was not contemplated. The resourcefulness, patience, and inventive genius of Alfred Nobel wholly changed the situation.

A recently issued English edition of " The Life of Alfred Nobel ", by Prof. H. Schück and R. Sohlman,[1] translated from the German edition of Dr. Muelbe, supplies details of Nobel's first Swedish patent, and of those experiments and developments ensuing which revolutionised the technique of explosives. Particulars will also be found there as to the manufacture of dynamite (1863), ballistite (1888), and other explosive materials.

This " Life " is a welcome compilation, affording so far as possible an authentic account of Nobel's family history and upbringing, and of the activities which dominated his career. Hitherto, details have appeared, more or less uncertain and incomplete. But this issue bears the authority of the Nobel Institute, whilst the authors are specially qualified for their task. Two forewords, by the late Dr. Gustav Stresemann, and Sir Austen Chamberlain, respectively, are of interest in relation to the subject of international peace.

[1] " The Life of Alfred Nobel." By H. Schück and R. Sohlman. Translated from the German of W. H. v. d. Muelbe by Brian and Beatrix Lunn. Pp. ix+353+18 plates. (London: William Heinemann, Ltd., 1929.) 21s. net.

It appears that owing to the reserve which was characteristic of Nobel, a biography of him could only be, in a sense, fragmentary, since extensive periods of his life's history remain as uncharted areas on a map. In 1893 the University of Uppsala conferred upon him a doctorate of philosophy. He furnished then a short autobiography, breaking silence, as follows : " The undersigned was born on the 21st October 1833 ; he acquired his knowledge in private studies, and did not attend any secondary school. He devoted himself particularly to applied chemistry, and discovered explosives known under the names of dynamite, and smokeless powder called ballistite and C. 89. Since 1884 he has been a member of the Royal Swedish Academy of Science, and is also a member of the Royal Society (London)[2] and the Société des Ingénieurs Civils in Paris. Since 1880 he has been a Knight of the Order of the Polar Star. He is an officer of the Legion of Honour."

Although a Swede, whose alternative tongue was Russian, he wrote German, French, and English in faultless style. To say that he seems never to have had leisure to live may appear paradoxical, nevertheless it has elements of truth. Owning a native kindliness of heart, many deeds of sympathy with affliction sprang therefrom. He was free from methods of dictatorship, and observed strict rectitude in business operations ; and he held open and fair dealings with all in his employ.

Nobel was conscious that his scientific discoveries, besides their technical and industrial applications, might have far-reaching overt implication. Incidentally, he had placed in the hands of internationals ways and means for new destructive agencies amongst mankind in general. The knowledge seems to have bred a haunting fear, and melancholy dread, intensified with passing years. Peace between peoples became a subjective necessity of his being. Possibly, after all, science and philosophy were in the middle distance only, and not in the foreground of his thoughts.

" I have been wondering ", he wrote (1892), " why the rules governing a duel between individuals should not be applied to a duel between peoples." Disarmament, he believed, could only be achieved by very slow degrees. Somewhat later he had reached this conclusion : " I am beginning to believe that the only true solution would be a convention under which all the governments would bind themselves to defend collectively any country that was attacked ". His final will provided (through prize awards) for the promotion of friendly relations between the peoples, for the abolition or reduction of standing armies, and for the formation and increase of peace congresses.

It is of interest to recall that on May 21, 1875, Nobel attended the Society of Arts in London, and read a paper " On Modern Blasting Agents ", and it was announced as by the founder of the nitro-

[2] Dr. Nobel was not a foreign member of the Royal Society of London.

glycerine industry. The chairman, Mr. (afterwards Sir) Frederick Abel, advised the audience that the great experience of Mr. Nobel, both from a practical and scientific point of view, entitled his views to very great consideration. There, were, however, debatable points. Abel summed up the discussion that took place at considerable length. At the ensuing annual general meeting (June 30, 1875) Nobel was awarded the Society's silver medal for this paper. Nobel had remarked that the foregoing was the only scientific memoir he had ever written. He did not do himself justice in this respect. Earlier, in 1865, he communicated a paper to the Paris Academy of Sciences, published with the following title: "Résultats des expériences de sautage faits avec la nitro-glycérine, à la mine de la Vielle-Montagne". Also, in 1868, he attended the meeting at Norwich of the British Association and read a paper on "Dynamite, a Recent Preparation of Nitro-glycerine, as a Blasting Agent". This was published in brief abstract.

Nobel's comparatively early death was not unexpected. From his earliest youth he had been delicate. When only twenty he underwent treatment at a spa, oftentimes repeated. Strenuous work and constant travelling from country to country naturally took their toll. In 1893 he reached the age of sixty and heart trouble became more frequent. From Paris he wrote, "It seems an irony of fate that they should be prescribing nitro-glycerine internally for me"; and this to his sister-in-law, Ludwig Nobel's wife: "You are anchored in contentment. I drift about without rudder or compass, a wreck on the sea of life; I have no memories to cheer me, no pleasant illusions of the future to comfort me."

The student of scientific biography will observe a curious parallel in the life story of Alfred Nobel and that of James Smithson, founder of the Smithsonian Institution, Washington, whose patrimony, though meagre by comparison, was designated (1826) for "the diffusion of knowledge among men". Each was unmarried, each of marked idealistic fibre. Bodily infirmities were alike common. Both careers came to a close in Italy, a land foreign to birth.

By his own wish Alfred Nobel was buried at Stockholm in a grave in the northern churchyard where his parents and a brother had been interred. Thus, the spirit of patriotism was preserved in the end.

Design of Nobel's Will.

It was provided in the will (drawn on Dec. 27, 1895) that the interest on the capital sum available should be awarded annually in prizes to those persons who shall have contributed most materially to benefit mankind during the year immediately preceding. Further, that the interest should be divided into five equal amounts.

In the domain of science the appointments were three in number, specified as under:

(*a*) One share to the person who shall have made the most important discovery or invention in the department of physics.

(*b*) One share to the person who shall have made the most important chemical discovery or improvement.

(*c*) One share to the person who shall have made the most important discovery in the department of physiology or medicine.

Further, the will stipulated that the prizes for physics and chemistry should be awarded by the Swedish Academy of Science, Stockholm; the prize for physiology or medicine by the Caroline Medical Institute, Stockholm. "I declare it to be my express desire", wrote Nobel, "that, in the awarding of prizes, no consideration whatever be paid to the nationality of the candidates, that is to say, that the most deserving be awarded the prize, whether of Scandinavian origin or not."

The instructions of the will settled the form and scope of the Nobel Foundation, which was ushered into being in the year 1900, after prolonged deliberations. The Royal Academy of Science, Stockholm (K. Svenska Vetenskaps-Akademie) one of the two corporate bodies with whom is vested the adjudication of the three prizes in science, was founded in 1739. The functions of the Academy are to encourage the pursuit and the development of the sciences, and also to spread a knowledge of them through scientific papers and monographs. The King is patron, and there are 100 Swedish and Norwegian members and 75 foreigners. The Caroline Medical-chirurgical Institute, Stockholm (K. Karolinska Institutet) was founded in 1815. It corresponds to a university medical faculty, and has the same standing as the medical faculties at Uppsala and Lund.

The Statutes of the Foundation provide that it is within the power of each corporation entitled to adjudicate prizes, to determine whether the prize or prizes it has to award might be granted to some institution or society.

Nobel Committees.

An elective Nobel Committee for each of the three scientific prize sections exists to promote the obligations devolving yearly upon the Stockholm institutions, consisting of three, four, or five members. The committees receive and make suggestions respecting the grounds for allotments of prizes, whilst they have power to seek the aid of a specialist, if necessary, in furtherance of investigation. To be qualified for election on a Nobel Committee it is not essential to be a Swedish subject.

During the course of the month of September in each year the Nobel Committees are empowered to issue a circular to all those who are qualified, asking for nominations of candidates for prizes before the first day of February in the following year; such nominations to be supported by evidence, documentary and otherwise. It is essential that only duly qualified persons propose candidates. A direct application for a prize is not taken into consideration.

1. *Physics and Chemistry Sections*. The right to hand in the name of a candidate appertains to:

(*a*) Home and foreign members of the Royal Academy of Science, Stockholm.

(*b*) Members of the Nobel Committees of the Physical and Chemical Sections.

(*c*) Men of science who have received a Nobel prize from the Academy.

(*d*) Professors of the physical and chemical sciences of the Universities of Uppsala, Lund, Oslo, Copenhagen, and Helsingfors, at the Caroline Institute, Stockholm, and the Royal Technical College, Stockholm, and also those teachers of the same subjects who are on the permanent staff of the Stockholm University College.

(*e*) Holders of similar chairs at other universities or university colleges, to the number of at least six, to be elected by the Academy of Science in the way most appropriate for the just representation of the various countries and their respective seats of learning.

(*f*) Other men of science whom the Academy of Science may see fit to select.

The members of the present Committee for Physics are—

Prof. Carl W. Oseen (Uppsala).
Prof. V. Carlheim-Gyllensköld (Stockholm).
Prof. Karl M. G. Siegbahn (Uppsala—Nobel prize, 1925).
Prof. Henning B. M. Pleijel (Stockholm).
Prof. Erik W. Hulthén (Stockholm).

The members of the present Committee for Chemistry are—

Prof. Henrik G. Söderbaum (Stockholm).
Prof. Theodor Svedberg (Uppsala—Nobel prize, 1926).
Prof. Knut W. Palmaer (Stockholm).
Prof. Ludwig Ramberg (Uppsala).
Prof. Hans Karl von Euler-Chelpin (Stockholm—Nobel prize, 1929).
Secretary to the above Committees—
Prof. Arne Fredrik Westgren (Stockholm).

2. *Physiology and Medicine Section.* The qualification for the right to nominate candidates is possessed by:

(*a*) Members of the professorial staff, Caroline Institute, Stockholm.

(*b*) Members of the medical class of the Royal Academy of Science, Stockholm.

(*c*) Nobel prize-winners in the section.

(*d*) Members of the medical faculties of the universities of Uppsala, Lund, Oslo, Copenhagen, and Helsingfors.

(*e*) Members of at least six other medical faculties, to be selected by the staff of the Caroline Institute in the way most appropriate for the just representation of the various countries and their respective seats of learning.

(*f*) Men of science whom the above staff may see fit to select.

The Nobel Committee of the section shall hand in its verdict and proposals for the prize award to the professorial staff of the Caroline Institute within the month of September.

The members of the present Committee for Physiology and Medicine are—

Prof. Gunnar Hedrén (Stockholm).
Dr. Hans Christian Jacobæus (Stockholm).
Dr. Hans Valdemar Gertz (Stockholm).
Dr. Einar Hammarsten (Stockholm).
Secretary to the Committee—
Dr. Göran Liljestrand (Stockholm).

Special Funds of the Sections.

The Statutes provide, within strictly defined limitations, for the establishment of Special Funds for each of the five sections of the Noble Foundation. The proceeds of any and every such fund may be employed, subject to the approval of the adjudicators concerned, to promote the objects which the testator ultimately had in view in making his bequest, *in other ways than by means of prizes.* In the domain of physical and chemical science, support in furtherance is consequently available, if judged to be of significance either in a scientific or a practical regard. Proposals for the awarding of assistance of this nature remain with the respective Nobel Committees. Similarly, such proceeds may be devoted to promoting research in medical science, and in rendering the results of that research of practical use to mankind. In this section a proposition may be made by a member either of the staff of the Caroline Institute, or of the Nobel Committee.

Obituary.

THE RIGHT HON. THE EARL OF BALFOUR, K.G., O.M., F.R.S.

THE genuine statesman, so we read in the *Republic*, will be the man who, in contemplating the true good, makes it a pattern for ordering the State and individuals and his own conduct; who spends much of his time in philosophic reflection, and yet, when his turn comes, endures for the sake of the public welfare the toil of politics and ruling, not as though he were performing some meritorious deed but simply as a matter of duty. In writing of the great personality lost to the nation on Mar. 19 last, one can scarcely avoid recalling the well-known portraiture. For, if ever in the chequered course of human history Plato's ideal has been to some extent realised, it was in Lord Balfour's case. Other political leaders have been classical scholars, men of letters, and even men of science. Who, however, among Prime Ministers, has ever before not only made philosophy his main pursuit as an undergraduate, but also at the age of thirty published in a technical journal an elaborate criticism of the transcendental theory of knowledge of sufficient importance to elicit replies from such eminent Kantian scholars as Edward Caird and John Watson? And, needless to add, this was the outcome not merely of a passing phase in the career of a distinguished public man; it was the prelude to a large number of subsequent efforts in the field of speculative thinking, interest in which was no less keen in the man of eighty than in the man of thirty.

Arthur Balfour came to Cambridge from Eton in

1866, and at once fell under the spell of Henry Sidgwick, his senior by about ten years. Of Sidgwick it has been said " he did not teach as a prophet, and he required of his pupils hard thought, without promising them that this would result in any revelation of the secret of the universe " ; and Balfour himself wrote of him that " he never claimed authority ; he never sought to impose his views ; he never argued for victory ; he never evaded an issue ". That the pupil who was destined soon to become a warm personal friend was immensely influenced by his teacher there can be no doubt. In all Balfour's published work, characterised, indeed, by an ease and beauty of style and a wealth of epigram to which Sidgwick's can lay no claim, there is to be traced that critical habit of mind, that evenly balanced judgment, and that distrust of dogmatic systematising which, in his undergraduate years, he had seen so uniquely exemplified. In the year 1869, he took the Moral Sciences Tripos, one of the first to be examined under the new scheme, with the framing of which Sidgwick had been closely concerned.

Ten years intervened between his taking the degree and the appearance in 1879 of Balfour's first book, " A Defence of Philosophic Doubt ", although he had previously published several philosophical articles in *Mind* and elsewhere ; and meanwhile he had entered the House of Commons as member for Hertford. Fourteen more years elapsed before his second book, " The Foundations of Belief ", saw the light in 1895 ; but, again, during the interval numerous articles of his had appeared in periodicals, amongst them a delightful essay on Berkeley, and two Lord Rector's addresses had been delivered, one at St. Andrews in 1887, and the other at Glasgow in 1891. Then followed in 1915 the first volume of Gifford Lectures on " Theism and Humanism ", delivered in Glasgow just prior to the outbreak of the War, and which he managed to prepare for the press before joining the Coalition Cabinet ; and finally, in 1923, there appeared the further volume on " Theism and Thought ", containing the second series of Glasgow lectures, delivered in 1922–23, when the author was more than seventy-four years of age. Many smaller things ought to be mentioned, especially the striking presidential address to the British Association at the Cambridge meeting of 1904. It is an extraordinary record of independent and vigorous intellectual activity on the part of a man who was never free from the strenuous demands of political life, and was fulfilling various functions in the educational world and in many other spheres. " Literary composition ", he once said, " I have always found laborious and slow, even in favourable conditions." Yet whatever he wrote is remarkable for its fresh, lucid, and graceful mode of expression ; as Sir Frederick Pollock put it in 1895, he will have done much to bring back the good days of Berkeley and Hume when philosophy could speak English.

At the time when Balfour's first book was written, the dominating philosophical influences in England, both at the universities and perhaps more decidedly among the philosophically minded outside the universities, were J. S. Mill and Herbert Spencer—Mill more than Spencer, although it is true that in Oxford and Glasgow German idealism had powerful representatives. The philosophic doubt which Balfour defended was doubt as to the legitimacy of either of these ways of handling ultimate problems. In dealing with the former, which had culminated in an agnosticism the cardinal tenet of which was that knowledge is confined to phenomena and the laws of phenomena, he directed attention not upon what was alleged to be unknowable but upon what was alleged to be known. If we are to believe nothing but what we can prove, let us see, he urged, what it is that we *can* prove. He started by emphasising as fundamental the distinction between the causes or antecedents which produce a belief and the grounds or reasons which justify one,—a distinction which every competent thinker would acknowledge as vital now, but which was constantly being lost sight of then. Confining himself to logical grounds or reasons, Balfour tried to show, and certainly succeeded in showing, that, on the basis of an empirical theory such as was then current, the premises on which the system of modern science rests can neither be proved nor rendered even probable.

A philosophy which is to justify the procedure of science must be prepared to give a coherent account of two radical beliefs at least—the belief in the uniformity of Nature and the belief in a world of physical things existing independently of the individual mind that is apprehensive of them ; and of neither could the current empiricism give a coherent account. As regards belief in an external world, Mill's doctrine of ' permanent possibilities of sensation ' and Spencer's doctrine of ' transfigured realism ' fell easy preys to Balfour's incisive dialect. Neither could afford the slightest warrant for asserting the existence of a material universe the objects of which are composed of atoms and molecules, vibrating with different degrees of rapidity, and in which modes of energy are everywhere operative. Spencer had himself admitted that if the theory of subjectivism were right the doctrine of evolution would be a dream ; but the arguments which he brought to bear against what he called ' crude realism '—the " realism of the child and the rustic "—involved him in the very subjectivism he had attributed to the ' unimaginable blindness ' of the ' metaphysicians '. As regards the uniformity of Nature, Balfour argued that not only is the statement of it as an inference from particulars ' by simple enumeration ' incapable of proof, but that, when so interpreted, it cannot be thrown into any accurate form save at the expense of making it unmeaning. In dealing with transcendentalism, he maintained that, so far as causality is concerned, all that Kant, even on the most favourable view of his reasoning, can be said to have established is that the totality of phenomena at one instant is the effect of the totality of phenomena at the previous instant,—a general proposition which by itself is wholly inadequate to serve as a basis for scientific induction. For this general proposition might be quite true, and yet the course of Nature might be, to all intents and purposes, absolutely irregular, unless a fixed relation subsist not merely between the totality of phenomena but likewise between extremely small portions of that totality, and not merely between individual concrete phenomena but between classes of phenomena.

The argument of the early work was, it is true, conducted with an *arrière pensée* in the shape of 'practical results' it was taken to yield, so far as a theistic view of the world is concerned. But, in his second book, Balfour attempted to develop the negative speculations of philosophic doubt into a constructive, if provisional, system of thought. As before, he proceeded by criticising what he here designates 'naturalism', meaning by that term virtually a purely mechanical theory of Nature, which "forces itself into the retinue of science", and "claims, as a kind of poor relation, to speak with her voice". With singular effectiveness, he sought to bring into the foreground the implications, in the spheres of ethics, æsthetics, and of rational thought generally, which this doctrine entails. In the first place, the consciousness of freedom, the sense of responsibility, the authority of conscience, —these, along with the train of beliefs and sentiments from which virtuous deeds and generous ambitions spring, evince themselves as mere devices for securing certain competitive advantages in the struggle for existence. In the second place, the persistent endeavours of æsthetic theory to show that the beautiful is a necessary and unchanging element in the general scheme of things indicate, at any rate, that mankind will not be easily reconciled to the view that beauty is but the chance occasion of a passing pleasure, and that, so far from disclosing hidden mysteries to us, poets and artists portray what, though it may be very agreeable, is seldom true and never important. "We cannot willingly assent to a theory which makes a good composer only differ from a good cook in that he deals in more complicated relations, moves in a wider circle of associations, and arouses our feelings through a different sense." In the third place, human reason, so far from being Nature's final product, is, according to the doctrine in question, no more than one of many expedients for increasing our chance of survival, and which, we may suppose, will be gradually superseded by the growth of instincts or inherited habits, by which such adjustments between the organism and its environment as now seem dependent on it will be more successfully effected.

Having thus exhibited the inherently irrational character of the naturalistic theory, Balfour attempted to sketch in outline a philosophic position which, while admittedly incomplete and suffering from gaps and rents, from loose ends and ragged edges, would yet do justice to the fact that in accepting science, as we all do, we are moved not merely by strictly logical considerations but also essentially by 'values'. A fearless examination of the grounds on which judgments about the physical world are founded will disclose, he argued, that they rest on postulates about which it is equally impossible to say that we can theoretically regard them as self-evident, or practically treat them as doubtful. We can neither prove them nor can we give them up. Grant the same philosophic weight to values in those departments of speculation that look beyond the physical world, and naturalism will have to be abandoned once for all. The vast majority of our beliefs, of our ethical, social, and religious beliefs especially, have not been attained by any process of logical reasoning; they have been generated in us by custom, education, public opinion, by the contagious convictions of countrymen, family, and so on; and, not least, by "the 'spirit of the age', producing a certain psychological 'atmosphere' or 'climate' favourable to the life of certain modes of belief, unfavourable, and even fatal, to the life of others". Unfortunately Balfour used the misleading and inappropriate term 'authority' by which to denote the group of influences thus enumerated. But, as a discerning German critic has observed, what he really meant "may all be covered by the proposition that we men, in our higher spiritual life, are the products of history before we are its producers, and that in this double relation of ours to history the weight is permanently to be placed upon our dependence on the historical factors which surround and determine us." And it is, I take it, certain that, although he not seldom contrasted what he called 'authority' with reason, Balfour did not mean to imply that, in the last resort, the beliefs in question are 'irrational'. On the contrary, he insisted that we are driven to believe in a supreme Reason, in order to account for the presence of these factors in the human world at all. The presupposition that the world is "the work of a rational Being, who made *it* intelligible, and at the same time made *us*, in however feeble a fashion, able to understand it" is a presupposition "forced upon us by the single assumption that science is not an illusion".

I must not dwell upon Lord Balfour's further elaboration of these principles in the Gifford Lectures. Those of us who have been privileged to take part with him in philosophical discussion need not to be reminded of his invariable fairness and patience in listening to views that were opposed to his own, or of his wonderful power of quickly seizing the main points in a complicated argument, and of freeing it from irrelevancies. Nowhere will his presence be more sincerely missed than in the small gatherings of philosophic workers, where he was always so much at home.

G. Dawes Hicks.

From Sir J. J. Thomson, O.M., F.R.S.,
Master of Trinity College, Cambridge.

It may fairly be said of Lord Balfour that no statesman ever did so much to promote the development of science or kept in closer touch with its progress. He was First Lord of the Treasury during the initial stages which led to the foundation of the National Physical Laboratory, and it was his sympathy and support which made the Laboratory possible. He was instrumental in founding the Department of Scientific and Industrial Research, and was, as Lord President of the Council, for many years its official head. Everyone who has been connected with the Department knows the keen interest he took in its work and development and how much it owes to his advice and sympathy, on which they felt they could rely in any case of difficulty: help was never given more gracefully or more tactfully. The same is true of the Medical Research Council, in which he took deep interest.

Lord Balfour was one of the pioneers in advocating the application of research to industry. In the Sidgwick Memorial Lecture for 1908 he said of it: "That on this we must rely for the improvement of the material conditions under which societies live is in my opinion obvious, though no one would conjecture it from a historic survey of political controversy". It was not only in industry that he recognised the importance of science, for in the same lecture he said: "Science is the great instrument of social change, all the greater because its object is not change but knowledge; and its silent appropriation of this dominant function amid the din of political and religious strife is the most vital of all the revolutions which have marked the development of modern civilisation".

A liking and aptitude for science were in Lord Balfour's blood. His uncle, the late Marquis of Salisbury, was distinguished among statesmen by his interest in science, and was president of the British Association at the famous meeting at Oxford when Lord Rayleigh and Sir William Ramsay announced the discovery of argon. Lord Balfour's brother, Frank Balfour, before he was thirty, was the most distinguished morphologist in Great Britain, and his tragic death when he was but thirty-one affected Cambridge more deeply than any event I can remember.

Apart from his interest in science as a social and industrial force, Lord Balfour took a keen interest in it from the philosophical side and kept in close touch with modern developments. He had been a fellow of the Royal Society since 1888 and had served twice on its Council; he was president of the British Association at the Cambridge meeting in 1904, and gave a very characteristic address which showed a close acquaintance with the new views about the nature of matter and was illuminated by witty and weighty criticisms of their philosophic aspect. Conversation on scientific subjects with Lord Balfour was an intellectual tonic: he was so quick in seizing the points, in picking out those which were vital, and in foreseeing possible developments.

In 1919, Lord Balfour succeeded Lord Rayleigh as Chancellor of the University of Cambridge, and was most active and helpful in securing the means for the erection of a new library for the University, the most important event in its recent history. He had previously been instrumental in securing a new professorship—the Arthur Balfour professorship of genetics. A short paper he wrote in 1910 induced an anonymous benefactor to offer to found the professorship provided it was associated with the name of Arthur Balfour. His connexion with Trinity College was long and intimate: he had been a member of the College for sixty-four years and an honorary fellow for forty-two: two brothers, Gerald and Frank, and two brothers-in-law, Lord Rayleigh and Henry Sidgwick, were fellows of the College and took an especially active part in its work, and the connexion, much prized by the College, has been continued in the younger generations of his family.

From Sir ALFRED EWING, K.C.B., F.R.S., lately Principal and Vice-Chancellor of the University of Edinburgh.

I HAVE been asked to write a note about Lord Balfour's association with universities, perhaps because I served under him as Vice-Chancellor in one of them for thirteen years. Perhaps also because a previous service under him at the Admiralty, when he was First Lord during the War, had created a personal link which the subsequent intercourse maintained and strengthened. Meeting Lord Balfour from time to time in the serene yet vigorous evening of his life, one found in him continually more and more to admire and revere and love.

Lord Balfour's connexion with universities is too big a subject for a brief note. He was Chancellor of two—Edinburgh for thirty-nine years and Cambridge for eleven. He was honorary doctor of at least sixteen, rector of two, a member of the senate of another. He had been Gifford lecturer, Romanes lecturer, and so on. Such points of established contact meant much to the universities concerned. His immense influence and authority could be invoked; his advice could be sought; his sympathetic comprehension of university affairs never failed. It was for such reasons that he undertook, in his double capacity as Chancellor of Cambridge and of Edinburgh, to lay the case for the universities before the Treasury, thereby securing a much-needed increase in the annual grants.

To Balfour himself the academic atmosphere was congenial. He was conspicuously a fine flower of university culture. He understood the ways and aims of universities, their potentialities and their difficulties. In many addresses he spoke of them with insight and affection. He praised their past, noting especially how they had served as disinterested pioneers in scientific research. He had confidence in their future. But he was acutely alive to the need of adaptation to altering conditions. He saw that the promotion of research had become a public duty, to be undertaken on a scale larger than they could handle and needing greater resources. Fortunately, it fell to him, as Lord President of the Council, to direct the development of scientific and industrial research as a national task.

Through his membership of Trinity, his brothers' fellowships there, the tenure of the Cavendish chair and, later, the Chancellorship by his brother-in-law, the late Lord Rayleigh, and the appointment of his sister, Mrs. Sidgwick, to be head of Newnham, he had many ties with Cambridge. When he was asked to become Chancellor, he had already for a long time held the like office at Edinburgh, and it was typical of his courtesy that before accepting the

Cambridge invitation he consulted Edinburgh opinion as to whether there might be objection to his holding both. He was quickly reassured, and certainly neither University was prejudiced by his association with the other.

With Edinburgh Balfour had a geographical connexion, for his ancestral home was not far off. When in residence at Whittingehame, it was easy for him to come to us. His visits were not infrequent, especially after the claims of political life had grown less insistent. Some occasions were ceremonial, others more private, and these he unaffectedly enjoyed. I recall his presiding when the Prince of Wales opened a new building and received an honorary degree. The Prince, duly 'capped', was called upon to speak, and to the delight of a vast concourse of undergraduates proceeded thus to chaff the Chancellor :

> This is by no means the first time, Mr. Chancellor, that we have met one another in circumstances such as these. You will doubtless recall a day at Cambridge when you were good enough to confer a degree upon me in Latin, a language with which, I regret to say, I am unable to claim great familiarity. Shortly afterwards I found myself in a position, as Chancellor of the University of Wales, to retaliate, when in admitting you to a degree at Cardiff it fell to my lot to address you at some length in Welsh. Now, for the third time, with no handicap on one side or the other, we meet in a common tongue, and the match, if I may put it so, remains all square.

Another notable occasion was the rectorial address of Mr. Baldwin, then Prime Minister. A bad tradition among Scottish students had made the address of the rector an opportunity for a 'rag'. In pre-War days the Chancellor had suffered from this exuberance to an extent that strained even his good-nature. When I asked him to come he stipulated that this time there should be reasonable order. Accordingly I summoned the leaders of the students' unionist, liberal, and labour associations, the president of the athletic club, and one or two more, and showed them Lord Balfour's letter. They declared with one voice that in his presence order must be and would be kept. Sinking political differences they wrote a 'round robin' begging him to trust them and come. He did, and was gratified to find them as good as their word. The suppressive measures were their own; if drastic, they were completely successful. It was the dawn of a new era.

An example of a less formal visit was when Balfour came to talk to the students of history about the London Conference on Imperial Relations, and deftly countered an invited fire of questions. Another was when he presided at the first of Prof. Eddington's Gifford Lectures. Such contacts were, I think, as agreeable to him as to us. His greatness, his maturity, his detachment from the commonplace, were no bar to intercourse. He would charm those he met into giving him of their best. To some he would talk philosophy, to others music, to others medicine, to others the bewildering developments of modern physics. There his bent towards science as well as philosophy found a double interest. He rejoiced in the escape of scientific thought from the crude materialism which was vocal fifty years ago. He followed the kaleidoscopic changes of atomic theory with an alertness that was the envy of younger men.

My last meeting with him has left a happy memory. It was on the day in July 1928 when, in honour of his eightieth birthday, he was entertained by the British Academy. At the luncheon he had been in great form, clearly delighted with the tribute and moved by it. That summer evening I met him again, sauntering hatless near his house, genial, buoyant, radiant. It was hard to believe he had eighty years behind him. Those whom the gods love die young: of that company was Balfour.

From Sir FRANK HEATH, G.B.E., K.C.B., formerly Secretary, Department of Scientific and Industrial Research.

LORD BALFOUR was twice Lord President of the Council, first from October 1919 until the fall of the Coalition Government in October 1922, and again in 1925 on the death of Lord Curzon until the end of that Parliament in the spring of 1929. The Lord Presidency used to be considered a general utility office. He converted it into a Ministry of Research. The idea was not born in his fertile brain, for a Committee of the Privy Council for Scientific and Industrial Research and a similar Committee for Medical Research had been established during the War, and Lord Haldane's Committee on the Machinery of Government had recommended the creation of such a Ministry. But Lord Balfour it was who turned an experiment which many thought destined to disappear with other War-time devices into a reality which is now generally recognised as a permanent and essential part of modern government. His unparalleled prestige in the political and intellectual worlds, his liberation from the rough-and-tumble of party politics, were favourable circumstances, but his abiding faith in the power of science to promote the happiness and well-being of man, his enthusiastic interest in the advance of knowledge, his sympathy with the scientific outlook and with young people, and his long experience of the way in which things have to be done in Great Britain, were the decisive factors.

He was constantly called away during his first Lord Presidency by urgent Imperial affairs, to the Foreign Office when Lord Curzon was abroad, to Geneva in the first critical months of the League of Nations, to the United States for the first and so far the only international conference that has led to disarmament, but he found time in 1921 to lay the first foundations of a comprehensive structure destined ultimately to bring the whole national administration within the range of scientific influence. He was chairman of a Cabinet committee appointed to study and report on the co-ordination of the scientific work of all Government departments. The need for economy had been the theme of discussion, and this was his way of meeting it. Even to outline the findings of that Committee is impossible here, but it led to a gradual and decisive rationalisation of the research work done by the Admiralty, War

Office, and Air Ministry, of research for defence and for industry, of civilian and military research in medicine, of research in forestry and forest products, that has saved Great Britain untold expenditure and has brought an inestimable increase in efficiency.

During his second term of office in a post once thought of as full of dignity and leisure, Lord Balfour devoted the larger part of his many-sided interests, and ungrudgingly of his time, to the continuance of this work. He became chairman of the Medical Research Council and constantly attended the meetings of the Advisory Council for Scientific and Industrial Research, the bodies responsible for making recommendations to the Lord President as to the expenditure of the funds voted by Parliament for research in their respective fields. He felt no embarrassment in this dual position, for the differentiation of function between the organs of scientific and administrative advice seemed to him natural and inevitable, provided they were properly integrated at the point of decision. This integration the constitution of the two new departments of medical and industrial research had for the first time successfully achieved. He always believed, and he hoped to the end, that a similar organisation for research in agriculture would complete the circle and so link together the services of science for the health and all the productive activities of man. His chairmanship of the Research Committee of the Imperial Conference in 1926, followed by the Imperial Agricultural Research Conference in 1927 brought the realisation of this hope definitely nearer and led to most important advances in the co-ordination of agricultural research throughout the Empire.

Lord Balfour realised, however, that the completed picture must include even more than this. His first act on resuming office in 1925 was to consider a memorandum handed to him by Mr. Baldwin, which led his critical, constructive, and experienced mind to formulate a plan for establishing on the lines of the Imperial Defence Committee—itself an earlier creation of his—a Cabinet Committee for Civil Research of which he was chairman until 1929. The object of this committee was to provide a permanent and flexible organisation which, by working through temporary sub-committees of experts specially appointed for the purpose, might study, and help the Government to solve, problems which crossed the bounds of single departments, or even those of England as a single member of the Imperial Commonwealth. By this means co-ordination was secured in dealing either with general problems of organisation, or with specific questions such as sleeping sickness, the possibilities of geophysical survey, the scientific exploration of the Great Barrier Reef, or the restriction of rubber production. The best brains within and outside Government departments were brought into council, without advertisement or the incubus of a published report, and incidentally the inevitable tendency to departmentalism was mitigated. The present Government has altered the name of the committee and has added an Advisory Economic Council in more or less permanent session, with what results time alone will show; but Lord Balfour's plan will, it may be hoped, be understood and maintained.

It is at first sight unexpected that a mind so detached as Lord Balfour's, so philosophic in its outlook, so critical and even sceptical in its methods, should have shown this constructive genius. But if we remember, on one hand, the "Foundations of Belief" and on the other, the great Education Acts of 1902 and 1903, the riddle is plain. His criticisms, often put as a question, forced his councils and his officers to think clearly, his sympathy with their hopes and difficulties won their devotion; his understanding of the scientific mind their confidence, his courage in decision when they sometimes hesitated to commit themselves their respectful admiration. Often would he illuminate an intricate problem with a phrase which would simplify and clarify its complexities. Such a phrase occurs in the preface he wrote to the classical study of moving loads on bridges, the outcome of four years' work by the Bridge Stress Committee of the Department of Scientific and Industrial Research. "Fixed bridges and trains in motion become for brief periods parts of a single mechanical system." There stood the problem in crystalline clearness; and clear as crystal is the mind that has left us.

By H. T. Tizard, F.R.S., Rector of Imperial College of Science and Technology, formerly Secretary of the Department of Scientific and Industrial Research.

Lord Balfour held throughout his life a firm belief in the material as well as in the intellectual value of scientific knowledge. He lived to see his views shared by most public men. Largely through his influence, there has been brought about a complete change in the attitude of Parliament towards scientific matters, and the encouragement of research is now considered an essential duty of Government. Lord Balfour gradually and inevitably became the man to whom his political colleagues, and many of his political opponents, naturally turned to keep them in touch with scientific developments. It was remarkable how he managed to do it, busy man as he was. It is hard enough for the scientific worker to keep abreast of modern progress, and one would have thought it almost impossible for a man so fully occupied with other affairs. Lord Balfour succeeded partly by reading—one could usually find Nature and a modern scientific book on the little table by his chair—but mainly through meeting and talking to the leaders of scientific thought of the day, for whom he had a profound admiration.

Lord Balfour took an intense interest in the Department of Scientific and Industrial Research, and found time to exert an inspiring influence on its work. He never seemed to dictate policy or to interfere with executive matters: he preferred to give the utmost freedom of action to his officers and to his distinguished Advisory Council; and yet, somehow, he dominated us all. If a new proposal was submitted to him he received it always with interest, and often with enthusiasm. He liked to talk about it, not to read about it ; he found formal memoranda tedious ! In conversation he would probe its weak points, and illuminate its good points ; always sending one away with something more to think about, some fresh orientation of ideas.

He felt doubtful about the wisdom of making grants to universities for specific researches ; holding the principle that any grants given by the State to universities should be given for general purposes and not for specific objects. He was more strongly opposed to the Department undertaking research at the cost of the State in the interests of particular manufacturing industries. The argument that the particular industry was not doing enough, and that the work was necessary in the interests of the country, did not fundamentally appeal to him ; for he held, broadly, that if British industry could not or would not adopt scientific methods, nothing that the State could do would save it. This is not to say that he definitely refused to sanction such work ; but he wished that whatever was done was limited in scale and was intended rather as an example of what might be, than as a substitute for what should be, undertaken by industry. On the other hand, any research in the general interests of industry or of the community had his whole-hearted support ; one might instance a comparatively recent development, namely, that of research into the cause and prevention of the pollution of rivers, as the kind of thing that interested him, and in which he thoroughly believed.

In his somewhat infrequent visits to research stations—too infrequent for his and our liking—Lord Balfour's acuteness of observation often surprised me. Those who knew him will probably think the word ' surprised ' out of place : I use it because, with my fairly extensive experience of distinguished visitors to research stations, I cannot recall anyone who excelled him in accuracy of appreciation and criticism after a single visit. To his staff he was courtesy itself; and he was repaid by loyal and affectionate service. Like all really great men, he treated them as equals : need it be added that he knew how to get the best out of men ?

News and Views.

The Prince of Wales has promised to visit University College, Cardiff, on May 21, for the purpose of opening the new laboratories of physics and chemistry, which together form the north wing of the new buildings in Cathays Park, the civic centre of the city. The group of public buildings in this quarter form an *ensemble* which is said to be unique in Great Britain. To keep an honourable place in such an architectural constellation has taxed the resources of the College heavily, but the result of the effort has been duly gratifying. Altogether, the cost of the new wing amounts to £220,000, of which some £15,000 is still outstanding. It comprises laboratory accommodation of the most modern type and on a scale suitable to the needs of the large population of the district. The Council of the College having recognised that advances in technology are essential to the welfare of South Wales and that such advances can only rest on a basis of research in physics and chemistry, these two departments were given priority in the programme of development. The completion of this stage will, it is hoped, clear the way for further advances. The Prince of Wales will also inspect the new Advisory Department of Agriculture, which forms an addition to the south side of the College buildings.

Wide interest is being taken in the forthcoming Wedgwood bicentenary celebrations which are to be held on May 19–24 at Stoke-on-Trent. Their object is to commemorate the birth of Josiah Wedgwood (1730–1795), the great pioneer potter. His systematic methods and scientific outlook were unique amongst the potters of his own day, and still command the highest respect. The celebrations will be under the patronage of H. M. The Queen, whose sustained interest in the potteries and British pottery craftsmanship is well known ; Princess Mary is to pay a visit to the Potteries during the celebrations. A large influx of visitors is expected from all parts of the country and abroad, and the whole city will be in festive mood. A historical pageant of eight episodes illustrating the history of the district from the days of the early Britons up to the modern industrial developments of the city will be produced daily by some 5000 performers reinforced by massed orchestras and choirs. A military tattoo and torchlight spectacle, a tableau by 1500 pottery workers, physical training displays by 3000 school children, concerts, a fancy-dress ball, and other items will cater for the interest and amusement of the general public.

During the week of the Wedgwood celebrations the Ceramic Society, the object of which is the technical advancement of the pottery and other branches of the clay industries, will be the host of a large number of visitors representing kindred societies in Great Britain, the United States of America, Canada, France, Germany, Japan, Italy, Holland, Sweden, and Poland. The Society and visitors will be received by the Lord Mayor and Lady Mayoress of Stoke-on-Trent and entertained to luncheon. Numerous other functions are also being arranged for the three days, May 21–23, set aside for the Society's celebrations. These include a special visit to Wedgwood's works, when the party will be entertained to luncheon by Major Wedgwood, the present head of the works and a direct descendant of the great Josiah Wedgwood. The Ceramic Society is also holding technical meetings, for which a large number of papers has been promised, and is offering prizes for the best essays on "The Contributions of Josiah Wedgwood to the Technical Side of the Pottery Industry". A special commemorative volume is also being published by the Society. Extensive exhibitions of modern and historic pottery, amongst which will be certain pieces loaned by the Queen, will also be important features of the week.

The Fifth International Botanical Congress is to be held at Cambridge on Aug. 16–23 next. In this connexion a circular has been issued on behalf of the Imperial Forestry Institute at Oxford, the Yale School of Forestry, and the Forest Products Research Laboratory, Princes Risborough, in which it is suggested that an informal conference on the systematic anatomy of wood should be conducted. It is pointed out that this subject is rapidly increasing in importance, and more especially in the identification of timber. " The numerous anatomical descriptions of timbers ", state the authors of the circular, " which have been published of recent years, direct attention to the lack of any standard terminology, and it is thought that the Congress will provide a unique opportunity for discussing the possibility of introducing some measure of standardisation, at least among English-speaking people ". There is little doubt on the subject of the confusion at present existing in this matter. It will not be the first effort made to deal with it; but the present one has the advantage of being better planned. It is also hoped to arrange a scheme for the exchange of material among botanists and forest botanists who are willing to undertake the study of a family or group. Finally, the authors of the circular state that they are desirous of obtaining the views and co-operation of as many as possible of those who are interested in this subject. They therefore invite suggestions of matter for discussion both from botanists who propose to attend the Congress and from those who will be unable to do so. The suggested conference, should it receive adequate support, may be expected to achieve results of real practical importance to the forester, botanist, and timber merchant.

The Royal Society for the Protection of Birds has issued an appeal for £4000 to purchase the site of a proposed permanent sanctuary for wild-fowl in Romney Marsh. A nucleus of eighteen acres has been in the hands of the Society for some time, and there is now an opportunity of completing the scheme. The site consists of grassland, reed-beds, mud-banks, and open water: it is far from roads and is made still more inaccessible by wide intersecting ditches. The description suggests that the place is an exceedingly favourable one for the protection of the bird-visitors, particularly ducks and waders, for which this part of Kent is well known. The scheme has novelty for Great Britain in that the sanctuary will probably be more important as a reserve for wintering birds and resting migrants than as a breeding haunt. That there is need of such reserves was shown by the report of the international conference on the protection of migratory wild-fowl, held in London in 1927, and it is much to be hoped that the present proposal will be well supported.

The Symons Memorial Lecture for 1930 of the Royal Meteorological Society was delivered on Mar. 19 by Dr. Herbert Lapworth, who took as his subject " Meteorology and Water Supply ". Dr. Lapworth dealt mainly with the story of the rain between its precipitation as rainfall on the surface of the ground and its later appearance in the form of streams, springs, and underground water, that is to say, a brief outline of the sciences of hydrology and hydrogeology as bearing upon the preliminary investigation of the water-engineer. Precision in water-supply problems can only be obtained by the collection of data in these two sciences and in rainfall statistics. Water-engineers start from the basis of rainfall, the laws of fluctuation of which are regarded as more precise than the laws of hydrology and hydrogeology. The preliminary investigations of water supply, however, are based upon nineteenth century rainfall observations, whereas there is good evidence that in the previous century there were longer and worse droughts than those which occurred within the next hundred years. If such conditions recurred probably no waterworks in Britain could adequately meet them. After discussing the driest years, on which basis waterworks were designed, Dr. Lapworth dealt with floods and stream flow in general, reviewing the relation between rainfall and run-off and the losses due to evaporation and other causes in streams and underground water. The movement of underground water, the formation of springs, and the fluctuation of water-level were described, and references made to bournes and disappearing streams. The question of wells and the effects of pumping were discussed and the artesian basins of the world were briefly noted, illustrating the immense distances travelled by underground water.

In his Friday evening discourse on Mar. 21 at the Royal Institution on " Sea Birds and Seals ", Mr. Seton Gordon described the seals and birds found on the Atlantic coast of Britain. The gannet is the largest and strongest flier of British sea birds. In summer, from August until the second week in October, they are to be seen passing north and east, past Rudha Hunish, the most northerly point of the Isle of Skye. Most of the gannets may be seen later on flying back to St. Kilda. This is ninety miles west of Skye, and is their nearest nesting haunt to that island, so these gannets make (including the double flight) a journey of 200 miles each time they fish on the coast of Skye. A gannet has a great aversion to land. Thus all the gannets of St. Kilda which fish in the Minch towards its northern part all make for the Sound of Harris opening. When they fly homeward, heavy-laden with fish, they fly only a few inches above the sea; in large parties the numbers are almost always uneven. It is a remarkable thing that the gannets find their way home to St. Kilda through mist and fog, often when there is a strong side wind blowing. The stormy petrel is smallest of British sea birds; it is only 6 inches long. It was named petrel or ' peter-el ' (little peter) because it was believed that, like Saint Peter, it was able to walk upon the water. The stormy petrel is a nocturnal bird. That is why sailors count it unlucky to see a stormy petrel in daylight. It is only on very dark days (and dark days usually presage a storm) that the stormy petrel is abroad; on fine days it sleeps at sea. Mr. Seton Gordon also showed a film of the Atlantic seal, probably the first which has been taken of these animals on their island. In October all the Atlantic seals of a wide district go to a lonely isolated isle where they have their young. There may be 200 young seals on one of these islands. For the first six weeks young Atlantic seals are land animals; during all this time they do not enter the water of their own accord.

AT their meeting on Mar. 22, the Trustees of the British Museum approved the purchase for the Department of Zoology of the very extensive and valuable collection of skeletons of mammals, birds, reptiles, and fishes formed by the late Mr. E. T. Newton. A particularly valuable section is Mr. Newton's series of the otoliths or ear-bones of fishes; these are often the only remains of fishes found in a fossil condition, and the collection has frequently enabled geologists to determine remains that would otherwise have been quite unrecognisable. The collection will be available for study and research only. Recent acquisitions in the Department of Geology include British fossils bequeathed by the late Mr. G. W. Young, and others purchased from the collection of the late Mr. E. T. Newton; the most important of the latter are a series of Pliocene mollusca from the St. Erth beds, Cornwall. These beds are two small patches remarkable for being the only known English beds of Pliocene age lying west of Kent and East Anglia. The fossils occur in clay underlying sand and gravel, and unless this clay is opened up for some special reason, the fossils are unobtainable. H.M. the King has placed on loan in the Department of Botany 267 specimens of dried plants from Nepal. The collection is of special value in the Museum because of the lack of material from Nepal, only a very small area of which has been explored botanically. The large and valuable herbarium of the late Mr. C. E. Salmon has been bequeathed to the Department. Mr. Salmon was an authority on certain genera and on the distribution of British plants, and at his death he had almost completed a flora of Surrey. The European Herbarium has been further enriched by the purchase of the herbarium of the late A. A. de Carvalho Monteiro. This consists of about 4500 sheets and provides a good series of Portuguese plants.

THE importance of the medical and surgical applications of electricity can scarcely be overestimated. If we assume that the importance of any sphere of activity is reflected in the literature which arises regarding it, then Great Britain is very backward compared with other countries. In Germany there are seven journals exclusively devoted to radiology, in the United States six, in France five, in Italy four, and in Britain one. In a paper read to the Institution of Electrical Engineers on Mar. 20, Dr. Leggett pointed out that medical research would greatly benefit by an improved engineering finish being given to electro-medical apparatus. Much of this comes from abroad, where there is a large home demand for it. Foreign manufacturers are, therefore, in a better position to supply cheap apparatus than the British manufacturer who has to compete with them. There are firms for manufacturing medical apparatus in the United States, Germany, and France which, individually, are larger than the whole British industry for this class of goods put together. Since the late Mr. Campbell Swinton first used X-ray tubes in Great Britain, revolutionary improvements in their manufacture have taken place. Although the electron tube has many advantages, yet, as until recently its price was nearly £40, it is little used. Its price is now £25, but as in Germany one can be purchased for £9 there is a great scope for reduction in price. It is gratifying to find that England has taken the foremost place in protective measures against the disease which attacked many of the early operators. They form the basis of the international protective measures adopted at Stockholm in 1928.

MR. CHARLES HASKINS TOWNSEND, Director of the New York Aquarium, has published a most interesting account of his aquarium and the management of aquaria in general ("The Public Aquarium: its Construction, Equipment, and Management". Department of Commerce, Bureau of Fisheries, Appendix 7 to the Report of the U.S. Commission of Fisheries for 1928. Bureau of Fisheries Document No. 1045. Washington, 1928.) The New York Aquarium is very spacious and is able to keep under specially favourable conditions marine mammals and some of the larger fishes in addition to the smaller fishes and invertebrates usually to be found in the tanks. In the large floor pools there are porpoises and various seals. One unusually active Californian sea lion has lived nineteen years in the aquarium. Even manatees, which are difficult because of their sluggish habit, have lived there as long as seventeen months and two years respectively, a Jew-fish of 200 pounds weight has been kept more than ten years, and smaller fishes such as the gar (*Lepidosteus*), mudfish (*Amia*), and striped bass (*Roccus*) for more than twenty-four years. Results are very good also in the smaller tanks and aquaria, and various exhibits, including fish hatching, are on view. This very useful document includes not only the description of building and setting up of aquaria large and small with details of lighting, heating, water, and air supply and all other essentials, but also describes in detail the methods of collecting and transport of the various creatures, their general management, food, diseases and their treatment, together with the approximate cost of construction and upkeep. The paper is illustrated by photographic figures showing apparatus and many of the aquarium animals.

DR. A. C. GOODINGS, a graduate of the University of Leeds, has been appointed to an important post under the Ontario Research Foundation on the recommendation of Dr. S. G. Barker, of the British Research Association for the Woollen and Worsted Industries. Dr. Goodings, after taking first-class honours in chemistry, entered the Department of Textile Industries with a Clothworkers' scholarship, and, working under Prof. A. F. Barker and Mr. J. B. Speakman, proceeded to the degree of Ph.D. through textiles, and later took the post-graduate diploma in textiles. Dr. Goodings' studies have covered a wide field, including the chlorination of wool and other problems. During the past session, as a Clothworkers' fellow, he has been engaged on research into the fundamental principles underlying worsted drawing and spinning.

The Ninth International Horticultural Congress will be held in London on Aug. 7–15. The papers to be presented will be divided into three main groups : (1) Propagation, (2) pomology, and (3) botanical gardens and general subjects. Many countries on the continent of Europe, including Russia, will be represented, and several papers are promised by distinguished American workers. Particulars of the Congress and of the excursions which will follow it can be obtained from the secretary of the Royal Horticultural Society, Vincent Square, London, S.W.1, at the invitation of which the gathering is being held.

A preliminary notification has been issued of the twenty-fourth International Congress of Americanists to be held in Hamburg on Sept. 7–13, 1930. Questions of general import will be discussed by the Congress as a whole, but sectional meetings will also be held for papers dealing specifically with the aboriginal peoples of America and their ethnic relations, the prehistory of America, manners and customs of the various groups of Indians and their distribution in the Old and New World, the aboriginal languages, the discovery and colonisation of America, and the geography and geology of America, with special reference to human activities. The subject of one general session will be the civilisation of the Indians at the time of their first contact with Europeans and to-day, which will be opened by a report by Prof. Sapper, of Würzburg. The arrangements for the Congress are in the hands of an organising committee, of which the chairman is Prof. G. Thilenius and the secretary Dr. R. Grossman. Subscriptions should be sent to " Internationalister Kongress ", c/o M. M. Warburg and Co., Bankers, Hamburg.

Sterilised surgical catgut has been added to the schedule to the Therapeutic Substances Act, 1925, as being a substance the purity of which cannot be adequately tested by chemical means (*Statutory Rules and Orders*, 1930, No. 26. H.M. Stationery Office. Price 1*d*.). Before sale of sterilised catgut, manufacturers must test, or have tested by a recognised institution, samples for the presence of living bacteria, and full directions are given of the procedure to be ollowed in carrying out this test.

The annual ' Medical Directory ' guide to British spas and marine health resorts, now entitled, " The Waters and Coasts of Britain ", by Dr. Fortescue Fox, has recently been issued (Messrs. J. and A. Churchill, 40 Gloucester Place, W.1. 1*s*. net). Information is given respecting the situation, climate, and other features of the principal health resorts in the British Isles, together with the characters of their waters, if any, and the medical indications for their use. Lists of hotels, hydros, and other residential accommodation are also included.

The new Belfast Museum and Art Gallery has not been long in showing that it means to adopt the most up-to-date methods in educational propaganda. A very attractive programme of Wednesday night lectures has been announced, and these and the exhibition of natural history and industrial films on Saturdays, have attracted audiences which crowd the lecture hall. Naturalists' field clubs in Ulster are alive to the value of the Museum, and are gradually extending their membership and their activities.

The issue for December 1929 of *Terrestrial Magnetism and Atmospheric Electricity* contains a portrait and brief obituary and appreciation of Dr. J. P. Ault, commander of the non-magnetic ship *Carnegie*, who lost his life in the destruction of the ship by an explosion at Apia on Nov. 29 last. A further list is given of the ocean magnetic results obtained on this seventh and last cruise of the *Carnegie* ; the list relates to the period from June 25 to Sept. 23, 1929, when the ship arrived at Honolulu.

We are glad to find that *The Aquarist and Pond Keeper* is prospering. It has already increased by four pages, and this year it is being published every alternate month instead of quarterly. The winter number (No. 8, vol. 3, 1929) contains an interesting article on the breeding of the angel fish *Pterophyllum scalare* by the Rev. Bertram Stower. This is the first time that the angel fish has bred in Great Britain, and it has never been known to breed in captivity in such numbers. It is estimated that three hundred young from the broods were alive in the pond at the age of three months. The parents were still guarding their young, although some of them showed a certain amount of independence.

The transactions of the Prague meeting, in September 1927, of the Section of Terrestrial Magnetism and Electricity of the International Union for Geodesy and Geophysics, appeared under date June 1929, at the close of last year, as *Bulletin* No. 7 (pp. 269 + xii) of the Section. On account of the illness of Dr. L. A. Bauer, secretary of the Section up to the close of the meeting, and now president, the bulletin was prepared by Dr. J. Fleming on his behalf, and has been printed under the care of Dr. Ch. Maurain, the present secretary. It comprises the proceedings and minutes of the meetings (pp. 54), special reports (pp. 30), reports of national committees (pp. 92), comments on the agenda, and various scientific communications (pp. 80), and official information (pp. 12).

Applications are invited for the following appointments, on or before the dates mentioned :—Graduate assistants in mechanical engineering and electrical engineering at the Rutherford Technical College, Newcastle-upon-Tyne—The Director of Education, Northumberland Road, Newcastle-upon-Tyne (April 4). A temporary lecturer in civil engineering in University College, Rangoon — The Secretary to the High Commissioner for India, General Department, India House, Aldwych, W.C.2 (April 5). A responsible teacher in the Engineering Department (Mechanical and Electrical Engineering), and a teacher of electrical engineering, at the Oldham Municipal Technical College

—The Secretary for Education, Education Offices, Oldham (April 10). An assistant master for mathematics and science at the Westcliff Day Technical and Commercial School—The Headmaster, Day Technical and Commercial School, Fairfax Drive, Westcliff-on-Sea (April 11). A pathologist and an assistant pathologist in the Pathological Department of the Royal Northern Hospital—The Secretary, Royal Northern Hospital, Holloway Road, N.7 (April 12). Six temporary marketing investigators under the Ministry of Agriculture and Fisheries, for investigations into methods of agricultural marketing organisation — The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (April 14). A director of the Bristol Municipal Museum and Art Gallery—The Town Clerk, Council House, Bristol (April 30). An assistant professor of biochemistry in the University of Alberta—The Secretary of the Board of Governors, University of Alberta, Edmonton, Canada (May 15). A professor of chemistry in the University College of North Wales—The Registrar, University College of North Wales, Bangor (May 24). A male temporary junior assistant metallurgist or metallurgical chemist under the Directorate of Metallurgical Research of the Research Department, Woolwich—The Chief Superintendent, Research Department, Woolwich, S.E.18. A lecturer in mathematics and physics at the Dudley Training College for Teachers—The Secretary to the Dudley Training College Council, Education Offices, Dudley. A physicist under the Linen Industry Research Association, for work on applications of physical and colloid science to textile finishing processes—The Secretary, Research Institute, Lambeg, co. Antrim. An assistant pathologist in the Public Health Department of the Shanghai Municipal Council—J. Pook and Co., 68 Fenchurch Street, E.C.3. Two women B.Scs. at the Wellcome Physiological Research Laboratories for, respectively, biochemistry or chemistry and for the bacteriological department—The Director, Wellcome Physiological Research Laboratories, Langley Court, Beckenham.

Our Astronomical Column.

The Trans-Neptunian Planet.—The following observations of position have been received: those of Mar. 12 and 17 were given only to the nearest second of time in R.A.:

U.T.	R.A.	N. Decl.	Place.	Observer.
Mar. 12·125	$7^h\ 15^m\ 49·6^s \pm$	° ′ ″	Flagstaff	..
17·049	7 15 41 ±	22 7 18	Yerkes	van Biesbroeck
19·9206	7 15 39·86	22 7 38	Königstuhl	Wolf
21·9333	7 15 35·00	22 7 47	Neu-Babelsberg	Struve

The planet is now approaching the stationary point, which it will reach about the end of March. On the assumption of circular motion with radius 45 units, opposition would have taken place about Jan. 9·4 U.T., the longitude then being 108° 26·5′, and south latitude 12′ or 13′.

Prof. Shapley reports that the brightness has been measured at Harvard Observatory: the magnitude is 16·0 (*Morning Post*, Mar. 22). From its faintness it appears that the planet is not larger than the earth, and that its albedo is very low. Dr. Struve (who called the body a comet) gave the magnitude as 15·3.

In all probability the mass is considerably below Lowell's estimate of 6½ times the earth's; in this case, it would be largely a matter of good fortune that his predicted longitude was so near the truth. It is, however, just possible that a planet covered with liquefied gases would have a very low albedo, in which case its diameter might exceed the earth's.

Comets.—Comet discoveries are coming in quick succession, and we are already assured of four perihelion passages in 1930, apart from the possible detection of the periodic comets D'Arrest and Tempel (2). Comet 1930 *c* was discovered by Mr. Wilk, of Cracow Observatory. It is his second discovery within three months. The following positions have been received from the I.A.U. Bureau:

U.T.	R.A.	N. Decl.	Observer.	Place.
Mar. $21^d\ 18^h\ 38·0^m$	$1^h\ 31^m\ 2^s$	18° 26′ ″	Wilk	Cracow
22 19 46·7	1 29 21·2	19 55 11	Struve	Neu-Babelsberg

Struve gave the magnitude as 5·9, so the comet should be an easy object in a small telescope. The deduced daily motion is -97^s, N. 85′, which would give R.A. $1^h\ 18^m$, N. Decl. 29° 50′ on the evening of Mar. 29, about 7° south-east of β Andromedæ.

The following elliptical orbits have been computed for Beyer's comet, 1927 *b*. The equinox is 1930·0:

T	1930 Apr. 21·64 U.T.	1930 Apr. 28·5760
ω	26° 27′	29° 54′ 53·4″
Ω	116 33	116 53 12·7
i	71 17	70 5 47·4
log q	0·3120	0·301150
Period	640·6 years	91·503 years
	Computer, Mr. Bower and Miss Moore. Observations, Jan. 23, Feb. 18, Mar. 14.	Dr. C. H. Smiley. Feb. 19, Mar. 2, 13.

The comet is a good deal fainter than Wilk's, but is approaching perihelion, and is visible with moderate instruments. The following ephemeris is for 0^h U.T. (*I.A.U. Circ.* 258):

	R.A.	N. Decl.
Mar. 29	$6^h\ 9^m\ 9^s$	39° 11′
Apr. 2	6 11 42	40 32
6	6 14 52	41 49
10	6 18 36	43 3

Mr. F. E. Seagrave finds a period of 20,000 years for Wilk's earlier comet, 1929 *d*. This should only be taken to imply that there is very little deviation from parabolic motion.

Observatory at Bedford College, London.—The completion of a fresh wing at the Bedford College for Women (University of London) has made possible the erection of a small observatory on the roof of the new building. The Woolwich Arsenal Institution, acting on the advice of the Astronomer Royal, generously handed over to the College a seven-inch refracting telescope by Grubb, which had been at the Institution since 1872, and which it is now hoped will enter on a new sphere of usefulness. The Astronomer Royal performed the opening ceremony on Mar. 17, the chair being taken by Prof. H. H. Turner. Sir Frank Dyson gave an address on "Everyday Astronomy", in which he pointed out how little is known of astronomy from a practical point of view, even by educated people interested in the theoretical side, and indicated how the simpler phenomena may be studied by comparatively simple observations leading up to the more detailed observations which the telescope makes possible.

Research Items.

Systematic Studies of Mammals.—Mammalogy, in the curiously restricted sense in which Gerrit S. Miller uses the term in his review of the progress of this branch of zoology (*Smithsonian Report for 1928*, p. 391; 1929), concerns itself primarily with the systematic study of mammals. The advance which has been made in the cataloguing and classifying of the world's mammals is very striking. In 1758, Linnæus knew only 86 mammals, a century later Baird knew 220 kinds in North America alone, and now in the same limited portion of the earth's surface about 2500 forms are recognised. Especially since 1890 progress has been rapid, and this, strange to say, has to do with the invention of the break-back pattern of mouse-trap, which has played an invaluable part in bringing into the study the smaller denizens of woods and fields. In the 'nineties Trouessart's "Catalogus Mammalium" enumerated 4423 species; since his last volume appeared in 1898, not less than 8700 new names have been added to the list of living species and sub-species, and the process is continuing at an undiminished rate of about 250 a year. This and the general development of systematics is interesting and important, but mammalogy means more than this, and we wish that the author could have found space to refer to the great development which has taken place also in the study of the mammal as a living organism, for it is the biological trail that promises to lead furthest into the unknown.

Zebra-Horse Crosses.—In 1902, Cossar Ewart described successful crosses made between horses and Burchell's zebra. Afterwards in America the ass was successfully crossed with Grevy's zebra, which is larger and more docile, but matings with the horse failed. Mr. Elmer Roberts (*Jour. of Heredity*, vol. 20, No. 12) describes crosses since made in Indiana between a male *Equus grevii* and thirty mares, beginning in 1912. Eight colts in all were reared. They were all chocolate-coloured with black stripes, although the dams were of different colours, bay, black, and gray. Three of the colts were male and five female, but all were sterile. These zebroid hybrids were gentle and intelligent, somewhat smaller than horses, but beautiful in appearance. They were good workers, and were better able than horses to withstand high temperatures. Being easily trained, they would appear to be valuable as domestic animals, and in certain respects preferable to mules.

Japanese and Chinese Fishes.—Mr. Henry W. Flower has gathered together a large number of notes and records of fishes chiefly obtained from the markets of Japan, Shanghai, and Hong-Kong ("Notes on Japanese and Chinese Fishes", *Proceedings of the Academy of Natural Sciences of Philadelphia*, vol. 81, 1929). Among those from Shanghai is a new species of barbus, *Barbus nigriparipinnis*, which the author places in the new sub-genus *Glabrobarbus*, differing from *Hemibarbus* in the presence of two barbels which are maxillary, and a very short snout, the dorsal spine being long and smooth. The lower fins are very dark, giving the fish a characteristic appearance. Most of the fishes listed are from Hong-Kong, upwards of 180 species being recorded.

Collembola of Ireland.—In *Proceedings of the Royal Irish Academy*, Vol. 39, 39B11, January 1930, Mr. H. Womersley contributes a useful list of the Collembola of Ireland, adding 17 species to the 50 kinds already known from that country. His paper commends itself to all students of these obscure insects, since he provides diagnostic keys to the families, genera, and species of all the British forms. No comprehensive work on the latter is available at the present time, and Mr. Womersley's paper supplies a means for their identification once the student has familiarised himself with the structure of a few leading types and is able to dispense with the use of illustrations. Out of a total of more than 700 described species of the order, 153 are here listed as British. The need for a monograph on the group is becoming increasingly evident as Lubbock's well-known volume is now completely out-of-date. Collectors and observers of these insects are few and far between, and even to-day there must be still a number of British species awaiting discovery.

Duration of Life in *Drosophila*.—Considerable quantitative studies have now been made on the influence of various environmental conditions on the length of life in *Drosophila*. It has been found that low temperature, ventilation, and alcohol prolong the duration of life in these flies, while various degrees of starvation with or without water shorten it. Mr. W. W. Alpatov (*Amer. Naturalist*, January 1930) has studied the effect of different kinds of feeding of the larval and imaginal stages on the life of the fly. In one experiment, small flies were produced by removing the larvæ from food before the normal end of larval feeding, but there was no effect on their longevity. It was already known that flies grown at low temperature were larger. Small flies can also be produced by growing them at high temperature, but the duration of life is different from that of the small flies produced by under-feeding. In other experiments, flies were kept on synthetic food with or without yeast. The absence of the yeast greatly reduces the length of life of both males and females. From earlier work of Pearl, it is concluded that the relation between temperature and duration of life is represented by a simple exponential curve, while the relation between starvation and duration of life follows the upper part of a logistic curve.

Mycorrhiza in the Ericaceae.—Prof. Knudson, of Cornell University, and Dr. Rayner discuss again this oft-debated question in the *New Phytologist*, Vol. 28, No. 5, December 1929. Prof. Knudson is of the opinion that he has grown *Calluna vulgaris* from seed, after sterilisation with calcium hypochlorite, and obtained perfectly healthy seedlings under sterile conditions. He is aware that Dr. Rayner has previously failed to do this, and argues that her sterilisation methods (with mercuric chloride) were so drastic that the seedlings never grew thoroughly healthily, and also suggests that injection with the fungus symbiont just tipped the balance in favour of growth, by its effect upon the residual mercuric chloride left on the seed coat from the washing operations. Dr. Rayner, however, argues that Prof. Knudson's grounds for regarding his seedlings as completely sterile are far from convincing, and that his subsequent methods of examining these seedlings would leave the hyphæ of the symbiont still undetected. Under the conditions of his experiment, the hyphal complexes in the host cells, characteristic of fully developed mycorrhizal infection, were not to be expected; the fineness of the normal mycelium necessitates a special technique for its detection.

Floods of the Seine.—The floods that periodically threaten Paris are due to the coincidence of sudden thaw and heavy rainfall in the east and south-east of the Paris basin. The result is that the Seine is unable to carry away the water quickly enough. Many preventive measures have been suggested. In *Matériaux pour l'Étude des Calamités*, 4, No. 20, Dr. E. Joukowsky proposes a new solution of the problem by the boring of absorbent pits establishing communication between the surface water and the subsoil. This would result both in storage and in drainage. The pits would be in river beds in order to save waste of land and preferably at river junctions. They would be dug at some distance from any artesian well. The value of the wells or pits would clearly depend on their number, diameter, and depths, and to decide these questions a careful study of the level of ground water and the absorption power of the soil would be required.

Formation of Limestone.—Most great limestone formations of past geological ages have had an origin independent of coral reefs, and were apparently laid down in relatively shallow seas. Many were alternately above water, with resultant sun-cracking, and submerged, with marks of wave action. On the Great Bahama Bank such conditions of deposition occur to-day. Waste of terrigenous origin is absent, and there are no coral reefs. Yet a white chalky mud known as drewite is being deposited. In the March number of *Discovery*, Mr. M. Black gives some account of a preliminary investigation of this deposit by an American expedition in which he took part. Needle-shaped crystals of aragonite and grains of calcium carbonate compose 90 per cent of drewite. The remainder is sponge spicules, tests of foraminifera, etc. Hard lumps among the soft ooze proved to be composed of crystalline calcite enclosing rather more foraminifera than ordinary drewite. This recalls the recrystallisation of ancient limestones known as pseudo-breccias. The second recrystallisation by which the whole mass, and not merely the lumps, become solid is still obscure, but it is probable that the cementation takes place when the aragonite needles are converted into calcite. This, however, would appear to take place only in the layers that are buried, since the aragonite is comparatively stable in contact with sea-water. Further investigations are promised.

***K*-Absorption Edge of Zinc.**—In their communication on "The Fine Structure of X-Ray Absorption Edges", in NATURE of Oct. 26, 1929, p. 652, Prof. D. Coster and M. Wolf remark that although they have had no difficulty in observing several secondary edges in the K-absorption spectra of copper, they were unable to observe fine structure in the case of zinc. Mr. Suekichi Kawata, of the Physical Institute, Kyoto Imperial University, informs us in a letter dated Jan. 25 that he has obtained three secondary edges with zinc in the zincblende used as an analysing crystal employing the method of Lindsay and others (G. A. Lindsay and G. D. Van Dyke, *Phys. Rev.*, **28**, 1926; J. C. Nuttal, *Phys. Rev.*, **31**, 1928). The energy differences relative to the main edge are (in ν/R) 12·3, 8·0, and 3·3, which may be the right order of magnitude of the energies of $M_{\text{IV, V}}$, $M_{\text{II, III}}$, and M_{I} of zinc or the next higher element gallium respectively. The details of the photogram will not reproduce satisfactorily, but we submitted it to Prof. Coster, who writes: "I have seen the photograph of the K-absorption edge of zinc obtained with the zinc of zincblende as analysing crystal. It seems possible that Mr. Kawata has really got a fine structure of this edge. If this is true, the question which remains to be solved is, whether there is an essential difference between the intensity of this fine structure in the case of zinc and that of copper as was supposed in the letter of Coster and Wolf (NATURE, Oct. 26, 1929) or not. Experiments are in progress at Groningen to try to settle this question."

Capture of Electrons by α-Particles.—The first February number of the *Physical Review* contains further details of the experiments of A. H. Barnes on the capture of electrons by α-particles. In a preliminary report published last year (see NATURE, Sept. 7, 1929, vol. 124, p. 389), it had been claimed that capture occurred only when the relative velocity of the electron and α-particle was the same as the speed of an electron in one of the inner Bohr orbits of singly ionised helium, or when the two particles were relatively at rest. A similar result is now reported for the capture of two electrons to give a neutral atom of helium, and the form of apparatus which has been used is described. This consists of an evacuated tube, holding an incandescent plate as a source of electrons, with a set of auxiliary electrodes to give the electrons any desired speed, and to determine their paths. To avoid contamination, the α-particles enter the tube through a thin glass window, and after passing through the cloud of electrons are sorted magnetically and detected by the method of scintillations, the zinc sulphide screens being set up either inside or outside the tube. The total number of scintillations which have been counted is more than 7×10^5. Mr. Barnes's results seem to show that electron capture takes place in less than 3×10^{-10} sec. in a region where the electron density is probably not greater than 10^7 per c.c.

Prevention of Corrosion in Lead Buildings.—*Bulletin* 6 and *Technical Paper* 8 of the Building Research branch of the Department of Scientific and Industrial Research (H.M. Stationery Office) deal with the above subject. They are drawn up by Mr. F. L. Brady and deal with the subject in a way likely to be of service to builders and architects.

Mine Rescue Apparatus.—We have received *Paper* No. 47 of the Safety in Mines Research Board, which deals with a type of gas mask evolved by the Board on the basis of experiments by Dr. S. H. Katz (of the U.S. Bureau of Mines), who has been working at Sheffield under a scheme of exchange of skilled investigators, and Mr. C. S. W. Grice (London: H.M. Stationery Office, 9*d*. net). The mask is of the hopcalite type, employing a specially prepared mixture of manganese dioxide and copper oxide which converts carbon monoxide into carbon dioxide. The type of mask successfully used in the United States, known as the 'All Service' mask, has been improved so as to show appreciably less resistance to breathing, and the results are of importance not only to mine workers but also to firemen and other workers who are liable to encounter poisonous gases in the course of their occupation.

Distillation under Low Pressure.—The extraction from solutions of solids which readily undergo chemical change at high temperatures necessitates usually some form of vacuum-still. In the *Chemiker-Zeitung* of Feb. 19 will be found the description of a patent still which embodies some new features. In the usual type of still, the resistance to the flow of vapour caused by the pressure of a column of vapour above the liquid often presents difficulty in operating on an extensive scale; moreover, the narrow cross-section and rather sharp angle of the outlet tube tend to increase the difficulty. These features are to a very great extent eliminated in the new design, in which the vapour is led from a wide tube near the surface of the boiling liquid to the condenser in such a way that very little of the condensed vapour flows back into the liquid. The evaporating vessel is made of special resistance glass, which gives better results than porcelain. The apparatus is supplied by the firm Greiner and Freidrichs of Stützerbach.

The Structure of Silicates.*

By Prof. W. L. BRAGG, F.R.S.

DURING the last few years a number of silicate structures have been analysed by means of X-rays in the Physical Laboratories of the University of Manchester. In the course of these investigations, we have found the atomic arrangement in the olivine, chondrodite, phenacite, pyroxene, and amphibole groups amongst the silicates of divalent metals, and in a number of aluminium silicates such as the forms of Al_2SiO_5, staurolite, topaz (analysed also by Pauling), beryl, and the zeolite analcite. Other silicates analysed are titanite, and benitoite containing titanium, danburite containing boron, zircon (analysed also by Vegard) and thortveitite. A group of workers has carried out these analyses, important contributions being made by Warren (pyroxenes and amphiboles), Zachariasen (titanite, thortveitite, benitoite), Naray (staurolite, cyanite), Taylor (forms of Al_2SiO_5 and analcite), and West (chondrodite group). Warren has just reported an analysis of the melitite group. In addition, Menzer has analysed the garnet group, and Jaeger the family of compounds to which ultramarine belongs. Preliminary observations have been published by Schiebold on the felspars, and by Mauguin on the composition of the micas. So much ground has been covered that it is possible to review the silicates as a class of compounds, though of course such a survey must be of a very preliminary character.

In the following description, the silicates will be considered in the light of the new knowledge of their atomic arrangement. The conclusions arrived at often reflect well-known and widely accepted views of their nature, but the X-ray analysis has introduced a greater precision and many novel elements.

The distinguishing feature of silicate structures may be described as their intermediate position between salts of acid radicals on one hand, and metallic oxides on the other. We may consider the way in which oxygen is associated in crystal structures with the successive elements magnesium, aluminium, silicon, phosphorus, sulphur, and chlorine. The last three form acid radicals $(PO_4)^{3-}$, $(SO_4)^{2-}$, $(ClO_4)^{1-}$, and these self-contained groups (and also complicated groups such as $(S_2O_7)^{2-}$) combine with metallic ions to form salts. Silicon also forms self-contained groups such as $(SiO_4)^{4-}$, $(Si_2O_7)^{6-}$, and more complicated forms, which may, if we choose, be considered as acid radicals of the usual type. The novel feature is introduced by its additional power of forming *silicon-oxygen complexes with indefinite extension in space*. It is this feature which gives rise to the vast variety of silicates and explains the difficulty of assigning chemical formulæ to them as if they were ordinary salts.

The rôle played by silicon in the inorganic world has been compared to that played by carbon in the organic world, but there is an essential difference between them. In organic chemistry the great variety of compounds is due to the possibility of continuing the link between carbon and carbon so as to form more and more complex groups. In the silicates, there often is a similar indefinitely extended linking, but it is always one in which an oxygen atom is interposed between two silicon atoms. The extended silicon-oxygen linking is a transition towards the ionic lattices which metals such as magnesium form with oxygen. The passage is the more gradual because aluminium can replace silicon in a silicon-oxygen complex, and at the same time can replace a metal such as magnesium. Our very use of the term 'silicate', however, implies a separation of the silicon-oxygen groups in a somewhat arbitrary way from the rest of the structure and a consideration of them as acid radicals, and there is good reason for regarding the silicon-oxygen bond as essentially different from the polar bond in an ionic crystal of metal and oxygen.

In all compounds hitherto analysed, silicon is found at the centre of a regular tetrahedral group of oxygen atoms. The oxygen atoms are about 2·6 A. apart, and the oxygen silicon distance is 1·6 A. These tetrahedral groups can link together by sharing an oxygen atom. In general, the lower the ratio of oxygen to silicon in a silicate, the greater is the extent to which this linking takes place. In this way, a range of structures is built up with a successive extension in space of the silicon-oxygen linking, represented at one end by the orthosilicates with *independent* groups $(SiO_4)^{4-}$, and at the other end by the forms of silica such as quartz which W. H. Bragg and Gibbs first showed to be a structure of linked tetrahedra where *every* oxygen atom is shared by two silicon atoms.

We can distinguish the following forms of silicon-oxygen complex:

(*a*) *Orthosilicates.*—Independent groups $(SiO_4)^{4-}$.

(*b*) *Self-contained Groups.*—These are formed by linking a finite number of tetrahedral groups. Examples are $(Si_2O_7)^{6-}$, $(Si_3O_9)^{6-}$, $(Si_4O_{12})^{8-}$, $(Si_6O_{18})^{12-}$. The latter three groups are formed by linking three, four, or six tetrahedral groups in a ring (the sixfold ring in beryl is a striking example).

(*c*) *Silicon-Oxygen Chains.*—In the pyroxenes there is a simple chain of tetrahedral groups, each sharing an oxygen atom with its neighbours on either side, and thus leading to a composition represented by $(SiO_3)^{2-}$. It is interesting to note that this linking found by Warren and the author was predicted shortly before by Machatschki. In the amphiboles two such chains are joined side by side by a further sharing of oxygen atoms or ' condensation ', leading to a composition $(Si_4O_{11})^{6-}$. These chains in the pyroxenes and amphiboles (and probably other types of chain in other compounds) lie side by side. They are like acid radicals with indefinite extension in one dimension, and are bound together by the metallic ions. They are parallel to the fibre direction in the fibrous forms which these compounds often assume.

(*d*) *Silicon-Oxygen Sheets.*—If three oxygen atoms of each tetrahedral group are shared, the resulting ratio will be represented by $(Si_2O_5)^{2-}$. No compounds of this type have yet been analysed, but it is interesting to note two features. The most direct way of linking tetrahedral groups into sheets leads to an arrangement which has hexagonal symmetry, and the dimensions of the network are precisely those of the basal plane of mica (measured by Mauguin). It may be that such sheets will be found to form the basis of the scaly minerals, such as mica, chlorite, and talc, which have a marked basal cleavage and pseudo-hexagonal structure.

(*e*) *Three-dimensional Silicon-Oxygen Networks.*—If every oxygen of the tetrahedral groups is shared between two silicon atoms, the structure will be silica, SiO_2. Machatschki first pointed out that if a certain proportion of the silicon were replaced by aluminium, the result would be a silica-like arrangement of linked tetrahedra which had a total negative charge, and into which in consequence metallic cations could be incorporated. This is the essential feature of ultramarine and the *zeolites*, and according to Schiebold

* Lecture delivered before the Mineralogical Society on Mar. 18.

of the *felspars*. In some zeolites the ratio of aluminium to silicon is quite low, so we have justification for describing these structures as having acid radicals with endless extension in three dimensions. The bearing of this on the ease with which the water content is changed and metallic ions substituted in the zeolites without breaking down a crystal, is obvious.

These silicon-oxygen complexes are bound together by metallic ions, which fit into the spaces between the large oxygen atoms. The way in which the cations are incorporated is very interesting. I first pointed out the prevalence in silicate structures of close-packed regular groups of oxygen atoms, as if many cations such as $Be^{\cdot\cdot}$, $Al^{\cdot\cdot\cdot}$, $Mg^{\cdot\cdot}$, $Fe^{\cdot\cdot}$, $Ti^{\cdot\cdot\cdot\cdot}$ fitted into close-packed groups of four oxygen atoms at the corners of a tetrahedron, or six at the corners of an octahedron, with little distortion. Larger ions such as $K^{\cdot}$, $Ca^{\cdot\cdot}$, $Na^{\cdot}$ have often more oxygen atoms round them, and the group is distorted. This is natural, for while four or six spheres packed together assume a regular tetrahedral or octahedral form, eight spheres can be packed together more compactly by a less regular arrangement than that at the corners of a cube. In the next place, these metallic ions appear to be attracted to the oxygen atoms which have only *one* link to silicon. Oxygen atoms linked to two silicon atoms have little external field, as if their valency were saturated. It is very likely, as Lowry has insisted, that we must regard the silicon-oxygen link as wholly or partly a homopolar bond. Oxygen atoms with a single bond to silicon behave as if they had a single charge $-e$, those with a double bond as if they were uncharged. Another very important principle enters, which Pauling was the first to point out, in a general treatment of ionic compounds. The metallic atoms are so incorporated into the structure that there is a *local balancing of electric charge* between cations and the negatively charged oxygen atoms. These features are beautifully illustrated by models of silicate structures.

West and myself, in a paper on the structure of certain silicates in 1927, directed attention to the *importance of oxygen in silicate formulæ.* Oxygen atoms cannot be removed from the structure without breaking up the regular groups, and in most cases, owing to their relatively large size, additional oxygen atoms cannot be incorporated in the unit cell. This applies not only to the oxygen atoms which are linked to silicon, but also to additional ions O'', OH', F' which are part of the structure, the latter ions taking up the same space as oxygen. On the other hand, Al can replace Si or Mg, Mg, Fe, and Mn are interchangeable, Ca can replace Na, and so forth, in the familiar way. Hence in giving the atomic composition of a silicate after a chemical analysis has been made, the relative numbers of the constituents must be so expressed that the absolute number of oxygen atoms is correct for that particular type of crystal. This immensely simplifies the problem of composition in such substances as the silicates where isomorphous replacement is so frequent. Mauguin's work on the micas, Warren's on the amphiboles, and Berman's study of the melitite group, afford examples. The relatively large size of oxygen, and the constancy with which a distance of about 2·7 A. between oxygen centres appears in the silicate structures, make it convenient to think of the silicates as based on an oxygen framework which determines their dimensions, a fact of which considerable use was made in the earliest analyses.

Although so little ground has been covered, we can begin to see the general lines on which this interesting class of inorganic compounds is based. The technique of X-ray analysis has reached a stage where the complexity of the structure is no barrier, for examples already worked out are as complex as any we are likely to encounter.

A Large Power Plant at Billingham-on-Tees.

In a paper read to the Institution of Electrical Engineers on Mar. 13, H. A. Humphrey, D. M. Buist, and J. W. Bansall gave a complete description of the new industrial power plant which has been erected by Imperial Chemical Industries, Ltd., for the factory at Billingham-on-Tees belonging to Synthetic Ammonia and Nitrates, Ltd. The conditions governing the design of this power plant differ from those relating to a public electricity supply station. The extension programme required nearly 7000 tons of steam per day for process purposes as well as 37,500 kilowatts of electrical power. The quantity of steam required for process purposes is double that required to generate the electrical energy. Hence the boiler plant capacity had to be made three times as great as if electrical power only had been required.

Chemical works have an almost constant load ; in technical language, their load factor is a hundred per cent and continuity of supply is of vital importance. A cessation of power would not only cause a loss of output, but would also upset the steady conditions of temperatures and pressures on which the satisfactory operation of the plant depends. The power plant, therefore, must have a sufficient stand-by plant and means for bringing that plant rapidly into operation. Everything has to be considered on the lines of ' safety first '. As the output of the plant has to be as great as that of the largest electricity station in Great Britain, great attention was paid to securing economy in the generating costs.

It was considered that 856° F. was the highest safe temperature for ordinary steel superheaters, as a great deal has yet to be learned about ' creep ' stresses at this temperature. Considerations of safety, therefore, led the designers to adopt a maximum boiler pressure of 815 lb. per square inch. As high pressure boilers must have distilled water feed, and as only sixty per cent of the necessary supply could be obtained from the condensed steam, 2500 tons of water have to be distilled every day to add to the ' make up ' feed.

By passing the total amount of steam generated, including that required for process purposes, 23,800 kilowatts are obtained. Two turbo-alternators, each of 12,500 kilowatts, provide the working units, and one is added as a reserve. It was stated that the estimated cost of the electric energy generated in the station is well below the cost of any electric generating station in the world depending on coal as fuel. This is attributed to the use of the high pressure and high temperature steam. The primary turbines pass a greater quantity of steam than would be available in an ordinary power station. Owing to the locality, the coal is cheap, and there is an abundant supply of cooling water. The load factor also is the highest possible.

An ingenious method of supplying the two boiler and pulveriser buildings is adopted. The raw coal is brought in by rail and dropped into underground bunkers, from which it is raised by hoists to overhead belt conveyors. It is thus carried to overhead steel bunkers in the pulveriser house, where it falls through chutes to the weighers and thence to the mill hoppers, where it is pulverised. It is next carried to an overhead cyclone separator by an air stream driven by exhauster fans. From the cyclones the pulverised coal drops through rotary air locks to screw conveyors, which distribute it to the fuel bunkers, of which there is one to each boiler. From these bunkers the powder passes through feeders driven by motors, the speed of which can be varied. Finally, it is picked up by the air stream from the primary air fans and fed to the burners. The air for combustion is supplied by forced draught fans after having been brought to a temperature of about 500° F. by preheaters.

The main generating units consist of three 12,500 kw. high pressure primary units and two 12,500 kw. intermediate pressure condensing turbines. The turbines run at 2400 revolutions per minute, and are direct-coupled to three phase alternators. This station marks an important advance in the design of high temperature and high pressure power plants. It is the largest high pressure pulverised fuel plant in the world.

University and Educational Intelligence.

Manchester.—A Consultative Committee on Cancer Research consisting of representatives of the University and of the Manchester Committee on Cancer, including the Christie Hospital and the Radium Institute, has been established. The research work will be conducted in the University laboratories and will be directed and controlled by the Consultative Committee. Dr. C. C. Twort, who has been working nder uthe direction of the Manchester Committee on Cancer, has been appointed as director of the Department of Cancer Research.

Oxford.—The Latin oration delivered on Mar. 19 by the outgoing Senior Proctor, Mr. L. H. Dudley Buxton, of Exeter College, contained an appreciative reference to Prof. R. V. Southwell, who comes from Cambridge to succeed Dr. Frewen Jenkin as professor of engineering science; and to Prof. R. Robinson, who takes the place of the late Prof. W. H. Perkin in the Waynflete chair of chemistry. A tribute was paid to the skill of the latter in the by-paths of music and horticulture. Reference was made to the increasing pressure upon library space caused in part by the desire of natural science to "extend beyond the flaming boundary walls of the universe". It was to be hoped that the labours of the Commission, the appointment of which was made possible by the munificence of our cousins in America, would be able to solve the difficult question of library accommodation. In view of the invasion of the seat of the Muses by factories, noisy motor traffic, and of the sky itself by aeroplanes and the smoke of furnaces, it was not wonderful that the Radcliffe Observer (Dr. Knox-Shaw) should have forsaken his post of observation for "thirsty Africa", where the stars are still visible through a cloudless atmosphere. Finally, the proposed zoological garden for the delectation of the populace is not regarded by all with approval.

The Royal Society of Medicine, 1 Wimpole Street, W.1, has accepted, as a trust, the sum of £1000 presented by Mr. Norman Gamble for the purposes of providing a prize of £50 every fourth year for the best original work in otology carried out by any British subject, lay or medical, during the preceding four years, the balance of the fund to be used for the purpose of awarding grants in aid of research work in otology. Applications for the prize and for grants in aid must be received by the secretary of the Society not later than Sept. 30 next.

Historic Natural Events.

Mar. 29-31, 1901. Snowstorms.—During the passage of a deep barometric depression across Ireland and Scotland, heavy snow fell in North Wales, Scotland, and the north of England, mainly on Mar. 29. In some places the depth of snow was three feet on level ground, and it was piled by the wind in great drifts, especially on the Snowdon Range.

Mar. 30, 1912. Antarctic Blizzard.—After reaching the south pole on Jan. 17, Scott met with calms and light winds with powdery snow which formed a great hindrance to travel. Finally, on Mar. 20, a blizzard set in, so thick and violent that his party could not leave their tent. A gale from west-south-west and south-west continued for at least ten days, and was still blowing when Scott made the last entry in his diary on Mar. 30. Every day the party had been ready to start for the depot, only eleven miles away, which would have saved them, but the air was full of whirling drift, and travel was impossible.

Mar. 30, 1924. Floods.—The end of March and the beginning of April were marked by heavy rain and extensive floods in Europe, which were accentuated by a sudden thaw following a heavy snowfall. In Poland at the end of March the Vistula stood 27 feet above its normal level, a height said not to have been recorded since 1570, and there was much damage and suffering. In Jutland a newly built dam burst, and in Spain and Portugal the rivers overflowed their banks; Seville was flooded and many persons were drowned. There were extensive landslides in Granada and northern Italy, and in Switzerland traffic was impeded by the heavy falls of snow which blocked the passes.

April 1, 1427. Heavy Rain.—It is recorded in Fabyan's "Chronicles" that "This yere was unreasonable of Wederynge, for it reyened mosli contynually from Ester to Myghelmasse, where through hay and corne was greatly hyndered".

April 1, 1917. Great Snowstorm.—On the afternoon and evening of April 1, which was Palm Sunday, heavy snow fell in western Ireland, especially in East Clare. By 5.30 p.m. it was nine inches deep on the roads about Broadford, and on the morning of April 2 all the roads were blocked by snow-drifts several feet deep. More snow fell on April 3, and the roads were not freed until the following day. On the night of April 1, there was an intense frost, and two men riding home over a mountain pass were killed by the cold.

April 1, 1922. Landslide.—Heavy rains in Switzerland at the beginning of the month caused a serious landslide near Le Bouveret (Valais), in the Rhone valley. The village of Les Evouettes was partially buried. Floods were afterwards reported from all parts of the country and also in the Rhone valley in France; at Lyons the lower part of the town was under water. There was a considerable amount of minor damage by avalanche and landslide throughout the month, owing to the continued rainfall.

April 2-3, 1909. Heavy Rain.—With depressions in the Atlantic and Mediterranean, heavy rain fell over the greater part of Ireland. The average rainfall in the two days over the whole island was 1·69 in., corresponding with a total precipitation of 3558 million tons, or 797,000 million gallons of water. The heaviest falls occurred in the south and south-west, where several places received more than five inches.

April 3, 1901. Blood-rain Plant. During March and April the large evaporation tank at the former headquarters of the British Rainfall Organization in Camden Square was invaded by a microscopical water-plant, which on April 3 was identified by Mr.

V. H. Blackman as *Sphœrella pluvialis*, the 'blood-rain plant'. The water assumed a deep crimson tint, and resembled a pool of blood. This organism is usually found in small pools, the water of which is occasionally carried up into the air by small whirlwinds and afterwards falls as 'blood rain'.

April 4, 1901. **Phosphorescent Sea.**—At 8.30 P.M., in the Persian Gulf, the officers of the s.s. *Kilwa* saw the sea instantly covered with faint moving phosphorescent light, not visible continuously as in ordinary phosphorescent displays, but the sea appeared like a field of corn rippling under a fresh breeze. In a few minutes the ripples grew more regular in direction and appearance, coming from south-south-east, and as each ripple of light reached the ship, phosphorescent 'droppings' appeared close to the ship, the water having the appearance of the starry heavens, or as if large handfuls of small pebbles had been thrown into a lake of phosphorus. The ripples were very regular, at half-second intervals. After a few minutes, the ship passed the centre of the display and the ripples came from north-north-west. Their apparent speed was about 60 miles a minute; they were ripples of light only, there being no movement of the water.

April 4, 1905. **Great Indian Earthquake.**—The Kangra earthquake originated in the north-eastern Himalayas, the meizoseismal area including Kangra and Dharmsala, where more than 18,000 persons were killed. The disturbed area is one of the largest known, being little short of two million square miles. The depth of the focus was estimated to lie between 12 and 21 miles. The earthquake was unusual in one respect. There were no dislocations visible on the surface, but a new line of levels carried out through a secondary epicentre at a distance of 120 miles from Kangra showed that the district, including Dehra Dun, had risen about 5 inches.

April 5, 1926. **Record Rainfall in California.**—At Opid's Camp, on the west front of the San Gabriel range, a rainfall of 1·02 in. was registered in one minute. The weather station at this place is equipped with a weighing raingauge, which makes an automatic record. A second gauge of the same pattern had been installed temporarily alongside the regular gauge, and the two gauges showed the same reading.

Societies and Academies.

LONDON.

Geological Society, Feb. 26.—**S. E. Hollingworth**: The glaciation of western Edenside and adjoining areas, and the drumlins of Edenside and the Solway basin. In the lowland areas the threefold sequence of Early Scottish, Lake District-Edenside, and late Scottish glaciations is recognised. Almost the whole of the deposits are referable to the maximum of the second or main glaciation. A great flood of ice travelled anti-clockwise around the northern end of the Lake District—first northwards towards the Solway, and then westwards and south-westwards into the Irish Sea Basin; it was joined en route by ice from the Lake District valleys. Some twenty stages in the retreat from the Eden back to the valley-glacier stage are recognised. The ice-fronts were, during the retreat, parallel to the trend of the drumlins over extensive areas. This unexpected result led to the study of the drumlins of the much wider area, embracing all Edenside and the Solway Basin, from which it appears that the drumlins were formed at the maximum of the Main or Lake District-Edenside glaciation and not—as has been frequently claimed for other areas—at a late stage.

Physical Society, Feb. 28.—**C. N. H. Lock**: The equations of motion of a viscous fluid in tensor notation. An outline of the tensor calculus for three dimensions is given, and an attempt is made to develop the theory of the motion of a fluid, by tensor methods, as far as the general equations of viscous flow.—**W. L. Watton**: A new type of Dewar flask, for use as a calorimeter. The water equivalent of a new type of Dewar flask, of which the inside is of copper, has been measured at laboratory temperatures, and found to be more constant than the usual type.—**R. O. Cherry**: Field intensity measurements around some Australian broadcast stations. A simple loop, condenser, and valve voltmeter circuit has been employed and careful tests show that this method is available for the measurements of intensities as low as 1 millivolt/metre. The field strength contours of three broadcast stations have been determined. From these the following conclusions have been drawn: (i) Very rapid attenuation of the signal is caused by Australian forest areas; this curtails enormously the areas for which a satisfactory service is provided. (ii) The effective conductivity of the various types of ground surface met with varies from 4×10^{-13} to $0{\cdot}07 \times 10^{-13}$ e.m.u., according to the number of trees in the areas covered. (iii) The use of a longer wave-length gives a marked increase of intensity at distant points beyond forest areas. (iv) For daylight transmission over sea water up to a distance of 85 miles, after the application of curvature-corrections to the intensity, Sommerfeld's formula is correct, to within the limits of experimental error. (v) The efficiency of radiation of the three aerials examined ranges from 48 per cent to 60 per cent. Atmospherics and other disturbances are less prevalent in Victoria than in Europe or America.

Institute of Metals (Annual Meeting), Mar. 13.—**D. Hanson, S. L. Archbutt, and Grace W. Ford**: Investigation of the effects of impurities on copper. Part 6. The effect of phosphorus on copper. Phosphorus removes oxygen from copper and improves its casting properties. Small amounts of oxygen can be found together with phosphorus in copper, depending on the amount of phosphorus present. Removal of oxygen by phosphorus improves the cold-working qualities of copper. Copper containing up to 0·95-1·2 per cent phosphorus can be hot-rolled, and up to 0·79-0·95 per cent cold-rolled from cast billet. Phosphorus improves all mechanical properties of copper studied, and raises the softening temperature of cold-worked material. It is seriously detrimental to electrical conductivity. The wrought alloys of higher phosphorus content exhibit a small amount of age-hardening after suitable heat-treatment.—**R. Genders**: The aluminium-brasses. Over certain ranges of composition, the presence of aluminium in brass has a beneficial influence in several directions, especially as regards resistance to corrosion and to oxidation at high temperatures. The composition of the alloys can be adjusted to give a wide range of mechanical properties.—**C. F. Elam**: The diffusion of zinc in copper crystals. This only takes place to a limited extent at high temperatures. When a β-brass crystal was heated in zinc vapour, a layer of γ-brass was deposited which was also a crystal. The relationship between the two crystals was found to be sometimes parallel growth and sometimes a twin.—**L. Davies and L. Wright**: Protective value of some electro-deposited coatings. Specimens of steel, brass, phosphor-bronze, and copper were plated with cadmium, zinc, nickel, and chromium, of thicknesses 0·0001 in., 0·0005 in., 0·001 in., and 0·002 in., and exposed to corrosion sprays of salt and sulphuric acid. Cadmium afforded better protection than zinc against the sulphuric acid spray. Against the salt spray, the thinnest deposits of zinc gave better protection than the corresponding cadmium deposits. In general, for equal thicknesses of zinc and cadmium, the intrinsic protection afforded by the zinc more than compensates for its higher solution potential. Chromium deposits afforded no protection whatever to steel, but very good protection was afforded to the non-ferrous basis metals. A deposit of 0·002 in. nickel is necessary to give any degree of permanent protection to steel. For general purposes, nickel deposits are most suitable, but no deposit can be recommended unless the service conditions are known.—**R. Lancaster and J. G. Berry**: A note on zinc-base die-casting alloys. Small quantities of magnesium added to a zinc-base alloy, hardened with copper and aluminium, causes a variation in the physical properties, and a distinct change in the crystalline structure.—**Bernard P. Haigh and Brinley Jones**: Atmospheric action in relation to fatigue in lead. An oil-bath round the test-piece, or even a water-bath, greatly delays fatigue in lead, and a thin layer of grease delays fatigue appreciably. A bath of acetic acid appears to eliminate fatigue in lead, although a thin film of the same acid does not do so. The fatigue fracture of lead is intercrystalline only round the margin. It appears that oxygen diffuses through lead subject to cyclic stress; and that, at an appreciable depth below the surface, it provokes a conjoint chemical and mechanical action that leads to fatigue cracking.—**W. R. D. Jones**: A note on metallic magnesium. Redistilled magnesium of 99·99 per cent magnesium is obtainable at such a reasonable price, in view of its purity, that it can be used in metallographic researches.

EDINBURGH.

Royal Society, Mar. 3.—W. N. McClean: River flows of the Ness Basin. After explaining briefly the need for flow measurements and for continuous records of water levels on our river systems, the author points out the peculiar value of the Ness Basin for navigation, fishing, water supply, and water power. The measurements described form the basis of the quarterly reports giving the daily rainfall, water level, and flow of the rivers of the Ness Basin. (See NATURE, Mar. 1, p. 334.)—**Gertrude Lilian Elles and Cecil Edgar Tilley**: Metamorphism in relation to structure in the Scottish Highlands. The tectonic structure of the Dalradian sediments of the south-west and central Highlands is considered in detail in relation to the regional metamorphism which these rocks display. A zonal metamorphic map of the greater part of the area has been made. The fundamental large-scale folding of the type postulated by E. B. Bailey is confirmed, but a different structural interpretation of the Loch Awe region is suggested. The identity of the Ardrishaig and Ben Lawers schists as seen in the critical area in the vicinity of Dalmally is upheld and the rocks of the Loch Awe basin are considered as a continuation of the rock sequence of the Cowal area. A table of correlations of the rocks of the several districts (Islay, Ballachulish, Loch Awe, Loch Tay, etc.) is given, the stratigraphical sequence as developed beginning with the Eilde Flags. Individual correlations include:

Islay Limestone and Black Schists	=	Ballachulish Limestone and Slates	=	Tayvallich Limestone and Schists	=	Blair Atholl Series

and the identity of the well-known boulder beds of Portaskaig, Loch na Cille, and Schiehallion. The metamorphism is regarded as developing in an original Dalradian geosyncline: a depth metamorphism in which temperature and the stress necessarily incident upon increase of temperature have been the prime factors. The development of large-scale recumbent folding during this process has led to inversion of the metamorphic zones over wide areas.

PARIS.

Academy of Sciences, Feb. 17.—A. Buhl: The planification of families of analytical surfaces.—**Marcel Brelot**: The equation $\Delta u = c(x, y)u(x, y)(c>0)$.—**Michel Fekete**: The changes of sign of a function in a given interval.—**Basile Demtchenko**: A mixed problem.—**Vladimir Bernstein**: Integral functions and Dirichlet's series.—**Paul Lévy**: Some inequalities relating to integral functions.—**L. Pirot**: The determination of the astronomical positions in view of the study of the deviation from the vertical in the peninsula of Brittany.—**Luis Rodés**: The diurnal and annual periods in the distribution of 1944 earthquakes recorded by the same seismograph. The analyses show that changes of temperature due to the sun, though slight, are an important factor in the production of earthquakes.—**D. Chalonge and Ny Tsi Zé**: The continuous spectra of hydrogen connected with the Balmer and Paschen series.—**G. Déjardin and R. Ricard**: The structure of the first spark spectrum of mercury (Hg II).—**J. Perreu**: The limiting heat of solution of sodium hyposulphite and of hydrated magnesium sulphate.—**Armel Sévault**: The special aluminium bronzes with zinc, silicon, and antimony. Tables are given showing the influence of zinc and of silicon on the hardness of aluminium bronzes.—**Ch. Bedel**: Compact fused silicon and the density of this element. Accurate density measurements on samples of silicon prepared in various ways showed that crystallised silicon and fused silicon have the same density, 2·33, provided that the fused silicon, which is liable to contain some small cavities, is powdered before taking its density.—**Georges Laude**: New syntheses of cyanic acid and urea by oxidation of carbon and its derivatives in the presence of ammonia. The oxidation of numerous organic compounds was effected by a solution of potassium permanganate in the presence of concentrated ammonia. In every case the production of a cyanate was proved: this included even sugar carbon.—**Deluchat**: A class of benzene glycols. A description of the preparation and properties of glycols of the type $C_6H_4(CH.OH.R)_2$, in which R was methyl, ethyl, propyl or benzyl.—**R. Cornubert**: The possible existence of several dibenzylidene-cyclo-pentanones.—**Marcel Godchot and Max Mousseron**: The hydrogenation of octohydrophenazine.—**Ch. Brioux and Edg. Jouis**: The neutralising action of hydraulic lime silicates on the soil.—**Cannon**: The sympathetic system as an agent of stability of the organism. After removal of the two sympathetic trunks, the animals (dog, cat, ape) lived in the laboratory several months. The basal metabolism was unchanged and the reproductive functions remained intact. Temperature control was affected and resistance to heat and cold was reduced. The other changes produced were such that the animals if set free could not long maintain their normal existence.—**F. Rathery, R. Koubilsky and Mlle. Yvonne Laurent**: The glycæmic recharge of the liver.—**Philippe Fabre**: The law of neuromuscular stimulation by short electric discharges in man.—**A. Leulier and L. Revol**: The localisation of virtual adrenaline.—**G. Mouriquand, A. Leulier and P. Sedallian**: The arrest of the diphtheric intoxication by the placenta. The experiments described show that in the guinea-pig the placenta arrests the diphtheric toxin, or at least, the phenomena of intoxication to which it gives rise, especially so far as the suprarenal capsules are concerned.

Official Publications Received.

BRITISH.

Publications of the South African Institute for Medical Research. No. 24: A Comparative Study of the Aptitude of the Higher Animal Organism to acquire Immunity throughout the Vital Cycle, and the relation of this Aptitude to Hereditary Transmission. By Dr. E. Grasset. Pp. 171-190. No. 25: Plague Studies. i. Bacteriophage in the Prophylaxis and Treatment of Experimental Plague; ii. Microbic Dissociation of *B. pestis* and its Importance in connection with the Preparation of Plague Vaccine and Serum; iii. A Veld Rodent Epizootic due to a *Pasteurella* other than *Pasteurella* (*Bacillus*) *pestis*. By Dr. J. H. Harvey Pirie. Pp. 101-230. (Johannesburgh.)

Air Ministry: Aeronautical Research Committee. Reports and Memoranda. No. 1269 (Ae. 415): Full Scale Maximum Lift Coefficient of R.A.F. 28 Section Wing. By E. T. Jones and K. W. Clark. (T. 2815.) Pp. 2+2 plates. 3*d*. net. No. 1270 (Ae. 416): The Full Scale Determination of the Lateral Resistance Derivatives of the Bristol Fighter Aeroplane. Part 3: The Determination of the Rate of Roll Derivatives. By E. T. Jones. (T. 2828.) Pp. 7+6 plates. 9*d*. net. No. 1272 (Ae. 418): Wind Tunnel Tests with High Tip Speed Airscrews; Experimental Investigation of Blade Twist under Load. By Dr. G. P. Douglas, W. G. A. Perring and R. A. Fairthorne. (T. 2803.) Pp. 7+2 plates. 6*d*. net. No. 1271 (Ae. 417): Investigation of the Boundary Layers and the Drags of two Streamline Bodies. (T. 2832.) Pp. 19+11 plates. 1*s*. 3*d*. net. No. 1273 (Ae. 419): Experiments on an Ape Aeroplane fitted with Pilot Planes. By S. Scott-Hall. (T. 2814.) Pp. 5+8 plates. 9*d*. net. (London: H.M. Stationery Office.)

The Journal of the Astronomical Society of South Africa. Edited by Dr. H. Spencer Jones. Vol. 2, No. 4, January. Pp. 141-212. (Cape Town.) 2*s*.

Ministry of Health: Advisory Committee on the Definition of Drugs for the Purposes of Medical Benefit. First Report. Pp. 6. Second Report. Pp. 9. (London: Ministry of Health.)

Publications of the Safety in Mines Research Board. Vol. 4, 1928. Reports and Papers relating to Research with Coal Dust, Firedamp and other Sources of Danger in Coal Mines. Pp. 10. (London: H.M. Stationery Office.) 2*d*. net.

The Institution of Mechanical Engineers. Annual Report of the Council for the Year 1929. Pp. 40. (London.)

University of Leeds. Twenty-fifth Report, 1928–29. Pp. 165. Publications and Abstracts of Theses by Members of the University during Session 1928–29. Pp. 40. (Leeds.)

The National Institute of Industrial Psychology. Studies in Vocational Guidance, Report 3: Tests of Mechanical Ability. By F. M. Earle, A. Macrae, and other Members of the Institute's Staff. Pp. 42. (London.) 3*s*. 6*d*.

The Proceedings of the Physical Society. Vol. 42, Part 2, No. 232, February 15. Pp. viii+43-151. (London.) 7*s*. net.

Journal of the Society for the Preservation of the Fauna of the Empire. New Series, Part 10. Pp. 53. (Hertford: Stephen Austin and Sons, Ltd.) 1*s*. 6*d*.

Ministry of Agriculture and Fisheries. Marketing Leaflet No. 16: The Pig Industry in England and Wales. Interim Report by the Pig Industry Council. Pp. 9. (London: Ministry of Agriculture and Fisheries.)

Department of Scientific and Industrial Research. Building Science Abstracts. Compiled by the Building Research Station and published in conjunction with the Institute of Builders. Vol. 3 (New Series), No. 1, January. Abstracts Nos. 1-241. Pp. ii+35. (London: H.M. Stationery Office.) 9*d*. net.

Journal of the Indian Institute of Science. Vol. 13A, Part 1: Some peculiar Lowlying Soils of Central Travancore. By T. R. Narayana Pillai and V. Subrahmanyan. Pp. 10. (Bangalore.) 12 annas.

Biological Reviews and Biological Proceedings of the Cambridge Philosophical Society. Edited by H. Munro Fox. Vol. 5, No. 1, January. Pp. 90. (Cambridge: At the University Press.) 12*s*. 6*d*. net.

Publications of the Dominion Observatory, Ottawa. Vol. 10: Bibliography of Seismology. No. 2: April, May, June, 1929. By Ernest A. Hodgson. Pp. 19-34. 25 cents. No. 3: July, August, September, 1929. By Ernest A. Hodgson. Pp. 35-47. 25 cents. (Ottawa: F. A. Acland.)

Air Ministry: Aeronautical Research Committee. Reports and Memoranda. No. 1267 (Ae. 413): Reduction of Drag of Radial Engines by the Attachment of Rings of Aerofoil Section, including Interference Experiments of an Allied Nature, with some Further Applications. By H. C. H. Townend. (T. 2819.) Pp. 77+29 plates. (London: H.M. Stationery Office.) 4*s*. net.

Ministry of Agriculture and Fisheries. Reports on Salmon and Freshwater Fisheries for the Years 1925, 1926, 1927 and 1928. Pp. 138. (London: H.M. Stationery Office.) 7*s*. net.

Journal of the Royal Statistical Society. Vol. 93, Part 1. Pp. 184+xii. (London.) 7*s*. 6*d*.

Proceedings of the Royal Society of Edinburgh, Session 1929–1930. Vol. 50, Part 1, No. 1: Variations of the Rest Metabolism of the Rat in relation to the Sex Cycle. By Dr. A. C. Fraser and Dr. B. P. Wiesner. Pp. 7. 9*d*. Vol. 50, Part 1, No. 2: Further Invariant Theory of two Quadratics in *n* Variables. By H. W. Turnbull and J. Williamson. Pp. 8-25. 1*s*. 6*d*. Vol. 50, Part 1, No. 3: Some Observations on the Thymus Gland in the Fowl. By A. W. Greenwood. Pp. 26-37. 1*s*. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

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Journal of the Chemical Society. February. Pp. iii+185-321+viii. (London.)

The National Institute of Industrial Psychology. Annual Report and Statement of Accounts for the Year ended December 31st, 1929. Pp. 31. (London.)

University of London: University College. Report of the University College Committee (February 1929–February 1930), with Financial Statements (for the Session 1928–29), and other Documents, for Presentation to the Senate. Pp. 126. (London.)

Ceylon Journal of Science. Section A: Botany. Annals of the Royal Botanic Gardens, Peradeniya. Edited by A. H. G. Alston. Vol. 11, Part 3, January 30th. Pp. 213-305+plates 25-44. (Peradeniya: Department of Agriculture; London: Dulau and Co., Ltd.) 3 rupees.

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The Agricultural Department, Madras. Bulletin No. 97: Results of Demonstrations of Agricultural Improvements in the Madras Circle carried out in 1924–1927. Compiled by Rao Bahadur D. Ananda Rao. Pp. ii+89. 8 annas. Bulletin No. 98: Pepper Cultivation on the West Coast. By M. Govinda Kidavu and P. A. Venkateswaran. Pp. 10. 2 annas. Bulletin No. 99: Results of Experiments at Samalkota on Intermediate Season Cropping. Pp. 12. 2 annas. (Madras: Government Press.)

FOREIGN.

Report of the Secretary of the Smithsonian Institution for the Year ending June 30, 1929. (Publication 3031.) Pp. vii+144. (Washington, D.C.: Government Printing Office.)

Library of Congress. Report of the Librarian of Congress for the Fiscal Year ending June 30, 1929. Pp. xvi+369. (Washington, D.C.: Government Printing Office.)

Year-Book of the International Hydrographic Bureau, Monaco, 1930. Pp. 178. (Monaco.)

Report of the Director of the Institute for Biological Research, 1928–1929. Pp. 15. (Baltimore, Md.: Johns Hopkins University.)

United States Department of Agriculture: Weather Bureau. Monthly Weather Review, Supplement No. 33: Climate of Mexico. By John L. Page. (W.B. No. 999.) Pp. 30. (Washington, D.C.: Government Printing Office.) 15 cents.

Instituts scientifiques de Buitenzorg: "'s Lands Plantentuin". Treubia: recueil de travaux zoologiques, hydrobiologiques et océanographiques. Vol. 7, Suppl., Livraison 4, Décembre 1929. Pp. 149-164. (Buitenzorg: Archipel Drukkerij.) 2.50 f.

The Boston Society of Natural History, 1830–1930. Edited by Capt. Percy R. Creed. Pp. xii+117. (Boston, Mass.)

Proceedings of the United States National Museum. Vol. 76, Art. 24: A Systematic Classification for the Birds of the World. By Alexander Wetmore. (No. 2821.) Pp. 8. Vol. 76, Art. 25: New Species of Ichneumon-Flies and Taxonomic Notes. By R. A. Cushman. (No. 2822.) Pp. 18. (Washington, D.C.: Government Printing Office.)

United States Department of Commerce: Coast and Geodetic Survey. Special Publication No. 158: Bilby Steel Tower for Triangulation. By Jasper S. Bilby. Pp. v+23. (Washington, D.C.: Government Printing Office.) 15 cents.

United States Department of Agriculture. Technical Bulletin No. 147: The Habits and Economic Importance of Alligators. By Remington Kellogg. Pp. 36. 10 cents. Technical Bulletin No. 161: Life History, Habits and Control of the Mormon Cricket. By Frank T. Cowan. Pp. 28. 10 cents. (Washington, D.C.: Government Printing Office.)

University of Illinois Engineering Experiment Station. Bulletin No. 198: Results of Tests on Sewage Treatment. By Prof. Harold E. Babbitt and Harry E. Schlenz. Pp. 98. 55 cents. Bulletin No. 199: The Measurement of Air Quantities and Energy Losses in Mine Entries. Part 4: Investigations in Timbered Entries. By Cloyde M. Smith. Pp. 50. 30 cents. Bulletin No. 200: Investigation of Endurance of Bond Strength of various Clays in Moulding Sands. By Carl H. Casberg and William H. Spencer. Pp. 28. 15 cents. Bulletin No. 201: Acid Resisting Cover Enamels for Sheet Iron. By Prof. Andrew I. Andrews. Pp. 46. 25 cents. (Urbana, Ill.)

Smithsonian Institution. Publication 2995: Mammalogy and the Smithsonian Institution. By Gerrit S. Miller, Jr. (From the Smithsonian Report for 1928.) Pp. 391-411+3 plates. Publication 2996: The Controversy over Human "Missing Links". By Gerrit S. Miller, Jr. (From the Smithsonian Report for 1928.) Pp. 413-465 + 5 plates. (Washington, D.C.: Government Printing Office.)

Suomalaisen Eläin- ja Kasvitieteellisen Seuran Vanamon Julkaisuja. Osa 10, No. 1: Über Entwicklung und Vererbung (eine theoretische Studie). Von Gunnar Ekman. Pp. 141. (Helsinki.)

The Science Reports of the Tôhoku Imperial University, Sendai, Japan. Third Series (Mineralogy, Petrology, Economic Geology), Vol. 3, No. 3. Pp. 161-270. (Tokyo and Sendai: Maruzen Co., Ltd.) 2.00 yen.

Japanese Journal of Mathematics: Transactions and Abstracts. Vol. 6, No. 3. Pp. ii+251-318+8. (Tokyo: National Research Council of Japan.)

Proceedings of the Imperial Academy. Vol. 5, No. 10, December 1929. Pp. xxiii-xxvi+443-486. (Tokyo.)

Collection des travaux chimiques de Tchécoslovaquie. Redigée et publiée par E. Votoček et J. Heyrovský. Année 2, No. 2, Février. Pp. 63-112. (Prague: Regia Societas Scientiarum Bohemica.)

Journal of the Faculty of Science, Imperial University of Tokyo. Section 1: Geology, Mineralogy, Geography, Seismology. Vol. 2, Part 9: Molluscan Fossils from Karafto. By Matajiro Yokoyama. Pp. 369-398+plates 71-76. 1.10 yen. Vol. 3, Part 1: The Iwatsuki-Seismic Zone as a Factor of the Habitual Tokyo Earthquake. By Dr. Bundjiro Kotô. Pp. vi+28+4 plates. 1.00 yen. (Tokyo: Maruzen Co., Ltd.)

Carnegie Institution of Washington. Annual Report of the Director of the Department of Terrestrial Magnetism. (Reprinted from Year Book No. 28, for the Year 1928–29.) Pp. 209-276. (Washington, D.C.)

Bulletin of the National Research Council. No. 73: A Survey of the Law concerning Dead Human Bodies. By George H. Weinmann. Issued under the Auspices of the Committee on Medicolegal Problems. Pp. 199. 2 dollars. No. 74: Report of the Conference on Midwestern Archæology, held in St. Louis, Missouri, May 18, 1929; including a Report of an Open Meeting of the Committee, held May 17, 1929. Pp. 120. 1.25 dollars. (Washington, D.C.: National Academy of Sciences.)

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 81. A Mississippian Fauna collected by Miss Eleanor T. Long from Windsor, Nova Scotia. By W. A. Bell. Pp. 617-625+plates 22-23. A new Kingfisher from East Africa: First Preliminary Paper on the Birds collected during the Gray African Expedition, 1929. By W. Wedgwood Bowen. Pp. 627-631. (Philadelphia.)

Reprint and Circular Series of the National Research Council. No. 90: Enzyme Catalysts. Seventh Report of the Committee on Contact Catalysis, National Research Council. By E. F. Armstrong and T. P. Hilditch. Pp. 15. 25 cents. No. 91: Doctorates conferred in the Sciences by American Universities, 1928–1929. Compiled by Callie Hull and Clarence J. West. Pp. 46. 50 cents. (Washington, D.C.: National Academy of Sciences.)

United States Department of Commerce: Bureau of Standards. Bureau of Standards Journal of Research. Vol. 3, No. 6, December 1929. Pp. 829-1052. (Washington, D.C.: Government Printing Office.)

U.S. Department of Commerce: Coast and Geodetic Survey. Annual Report of the Director, United States Coast and Geodetic Survey to the Secretary of Commerce for the Fiscal Year ended June 30, 1929. Pp. iii+41+17 plates. 15 cents. Serial No. 452: Results of Observations made at the United States Coast and Geodetic Survey Magnetic Observatory near Honolulu, Hawaii, in 1923 and 1924. By W. N. McFarland. Pp. ii+108. 30 cents. (Washington, D.C.: Government Printing Office.)

CATALOGUES.

B.D.H. Vitamin Products: their Composition and Uses. Pp. 4. (London: The British Drug Houses, Ltd.)

Catalogue of Important Works on Botany, Herbals, Phanerogams, Floras and Cryptogams, Zoology and Geology. (No. 11.) Pp. 20. (London: John H. Knowles.)

Diary of Societies.

FRIDAY, MARCH 28.

ROYAL SOCIETY FOR THE PROTECTION OF BIRDS (at Middlesex Guildhall, Westminster), at 3.—Annual Meeting.

ROYAL SOCIETY OF MEDICINE (Disease in Children Section) (Clinical Meeting at King's College Hospital), at 5.

PHYSICAL SOCIETY (Annual General Meeting) (at Imperial College of Science), at 5.—Presentation of the Duddell Medal to Prof. A. A. Michelson.—At 5.45 (in Electrical Engineering Department of the City and Guilds Engineering College).—Exhibition of Research Work now in Progress.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre, jointly with Manchester Association of Engineers) (at Manchester), at 7.15.—J. Calderwood: Marine Diesel Installations, with particular reference to Auxiliary Machinery.

JUNIOR INSTITUTION OF ENGINEERS (at Royal Society of Arts), at 7.30.—G. S. Taylor: Industrial Accidents; their Cause and Prevention (Gustave Canet Memorial Lecture).

ROYAL SOCIETY OF MEDICINE (Epidemiology Section), at 8.—Dr. W. Fletcher: Typhus-like Diseases of Unknown Ætiology.

PHILOLOGICAL SOCIETY (at University College), at 8.—L. C. Wharton: Slav Philologists' Congress.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Ernest Rutherford: The Transmutation of Matter.

INSTITUTION OF ELECTRICAL ENGINEERS (West Wales (Swansea) Sub-Centre).

SATURDAY, MARCH 29.

BRITISH MYCOLOGICAL SOCIETY (in Botany Department, University College), at 11 A.M.—Miss E. M. Blackwell and Miss G. M. Waterhouse: Spores and Spore Germination in the Genus *Phytophthora*.—Miss M. Brett: Stemphylium-Alternaria.—K. St. G. Cartwright: The Study of Basidiomycetes in Culture.—S. Dickinson: The Genetics of the Smut Fungi.—Exhibition by S. P. Wiltshire on The Preservation of Petri Dish Cultures of Fungi.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Atomic Nuclei and their Structure (4).

MONDAY, MARCH 31.

INSTITUTE OF ACTUARIES, at 5.—C. F. Wood: Experiments in Modified Forms of Select Mortality Tables.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—Capt. P. P. Eckersley and others: Discussion on Loud-Speakers.

ROYAL SOCIETY OF ARTS, at 8.—Comdr. F. G. Cooper: Aids to Navigation (Thomas Gray Lectures) (2).

TUESDAY, APRIL 1.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. C. Singer: The Passage from Mediæval to Modern Science (4): The Scientific Crux.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Major R. W. G. Hingston: In the Tree Roof of the Guiana Forest.—Prof. A. Meek: Further Notes on *Bipinnaria asterigera* from the Northumberland Plankton (Echinoderma).—Nellie F. Paterson: The Bionomics and Morphology of the Early Stages of *Paraphædon tumidulus* Germ. (Coleoptera, Phytophaga, Chrysomelidæ).—C. P. Gnanamuthu: The Anatomy and Mechanism of the Tongue of *Chamæleon carcaratus* (Merrem).—J. Omer-Cooper: Report on the Gyrinidæ (Coleoptera) collected during Dr. Hugh Scott's and Mr. Omer-Cooper's Expedition to Abyssinia.

LONDON NATURAL HISTORY SOCIETY (at Winchester House, E.C.), at 6.30.—A. D. Middleton: Red and Grey Squirrels.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—H. A. Humphrey, D. M. Buist, and J. W. Bansall: The Imperial Chemical Industries Limited's Steam and Electric Power Plant at Billingham.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—H. Pickwell: The Pilgrim's Way.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.30.—Capt. J. S. Irving: Some Problems Encountered and Overcome in the Design and Construction of the *Golden Arrow*.—J. H. Hyde and Dr. F. Aughtie: Measurements made of the Power and Efficiency of a Motor Lorry Gear Box.

LEICESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemistry Section) (Annual General Meeting) (at Leicester Museum), at 8.

WEDNESDAY, APRIL 2.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—R. H. Barfield: Recent Developments in Direction-Finding Apparatus. (Part 1. Medium Wave Apparatus, 250-600 metres. Part 2. Short Wave Apparatus, 12-60 metres.)

INSTITUTION OF ELECTRICAL ENGINEERS (Tees-Side Sub-Centre) (Annual General Meeting) (at Cleveland Technical Institute, Middlesbrough), at 7.—At 7.30.—L. C. Grant: The Breaking Performance of High-Power Switchgear and of a New Form of Quenched-Arc Switch.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—Prof. M. Eldin Bey: The Detection and Identification of Alkaloids in the Saliva and Salivary Glands.—Ella M. Collin: The Separation of Cadmium and Copper in Spelter and Zinc Ores by Internal Electrolysis.—A. F. Lerrigo: The Routine Detection of Nitrites in Milk.—Dr. J. C. Ghosh: A Method for the Determination of Titanium as Phosphate.

ROYAL SOCIETY OF ARTS, at 8.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section) (Reception at Wellcome Historical Medical Museum), at 8.30.—Lord Dawson of Penn: Henry Hill Hickman.

ROYAL SOCIETY OF MEDICINE (Surgery Section), at 8.30.—C. M. Page, P. J. Verrall, Dr. R. D. Langdale-Kelham, and Capt. A. R. Maxwell: Discussion on Amputations and their Relation to the Artificial Limb.

ROYAL MICROSCOPICAL SOCIETY (Biological Section).

THURSDAY, APRIL 3.

INSTITUTION OF CHEMICAL ENGINEERS (Annual Corporate Meeting) (at St. Ermins, Westminster), at 3.—Dr. J. T. Dunn and Dr. B. Moore: Pulverised Fuel.

LINNEAN SOCIETY, at 5.—H. Lister: Some Observations on the Comparative Morphology of the Protozoan Fauna, etc.—Prof. H. S. Holden: Some Wound Reactions in *Ankyropteris corrugata*.—Dr. J. M. Cowan: Botanical Exploration through North-west Persia.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. B. S. Haldane: Some Problems of Genetics.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—P. Grimault: Operation of the Aero-Postale Service in Europe.

CHEMICAL SOCIETY, at 8.—Prof. C. S. Gibson, A. R. Penfold, and J. L. Simonsen: The Essential Oil of *Backhousia Angustifolia*. Part II. The Isolation of Naturally Occurring β-diketones: Angustione and Dehydroangustione.—Miss F. M. Hamer: Attempts to Prepare Cyanine Dyes from Quaternary Salts of 2-methylacenaphthpyridine and of ms-methylacridine.—Prof. C. S. Gibson, E. S. Hiscocks, J. D. A. Johnson, and J. L. Jones: 10-Chloro-5:10: Dihydrophenarsazine and its Derivatives. Part XII. Absorption Spectra.—R. W. Aldis and Prof. J. C. Philip: The Production of Fog in the Neutralisation of Alkali with Hydrogen Halides. Part II. The Significance of the Presence of Ammonia.

OPHTHALMOLOGICAL SOCIETY.—Sir Arthur Keith: The Genius of William Bowman (Bowman Lecture).

FRIDAY, APRIL 4.

INSTITUTION OF CHEMICAL ENGINEERS (Annual Corporate Meeting) (at Hotel Victoria, Northumberland Avenue), at 11.30 A.M.—Presentation of Medals: The Moulton Medal, The Junior Moulton Medal, The Osborne Reynolds Medal.—At 12.15.—J. A. Reavell: The Rôle of Science in Industry (Presidential Address).—At 2.15.—H. Tongue: The High Pressure Equipment of the Chemical Research Laboratory, Teddington.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Lieut.-Col. Sir Wolseley Haig: The Maratha Nation (Sir George Birdwood Memorial Lecture).

FEDERAL COUNCIL FOR CHEMISTRY (at Burlington House), at 4.30.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Mining Institute, Newcastle-upon-Tyne), at 6.—A. Read: Ship's Electrical Deck Auxiliaries.

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (Annual Meeting) (at Chamber of Commerce, Birmingham), at 6.30.—At 7.—A. R. Warnes: Some Little Known Causes of Stone Decay.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (Annual General Meeting) (at Engineers' Club, Manchester), at 7.—Major A. G. Church: The Attitude of the Government towards Scientific Research.

INSTITUTION OF ELECTRICAL ENGINEERS (Meter and Instrument Section), at 7.—Dr. E. H. Rayner, W. G. Standring, R. Davis, and G. W. Bowdler: Studies in Low-Power-Factor Measurements at High Voltages.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—A. L. Stanton and others: Discussion on Smoke.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—Informal Meeting.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—W. M. Hurrell: Visits to Iceland and other Places.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—A. L. Leach: Geological Structure and British Coastal Scenery (Lecture).—A. L. Leach and A. C. Young: On a Section in River Ravensbourne Valley Gravels at Lewisham.—A. L. Leach: Recent Excavations in the Shooters Hill Gravel.

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (Annual Meeting) (at Liverpool University).—A. H. Amery: Methods of Extracting Oil from Seed.

SATURDAY, APRIL 5.

GILBERT WHITE FELLOWSHIP (Annual General Meeting) (at 6 Queen Square, W.C.1), at 2.30.—At 3.—Sir Richard Gregory: Primitive Astronomy (Lecture).

MINING INSTITUTE OF SCOTLAND (at Glasgow).—Annual Meeting.

PUBLIC LECTURE.

SATURDAY, MARCH 29.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—J. E. Dallas: June Flowers in Alpine France.