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Management of Industrial Research

THE paper by Dr. Friedrich Bergius delivered before the Institution of Chemical Engineers on November 15 last describing the development of the process of wood saccharification up to a commercial scale at Mannheim has a much wider interest than in relation to the actual manufacture of glucose, lignin or acetic acid. It provides a striking example of the difficulties which are so frequently encountered in the transference of a process from a laboratory to an industrial scale, but it possibly provides an even more impressive example of the way in which the prosecution of industrial research in one direction reacts to the advantage of industry in many other ways.

Dr. Bergius laid particular stress on the large amount of experimental work required to find the right form of apparatus and the proper constructional materials. In the course of these investigations, a knowledge was acquired of the properties of different kinds of special materials and combinations of materials to protect metal parts against hydrochloric acid, which should be of widespread utility in chemical engineering. Apart from this, the successful conclusion of the investigations depended largely on the development of an adequate engineering technique as well as on the solution of the chemical problems involved, and problems arising out of the low conductivity of stoneware, for example, as well as out of corrosion difficulties, were also encountered. It is interesting to note that after a satisfactory solution had been found by utilising the principle of direct transfer of heat from a fluid conductor to the solution to be distilled, the introduction of stoneware with a much higher heat conductivity avoided the difficulty by allowing the construction of suitable vacuum stills.

The multilateral benefits of industrial research are, however, equally well illustrated in the address which Sir Kenneth Lee delivered before the Royal Institution on December 15, in which a review of the research work leading to the commercial development of creaseless cotton fabrics by Messrs. Tootal Broadhurst Lee and Co., Ltd., was accompanied by shrewd and pertinent observations on the general principles of industrial research which are worthy of widespread attention.

One of the first points stressed by Sir Kenneth in regard to the direction of industrial research was the selection of a definite objective, and he attributed the successful issue of the research

campaign largely to the selection of a definite and appropriate subject. It would be easy to multiply examples of success in industrial research which have similarly followed the selection of a target or objective which was worth while and was clearly defined. The manufacture of synthetic indigo, the fixation of atmospheric nitrogen, the hydrogenation of coal, the saccharification of wood, or the development of numerous synthetic chemicals from acetylene, for which the first award for chemical engineering to a company was made to the Carbide and Carbon Chemicals Corporation at the Fourteenth Exposition of Chemical Industries, New York in December—these are all examples of investigations in which the first step was the definition of an objective worthy of the expenditure of effort involved.

Although such examples are so familiar, it is scarcely sufficiently realised that industrial research is largely a matter of selecting appropriate targets or objectives, and that such selection forms a large part of the science and art of research management. Success in this field to-day is largely a matter of clearly visualising objectives which are worth while and bringing to bear on them a team of highly skilled research workers equipped with all the technical resources which the modern industrial research laboratory can place at their disposal.

When this has been said, however, it must be admitted that a considerable amount of accurate fundamental knowledge is essential if wise selection of research objectives is to be practised. It is precisely the absence of a more or less accurate knowledge of the broad outlines of their field in which certain industries in Great Britain are deficient, and until they have built up such a general body of scientific knowledge covering the principles and practice of their industry, then the research they prosecute is unduly at the mercy of chance. Sir Kenneth Lee, for example, emphasised how the absence of previous systematic research in the cotton industry necessitated much fundamental research before any real progress could be made with the specific problem of producing a creaseless cotton fabric, and how the growth of such knowledge contributed to the clearer definition of the research objective.

The selection of an appropriate objective and the existence of an adequate foundation of scientific knowledge are as important to successful industrial research as they are indeed to the successful conduct of industry, whether of an old established industry such as the textile industry or of the new industries such as rayon, dyes, radio, etc., which are firmly based on scientifically established facts. Equally important, however, is the matter of team work. Industrial research is rarely a matter for one class of research worker alone. Co-operation between chemist, engineer, physicist and others is almost always required, and freshness of outlook and capacity to conduct research are often more important than a prolonged technical experience, which may make for less receptiveness to new ideas. Moreover, in the difficult intermediate stage between laboratory success and actual manufacture, the man with a good general training may be more useful than the brilliant but sometimes over-specialised research worker.

It is this overlapping of various sciences in industry which makes the multilateral or incidental advantages of industrial research so important and also, apart from success or failure in the main objective, tends continually to raise the general standard of day-to-day practice in an industry which encourages research. On this ground alone, Sir Kenneth Lee's assertion that the time is opportune for a considerable expansion in industrial research in Great Britain is thoroughly justified.

Relevant to this question is that of service, to which Sir Kenneth also alluded. The selection of valuable objectives is largely dependent on an accurate and scientific knowledge of the principles and practice in the various industries in which the products of a particular industry are used. As Sir Kenneth pointed out, the three main defects of goods sold by his company have all been overcome by research conducted either by themselves or by other industrial firms : the fastness of the dyes has been greatly improved : the creasing difficulty has been solved ; and a solution has also been found to the shrinkage problem. There are indeed few fields in which the advantages of industrial co-operation are more obvious than in the matter of continuously raising the standard of service given by the products of an industry.

Despite the considerable volume of industrial research now being carried out in Great Britain, there are many signs which indicate that industry as a whole is far from making full use of research. Even such a rough pointer of research activity as the number of patents taken out in different countries indicates an alarming disparity in the number of patents taken out in Germany or the United States as compared with Great Britain by persons resident in those countries. Moreover, even the newer industries, which are based on

scientific knowledge and are vigorously prosecuting research, are often paying heavy tribute to foreign countries in the form of licences to work fundamental processes covered by master patents. The number of industries in which the fundamental discoveries and master patents are of entirely British origin is disappointingly small.

It is true of course that the position is steadily improving in certain industries, such as the electric lamp industry and also in metallurgy, by the expiry of some of the master patents, but that improvement can only be temporary unless British industries, through a vigorous research policy, are able to claim a full and progressive share in the discoveries upon which further industrial developments are based. The subjects for research are almost legion. To select the major and most profitable problems for investigation is an embarrassing task and may well demand, as a first step, commercial research —the analysis of market probabilities and possibilities, the interplay of main products and by-products, the effect of displacing existing by new products—linked with scientific knowledge, wide vision and sound judgment, on a scale which is still by no means common in British industry.

This plea for research as an essential element in business policy is all the more opportune when the whole question of financing industrial research is under consideration. Whatever plans may be evolved by the Government for the endowment of industrial research and for stabilising that endowment, so as to eliminate the threat of day-to-day financial and economic exigencies whether in public funds or industrial prosperity, the need of vigorous internal prosecution of research by industry remains. This is not even a matter for international trade alone. It is equally important in the home market, where opportunities are largely dependent on the adoption of adequate development policies by unrelated industries.

We have come at last to the realisation that the condition of an industry is not solely a matter for that industry alone. A depressed industry depresses other industries, and if that industry is depressed primarily or even partly because of its own negligence of inefficiency, public interest now demands that appropriate measures be taken to remove that neglect of inefficiency. Sir Kenneth Lee's exposition of research and business policy is a valuable reminder of the factors which make for industrial success and prosperity. Dr. H. Levinstein recently asserted that much of the progress achieved by Japan in recent years is to be attributed to Imperial endowment of the Institute of Physical and Chemical Research. We have undoubtedly the necessary scientific ability to undertake all the industrial research required, whether of the fundamental or technical and semi-commercial kind. What must be brought to bear are the trained intelligence and restrained imagination which are adequate to plan the research required to make full use of all our available resources, and, while continuously raising the general standard of everyday industrial practice, to secure also such a share in the developments of industry as will enable us to meet foreign competitors on equal terms in regard to technical skill, industrial efficiency and freedom from patent restraints.

The Technique of Human Genetics

Nature and Nurture: being the William Withering Memorial Lectures on "The Methods of Clinical Genetics" delivered in the Faculty of Medicine of the University of Birmingham for the Year 1933. By Prof. Lancelot Hogben. Pp. 144. (London: Williams and Norgate, Ltd., 1933.) 6*s.* 6*d.* net.

IT is a significant fact that in recent years the editorial columns of NATURE have become more and more concerned with the relation of science to the State. These articles give expression to the conviction which has been growing among men of science that they have certain responsibilities to the community in which they live, and that they should no longer be diffident in offering to help in the solution of the social and economic problems which beset it, by the application of the scientific method in which they have been trained and the special knowledge which they possess. The book under review, which is written by the professor of social biology in the University of London, is a summary of recent work on one phase of the application of science to human affairs, and is therefore of more than purely parochial scientific interest; at the same time the scientific community will be glad to see such problems are being treated with the earnestness, daring and caution which are characteristic of the scientific spirit.

The particular aspect of human biology in which Prof. Hogben has interested himself is heredity. The genetical study of plants and of animals other than man is already in an advanced stage: genetics is in a position to give a causal account of its data which is as complete and coherent as

any which can be offered in other branches of biological inquiry. Its practical triumphs, the creation of new species in plants, and of new animal varieties adapted to particular functions, seem to offer Utopian promises to the human geneticist. But in reality there are very great difficulties in applying to man even the theoretical results derived from genetical analysis of animals, and until this is done any considerable attempts at the practical application of modern genetical methods of breeding must be considered premature. In this book Prof. Hogben confines himself to the preliminary question of a rigorous analysis of the genetical mechanism underlying the variability of human beings, and has left on one side the problems of its experimental modification. His discussion of the methods of analysis is straightforward and enables the reader to form some estimate of the validity of the arguments, which one hears more and more frequently, proposing concrete eugenical reforms.

The human geneticist, since he cannot undertake any experimental breeding, must adopt analytical methods which are rarely employed in animal genetics, and which are therefore still in their infancy. These methods are primarily statistical. The general principle is to deduce, from the ascertained Mendelian laws, the proportions of different phenotypes which would be expected in the population on several different hypotheses, and then to decide which of these conclusions is best borne out by the facts. Such a procedure was, of course, impossible until the general laws of heredity were thoroughly known and securely based on observations with animal material.

It is always desirable, and frequently necessary, to develop and examine several different consequences of each hypothesis which it is desired to test. The demonstration of the existence in man of rare recessive characters, which a geneticist would expect on general grounds, provides a good example of the kind of difficulty met with. If a character is determined by a rare recessive gene, some matings between an affected and a normal parent will give rise to affected offspring, the normal parent being in this case heterozygous for the gene in question, while other such matings will give no such offspring, the normal parent being homozygous dominant. We can calculate the proportion, among all affected by normal matings, of those which give at least one affected offspring. The formula depends on the frequency of affecteds in the population as a whole. When this formula is applied to the figures available for various abnormalities (such as albinism, p. 52 *seq.*) it fails to fit.

This failure may be due to the concentration of the gene for albinism in a small local section of the population, within which its frequency may be considerably higher than in the community at large. Other tests must therefore be applied, and Prof. Hogben discusses several possibilities. On p. 72 he investigates the expected proportion of affecteds : normals among the offspring of matings between two heterozygous parents, and between a heterozygous and a recessive parent. The animal geneticist expects, and obtains, a 3 : 1 ratio in the first case and a 1 : 1 in the second. But, as usual, the human geneticist immediately finds himself in difficulties, because the only practicable way of differentiating these two types of matings from matings involving a homozygous dominant parent is the fact that they give rise to recessive offspring. Now many human families are so small that statistical expectations are not realised, and the expected recessives may therefore not appear.

Several methods, one of them due to Prof. Hogben, are available for adjusting the expected ratios to include this complicating factor. Even with these refined methods, however, it is not always possible to decide whether a given abnormality is inherited strictly as a Mendelian recessive, since in some circumstances it is impossible to distinguish between this hypothesis and the hypothesis that the character is dependent on the presence of both of two independent dominant genes. Prof. Hogben produces another weapon from his armoury to deal with such cases. If a recessive gene is rare, that is, has not spread through the whole population, many of the heterozygous carriers of it will be descended from the same ancestors. Marriages between such related individuals will, therefore, be more likely than random matings to produce affected offspring. Reversing this argument, it is possible to calculate what proportion of all recessives have related (for example, first cousin) parents (p. 59).

This outline of the analysis of rare recessive characters has been carried far enough to show the difficulties which stand in the way of exact work in this field. It is no longer sufficient to identify the hereditary basis of human characters by purely qualitative considerations. The study of human genetics will only advance when exact quantitative methods can be applied to a rich

supply of data. It is the particular merit of this book that it gives a short account of nearly all the most important techniques for exact work of this kind. Some of these techniques are due to the original researches of Prof. Hogben, but in this set of lectures he is more concerned to give an easy exposition of the principles involved than to provide mathematically unassailable derivations of the various formulæ. The mathematics therefore are of the order which can be understood by most biologists who have no special training in this field. The simplification of the calculations has been most successfully carried out, but the order in which the whole subject is treated is not so happy. The matters dealt with in the first four-fifths of the book are complicatedly interwoven and a greater number of cross-references might have made it easier for the beginner to get his bearings.

The fifth and last chapter deals with a rather different subject, namely, the problem of assessing the contributions of heredity and environment to the expression of a character. Here again the author most happily lays the emphasis on the exact quantitative methods which are available, and this chapter contains the most critical short account of this problem which has appeared in Great Britain since the fundamental pioneer work of Fisher. Prof. Hogben comes to the conclusion that Fisher's treatment is invalidated by the fact that human individuals live in families, whence arises a correlation between the incidence of gene differences and environmental differences. If two different genetic stocks are kept in different environments, it is impossible to determine how much of the observed difference between them is due to the genetic difference and how much to the environmental difference. The question is in fact strictly meaningless. The eugenical and sociological importance of such conclusions is obvious, and this section of the book, though it makes no pretensions to finality, contains much which should be regarded as indispensable fundamentals in the eugenist's education.

The whole book can be heartily recommended to the attention of all those who are interested in the genetical basis of human variability with the assurance that, although it may need more effort to understand than some of the popular works on such subjects, the reader may have confidence that Prof. Hogben is leading him, not 'down the garden', but up the strait and narrow path of scientific rectitude. C. H. W.

Modern Photochemistry

Grundlagen der Photochemie. Von Prof. Dr. K. F. Bonhoeffer und Dr. P. Harteck. (Die chemische Reaktion, herausgegeben von H. Mark und M. Polanyi, Band 1.) Pp. viii+295. (Dresden und Leipzig: Theodor Steinkopff, 1933.) 24 gold marks.

IN no branch of physical chemistry is there a greater danger of a divorce between theoretical treatment and experiment than is the case in modern photochemistry. The adequate interpretation of band spectra even of the simpler diatomic molecules is a problem requiring no little mathematical skill and ability, a level not frequently attained by the experimenter. The authors must be congratulated on producing a volume which, whilst written primarily for chemists, lays stress on the theoretical aspects of the subject. The book is divided into four sections, the first being devoted to the consideration of the Einstein law of photochemical equivalence; the two following to the primary and secondary photochemical processes, and the last to more complex cases of photochemical action.

The difficulties which the chemist usually finds in understanding the complexities of atomic and molecular spectra when interpreted by the physicists are practically eliminated in the volume, a feature of which the authors should be proud. Frequent use is made of analogy, which renders the material not only extremely interesting but also very readable. One of the most useful sections of the book deals with the behaviour of free atoms, a subject to which the authors themselves have been the chief contributors.

The identification of the reaction products formed when hydrogen, oxygen or halogen atoms undergo reaction with simple substances has been the subject matter of investigations only of the last few years, and the collection and critical survey of the results obtained forms one of the most interesting sections in the book. It is clear that whilst some progress has been made in understanding the mechanism of the hydrogen-chlorine reaction, the hydrogen-oxygen reaction bids fair to provide us with a worthy substitute. Whilst some would have cared to see the inclusion of a little more material on fluorescence and its quenching both in gases and in solution, the book must certainly be regarded as the best that has yet appeared on the subject. E. K. R.

Science and Human Welfare

The Book of Scientific Discovery: how Science has aided Human Welfare. By Dr. D. M. Turner. Pp. 259+31 plates. (London, Bombay and Sydney: George G. Harrap and Co., Ltd., 1933.) 7*s.* 6*d.* net.

MISS DOROTHY TURNER (now Mrs. Féjer) has given us an admirable book which would serve well as a foundation for the teaching of the history of science in any school, and yet at the same time is mature and comprehensive enough to be welcome to any adult who does not despise the good things devised primarily for his juniors. There is so much to praise that one hastens to discharge one's only grumble. It seems a pity not to have given the few pages which would have been necessary to introduce the work of the Greeks as the indispensable foundation. As the book stands, no one would gather from it that the Greek work was indispensable; in fact, where a Greek is mentioned, it is only to point out that he made some mistake or at best a lucky guess. We start in the first sentence by "living in the twelfth century", and "searching for what any ancient writer said" to enlighten our ignorance.

It is of course right and necessary to insist on the need of constant criticism, and to show that, before the Renaissance, science had been languishing from want of fresh and accurate observation and from the slavish repetition of the errors of Aristotle and Galen. But the fault was Alexandrian and not Greek. The Greeks, from whom we derive not only science but also the whole framework of our intellectual life, were critics *par excellence*, and their failure to go further on the path they first opened to mankind, was due not to intellectual apathy but to their too eager wits, to the lack of scientific instruments, to the want of co-ordination between science and industry, perhaps, most of all, to the prevalence of slavery and the slave spirit.

It is also of the first importance from the historical point of view which Miss Turner keeps so well in mind in the rest of her book, to recall both to scholars and teachers, that Western civilisation, of which science is now the chief instrument and leading feature, was founded and built up by the Greeks and their kindred in Rome. The joint work of Greece and Rome is the signal example in the world of the application of the scientific spirit to human affairs.

The merits of Miss Turner's book which most strike the eye, are its great clearness and accuracy of statement, and the way in which she manages to select interesting and significant facts to illustrate the most important turning-points in her story. Her account of Newton is a case in point, with its excellent sketches both of the prisms used in his optical experiments, and of the path of projectiles and of celestial bodies to illustrate gravitation.

It is also a great merit to have divided the matter so well into its natural periods. Newton's work leads directly to the application of mechanical powers to industrial production. Then comes a chapter on "Science as a Factor in Social Change", in which is included the beginnings of a scientific policy in public health. This, as the author rightly sees it, is an integral part of the industrial system, which by grouping the workers in large town communities, enforced the public control of their living conditions and brought on State action both in health and education. Subsequent to this she places the beginning of an age in which chemistry became the leading science, to be followed with one, which we are now entering, when biological discoveries have a dominating influence on our ways of thinking. She is right to place this last, and right also to deal with it in rather a more summary fashion, as, being herself a teacher on the physical side of science, she is able on that to speak with greater fulness and sureness in detail. The biological chapters are, however, perfectly competent and fit in well with the rest. Several authorities, including Prof. Charles Singer and Prof. Frankenberg of the Department of Histology in the University of Bratislava (Czechoslovakia), have given adequate assistance in various ways.

It is not surprising, in view of the social spirit which inspires the whole book, to find that the author ends with a sound appreciation of the boons which science has conferred, especially on the masses of the workers, and in spite of the added dangers in war and the loss of quiet and natural beauty which have undoubtedly to be reckoned on the debit side. Unfortunately, too many of us are inclined to dwell rather on the evils than on the good which far outweighs it. Such people may be advised to read Miss Turner's concluding pages. She points out that the spread of science is essentially a popular cause. Before the industrial revolution, "for one happy craftsman there were thousands of starving beggars". The good things of life were far less widely distributed.

"Applied science has relieved man from grinding toil. Leisure is more widespread and appreciation of art and learning no longer confined to the very few. . . . Science bids us take a long view of time". But also a hopeful one. If after the lapse of a few hundred years with their blunders, national jealousies and wars, we have been able to accomplish so much, what may not the future bring, if we have but the common-sense to work together ?

F. S. MARVIN.

Short Reviews

Plant Parasitic Nematodes and the Diseases they Cause. By Dr. T. Goodey. Pp. xx+306. (London : Methuen and Co., Ltd., 1933.) 21*s.* net.

DR. GOODEY has for more than twelve years carried out investigations on eel-worms, and his special qualifications have enabled him to produce this practical account of parasitic plant nematodes with its admirable illustrations. He describes the general structure of a nematode and the technique of preparing these worms for microscopic examination and explains the significance of the formulæ originated by Cobb and refers to certain matters of nomenclature which affect the names of the worms. He then passes to the consideration of the species of *Anguillulina* which cause galls or are otherwise parasitic on shoot structures or are parasitic on roots. In succeeding chapters the species of *Heterodera* which parasitise roots and the species of *Aphelenchoides* are considered, and a chapter is devoted to plant nematodes which are parasites and semi-parasites of doubtful pathogenicity, to saprophytes and to predators.

The usual treatment of each species is to give first a summary of the results of researches upon it, then to state the characters of both sexes and of the eggs and larvæ, to trace the life-history, to note the usual hosts and the symptoms produced in them by the attacks of the parasites, and to refer to the pathology of the plant tissues affected by the worm. The geographical distribution of the worm is stated and the methods of control are concisely described. A final chapter is devoted to the presentation of data on the existence of biological races in two species of plant parasitic nematodes. The evidence presented shows that, for example in *Anguillula dipsaci*, there exist unspecialised polyphagous races, also races which are more specialised and are able to attack few hosts, and other races which are highly adapted and can live on only one or two host-species.

The author is to be congratulated on the sustained lucidity and practical outlook of his book, qualities which will ensure for it a welcome from zoologists and plant pathologists.

The Wright Encyclopædia of Gardening. By Walter P. Wright. Pp. xvii+624. (London and Toronto : J. M. Dent and Sons, Ltd., 1933.) 15*s.* net.

THOSE who have known, and used with profit, the "Everyman Encyclopædia of Gardening", will be interested in this new and greatly enlarged development of those two handy volumes. After a sketchy chapter entitled "Introductory Memoranda" there follows a good and well-illustrated glossary of terms. The main substance of the book consists of an alphabetical list of plants and gardening operations, including larger articles on specific sections such as annuals, fruit orchards, herbaceous borders, vegetables and so forth. Subsequent chapters include a gardening calendar, that 'hardy perennial' so invariably found in any book on gardening in general, an "Outline of Garden Science" in which the elementary physiology and anatomy of the growing plant is presented in a brief but adequate form, an article on "Home Landscape Gardening", which might well have been included in the main text, and finally a chapter on the making of garden structures such as green-houses and frames, summer-houses and numerous rustic articles.

As a convenient reference book which is not too large to handle with comfort the publication can be recommended, but it is to be hoped that in the next edition some major errors of omission and commission will be corrected. For example, under diseases of apples we find the statement that ammonium polysulphide is a "good remedy" for "Bitter-pit"—a purely physiological affection of apples in store. Again, it is surprising to be told that "nitrogenous fertilisers are valuable according to the amount of ammonia they yield" ; one of the most widely used nitrogenous fertilisers, nitrate of soda, is rarely assessed in terms of ammonia. Yet one other example ; any treatment of the subject of tomato cultivation is incomplete without reference to the *Encarsia* parasite of white fly. With such a simple method of control of that troublesome pest available to anyone, it is scarcely wise to recommend to amateurs the troublesome and dangerous method of fumigation with hydrocyanic acid gas.

The Testing of High Speed Internal Combustion Engines : with Special Reference to Automobile and Aircraft Types and to the Testing of Automobiles. By Arthur W. Judge. Second revised and enlarged edition. Pp. xvi+459+84 plates. (London: Chapman and Hall, Ltd., 1932.) 25*s.* net.

THIS is a revised edition of a book first published nine years ago. In its original form it gave a full and uncritical account of the many ways there are of testing high-speed internal combustion engines on the test bed, on the road, or in the air. It also described the numerous pieces of ingenious mechanism necessary for carrying out these tests. The present volume adds to this earlier account, but

the same remarkably inclusive—and uncritical—plan has been followed.

The most interesting of the additions is an account of the wonderful Rolls-Royce engine used for the British Schneider Trophy seaplanes and its manner of test. The author describes how this engine of but 34 litres cubical capacity, giving in its original form 825 h.p., was so skilfully modified as to yield no less than 2,300 h.p.—an increase from 25 h.p. per litre to no less than 68—with an increase of speed of as much as 1,000 r.p.m. beyond that of the parent engine.

As illustration of the immense ingenuity of modern testing methods, the author mentions the discovery of hair cracks in connecting rods by the painting of the rod after magnetisation with fine iron filings carried in paraffin; and the revealing of cracks in aluminium pistons by oil marks on a dusting of powdered chalk. It must be confessed that the text is on occasion obscure. One example will suffice: the author wishes to say that the capacity of an exhaust silencer must be twenty times the cylinder-swept volume; what he does say is that the capacity of the silencer in cubic feet must be eighty per cent of the cylinder capacity in litres. Despite these occasional lapses the book will prove of real value to those engaged in the testing of this prime mover.

Suns and Worlds: an Introduction to Astronomy. By W. H. Steavenson. (The How-and-Why Series.) Pp. 104+4 plates. (London: A. and C. Black, Ltd., 1933.) 2*s.* 6*d.* net.

As was to be expected of one who is himself above all a diligent observer, Dr. Steavenson has written a book in which the actual appearance of the heavens is given considerable prominence. The last few years have seen a number of books on popular astronomy, but the present volume has a great deal to recommend it, partly on account of this circumstance. One of the difficulties which beset the writer of popular expositions is the choice of a mental standard for his public; the author must make up his mind whether he is addressing an intelligent schoolboy, a casually interested adult, or an enthusiastic and painstaking reader. Dr. Steavenson starts off by explaining the seasons and the phases of the moon; but he goes right on to give an account of galactic rotation. The mathematics is suppressed, but the general line of the argument is sometimes given. Judging by the phases of the moon, which we usually see expounded in fairly elementary school-books, Dr. Steavenson has chosen for his public the intelligent schoolboy: and judging by the rotating galaxy—but why not the schoolboy too? There is a lot to be said for astrophysics as an academic exercise for the young, and it is a pity that it is not a school subject. Astrophysical work involves a peculiar mixture of mathematical and general reasoning, and would provide an excellent mental gymnastic. But this is a digression; Dr. Steavenson is out to interest more than to instruct, and in this we can have no doubt but that he has succeeded.

The Methods of Cellulose Chemistry: including Methods for the Investigation of the Compound Celluloses. By Dr. Charles Dorée. Pp. x+499. (London: Chapman and Hall, Ltd., 1933.) 21*s.* net.

THE title of this book and the name of the author provide an indication of an excellence which is not belied by its contents. Dr. Dorée has, in fact, succeeded admirably in his stated object of providing a collection of the best available methods for the experimental investigation of cellulose and of its associates and derivatives. He has achieved this by drawing lavishly, but with discretion, on the literature of chemistry, physics, botany and biochemistry, and on the technical side, from journals dealing with textiles, paper, dyeing and colloids, and he has supplemented this information by his own original work and tests of the methods concerned. Theoretical discussion of experimental data is, perhaps wisely, avoided.

The methods are classified in three sections dealing with normal cellulose, its synthetic derivatives and compound celluloses. The latest developments in determinations such as of viscosity, of degradation products of celluloses and of α-cellulose are treated fully, and will make special appeal to the worker in industry, who in the past has usually had to build up a composite method of his own from the numerous published alternatives. The section on woods neglects some important work carried out in Australia which will probably result in fundamental modification of the methods of wood analysis. J. G.

Analytic and Vector Mechanics. By Prof. Hiram W. Edwards. (International Series in Physics.) Pp. x+428. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1933.) 24*s.* net.

THIS useful work is well adapted for students entering upon a university honours course. The notation and fundamental principles of vector analysis are fully explained, and vector methods are freely though not so forbiddingly employed as to repel a generation which still finds it easier to think in terms of Cartesian methods than to apply a vector calculus *ab initio*.

After chapters which deal with velocity and vectors, the author develops the subject by way of the traditional topics handled clearly and skilfully. Harmonic motion, the dynamics of translation and rotation, elementary statics (including attraction and potentials), central forces, particle motion in fluids with resistance, and damped harmonic motion—these headings give a conspectus of the principal topics leading to chapters on vector fields, precessional motion, Lagrange's equations and Hamilton's principle. Physical applications are kept well in the foreground, and, while the treatment of such fundamental physical problems as the definition of mass might very well be extended, junior honours students in physics will find the book reasonably well suited to their needs. A. F.

The Positron*

By DR. CARL D. ANDERSON, California Institute of Technology, Pasadena, Calif.

THE existence of free positive electrons or positrons was first reported by me in September 1932[1], from cosmic ray experiments carried out at the California Institute of Technology. In the original paper, all possible alternative interpretations of the effects there presented were discussed in detail, and it was shown that only by calling upon the existence of free positive electrons could those effects be logically interpreted.

As a part of Prof. R. A. Millikan's programme of cosmic ray research, in particular to make energy measurements of the cosmic ray particles by the use of a vertical cloud chamber in a very powerful horizontal magnetic field, photographs were first taken in August 1931 in such an apparatus involving the maintenance of a field of strength up to 20,000 gauss over a space measuring 17 cm. × 17 cm. × 3 cm. As reported in lectures in Paris and Cambridge, England, in November 1931 and published in March 1932 by Millikan and myself[2], this work brought to light for the first time the fact that nuclear effects are of primary importance in the absorption of cosmic rays, as demonstrated by the frequent occurrence of associated tracks or showers containing particles of positive charge as well as those of negative charge.

Through the insertion in May 1932 of a lead plate across the centre of the cloud chamber, it was possible to show definitely in several cases that the mass of these particles of positive charge could not possibly be as great as that of the proton. The direction of motion of the particles was given in two ways: first, by allowing them to pass through the lead plate and suffer a loss in energy, and secondly, by the observation in several instances of two or more tracks all originating at one small region in the material surrounding the chamber. For a given curvature of track, the specific ionisation showed that the mass was small compared with the proton mass, but even more definite evidence was gained from an observation of the range of the particles. The observed ranges were several times, in some instances more than ten times, greater than the possible ranges of proton tracks of the same curvature.

These considerations were the basis of the report announcing the existence of the free positive electron or positron published in September 1932. Within the next five months a large number of confirmatory photographs revealing unambiguously the existence of positrons was taken, and a second report was published in March 1933[3] in which fifteen of these photographs were discussed. The specific ionisation exhibited by the positron tracks on these photographs showed that the magnitude of charge of the positron could not differ by as much as a factor of two from that of the free negative electron, and it was, therefore, concluded, unless one admits fractional values of the elementary unit of charge, that the free positive and negative electrons were exactly alike in magnitude of charge. This fact, together with the curvatures measured in the magnetic field of a positron before and after it penetrated a plate of lead, fixed its mass as not greater than twenty times that of the free negative electron.

Since then[4], an observation of a collision between a moving positron and a free negative electron in the gas of the chamber revealed, on the basis of the conservation laws, that its mass was equal to that of the free negative electron with an error of not more than 30 per cent. More recent measurements[1,5] of the specific ionisation of the positives and negatives for both high and low speed particles, by actual ion-counts on the tracks in the magnetic field, showed the specific ionisation of the positives and the negatives to be equal to within 20 per cent. This fixes the limits of difference between the positives and negatives with regard to their charges and masses at 10 per cent and 20 per cent respectively. Further details of the history of this discovery were presented at the American Association for the Advancement of Science meeting in Chicago in June 1933[4].

In March 1933 confirmatory evidence for the existence of positrons was presented by Blackett and Occhialini[5], based on similar experiments with a vertical cloud chamber operating in a magnetic field of 3,000 gauss and actuated by the responses of Geiger-Müller counters. In April 1933 Chadwick, Blackett and Occhialini[6], Curie and Joliot[7], and Meitner and Philipp[8] reported that the bombardment of beryllium by α-particles can produce radiation which results in the production of positrons, though in these experiments it was not possible definitely to identify the nature of the radiation producing the positrons. By absorption experiments, however, Curie and Joliot showed that the yield of positrons decreased approximately as was to be expected if the γ-ray rather than the neutron component of the radiation were responsible for their production.

The first experiments proving directly that a γ-ray photon impinging upon a nucleus gives rise to positrons were carried out at the Norman Bridge Laboratory, using the γ-rays from thorium C″, and reported in April 1933[9]. In this paper the fact that free electrons of both positive and negative sign are produced simultaneously by the impact of a single γ-ray photon, an observation of considerable theoretical import, was first presented. Preliminary results of energy measurements were given in June 1933 by Neddermeyer and myself[10]. Curie and Joliot[11] in May 1933, and Meitner and Philipp[12] in June 1933, all of whom used γ-rays from thorium C″, also reported

* Address delivered at the Symposium on Nuclear Physics of the American Physical Society meeting in Boston, Mass., on December 27, 1933.

the detection of positrons from the same source. Curie and Joliot[13] have also shown that positrons are produced directly in the disintegration of aluminum and boron by α-particle bombardment. The positrons in the case of aluminum cannot here be produced by the internal conversion of a γ-ray photon unless the probability of such internal conversion is vastly greater than that to be expected on theoretical grounds[14]. Rather do these experiments indicate that an elementary positive charge is actually removed from the disintegrating nucleus and appears as a positron.

The foregoing furnishes in brief a historical survey of the early experimental work on positrons and their production.

A detailed study of the energy distribution and frequency of production of free positive and negative electron pairs by filtered thorium C″ γ-rays is of particular value because of the relative simplicity of these effects as compared with those appearing in the cosmic ray range of energies.

γ-Ray Effects

A discussion will now be given of experimental evidence as it bears on the theory suggested by Blackett and Occhialini on the basis of the Dirac electron theory, which postulates the creation of a free positive-negative electron pair out of the absorption of a photon impinging upon a nucleus. The nucleus itself in this picture undergoes no disintegration, but plays merely the rôle of a catalytic agent. This discussion will be given in the light of (1) new statistical studies by Neddermeyer and myself on the thorium C″ γ-ray effects, and (2) new experiments on cosmic ray showers by Millikan, Neddermeyer, Pickering and myself.

The work of Curie and Joliot, and of Chadwick, Blackett and Occhialini on the radiation from thorium and that excited in beryllium by α-particle bombardment, together with our own work on the cosmic radiation[15], has shown that the absorption process which gives rise to positrons becomes increasingly important with high energy radiations and heavy absorbing materials. Further, we have made a statistical study based on a total of more than 2,500 tracks of single electrons, both positive and negative, and positive-negative pairs ejected from plates of lead, aluminum and carbon by γ-rays from radiothorium filtered through 2·5 cm. of lead (in some cases with unfiltered rays for comparison) to determine the frequency of occurrence of pairs and single positrons, and their energy distribution for absorbing materials of different atomic numbers. The ejection of the particles was observed from lead plates of 0·25 mm. thickness, aluminum plates of 0·5 mm. thickness and a graphite plate of 1·4 cm. thickness (used also for cosmic ray studies). The magnetic field was here adjusted to 825 gauss.

We will consider first of all the energies. Both the single positives and the pairs (the sum of the energies of the positive and negative components being taken) ejected from the lead plates showed a maximum energy of about 1·6 *MV* (*MV* = millions of electron-volts), 80 per cent of the single positrons having an energy less than 0·8 *MV*. For the case of the unfiltered γ-rays, the positrons and the pairs, though occurring in relatively fewer numbers compared with those ejected by the filtered rays, showed also a maximum energy of 1·6 *MV*. Further, in the case of the positives and pairs ejected from the plates of aluminum, the maximum energy was about 1·6 *MV*.

The maximum energy of the single negative electrons in all cases was about 2·5 *MV*. Since the errors in the energy measurements may be as high as 15 per cent, this is in good agreement with the highest energy to be expected for extra-nuclear electrons resulting from Compton encounters or photoelectric absorption of the 2·65 *MV* photons.

A maximum energy of 1·6 *MV* for the positives and the pairs, both from the lead and the aluminum, is in good accord with that to be expected on the Dirac picture if 1 *MV* is allowed for the energy required to create a pair of electrons. There occurred, however, one pair the total energy of which was 2·9 *MV*; it is conceivable, though not likely, that it may have been produced by cosmic rays, or again it may represent the rebound of an electron against the under surface of the lead plate.

Of equal importance with the distribution in energy is the distribution in number of single positive electrons and pairs as compared with the single negative electrons. Out of a total of 1,542 electrons ejected from the 0·25 mm. lead plate by γ-rays from radiothorium filtered through 2·5 cm. of lead, there were 1,387 single negatives, 96 single positives and 59 pairs. From an aluminum plate 0·5 mm. thick and ejected by the same radiation there were, out of a total of 943 electron tracks, 916 single negatives, 20 single positives and 7 pairs.

The negatives may be assumed to have arisen in general from Compton and photoelectric encounters with extra-nuclear electrons in the lead or aluminum. But the single positives and the pairs must all, of course, correspond to nuclear encounters. If we assume that on the average an equal number of positives and negatives results from nuclear impacts, we can calculate the ratio of the nuclear to extra-nuclear absorption. This amounts to about 20 per cent for lead and about 50 per cent for aluminum. These values are in reasonably good agreement with those obtained by Chao[16], Meitner[17] and Gray and Tarrant[18] by entirely different methods in the matter of the excess absorption shown by lead over that shown by aluminum and also in the general relation of nuclear to extra-nuclear absorption in both metals.

That the nuclear absorption in carbon is very small for the thorium C″ γ-rays is shown by the fact that, as compared with 415 negatives, there appeared only 2 pairs and 6 single positives.

On the whole, the energy relations of the positives and pairs, from both the aluminum and the lead, appear to be quite consistent with the pair-

creation hypothesis, as are also the approximate values of the excess absorption in lead and aluminum calculated on this assumption.

The ratio of the observed numbers of single positives compared with the pairs is also of great importance in this connexion. Whether a positive is always formed paired with a negative, or whether a positive not accompanied by a negative can in some cases be produced, is a question difficult to answer from the data so far obtained. An accurate calculation of the probability of removal of the negative, if a pair is generated, so that only the positive emerges from the plate, is not simple to make, depending as it does on energy loss and plural scattering in the plate, and on the initial space and energy distribution of the components of the pairs. But on the basis of very approximate considerations, it appears somewhat difficult to reconcile the appearance, for example, in the case of aluminum, of 20 single positives and only 7 pairs with the view that they are always formed in pairs. Experiments now planned in which the particles are ejected from very much thinner plates should decide this question.

One case should be cited in which two negatives and two positives were all observed to originate at one point in the lead plate. The possibility that this can represent two pairs accidentally associated in time and position is so remote that it is taken as evidence that *photons of energy even so low as those of the thorium C″ gamma-rays can occasionally give rise to showers such as are a common feature of the cosmic rays*[9].

Cosmic Ray Effects

Our recent stereoscopic photographs taken in a 17,000 gauss magnetic field show numerous showers of more than thirty electrons, some positives and some negatives, originating in lead plates placed across the chamber. In all the observed cases of shower production, it was clearly seen from the photographs that non-ionising particles produced the showers. Also photographs taken in a magnetic field of only 800 gauss showed many examples of single negatives, single positives, pairs and triplets, of energies of the order of only a million or two electron volts, ejected from plates of lead by the impact of non-ionising particles. These low energy ejections are in all respects identical with those produced by the thorium C″ γ-rays and are undoubtedly due to low energy photons. These electron effects cannot be ascribed to ordinary neutrons since a considerable study of neutrons in this very range of energies has shown that their absorption results in projected nuclei and not in electron projection or shower formation. The appearance of several such small electron showers on one photograph which contains evidences of showers which occurred above the chamber, brings to light a new fact, namely, that *in the absorption of the cosmic rays there are produced, in addition to the electron showers, in some instances, sprays of large numbers of secondary photons.* The evidences for this conclusion were presented at the November 1933 meeting of the National Academy of Sciences by Millikan, Neddermeyer, Pickering and myself[19], and a full discussion together with the photographs will appear shortly in the *Physical Review*. In one case, more than eighty low energy electron tracks simultaneously projected were photographed, their positions and orientations in the chamber showing that they must have arisen from nearly as many separate centres in the material surrounding the chamber, and must therefore be ascribed to such a spray of secondary photons.

That pair production or shower formation by a fast electron (positive or negative) is a relatively rare event is shown by the fact that more than a thousand fast electrons have been observed to traverse a 1 cm. lead plate, and only in one instance was a definite pair projected from the lead by a fast electron, while a large number of secondary negative electron tracks appeared as the result of close encounters with the extra-nuclear electrons in the lead plate. The immediate secondaries of fast electrons are therefore seen to consist largely of negative electrons and only in rare cases of positrons.

Because of the powerful magnetic field we are using, it is possible to deflect all but a very small number of the electrons projected in the showers by the photon impacts. In general, in a shower a pronounced asymmetry is noted in the numbers of positive as compared with negative electrons emerging from the lead plates, in one instance 7 positives and 15 negatives, and in a second case 15 positives and 10 negatives These effects are only with some difficulty reconciled with the Dirac theory of the creation of pairs out of the incident photon. Rather might they indicate the existence of a nuclear reaction of a type in which the nucleus plays a more active rôle than merely that of a catalyst, as for example the ejection from it of positive and negative charges which then appear in the showers as free positive and negative electrons. The essential difference, however, between these two points of view may be merely that in one case the nucleus may change its charge, and in the other it does not do so.

To study nuclear absorption in a light element, more than four hundred successful photographs were taken in which a carbon plate of 1·4 cm. thickness replaced the lead plate. Many of these showed showers originating in a block of lead placed above the chamber, but in no instance was a secondary shower observed in the carbon plate. This indicates, in agreement with the thorium C″ data, the relatively small probability in comparison with lead of a carbon nucleus absorbing a photon by shower production.

A consequence of the pair-theory is that, in a suitably dense environment of negative electrons such as obtains in ordinary matter, a positron shall have a high probability of combining with a negative electron, resulting in the annihilation of both particles and the conversion of their proper and kinetic energies into radiation. The theory,

though at present incomplete, states that the mean free path for annihilation is in general greater than the range of the positron, so that such annihilation should be evidenced by the appearance of quanta of about half a million electron-volts energy and a very small number of quanta of about one million electron-volts energy when positrons pass through matter[20]. The experiments by Gray and Tarrant[18] on the scattering of thorium C″ γ-rays showed the existence of secondary radiation of such energies, but some of the more recent experiments on the scattering of hard γ-rays fail to show a secondary radiation which can be attributed to the annihilation of positrons. Our cosmic ray photographs show that in the electron showers there are present large numbers of secondary photons, many of which are in this range of energy, but it is not yet certain if they are produced in part by the annihilation of positrons. In two very recent papers, Joliot[21] and Thibaud[22] report the observation in experiments with artificially produced positrons of secondary photons of the energies to be expected if they arise from the annihilation of positrons. By control experiments with negative electrons, they showed that a beam of positrons impinging upon matter results in the production of a considerably greater quantity of photons than does an equal number of negative electrons.

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[20] Fermi and Uhlenbeck, *Phys. Rev.*, **44**, 510; 1933.
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[22] Thibaud, *C.R.*, **197**, 1629; 1933.

Research in the Cotton Industry

IN a discourse entitled "Industrial Research: A Business Man's View" delivered at the Royal Institution on December 15, Sir Kenneth Lee made some striking references to the place of research in industry, based largely on the actual experience of Messrs. Tootal Broadhurst Lee and Co., Ltd. Up to twenty-four years ago, they had no scientific staff connected with the business, and it was only experience gained during the War which induced them to make a direct attack by means of research on the production of cotton material like wool in its power to resist and recover from creasing. Sir Kenneth proceeded to outline briefly the steps which after fourteen years' work had enabled them to market successfully a creaseless cotton fabric.

The initial step was the assembling of the nucleus of a research staff in the belief that, even in such an old-established industry as that of cotton, research could be of immense advantage; systematic work on the chemical and physical properties of cotton or on the physical basis of the machine processes to which it was subjected in the course of manufacture should greatly facilitate uniform and steady progress. Alluding to the lack of such systematic work in the cotton industry, Sir Kenneth cited the process of mercerisation. Although Mercer discovered in 1844 that caustic soda had a marked action on cotton, it was nearly fifty years later when Lowe discovered how the conditions must be modified to produce lustre by mercerisation, while Mercer's discovery itself did not attract the active interest of academic scientific workers.

In its progress from the bale, through spinning, weaving, bleaching, dyeing and finishing, cotton is subjected to various physical and chemical processes. It was therefore decided, when the Research Department was formed, that the staff should consist of chemists and physicists who should work together on the problems involved, and when a laboratory solution had been found, should share their knowledge with technical men in an endeavour to harvest their results in manufacture. This was the first time that chemists and physicists had been engaged in co-operation in the cotton industry. It was also decided that lack of experience in dealing with cotton should be no bar to the engagement of any member of the staff. Provided ability to conduct research was evident, this lack of experience was even regarded as an advantage, since such workers would not have got into ruts and would be more likely to contribute a fresh outlook on the problem.

In addition to the decision to adopt a definite research objective, the further important initial decision was made to carry out routine testing by a separate staff, housed in the same laboratory, so as to provide the maximum contact between the research staff and the analytical or testing staff. The wisdom of the policy embodied in these preliminary decisions is attested not only by the results achieved by the Tootal Broadhurst Lee Co., Ltd., but also by the experience of numerous other industrial research organisations in Great Britain and in other countries.

Most of the published work on cotton had previously been concerned with large-scale experiments on yarns and fabrics. In view of the dependence of the physical behaviour of such materials not only on the yarn comprising them but also on the weave, on the twist and diameter of the yarns and the nature of the innumerable

cotton hairs, it was decided to commence by investigating the properties of the cotton hairs themselves, the fine fibres about an inch long and a few ten-thousandths of an inch in diameter from which all cotton yarns are made. Special apparatus was devised to compare the elastic properties of the various textile fibres in air and in various liquids, and the sponginess of the hairs proved to be of great importance.

It was early realised that there are at least two methods of attacking the creasing problem. One is to fill the spongy cotton hairs with some elastic substance : another is to combine with the cotton some substances which would eliminate its plastic nature and give it the necessary resilience. Both methods were tried and finally the introduction of synthetic resins into the fibre proved successful, though only after some years of work had shown the way to retain all the other textile qualities of cotton when it was impregnated with resin. To be suitable for this purpose, the synthetic resin molecules should be small during the impregnation of the fabric so as to enter the cotton hairs. The substances used must not damage the fabric nor must resinification by heat or otherwise be effected under conditions which damage the fabric. Furthermore, the resin must be colourless and not discoloured by strong sunlight ; it must be elastic so as to give the anti-creasing properties, and must be introduced without impairing the suppleness of the fabric. It must also withstand laundry treatment.

These conditions considerably limited the types of resin which could be used. Further investigation showed that when the resin was mainly inside the cotton hairs a soft fabric was obtained, but when a considerable amount of resin was left between the hairs and the yarns, the cloth was hard and stiff. The microscopic examination also showed that the diameter of the cotton hairs is permanently increased, causing the fabric to give better cover, and the treatment accordingly must be directed towards getting rid of all the resin between the fibres. By treating cotton and rayon fabrics in this way, effecting final condensation after the resin solution was put on the cloth, remarkable anticreasing properties were conferred. In addition, shrinkage by washing was reduced while the strength of rayon was increased by 30 per cent when dry and up to 100 per cent when wet.

The next stage of development, from the laboratory to a manufacturing scale, proved difficult as well as costly. In addition to mechanical difficulties, physical and chemical methods of control at each stage of the process had to be elaborated. Not merely the design of suitable machinery, but also the development of suitable testing methods for accurate control made demands on a combination of engineering, chemical and physical knowledge which the man with a general training was often better able to meet than a highly specialised research worker.

One of the major difficulties was concerned with an apparatus for converting the resin inside the cotton hair into insoluble form. This had to be done by running a continuous length of cloth through a machine capable of heating it evenly over its width for a short time to a high temperature. Finally an electrical method was selected, which was novel in the electrical trade, and with this machine a production of some thousands of yards sufficed to gain the experience for the design of full scale plant in which weakness of design and lack of robustness in various details were eliminated.

Discussing the successful conclusion of this research directed to a definite objective, Sir Kenneth Lee raised the question as to how much stronger our industrial position might be as a result of more well-directed research. Patents themselves indicate the extent to which our research activity is overshadowed by that of competitive countries. Even most of our newer industries are handicapped by paying heavy tribute to foreign countries in the forms of licences, and from the results achieved by his own company Sir Kenneth said that they would be glad to see other industries, particularly the older industries, pursuing the same policy to a much greater extent. He considers that the present time is opportune for a great increase in the amount of scientific research in industry, and reduced expenditure on research in other countries offers us a correspondingly greater chance of taking the lead. Researches directed to putting manufacture on a sound scientific basis would undoubtedly repay the expenditure of time, money and patience involved, and the nations doing the most intelligent research work are likely in the long run to have the greatest chance of prosperity. We have in Great Britain the necessary ability for fundamental research if only the business community would supply sufficient funds, and Sir Kenneth urged that there is no wiser expenditure for an industrial undertaking than the provision of funds for research.

Obituary

Dr. D. H. Scott, F.R.S.

WORKERS in the fields of natural knowledge are often described as pioneers in the development of novel views, as men whose enthusiasm was stirred in early life by the preaching of a new doctrine. Dukinfield Henry Scott's early days coincided with an intellectual revolution. He was born on November 28, 1854, a few years before the publication of the "Origin of Species", and graduated from Christ Church in 1876 at a time when men were under the influence of a new gospel. He died on January 29, 1934.

Following the example of other young men of

that generation, Scott went to the famous botanical school of Sachs at Würzburg, where he took the Ph.D. degree. On his return in 1882 he took a prominent part as a lecturer and later as assistant professor in applying modern methods at University College, London. A member of a family of distinguished architects, he was attracted to the works of Nature rather than to the works of man: throughout life he experienced the joys of a true naturalist. From 1885 he occupied the chair of botany at the Royal College of Science until 1892, when he accepted an invitation from the Director of the Royal Botanic Gardens, Kew, to be honorary keeper of the new Jodrell Laboratory; two years later he was elected fellow of the Royal Society.

Scott's earliest papers, the first of which was published in 1881, were on the latex-bearing vessels in certain rubber trees, on Algæ, and on the anatomy of *Ipomœa*. His last paper was published in 1933. Throughout life his botanical interests were wide and progressive: while faithful to the traditions of the older school of naturalists and great systematic botanists, he devoted himself mainly to the investigation of extinct plants, particularly those from the forests of the Coal Age. In an address delivered in 1909, when, as president of the Linnean Society, he opened the new botanical laboratories at University College, London, he spoke of the late Prof. W. C. Williamson as a friend to whom he perhaps owed more than to any other man, as it was Williamson who interested him in the subject of fossil botany.

The veteran botanist at Manchester had contributed nineteen memoirs on "The Organization of the Fossil Plants of the Coal-Measures" to the Royal Society (1871–93), but comparatively few botanists in Great Britain realised the full significance of Williamson's work; and this was largely due to the presentation of the results in language unfamiliar to students whose sense of proportion and appreciation of values suffered through inability to make allowances for old-fashioned terminology and ideas. On his retirement from Manchester, Williamson asked Scott to collaborate with him and, fortunately for the botanical world, a favourable reply was given. In a prefatory note to the first of a series of three memoirs—"Further Observations on the Organization of the Fossil Plants of the Coal-Measures"—Williamson wrote: "My morphological enquiries seem to have reached a stage that makes a more minutely careful examination of these questions of development and growth desirable, but before specially undertaking this, I saw clearly the extreme importance of doing so in combination with some younger colleague whose familiarity with the details of the physiology of living plants was greater than my own." The conspicuous success of this partnership is evidence of the tact and understanding of the younger man and of the confidence and respect for his companion on the part of an experienced palæobotanist who did not readily change his opinions. Scott's transforming influence was the determining factor in bringing about a more general recognition of the fundamental importance of extinct plants.

After Williamson's death in 1895, Scott contributed a series of papers to the Royal Societies of London and Edinburgh, to the *Annals of Botany* and other journals, in which he described many new types. In 1897 he gave an exhaustive account of a remarkable cone, *Cheirostrobus*, which demonstrated the existence in the early part of the Carboniferous period of a reproductive shoot more complex in structure than any previously known vascular cryptogram, recent or extinct. This was followed by equally interesting discoveries of many other Palæozoic plants. In 1901 Scott gave an account of a cone—*Lepidocarpon*—agreeing in the plan of its construction with the cone of a *Lepidodendron*, but differing in bearing 'seeds' in place of ordinary sporangia. The seed-like bodies were described as nascent seeds which did not and could not be expected to conform "in all the morphological rules that we lay down for seeds at the present day". Scott was not a hide-bound formal morphologist.

In all his many contributions to a more exact and intensive knowledge of extinct plants, Scott combined an almost meticulous attention to detail with broad philosophical and cautious views on the bearing of the facts on evolution. In 1900 he published as a single volume a course of lectures delivered at University College, London—"Studies in Fossil Botany": in the second and third editions the book is in two volumes. The author's aim was the presentation to botanical readers of results which appear to be of fundamental importance. This book has long been a classic, a scholarly work distinguished by well-balanced judgment and clarity of style. In 1911 he contributed to the "Home University Library" a more popular account of the "Evolution of Plants", and this was followed in 1924 by the publication of a course of lectures delivered at Aberystwyth—"Extinct Plants and Problems of Evolution".

In 1904, following a most important discovery by Prof. F. W. Oliver that certain seeds known as *Lagenostoma* belonged in all probability to the genus *Lyginodendron*, a plant in habit and in foliage closely resembling a tree-form, a paper was published by Oliver and Scott in which the name Pteridospermeæ was proposed for a group of certain fern-like seed-bearing plants which played a dominant part in later Palæozoic and, as we now know, in early Mesozoic floras. For several years Scott regarded the Pteridosperms as closely related to true ferns and derived from a fern ancestry. In 1918 he wrote (in a letter): "I have become a bit sceptical about the Pteridosperms and Ferns; all the comparisons seem to be mere analogies"; at the Bournemouth meeting of the British Association in 1919 he definitely gave up the idea of a fern origin in favour of the view that Pteridosperms represent a long-extinct stock which passed through a fern-like stage. This change of view is characteristic of the man: when,

as rarely happened, the weight of evidence was against his original opinion, he did not hesitate to say so.

Scott's influence was by no means confined within the limits of palæobotanical research: his "Introduction to Structural Botany", an elementary textbook in two volumes, Part 1 of which is now in its eleventh edition, is a model study of representative examples of flowerless and flowering plants. Mr. F. T. Brooks of Cambridge is associated with Dr. Scott as joint author of the last edition of both parts.

In 1921 Scott was the Wollaston medalist of the Geological Society of London; in 1906 he received a Royal medal and in 1926 the Royal Society awarded him the Darwin medal. In 1921 he was awarded the Linnean medal of the Linnean Society. He was president of the Linnean Society in 1908–12 and of the Royal Microscopical Society in 1904–6; foreign secretary (1912–16) of the Royal Society; twice president of Section K (1896 and 1921) and a general secretary (1900–3) of the British Association. He was an honorary LL.D. of the University of Aberdeen and D.Sc. of the University of Manchester, also honorary member or corresponding member of many foreign academies and societies.

Though neither by inclination nor temperament attracted to administrative work, Scott conscientiously discharged such duties as he felt called upon to undertake: he was essentially a student, a dreamer with a 'passion of the past'; a man with strong international sympathy and a keen sense of justice. On occasion impulsive, quickly roused by unreason; a man of lovable personality to those who knew him well. Few men of his age made a stronger appeal to the affection and loyalty of colleagues. Scott will be gratefully remembered by many younger men and women whom he treated as equals. It is fortunate that he was able to devote the best years of his life to research without the hampering necessity of spending the greater part of his energy in teaching.

Scott was happy in the companionship of a wife whose personal qualities were complementary to his own: from her he had much help in his work both directly and indirectly. He leaves four daughters: his younger son died at school (1914) and the elder son was killed in France (1917) when serving with the Royal Engineers. By friends in all ranks of life, Scott will be remembered for many unrecorded acts of kindness: as a botanist he has left a worthy memorial in his work and in the services he rendered to exact knowledge.

A. C. SEWARD.

DR. WILLIAM PAGE

WITH Dr. William Page, who died at Middleton in Sussex on February 3, at seventy-two years of age, has passed a singularly gracious personality, whose loss is regretted by a wide circle of friends. A far wider public will mourn, and continue to mourn, the editor of the most extensive and successful attempt ever initiated in Great Britain to produce a comprehensive series of county histories, a task to which Page devoted the last thirty-two years of his life.

At the outset, indeed, a very different career had seemed to lie before Page. After leaving Westminster School, he became a civil engineer, and for a time (1880–84) was assistant executive engineer to the Government of Queensland. But he already had other ambitions. At the age of twenty-five he abandoned engineering, and with his brother-in-law, W. J. Hardy, established a firm of record agents and legal antiquaries which achieved considerable distinction, and was engaged in a number of peerage, coronation and other claims. During this period Hardy and Page jointly published the "Feet of Fines for London and Middlesex" (1892), and Page was incidentally able to develop that extensive and peculiar knowledge of local and customary history which was to serve him in good stead later. In 1902 the Hardy-Page partnership was dissolved, and Page joined Mr. H. A. Doubleday as joint-editor of the "Victoria County History", which had been established two or three years previously; whilst two years later, on the retirement of Mr. Doubleday, Page became sole general editor.

The task which Page thereby undertook was immense alike in time and in space, including as it did the history, archæology, geology, botany and zoology of the English counties. Nor was it merely in breadth of knowledge and academic sympathy that the work demanded exceptional qualities in the editor. The human problem—the problem of co-ordinating the work of innumerable specialists and local students, of harmonising their divergent views, abilities and eccentricities—drew incessantly upon Page's unfailing patience, courtesy and astuteness. The contributions which he collected from these miscellaneous sources necessarily vary in value, but it is rarely that they fall below that high minimum of scholarship which he set himself to maintain. On the documentary side, the editor's wide first-hand knowledge was a sufficient guarantee. On the architectural side, Page's association with Sir Charles Peers resulted in the evolution of methods and standards which are likely to control all future research of the kind. Indeed, these methods have received an enduring sanction in their adoption by the Historical Monuments Commission (England), which is in many ways the child of the "Victoria County History".

Nor did the editor's human problem end with his contributors. Financial difficulties were never far from Page's mind, and more than once the "History" seemed to be doomed to founder on this rock. But Page's untiring courage did not fail him, and on more than one occasion he was able to secure at the last moment the patronage which his work demanded. In 1910 the generosity of the late Lord Hambledon carried the "History" forward a further stage, and in recent years, although

financial support was increasingly difficult to obtain, individual guarantees facilitated the publication of volumes relating to Northamptonshire, Huntingdonshire, Rutland and Kent. In 1932 Page offered to the University of London, subject to certain conditions, the copyright and unused material—a considerable and important collection—of the "History", and the offer was gratefully accepted by the Court of the University in November of that year. The Pilgrim Trust afterwards made a grant to the University of £500 a year for three years to assist in carrying on the work, and a University Committee associated with the Institute of Historical Research was established for the purpose. It is indeed difficult to imagine that a task so well and truly begun, and already carried so far, should be allowed to lapse, and it is scarcely necessary to express the hope that, in accepting the legacy of Page's great work, the University has accepted the responsibility of completing it.

Page never courted any sort of recognition for his devoted work, but he was long a distinguished fellow of the Society of Antiquaries, of which he was a vice-president from 1916 until 1920, and in 1932 he received the degree of hon. D.Litt. (Oxon.).

WE regret to announce the following deaths :

Baron Alphonse Berget, professor of physical oceanography in the Institut Océanographique, Paris, who published many works on physics and meteorology, on December 29, aged seventy-three years.

Prof. F. W. Hardwick, emeritus professor of mining in the University of Sheffield, a past president of the Midland Institute of Mining, Civil and Mechanical Engineers, on January 24, aged seventy-three years.

Prof. T. E. Peet, reader in Egyptology in the University of Oxford since 1933, formerly Brunner professor of Egyptology in the University of Liverpool, on February 22, aged fifty-two years.

Sir Vincent Raven, K.B.E., president of the Institution of Mechanical Engineers in 1925, who published several works on electric locomotives and traction, on February 14, aged seventy-five years.

Prof. Howard C. Warren, professor of psychology in Princeton University since 1914 and editor of the *Psychological Review*, on January 4, aged sixty-six years.

News and Views

Fundamental Cosmological Problems

PROF. M. N. SAHA, in his presidential address to the Indian Science Congress at Bombay delivered on January 2, dealt chiefly with fundamental cosmological problems. He believes that recent discoveries in nuclear physics will provide the key to the problems of stellar structure. In the absence of decisive evidence, he inclines to the view of Kothari and others that the neutron should be regarded as a dipole consisting of a proton and an electron, and he believes that this structure has far-reaching astrophysical consequences. The problem of the ultimate fate of radiation has been radically transformed by the discovery of the positive electron, and the idea that final stagnation of the universe is inevitable is vitiated by the fact that it ignores the possibilities of conversion of radiation into matter and the combination of small into large energy quanta. Prof. Saha considers that the experimental fact of "electrofission of quantum", that is, the conversion of γ-ray quanta of sufficient energy into a pair of electrons, positive and negative, inside the nucleus, may prove to be the realisation, possibly on the cosmic scale, of the first possibility. With regard to the second, he sees no theoretical reason why, in the radiation of space (presumably continuous from the hardest rays to visible light), hard cosmic rays may not be the result of fusion of softer quanta. He expressed the view that continuous evolution is confined to portions of the universe such as the earth and solar system, the cosmic process as a whole being cyclic.

Scientific Organisation in India

THE latter part of Prof. Saha's address was devoted to problems of scientific organisation. The present world is a single economic and cultural unit, and this fact should direct political and economic action. Practical problems can be solved only by the application of scientific principles, and a new educational scheme should be devised by a world's congress of foremost thinkers, with the object of training the coming generation to a proper appreciation of the beauty and powers of science. The lack of scientific organisation and preliminary research is particularly obvious in Indian public works, with serious consequences to the vitality of the population and resulting in great waste of money. Prof. Saha supported the formation of an Indian Academy of Science, organised somewhat on the lines of the Royal Society, which would co-ordinate Indian scientific work, and act generally for the promotion of scientific research and its utilisation in national and international affairs. He adduced evidence of the need of such a body, quoting in support of his view the statement of Sir F. Spring on river problems in India, that "more money has been wasted, for want of just such knowledge as a River Commission might provide, than would have sufficed to pay the entire cost of it many times over".

Dinosaur Skeletons in Brussels

WE regret to learn that the remarkable skeletons of the Wealden Dinosaur Iguanodon, which form the most striking feature of the Royal Museum of

Natural History in Brussels, are beginning to decay. The bones are unfortunately much pyritised, and being exposed to moist air, the pyrites becomes oxidised and causes disintegration. The director of the Museum, Dr. Victor Van Straelen, has for some time arranged to treat the more fragile parts with preservatives, but he realises that the only method of permanent preservation is to enclose the specimens in glass cases in which the air can be kept dry. He has accordingly induced the Belgian Government to ask Parliament for a sum of money sufficient to provide the cases. The Belgian Senate, however, after an animated discussion, has refused the appropriation on the ground that the preservation of these fossils is not worth the needed expenditure. To this Dr. Van Straelen has fittingly replied, that if the Belgian nation is unwilling to preserve so great a scientific treasure, the skeletons of Iguanodon should be offered for sale to museums in other countries, which would be glad to acquire them and keep them intact for research. Palæontologists everywhere will certainly endorse this proposition. The Belgian Senate, years ago, provided a large sum of money to obtain the unique collection of Iguanodons and other important fossils from the mine of Bernissart, to the great benefit of science and the enlightenment of the Belgian people. It is to be hoped that the Senate may yet reconsider its present retrograde step.

Ultra-Short Wave Radio Links for Telephony

IT is now well known that electric waves having a wave-length of less than about 8 metres are of little use for long-distance radio communication, owing to the apparent inability of the ionosphere to deflect such waves back to the earth's surface. For shorter distances and particularly over stretches of water, however, these short waves are being found to have a useful application in providing a radio link in the ordinary land-line telephone system. In this connexion, the radio link is an alternative to the use of a submarine cable, and it has the advantages of lower installation cost and ease of maintenance. An experimental two-way circuit of this type, operating on a wave-length of about five metres, was inaugurated by the Post Office engineers across the Bristol Channel in 1932 (see NATURE, **130**, 604, Oct. 22, 1932). This radio circuit operates between Cardiff and Weston-super-Mare and links up with the ordinary inland telephone network, thus forming part of the London-Cardiff trunk circuit. The recent opening of a similar radio link, on a much shorter wave-length, across the English Channel for use in connexion with the cross-channel air services was referred to in NATURE of February 3, p. 167.

ACCORDING to a report in the *Times* of February 24, the Postmaster-General, in his address to the Lincoln Chamber of Commerce, referred to the probable extension by the Post Office of the facilities provided in the radio link across the Bristol Channel. Modern submarine cables usually contain many circuits so that several conversations are possible simultaneously; and a similar facility must be provided by the radio link if this is to compete successfully with the cable. The experimental work which is now being conducted by the Post Office is directed towards ascertaining the practical possibilities of operating, between two fixed points, several small radio transmitters each on a separate wave-length and carrying a single conversation. The necessary equipment for this practical test is now being installed at Castleton, Monmouthshire, and at Backwell Hill, near Bristol. There will be six transmitters and six receivers on each site, and each of these will be associated with its own directional aerial system. All the twelve wave-lengths to be used will be within the range four to six metres. The whole system is being designed for economical operation, and such devices as the automatic charging of batteries and the indication at the controlling telephone exchange of faults on the radio link, are being incorporated. It is hoped to begin the tests in two or three months' time and the results of this larger-scale practical trial will be awaited with interest.

Structure of Chlorophyll A

THE fourth Pedler Lecture of the Chemical Society was delivered by Prof. Hans Fischer at the Royal Institution on February 22, his subject being the constitution of chlorophyll A. Prof. Fischer has been working on blood and leaf pigments in Munich for a number of years, and has recently synthesised hæmin, which is obtained from blood by heating with acetic acid and sodium chloride. He was awarded the Nobel prize for chemistry for 1930. The lecturer dealt first with the porphyrins, a group of compounds upon which both hæmin and chlorophyll are based, and which all contain a ring of four pyrrole-like nuclei. Willstätter's work has shown that substances of this type are formed in the breaking down of chlorophyll, but now many of these complex molecules have been synthesised, and the nucleus of chlorophyll is known with certainty to be an isomeric modification of the porphyrin ring. The hæmin molecule has essentially the same nucleus, but different side chains. It contains two vinyl groups, which are hydrogenated to ethyl groups in chlorophyll. The latter also contains an additional ring structure, derived from β-keto propionic-acid, in place of the propionic acid side chain of the hæmin molecule. In chlorophyll, a magnesium atom replaces the co-ordinately bound iron atom of hæmoglobin. The final formulation of the structure of the chlorophyll molecule has entailed an enormous amount of synthetic organic chemistry of the utmost complexity. The brilliant manner in which Prof. Fischer and his co-workers have carried it out makes one confident that they will ultimately succeed in the synthesis of chlorophyll itself.

Bootham School Natural History Society

THE foundation of this School Natural History Society in 1834 was an important landmark in educational history, and a largely attended meeting at Bootham School, York, celebrated its centenary. An interesting exhibition of work done by past and present members gave striking evidence of the range

of interest and the far-flung activities of Bootham Old Boys. The headmaster read messages of greeting from the Minister of Education, Sir Michael Sadler and many others. Referring to distinguished former members such as Joseph Barcroft, F. W. Oliver, S. P. Thompson, J. Gilbert Baker, Lewis Richardson, Sir George Newman and Henry Seebohm, he claimed that the Society has performed, through the lives of its members, great services to the development of tropical countries, as well as to pure science. Above all, it has given to a great number of men a permanent enrichment of life. Mr. J. L. Paton, formerly High Master of Manchester Grammar School, gave an inspiring address. He warmly commended the pioneering step taken a hundred years ago in bringing biological science into the school. He spoke of these naturalists overseas as conquerors, not of men, but of Nature. Finally, he maintained that men do not really know Nature until they know her as the interpreter or the medium of the supernatural.

The Diesel-Electric Train Ferry *Scilla*

FOR nearly forty years a service of train ferries connecting Sicily with the mainland has been running across the Strait of Messina. The distance between the two terminal points, Messina and Villa San Giovanni, is about five miles. Until recently the service was maintained by two small ships which crossed in opposite directions simultaneously, so as to prevent an accumulation of rolling stock on either side of the Strait. In October 1931 they were replaced by the Diesel-electric train ferry *Scilla*, which has a displacement of 4,000 tons and a length of 358 ft. In *Engineering* of February 23, a full description is given of the vessel. It has a horse power of 5,000 and a maximum speed of 17 miles per hour. The coaches are embarked and disembarked at the end by means of a movable bridge. The adoption of Diesel-electric propulsion for a vessel of this type has several advantages, in particular its ability to run economically at different speeds, and rapid and accurate manœuvring. There are two steering stations on the vessel, one on the boat deck and the other in the engine-room, and interlocks are provided so that it is impossible to operate the controls from both stations at the same time. The ferry carries both passengers and goods, and traffic in the latter, and more particularly the transport of fruit, has steadily increased since its inauguration. It is of a seasonal nature with a winter maximum, a summer minimum and a short peak load in June. The crossing takes 25 minutes and there are first and second class restaurants on the passenger deck. The corridor deck contains first, second and third class saloons for the passengers.

A James Watt Letter

A MOST interesting letter written by James Watt in 1784 to his father-in-law, Mr. Macgregor, has just been presented to the University of Glasgow by Mr. W. J. Wilson. The letter was published in full in the *Glasgow Herald* of February 9. Watt had once made surveys for the Caledonian Canal, and it had been proposed that he should become the engineer of the scheme. By 1784, however, he had become so fully occupied with the engine business at Birmingham that he felt he could not accept the position. He said, "the contriving of engines and the other necessary attention to a business which is now very extensive takes up all the time that bad health will permit me to work, and it is possible that, setting aside the damage which the distraction of my attention might do to the partnership, my share of the loss in the engine business might exceed my gain by the canal direction." Speaking of his great contemporary Arkwright, Watt said, "he is to say no worse one of the most self sufficient ignorant men I have ever met with. Yet by all I can learn he is certainly a man of merit in his way and one to whom Britain is much indebted and whom she should honour and reward, for whoever invented spinning Arkwright certainly had the merit of performing the most difficult part, which was the making of it usefull." When Watt wrote this letter he was forty-eight years of age, and eight years previously had married his second wife, Anne Macgregor.

Institution of Mechanical Engineers

AT the annual general meeting of the Institution of Mechanical Engineers held on February 16, the annual report was adopted and the ballot for the election of officers declared, Mr. C. Day becoming president for the ensuing year in succession to Mr. A. E. L. Chorlton. Honorary life membership, it was announced, had been conferred upon Mr. L. St. L. Pendred and the Right Hon. Lord Invernairn. The report showed a net increase in the roll of membership of 61 names, the total number of members now being 11,356. The total revenue of the Institution was £34,074. During the year the meeting hall had been much improved and the library accommodation increased. A standing Committee, entitled the Inventions Advisory Committee, had been formed to assist members, while another committee, entitled Works of National Importance Committee, had been established to consider proposals for works of national importance which could be submitted to the Government for consideration with the view of lessening unemployment. The report contains short reviews of the work done by the various research committees, the awards for papers and the results of the examinations for National Certificates and Diplomas in Mechanical Engineering. For these examinations there were 2,989 candidates in England and Wales, 226 in Scotland and 37 in Northern Ireland; a greater number than in any previous year. Twenty National Diplomas (Air) in Mechanical Engineering were awarded jointly by the Institution, the Board of Education and the Air Ministry.

Streets and Pavements in London

IN a paper read to the Newcomen Society on February 21, an interesting sketch was given of the history of the streets and pavements of London. In only two periods in its long history has London been efficiently paved and drained: in the days of

the Romans and during the last hundred years. How well the Romans worked can be seen from the remains of causeways and sewers now and again brought to light during excavations in the City. With the departure of the Romans went the art of road-making, and for century after century the citizens accepted with extraordinary complacency conditions which would not be tolerated in any city to-day. As a rule, the roads were unfit for wheeled traffic, the sidewalks were of gravel and dirt, the rain spouts projected over the pavements and such sewers as there were were connected ineffectively with gutters full of holes. Complaints were made over and over again, and though surveyors and paviors were appointed, things were seldom satisfactory. Even in the days of Wren and Newton, Ludgate Hill and Fleet Street drained into the mud-filled Fleet River, which had long ceased to be navigable and had become a nuisance. Westminster was every bit as bad as London, and in 1742 Lord Tyrconnel in the House of Lords said: "The filth of some parts of Westminster and the inequality and ruggedness of others, cannot but in the eyes of the foreigners disgrace our nation, and incline them to imagine us a people, not only without delicacy, but without government, a herd of barbarians, or a colony of hottentots". Improvements were effected from time to time, it is true, but it was only during last century that real progress was made.

Archæological Exhibitions at the British Museum

AT the recent annual meeting of the subscribers to the British School of Archæology in Athens, reference was made in the usual review of the School's work to the votive house, or temple, models which had been discovered in the course of the excavation of the Heræum at Perachora, near Corinth. From incomplete fragments a complete model has been reconstructed, which is now on view in the British Museum. The model is about a foot in height, and gives for the first time an idea in detail of the character of the house in the Ægean during the Geometric period. The models are dated at about the middle of the eighth century B.C. The most striking feature of the construction is the apse, which Sir Arthur Evans has suggested may have arisen from the earliest form of building, in which the back wall was formed by hollowing out a cliff-face. The door of the building has antæ with columns, and above it are three small windows.

ON March 7 an exhibition will open of the finds of the joint expedition of the British Museum and the British School of Archæology in Iraq under the leadership of Mr. M. E. L. Mallowan, at Arpachiyah, near Nineveh, in northern Iraq, during the season 1932–33. This material should have been on view last summer, but its dispatch from Iraq was delayed by action of the Government in settling the allocation of the material found by the expedition. The finds now shown will illustrate the cultures of the ten successive prehistoric settlements discovered at Arpachiyah. This sequence, in which the occurrence and development of the painted pottery can be followed from the earliest settlement, and the evidence of early relations with prehistoric India, Baluchistan, southern Mesopotamia and Crete, make Arpachiyah one of the most important sites known for the early prehistory of Iraq. Unfortunately, partly owing to lack of funds, excavations have been suspended.

Recent Acquisitions at the Natural History Museum

BY the will of the late Lieut.-Col. C. G. Nurse, the Trustees of the British Museum (Natural History) have received a bequest of 3,000 Indian insects mostly obtained at Quetta, Deesa and Jubbulpore, where Col. Nurse served with the Indian Army. Col. Nurse was one of the small band of naturalists among military officers who devoted their leisure to the study of entomology, and was an enthusiastic collector of Hymenoptera, forming a large and valuable collection which he presented to the Museum a few years ago. The present bequest comprises the remainder of his Indian insects and includes about 1,450 Diptera (two winged flies), 1,300 butterflies, 130 dragon-flies and some others; of these the most valuable are the Diptera. The collection is especially rich in species of the family Bombyliidæ, most of which are parasitic in the larval state on bees or wasps. Col. Nurse discovered and described fourteen species of this family which were new to science, and types of these are in the collection, as well as specimens of a number of other flies which were not previously represented in the Museum. Some interesting butterflies and other insects from Aden are included.

THE Department of Botany of the Museum has been presented with sixty-three bundles of plants by the Hancock Museum, Newcastle-upon-Tyne. These plants were presumably presented to the Newcastle Museum by William Robertson, who bought them at the sale in 1842 of A. B. Lambert's herbarium, which was one of the largest ever in private hands. The specimens are of historical interest as they presumably include the remainder of the herbarium of P. S. Pallas, a Russian botanist who died in 1811. Pallas's plants were acquired by Lambert, who picked out one set for himself and one for Sir Joseph Banks. Banks's set went to the Museum in 1827, and Robert Brown purchased Lambert's own set at the sale. Judging from the specimens so far examined, the present acquisition represents the remainder of the herbarium. Much will probably be duplicate material but a good deal of information can be obtained from the original wrappers in which the plants still are. Further, it is probable that some plants figured by Pallas, which have been missing, will be brought to light. The bundles also contain about 500 plants collected by the Rev. E. D. Clarke, who visited Pallas in the Crimea in 1800. The plants were named by Pallas. Among the purchases are 800 flowering plants from Spain and Morocco (Sennen), 1,500 from North America (Marcus E. Jones) and 900 from Eastern Greece, Ægean Islands, etc. (K. H. Rechinger).

Good Eggs and Old Age

THE man or woman who lives to be eighty years old started as an "extraordinarily good egg" is a conclusion stated by Dr. George L. Streeter, director of the Department of Embryology of the Carnegie Institution of Washington, according to Science Service, Washington. Human eggs, like hen's eggs, vary greatly in nature and quality. It is estimated that one fourth of the fertilised human ova are not good enough eggs to be born as living individuals. Whether the infant survives its first year—and, in fact, a large number of them fail to do this—depends in considerable part on the original quality of the egg. The individual who withstands the usual experiences of life until between fifty and sixty years old and then succumbs to its aggregate wear and tear, conforms to the actuary's 'expectation of life at birth' and to the embryologist's expectation of the performance of an egg of average quality. It is only the extraordinarily good egg that is still going strong at eighty years, and we see him or her doing this in the absence of any exquisite hygienic regime or environmental favour.

Plant Collecting in Persia

THE *Gardeners' Chronicle* is always to the fore in publishing reports of expeditions organised for the collection of new plants. In the issue of January 6 appeared the first of a new series of articles on "Plant Collecting in Persia" by Mr. E. K. Balls. The account gives full descriptions of the habitats of a wide variety of plants, particularly irises, campanulas, gentians and *Dionysia*. More intimate details of the trip are also included. The second article appeared in the issue of January 20, and articles are promised for some time ahead. If the plants collected prove amenable to cultivation in Great Britain, many beautiful species will be placed at the disposal of gardeners.

International Union for Chemistry

THE eleventh conference of the International Union for Chemistry will be held at Madrid at the same time as the ninth International Congress of Pure and Applied Chemistry. Among the matters to be considered by the various commissions of the Union are the reforms of inorganic, organic and biochemical nomenclature; physico-chemical standards; co-ordination of scientific terminology; international tables of constants; and finance. The election of president and vice-presidents, and the nomination of members of commissions, will take place on April 11.

International Congress of Actuaries

THE Tenth International Congress of Actuaries will be held at Rome on May 4–10. The subjects for discussion will cover a large field and particular attention is being given to different aspects of social insurance, including unemployment insurance. Various social functions and excursions have been arranged and the Congress promises to be one of the most interesting of recent years. The British Government has appointed as its representative the Deputy Government Actuary, Mr. G. S. W. Epps. It is hoped that those Cabinet Ministers whose Departments are specially concerned with actuarial questions will be associated in an honorary capacity with this as with past congresses. Membership of the Congress is open to members of the Permanent Committee of International Congresses of Actuaries and, subject to approval by the Managing Committee, to others or institutions professionally associated with actuarial work. Further information can be obtained from Mr. Geoffrey Marks, C.B.E., 39, King Street, E.C.2, or Mr. Stuart Cumming, 19, St. Andrew Square, Edinburgh.

International Agricultural Congress

THE third Technical and Chemical International Congress of Agricultural Industries will be held in Paris on March 26–31. The Congress will be followed by a tour of the French wine-growing districts, arranged so that those delegates who wish can continue to Madrid in time for the opening of the ninth International Congress of Pure and Applied Chemistry on April 5. The work of the Congress is divided into five main sections: scientific and economic studies; sugar manufacture; fermentation industries; food industries; and allied industries. The subjects selected for discussion cover a wide range, but will be chiefly of interest to technologists in the sugar and fermentation industries. Other questions to be discussed include water pollution, and new uses for surplus agricultural produce, in Section 1; the properties of wheat and flour in relation to bread quality, and the treatment of milk from the farm to the consumer, in Section 4; the use of alcohol fuels and of vegetable oils in motors, in Section 5. These ensure that the Congress will appeal to a wide circle of agricultural and other technologists. Adequate arrangements have been made for relaxation from the more serious work of the Congress. The subscription for individual delegates is 100 francs, payable to the Treasurer, M. Combrun, 156 Boulevard de Magenta, Paris, from whom application forms and other details may be obtained.

The Seventh Achema

WE have received an illustrated leaflet which contains the preliminary announcement of the seventh 'Achema' or Exhibition of Chemical Plant and Apparatus, organised by the 'Dechema' (Deutsche Gesellschaft für chemische Apparatewesen), which will be held at Cologne during Whitsuntide (May 18–27). The event has been timed to coincide with the annual meetings in the same city of several of the leading German allied societies, and the exhibition will be held in three large buildings on the banks of the Rhine and within easy walking distance from the centre of the city. Four years will have elapsed since the sixth 'Achema' was held at Frankfort and the promoters confidently claim that this will be the greatest exhibition of its kind that has yet been held anywhere in the world. Most of the leading German firms who supply chemical plant and apparatus have already booked stands and a big

gathering of experts is expected. A graph on the pamphlet shows how rapid has been the growth in popularity of this undertaking since the first 'Achema' was held at Hannover in 1920. Admission cards will be issued free on application to the Management, Dechema-Gesellschäftsstelle, Seelze bei Hannover. Two international postage stamps should be enclosed. A handbook containing fuller particulars will be issued shortly. Arrangements are being made by Messrs. Hagemann and Co., Travel-bureau, Bad Aachen, Bahnhofstrasse, 32, for the issue of cheap excursion fares from England and other countries.

Universal Decimal Classification in Germany

THE past three years have witnessed in Germany a rapid development of interest in the universal decimal classification, the most important manifestation of which has been the adoption of that system by the Deutscher Normenausschuss for codifying its published standards. The need for a German edition of the classification has been felt, and is now to be met. The production of a new (third) edition of the classification will take place in the next three years, 1934–36, under the auspices of the Normenausschuss and the Ministry of the Interior. The work has the official approval of the Institut International de Documentation and will incorporate all the considerable amendments and additions made to the second French edition 1927–29 since publication of the latter. The additions will total some 10,000 classes, mainly in science and technology, bringing the total number of classes to approximately 70,000. The work will be published in ten quarterly parts, of standard format *A* 4 and comprising about 160 pages. The first part will appear in April of this year, and the cost of each part will be 11 gold marks if ordered before March 1; afterwards 12.50 gold marks. Messrs. Beuth-Verlag, G.M.B.H., Berlin, S.W.19, are the publishers.

The Night-Sky in March

THE only striking planetary object in the March sky is Jupiter, which can be seen in the eastern sky before midnight close to the star α Virginis (Spica), and the two form a conspicuous pair. There will be an occultation by the moon of the star α Scorpii (Antares) on March 8, but the phenomenon will not be visible at Greenwich (it will be visible at the Cape of Good Hope). On March 26 the moon will occult δ Cancri, the magnitude of which is 4·2. This occultation will be visible at Greenwich and will take place early in the morning (at 3h.02m.G.M.T.). At this hour the phenomenon will scarcely tempt any save regular observers of occultations, especially as we can warn our readers of two occultations which will occur later in the year of bright stars both of which will occur before midnight.

Announcements

THE newly formed Microchemical Club will hold its first scientific meeting on Saturday, March 17, at 10.30 a.m. at the Lister Institute, Chelsea Bridge Road, London. At 2.30 p.m. on the same day and at the same place, the first annual general meeting will be held to elect officers, adopt a constitution and transact other business. Communications on microchemical subjects are invited; they may deal with applications and development of micro methods in any branch of science. Communications can be sent to S. J. Folley, National Institute for Research in Dairying, Shinfield, Nr. Reading.

THE prize for 1933 of £100 awarded by the Thomas Gray Memorial Trust of the Royal Society of Arts for an essay in connexion with fire in a modern passenger vessel or in a cargo vessel at sea, in port or in a builder's yard has been awarded to Commander R. D. Binney. The prize of £100 for an improvement in the science or practice of navigation has been awarded to Dr. A. B. Wood, F. D. Smith and J. A. McGeachy, Admiralty Research Laboratory, Teddington, for their silent magneto-striction echo sounder with recorder. The prizes for 1934 are being offered for an invention, publication, diagram, etc., which is considered to be an advancement in the science or practice of navigation and for an essay on a navigation topic. Essays or proofs of claim must be submitted before December 31. Titles of the essay and other information can be obtained from the Secretary, Royal Society of Arts, John Street, Adelphi, London, W.C.2.

IN an article on "Industrial Research" in NATURE of January 20, it is stated on p. 80 that the contribution of electric supply authorities in Great Britain to the British Electrical and Allied Industries Research Association is about £5,000. We are informed by the Association that its income from this source in 1933 was £15,000.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A probationary assistant engineer (male) in the Post Office Engineering Department—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1 (March 8). A senior library assistant to the Hertfordshire County Council—The Clerk to the County Council, 28, Castle Street, Hertford (March 10). A head of the Mechanical and Civil Engineering Department of the Technical College, Sunderland—Chief Education Officer, Education Offices, 15, John Street, Sunderland (March 12). A University professor of anatomy at St. Thomas's Hospital Medical School—The Academic Registrar, University of London, S.W.7 (May 16). A director of food investigation in the Department of Scientific and Industrial Research—The Secretary, 16, Old Queen Street, Westminster, S.W.1 (March 17). A head mistress of the Day Trade School for Girls, Wavertree Technical Institute—The Director of Education, 14, Sir Thomas Street, Liverpool (March 17). A professor of mathematics at the Royal Technical College, Glasgow—The Secretary (March 26). A staff lecturer and demonstrator in botany, and a demonstrator and assistant lecturer in chemistry at the Royal Holloway College, Englefield Green, Surrey—The Principal (April 14). A signal engineer for the Way and Works Department, Government Railway, Ceylon—Crown Agents for the Colonies, 4, Millbank, London, S.W.1.

Letters to the Editor

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

A supposed Submarine Ridge along the South-East Coast of Greenland

DURING marine biological work in the Denmark Strait with the Danish Research Ship *Dana* in August 1933, it was possible to proceed quite close to the coast of East Greenland south of Angmagssalik; practically no ice was met with during this year. For the purpose of the biological work on the drift of cod larvæ from Iceland to Greenland with the west-going branch of the Irminger Current, four sections were made from the coast out to deep water. During these sections, as also on the whole cruise, the echo sounding apparatus was constantly used and the soundings revealed—so far as it was possible to carry out the investigations during the time available—that a submarine ridge seems to follow the East

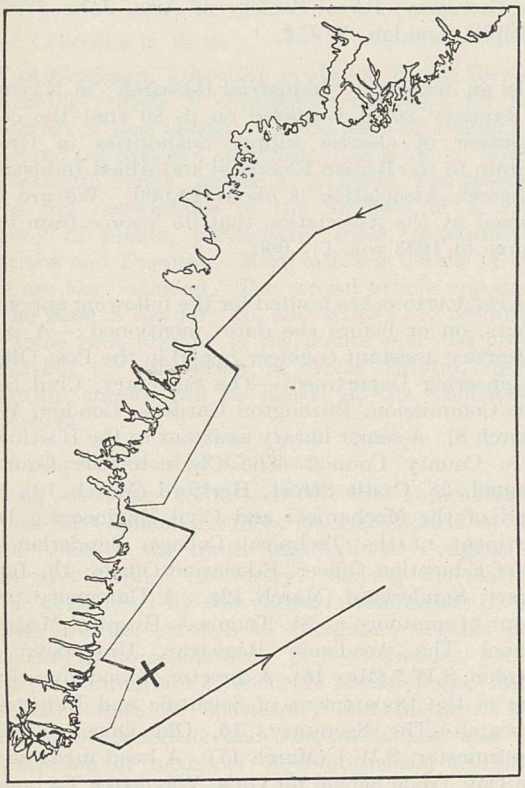

FIG. 1. Course of the *Dana* off the south-east coast of Greenland.

Greenland coast, at any rate from about Lat. 64° N. to Cape Farewell (lat. 60° N.).

Our work during the cruise was, as mentioned above, mainly marine biology, and it was impossible to go further into the studies of the relief of the sea bottom last summer. The matter is, however, of importance in several respects, and I wish therefore to announce our observation of this supposed ridge that other ships may possibly have the opportunity of making further soundings there and thus eventually prove or disprove the existence of this supposed submarine ridge in these remote waters. Our soundings point to a continuous ridge, but more close investigations are however necessary, as breaks may possibly be found in the ridge off the deeper fjords.

In Fig. 1 is given a rough sketch of the coast of East Greenland south of Angmagssalik showing the route of the *Dana*. Fig. 2 shows the bottom relief on one of the sections (marked with a cross in Fig. 1);

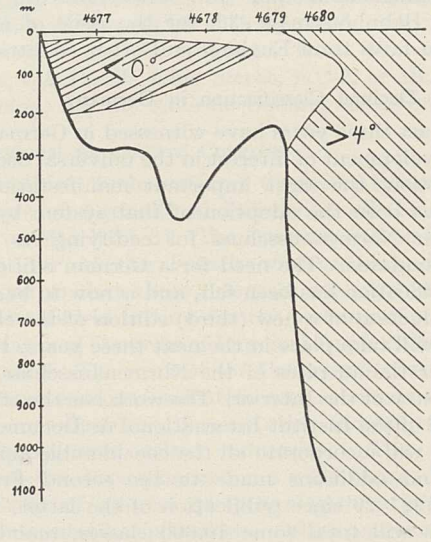

FIG. 2. Section at X in Fig. 1, showing submarine ridge and temperature of the bodies of water on each side of it.

the other sections show, however, on the whole, much the same conditions. It will be seen that the submarine ridge is about 230 metres below the surface in the section in Fig. 2 and it is about 20 miles off the coast line. Farther north the ridge is more than 20 miles from the coast-line (going up to about 30 miles). The greatest depth measured inside the ridge where the depths are rather variable is about 600 metres; outside the ridge the depth increases very rapidly to more than 1,500 metres. On the ridge itself we obtained depths of 170–240 metres, most often 200–240 metres. In the trough formed by the ridge along the coast we have the ice-cold East Greenland Current; outside or over the ridge we met with the warm Atlantic water with temperatures up to 8° C.; between these water masses we have mixed water layers.

During recent years the late Prof. Johs. Schmidt succeeded in showing that there is an interchange of the stock of cod in Icelandic and Greenlandic waters. In 1933 the migrations of cod from West Greenland to Iceland were even greater than in preceding years in which investigations were undertaken. Probably it will be possible in the future to show that the cod migrating from one of the areas mentioned to the other follow the ridge in question, where 'cod temperatures' will probably prevail during most years. We shall then be able to understand how the cod find the path from West Greenland to Iceland and vice versa.

Å. VEDEL TÅNING.

Marine Biological Laboratory,
Copenhagen.
Jan. 12.

Constitution of Dysprosium, Holmium, Erbium, Thulium, Ytterbium and Lutecium

CONTINUING the examination of the rare earth elements by the method of anode rays as already reported[1], I have now been able to complete the analyses of the group.

Dysprosium (66) gave poor spectra but sufficient to indicate that it consists of mass numbers 161, 162, 163, 164 not differing much in relative abundance.

Holmium (67) is quite definitely simple 165.

Erbium is not so complex as it was at first supposed to be. The early samples used were evidently contaminated. A pure sample gave three strong lines, 166, 167, 168 and a weak fourth 170.

Thulium (69) is simple 169.

Ytterbium (70) appears to contain mass numbers 171, 172, 173, 174, 176, of which 174 is the strongest.

Lutecium (71) is simple 175.

It will be seen that these six elements fill all the numbers from 161 to 176 and show no isobares.

A full account of this work will be published in due course with estimates of relative abundance and the atomic weights so deduced. It is already evident that the international values for several of the rare earths are in need of revision. That of holmium (163·5) is particularly bad.

F. W. ASTON.

Cavendish Laboratory,
Cambridge.
Feb. 17.

NATURE, **132**, 930, Dec. 16, 1933.

Value of e/m

SIR ARTHUR EDDINGTON[1] has developed theories according to which

$$hc/2\pi e^2 = 137,$$

and the ratio of the mass of the proton to that of the electron is

$$M/m = 1847{\cdot}6.$$

I have shown[2] that these theories and most experimental data are in extremely good mutual agreement. The only experimental evidence against them[3] is that given by recent determinations of the specific electronic charge[4], which may be summarised as

$$e/m = (1{\cdot}759 \pm 0{\cdot}000_5) \times 10^7 \text{ E.M.U.}$$

These measurements disagree with the value deduced[5] from $M/m = 1847{\cdot}6$, namely,

$$e/m = (1{\cdot}77031 \pm 0{\cdot}00014) \times 10^7.$$

However, Sir Arthur Eddington pointed out[6] that his work and the discovery of the neutron made it seem likely that the equations used in deducing the spectroscopic estimates of e/m are in error.

I am writing to suggest that some (or possibly all) of the experimental determinations of e/m are really measurements of

$$\frac{136}{137}(1{\cdot}77031 \pm 0{\cdot}00014) \times 10^7;$$

that is to say, of $(1{\cdot}757{,}4 \pm 0{\cdot}000{,}14) \times 10^7$ E.M.U. This is in reasonable accord with the $1{\cdot}759 \pm 0{\cdot}000_5$ recently obtained experimentally (being smaller than some and larger than other of the experimental results).

If this supposition proves to be correct, the only evidence against Sir Arthur's 137 and 1847·6 would vanish.

W. N. BOND.

Department of Physics,
University of Reading.
Feb. 13.

[1] Eddington, *Proc. Roy. Soc.*, A, **143**, 327, and earlier papers.
[2] Bond, *Proc. Phys. Soc.*, **44**, 374; 1932.
[3] Birge, *Phys. Rev.*, **40**, 319; 1932.
[4] Dunnington, *Phys. Rev.*, **43**, 404; 1933. Kretschmar, *Phys. Rev.*, **43**, 418; 1933. Robinson, Andrews and Irons, *Proc. Roy. Soc.*, A, **143**, 48; 1933.
[5] Birge, loc. cit.
[6] Bond, *Phys. Rev.*, **41**, 368; 1932.

Reaction of Heavy Water with Metallic Sodium

MESSRS. C. O. DAVIS and H. L. Johnston report[1] that when metallic sodium is dissolved in heavy water, the diplogen content of the evolved hydrogen is reduced and the diplogen content of the solution correspondingly increased. We wish to put forward the results of similar experiments, which have been carried out in a somewhat different way and seem to lead to a more precise interpretation of this reaction.

Metallic sodium was introduced into an evacuated glass bulb by electrolysis, and heavy water was then distilled into the vessel. In two experiments an excess of water was taken, in two other runs there was an excess of sodium metal. In all experiments the quantity of hydrogen evolved was found to be 0·5 mol. per mol. of decomposed water. The original water contained 1·81 parts of diplogen to 100 parts of hydrogen + diplogen.

1. Water excess, room temp.	0·96	per cent D in H_2+HD formed.
2. Sodium ,, ,, ,,	0·99	
3. ,, ,, −10° C.	1·01	
4. Water excess, room temp.	1·03	

These values are in agreement with the 'separation factor' reported by Davis and Johnston.

Since in presence of an excess of sodium the whole of the water was decomposed, the shift in the diplogen content of the hydrogen produced cannot be accounted for by a difference in the rate of reaction of H_2O and HDO with sodium. The case is therefore different from the shift observed in the reaction between iron and water[3].

The correct description of the phenomenon appears to be this: Decomposition of HDO by metallic sodium can lead alternatively to the formation of NaOH or NaOD, the latter alternative being preferred. Or, putting it in a different way: when HDO comes into contact with sodium, the H-atom escapes with greater ease to combine with an H-atom released by a neighbouring pair of reacting particles ($Na + H_2O$), than does the D-atom.

The greater ease of reaction of H as compared with D was predicted by Cremer and Polanyi[2] on account of: (1) the lower zero point energy of D-compounds[4]; (2) the stronger leakage of H through energy barriers.

In the present case of a single compound entering into two alternative reactions, the zero point energies of the initial states are identical. However, at the top of the activation barrier the two alternative

reactions will show a difference in energy due to the different zero point energies of NaOD and NaOH. The former having the smaller zero point energy, the barrier will be lower, when NaOD is formed. Formation of NaOD would therefore be preferred. An estimate of the effect of zero point energy makes it possible to assume that this is sufficient to account for the ratio of the two reaction rates actually found.

Obviously the difference in the 'leakage' of the particles H and D would also lead to a preference of the observed reaction.

We wish to express our thanks to Prof. Polanyi for valuable discussions.

J. HORIUTI.
A. L. SZABO.

The University,
Manchester.
Feb. 19.

[1] *J. Amer. Chem. Soc.*, **56**, 492, Feb. 1934.
[2] Cremer and Polanyi, *Z. phys. Chem.*, B, **19**, 443, 1932.
[3] Horiuti and Polanyi, NATURE, **132**, 819, Nov. 25, 1933.
[4] This has also been independently recognised by H. Eyring, *Proc. Nat. Acad. Sci.*, **19**, 78; 1933.

Production of Induced Radioactivity by High Velocity Protons

CURIE and Joliot[1] have reported that a number of new radioactive isotopes can be produced by the bombardment of various elements with α-particles, these isotopes emitting positive electrons. In particular, they showed that boron when bombarded by α-particles was transformed to the isotope N^{13}, radio-nitrogen, this isotope having a half life of 14 minutes. They suggested that the isotope might be produced by the bombardment of carbon with heavy hydrogen, the product, N^{13}, disintegrating with the emission of a neutron to radio-nitrogen.

We have bombarded a target of Acheson graphite with *protons* of 600 k.v. energy and have used a Geiger counter to search for any radiations produced after the bombardment ceased. After bombardment for 15 minutes with a current of about 10 micro-amperes of protons, the target was removed from the apparatus and placed against the Geiger counter. We then observed about 200 counts per minute, being about forty times the natural effect. The number of counts decayed exponentially with time, having a half life of $10{\cdot}5 \pm 0{\cdot}5$ minutes.

We then carried out an experiment similar to that performed by Becquerel, in which the source was placed on one side of a 9 mm. thick lead plate with the counter on the opposite side, the whole being placed in a magnetic field, so that any electron emitted could only reach the counter by applying a field of appropriate sign and magnitude. We found that when the field was such that positive electrons could reach the counter, the number of counts increased by a factor of 3; when the field was in the reverse direction no definite increase was observed. We conclude, therefore, that the radiations consist in part at least of positive particles.

We have also taken about 250 Wilson chamber photographs in a field of 2,000 gauss, placing the activated source against the outside of the chamber wall, which was about 3 mm. thick. Under these conditions, we observed only two electrons of positive curvature which could possibly have come from the source, these electrons having energies of the order of 500 k.v. We observed, on the other hand, 48 tracks of Compton electrons starting in the gas, having energies ranging from 100 k.v. to 500 k.v., suggesting the emission of γ-rays of energy between 500 k.v. and 1 million volts. These γ-rays may result from the annihilation of the positive electrons, presumably in the glass wall of the chamber. The deflection experiments, whilst not at present precise, tend to confirm that few of the positive electrons would have sufficient energy to penetrate the glass walls. Further experiments will, therefore, be carried out with the source inside the chamber.*

The observations suggest that the unstable isotope N^{13} is produced by the addition of a proton to C^{12}. The difference between the half life observed and that reported by Curie and Joliot may be due to the formation of N^{13} in a different excited state.

No marked increase in the number of counts was observed when a mixed beam of heavy hydrogen ions and protons was substituted for the proton beam.

We are very much indebted to Dr. K. T. Bainbridge, who supplied the Geiger counter with which the observations were made.

J. D. COCKCROFT.
C. W. GILBERT.
E. T. S. WALTON.

Cavendish Laboratory,
Cambridge.
Feb. 24.

* February 27. Experiments carried out with a counter having a mica window of small stopping power gave a great increase in the number of counts owing to the positive electrons now entering the counter. The absorption curve of the positive electrons is similar to that of negative electrons of 800 k.v. energy.

[1] *Comptes rendus*, **198**, 254; 1934.

A Perturbation in the Spectrum of Se II

WHEN the analysis of the spectrum of Se II has been completed, it is observed that the quartet

		ν (int.)
$4p\ {}^4S_{11/2}$	$- 5s\ {}^4P_{1/2}$	= 95270 (10)
	$- 5s\ {}^4P_{11/2}$	= 96753 (10)
	$- 5s\ {}^4P_{21/2}$	= 98676 (4)

due to the fundamental transition $4p \rightarrow 5s$ exhibits abnormal relative intensities of its components. The intensity ratio of these lines, according to Burger and Dorgelo's rule, should be 2 : 4 : 6, the line $S_{11/2} - P_{21/2}$ being thus the brightest and the most easily excitable of the group, whereas in Se II, it is extremely faint under all the variety of experimental conditions of excitation in which the group has been photographed. The corresponding quartets in other similar spectra, hitherto known, do not show this anomalous feature.

In Se II this must obviously be a perturbation in intensity arising from the mutual interaction of adjacent spectral terms; for our analysis has revealed a clear interpenetration of the levels due to the 5*s* and 4*d* configurations, while in the lighter elements there is a somewhat large separation between these two groups of energy states.

Excepting this intensity anomaly, the other characteristics of Se II are found to be generally analogous to those of As I or S II. Full details of this scheme will be published shortly.

K. R. RAO.
S. GOPALA KRISHNAMURTI.

Science College,
Andhra University,
Waltair. Dec. 18.

Feeding Mechanism of the Fairy Shrimp

IN a recent paper[1] Mr. Lowndes has put forward a new view as to the filtratory feeding mechanism of the fairy shrimp, *Chirocephalus diaphanus*. Hitherto all workers (Storch[2], Lundblad[3], Naumann[4], Borradaile[5], Wagler[6] and Cannon[7]) have agreed that the long setæ on the edges of the basal endites of the trunk limbs constitute the filter, or at least a retaining wall by which particles are abstracted from a current of water.

Mr. Lowndes maintains that water enters the inter-limb spaces between successive limbs, past the endopodites and exite series, which hitherto have been accepted as valves preventing the inflow of water, and that some of this water is then forced into the deep food groove running along the mid-ventral line of the body. Here it is filtered by patches of setules on the food groove walls, which he calls the "filter processes".

In a recent paper[8] I described and figured these 'filter processes' in the three orders of Branchiopoda in which they occur, and showed that they are comb setules which comb the residue off the filter setæ on the basal endites. That the latter are actually filters is shown by the two facts: (1) the water current can be seen to pass through them from the mid-ventral space, as I described in 1928, and (2) they have the typical structure of filter setæ. In all those numerous forms where, either experimentally or by the position of the food in sections of the fixed animal, it can be shown that a limb acts as a filter, the same type of seta is found (Cannon[8], p. 275) and this is the type found in *Chirocephalus*.

In all filtratory setæ the ultimate meshes of the filter are formed by fine setules regularly arranged on the edges of the setæ. If further evidence is required beyond direct observations that the water current passes from the mid-ventral space through the filters, it is found in the position of its setules—they always face the direction from which water to be filtered comes, and in *Chirocephalus* they all face the median plane.

The only point previously on which workers have been unable to agree is as to the mechanism by which the filtered food is transported to the mouth. Storch[2] (p. 387) maintains that it is swept forwards by the action of the most proximal setæ on the basal endites, while I maintained[7] (p. 811) that there is a definite oral current in the food groove. This is the only current which cannot be observed directly, and so I demonstrated it experimentally. I injected a coloured solution so as to fill completely one of the inter-limb spaces of a captive *Chirocephalus*, and was then able to show that at the end of the backstroke of the limb forming the anterior wall of this space, a spurt of the solution was forced along the food groove. Mr. Lowndes has now repeated my experiment and confirmed my results.

H. GRAHAM CANNON.

The University,
Manchester.
Feb. 12.

[1] Lowndes, *Proc. Zool. Soc. Lond.*, 1093; 1933.
[2] Storch, *Intern. Rev. Hydrobiol.*, **12**, 369; 1925.
[3] Lundblad, *Arkiv. Zoolog.*, **13**, 16; 1920.
[4] Naumann, *Act. Univ. Lund.*, **17**, 4; 1921.
[5] Borradaile, "The Invertebrata", Cambridge, p. 320; 1932.
[6] Wagler, Kukenthal's "Handbuch der Zoologie", 1926, p. 366.
[7] Cannon, *Trans. Roy. Soc. Edin.*, **55**, 807; 1928.
[8] Cannon, *Phil. Trans. Roy. Soc. Lond.*, **222**, 267; 1933.

'Mimicry' among Insects

THERE has just come to hand (*Entomologica Americana*, 13, No. 3, published (as stated on cover) Nov. 29, 1933, but dated on every page December 1932) a most admirable review of the Polybiine wasps of the Nearctic region, by Dr. J. Bequaert. Unlike many taxonomic papers, it treats not only of the structures of the insects, but also, at considerable length, of their biology, everything being set forth in the most interesting way. There is a good account of the cases of 'mimicry' involving these wasps. Thus the wasps of the genus *Nectarina*, in the neotropical region, belong to an assemblage of diverse insects of similar appearance, of which no less than twenty-eight are cited. Dr. Bequaert recognises the objections to the term mimicry as applied to these cases, and proposes to speak of homeomorphy and homeochromy instead, these terms merely referring to the observed facts, without suggesting any explanation. This seems to be an advantage, though perhaps the shorter words isomorphy and isochromy would be preferable.

In discussing the probable meaning of these resemblances, as related to natural selection, I think Dr. Bequaert takes too narrow a view. Thus he refers to the American *Pachodynerus nasidens*, which has been accidentally introduced into the Hawaiian Islands, where it has become extremely abundant. Now the Hawaiian Eumenid wasps have a totally different appearance; and so, he argues, *P. nasidens*, removed from the protection of its mimetic group, ought, according to the current theory, to be severely handicapped. This argument I think has no validity, in view of the great difference in the vertebrate fauna. *P. nasidens*, along the Hawaiian coasts, is not only without the natural enemies it left in tropical America, but also is relatively free from enemies of any kind, as will be readily appreciated by anyone who has travelled in both regions.

There is, however, another aspect of these matters which is not generally considered. Insects are extremely prolific, and the balance of Nature, under normal conditions, provides for the destruction of by far the greater part of each generation before the period of reproduction. This destruction is necessary for the insect itself, in order to avoid over-population and resulting starvation. Hence the normal survival rate, according to the species, may be only ten per cent, or five per cent, or even less than one per cent of the offspring hatched from the egg. It is astonishing that, working on such a narrow margin, insects in general survive as well as they do. I recall some observations on Coccidæ (scale insects) made in New Mexico many years ago. Certain species occur on the mesquite and other shrubs which exist in great abundance over many thousands of square miles of country. Yet the coccids are only found in isolated patches here and there. They are destroyed by their natural enemies, but the young larvæ can be blown by the wind or carried on the feet of birds, and so start new colonies which flourish until discovered by predators and parasites. This game of hide-and-seek doubtless results in frequent local extermination, but the species are sufficiently widespread to survive in parts of their range, and so continue indefinitely.

We may suppose, then, that neither 'mimicry' nor any other mode of protection prevents the destruction of the larger part of each generation of insects; and such prevention, were it possible, would result, not in stable conditions, but in over-production and

disaster. But during any lengthy period, the species of insects will show fluctuation in the number of surviving individuals, and must from time to time come very near to extinction. Indeed, very many do become extinct, as we can infer from a study of the fossil records. During these recurring 'hard times', slight advantages or disadvantages are of critical importance and may decide between survival and extinction. But at other times of greater prosperity, they seem to be of little consequence. If a 'critical' period occurred once in a thousand years, it would suffice for all the purposes of the theory.

Another important consideration is the frequency of parallel and 'convergent' variation; the continual recurrence of similar structures, patterns and colours in different genera and species. These phenomena indicate the existence of deep-seated tendencies, which find expression without any reference to immediate utility. In this way it often happens that diverse insects, even in different localities, come to look alike, and if 'mimicry' is promoted by natural selection, these resemblances are the raw material on which it works.

T. D. A. Cockerell.

University of Colorado,
Boulder, Colorado.
Dec. 8.

Bilateral Gynandromorphism in Feathers

In recent publications Lillie and Juhn[1], Domm, Gustavson, and Juhn[2], and Lillie[3], have suggested an explanation of the bilateral gynandromorphism of certain individual feathers. This explanation is based upon the idea that susceptibility to female hormone depends upon growth rate, being greatest for slow-growing and least for quick-growing feather tissue. These authors further describe the formation of the rachis by concrescence. The rachis thus has a double origin, and its two sides were once the two halves of the collar. This description differs widely from the accounts of Strong[4,5] and of Davies[6].

Now it may be remarked that past growth rates can only be measured by the relation of the size of present to past structures, and that present growth rates cannot be measured at all. It would seem, therefore, that the suggestion that in a bilaterally gynandromorphic feather the growth rates on the two sides of the collar were so different that, on the theory advanced by Lillie and his collaborators, female hormone could act on one side and not on the other, can only find a foundation in observation in one of two sets of circumstances. Either (*a*) the barbs on the two sides must be of different lengths, and the rachis curved, since one side of it has grown faster than the other; or (*b*) the feather germ must have an asymmetry of just such a kind and degree as to compensate for the difference in growth rate and give a straight feather. This asymmetry might be in fact a displacement of the ventral growing point from its theoretical position diametrically opposite the forming rachis; then the more rapidly growing side could get carried out of the region of growth so much sooner than the more slowly growing side, having less distance to travel, as to be the same size or even smaller.

The condition (*a*) is certainly not fulfilled in fact. The bilaterally gynandromorphic feathers shown in Figs. 51 and 52 by Lillie and Juhn[1] are straight, as are those figured by Cook, Dodds and Greenwood[7]. The retrices of Bond's pheasant[8] have a curvature which is not in constant relationship to their sexual dimorphism. There remains condition (*b*). Lillie and Juhn[1] figure an asymmetrical germ (Fig. 8), which gives rise to a feather symmetrical in shape, so that by their account its growth must have been different on the two sides. The relationship of colour to growth rate is, however, not shown by this example as the feather is also symmetrical in colour.

While the work of Lillie and Juhn and the other authors referred to is clearly of the very greatest interest and importance, it seems, in the light of the foregoing remarks, that the concept of the formation of the rachis by concrescence may lead to difficulties in the interpretation of sexually dimorphic colours which might be avoided by the adoption of other accounts of feather development, and that growth rate may not play quite the part assigned to it in determining the susceptibility to female hormone of the parts of the feather.

It is hoped soon to undertake work in this Department involving in particular an analysis of the relationship of asymmetry in the germ to asymmetry in the feather, and to review in the light of any evidence gained the physiological principles concerned, whether they be of growth rate, or of differentiation rate, or of a kind not yet apparent.

Paul G. 'Espinasse.

Department of Zoology
and Oceanography,
University College,
Hull.
Jan. 22.

[1] *Physiol. Zool.*, **5**, No. 1; 1932.
[2] Section on plumage tests in birds in "Sex and Internal Secretions". Edited by Allen (Williams and Wilkins, 1932).
[3] *Science*, **74**, 387; 1931.
[4] *Bull. Mus. Comp. Zool. Harvard*, **40**, 147; 1902.
[5] *Biol. Bull.*, **3**, 289; 1902.
[6] *Morphologische Jahrbuche*, **15**, 560; 1899.
[7] *Proc. Roy. Soc.*, B, **788**, 286; 1934.
[8] *J. Genetics*, **3**, 205; 1913.

Designation of the Positive Electron

I have been hoping that, following Lord Rutherford's proposal of a name for the heavy isotope of hydrogen, someone would suggest a more satisfactory word than 'positron' for the positive electron. Since, however, no better qualified reformer has appeared, may I raise the question before it is too late? 'Positron' is ugly; it offends literary purists by its hybrid character; and it not only bears no relation to the established name of the associated particle, the electron, but even suggests that that particle should be called the 'negatron', which fortunately it is not.

In order to balance destructive by constructive criticism, I venture to propose the name 'oreston' for the newcomer. The word is euphonious, pure Greek, and since, in one of the most beautiful of Greek stories, Orestes and Elektra were brother and sister, it implies an appropriate relation between the two particles. The name found favour among many physicists in Pasadena where Anderson first obtained evidence of the particle, when I mentioned it there last year. I do not propose, however, further to urge its claims, the purpose of this letter being mainly to cleanse the language of 'positron', and only incidentally to nominate a substitute.

Herbert Dingle.

Imperial College,
South Kensington, S.W.7.
Feb. 12.

Active Nitrogen and the Auroral Spectrum

IN my letter in a recent number of NATURE[1] I described an afterglow in nitrogen in which the first negative bands of N_2 were present, and in which the excitation of the first positive bands was different from that hitherto observed in nitrogen afterglows. At the time the letter was written, no photograph of the afterglow intense enough to print had been obtained. Fig. 1 shows a photograph of the spectrum of the afterglow which has been obtained since then, and it is to be noted that with the exception of the green auroral line, the afterglow spectrum is remarkably like the auroral spectrum. In my first letter it was stated that the second positive bands were completely missing from the afterglow, and that

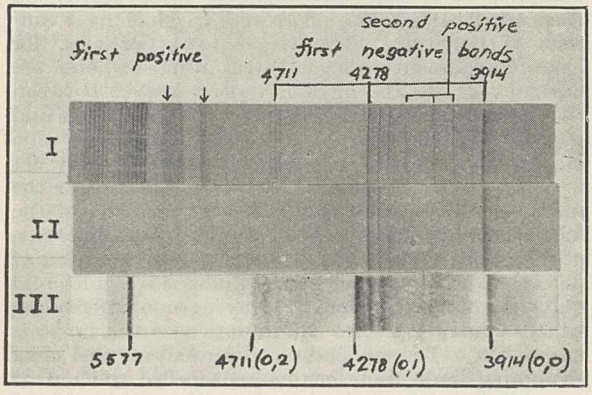

FIG. 1. I, Direct discharge (panchromatic plate); II, afterglow (Eastman astronomical green plate); III, aurora borealis (dispersion different from I and II).

was true of the plate which was described in that letter, but a trace of the second positive group can be very easily seen on the present plate and they have been obtained with considerable intensity on a plate taken on a small quartz Hilger spectrograph. The arrows on Fig. 1 point to first positive band sequences which originate on $V' = 16$, 17, 18, etc., and it is seen that these sequences are present on the afterglow plates also.

Further experiments are now in progress in order to obtain better pictures of the first positive bands in the green, red and the photographic infra-red.

JOSEPH KAPLAN.

University of California at Los Angeles.
Jan. 12.

[1] Kaplan, NATURE, **132**, 1002, Dec. 30, 1933.

Age of Sub-Crag Implements

MR. J. REID MOIR has recently directed attention to an interesting series of worked flints found beneath the Red Crag, exhibited at present in the British Museum[1]. Adhering to one of these flints is some ferruginous sandy material which Mr. Moir regards as Diestian, since it resembles the sandstone of which the well-known Suffolk Boxstones are composed. Thanks to the courtesy of Mr. Reginald Smith, I have had an opportunity of examining this specimen. The encrusting material is an iron-cemented sand which appears to me to bear a stronger resemblance to Red Crag sand than to Boxstone material. The quantity of sand is too small to permit mineralogical analysis; moreover, such a process would destroy the evidence. Even if it were proved to be Boxstone detritus, the possibility of its having been re-deposited in Red Crag times would have to be seriously considered.

Mr. Moir bases interesting speculations on the possibility of the rostro-carinate implement in question being pre-Diestian, that is, pre-Pliocene. In this connexion, it is important to bear in mind that the British representatives of the Continental Diestian deposits are the Lenham Beds (Early Pliocene) of Kent and Sussex, and not the Boxstones of Suffolk, as Mr. Moir states. Our knowledge of the fauna of the Lenham Beds has been increased by discoveries made during the last few years, and recent investigations have served to emphasise the greater age of the Boxstone fauna. The latter is regarded by many geologists as Miocene; in fact, some of the mollusca are apparently related to Upper Oligocene forms. Mr. Moir's arguments would therefore imply that the maker of the rostro-carinate implement lived in times not later than the Miocene.

P. G. H. BOSWELL.

Imperial College of Science
and Technology,
South Kensington,
London, S.W.7.
Feb. 13.

[1] NATURE, **133**, 64, Jan. 13, 1934.

Ernst Haeckel

MANY scientists will have read with keen interest Prof. MacBride's delightful sketch of Haeckel's work in NATURE of February 10. As he points out, Haeckel's career belongs to the heroic stage of the history of the theory of evolution; certainly few men have been subjected to greater obloquy for promulgating that or any other doctrine. When his "General Morphology" appeared, it was met with "icy silence"—a reception which the impetuous and combative Haeckel could not tolerate. He would have preferred hostile criticism, rather than indifference; and to this indifference on the part of his fellow-scientists can be traced the commencement of that series of popular works on evolution which were met, not with "icy silence", but with fiery blasts from scientists and laymen alike.

At one period of the controversy, Haeckel felt that his presence at Jena was jeopardising the good name of his beloved university, so he offered to resign his chair; but the head of the governing body replied: "My dear Haeckel, you are still young, and you will yet come to have more mature views of life. After all, you will do less harm here than elsewhere, so you had better stop here." In point of fact, Jena never forsook Haeckel and Haeckel never forsook Jena, despite the flattering offers he received from the Universities of Vienna, Würzburg, Bonn and Strasbourg; and he died there, not in 1914 as mentioned by Prof. MacBride, but on August 8, 1919. An obituary notice appeared in NATURE of August 21, 1919.

W. H. BRINDLEY.

11, Millmoor Terrace,
Glossop, Derbyshire.
Feb. 9.

I AM sorry that I made a slip in giving the date of Haeckel's death. I thank Dr. Brindley for correcting me.

E. W. M.

Research Items

Moravian Racial Types. Prof. V. Suk contributes remarks on the value of selective study in the anthropometric investigation of a population as a means of distinguishing ancestral types, to a study of groups of people in Moravian Wallachia by Dr. K. Augusta which has been published by the Faculty of Sciences of the Masaryk University. Two groups were investigated in a population which has long lived in isolation in conditions which do not invite immigration. The traditional mode of life is agriculture, woodcraft, or herding pursued in woodland clearings. The people here specifically called "Valaques", according to recent heory based on linguistic evidence, are partly of Slovak, partly of Rumanian origin. The principal results of Dr. Augusta's anthropometric examination go to show that they are of mixed origin. Taking the two groups together, they show a medium stature (165·9 cm. and 167·1 cm.); they are brachycephalic (85·2 and 85·8); while the mean circumference of the head increases proportionately with increase in growth of stature. The face is mesoprosopic and the nose lepto- to mesorrhine (69·7 and 70). In pigmentation the eyes most frequently are grey or greenish, while the hair is light brown, next in frequency coming dark brown, and then blond, which, however, is rare, showing only 1·0 and 2·7 per cent. 'Pure' types are rare and the most common by far is the 'mixed light brown'. In the valley of Dinotitza, where the selective method of Prof. Suk was employed and not the statistical method on which the figures above were based, a considerable percentage was found of a type differing from the remainder of the population, darker, taller and more pronouncedly brachycephalic, showing all the marks of a Dinaric origin. This confirms the view that the population of this part of Wallachia is of a different somatic origin from the rest of the population. Its derivation must be sought in Rumania.

The Australian Oyster. T. C. Roughley in his paper, "The Life History of the Australian Oyster, *Ostrea commercialis*" (*Proc. Linn. Soc. New South Wales*, **58**, Parts 3–4, 1933), studies the Australian edible oyster of commerce in great detail. This species appears to be confined to the Australian coast, its range extending from the far North Queensland coast to so far south as Wingan Inlet in Victoria. It thrives best in estuaries fed by much fresh water. Spawning always takes place on the chief bed studied (Port Macquarie) during spring tides when two or three hours on the ebb and often when a heavy sea is running outside, the temperature being usually 72°–76° F. In other places the oysters appear to spawn partially at intervals, and spawning proceeds daily or almost daily during the whole of the spawning period over five months. There is, however, great irregularity in the spawning of these New South Wales oysters, the reason probably being that the bulk of the oysters are grown in the tidal zone where temperature fluctuations, varying from cold water to hot sun in the course of a few hours, are enormous. A sex change is indicated in this species by the fact that practically all, if not all, young oysters spawn for the first time as males. Nine oysters were found (1–3 years) which contained both ova and sperms in the gonad. The determination of sex in this oyster does not appear to be governed by the amount of food available.

Feeding of the Fairy Shrimp. A. G. Lowndes has recently recorded observations on the feeding mechanism of the fairy shrimp, *Chirocephalus diaphanus* (*Proc. Zool. Soc.*, Lond., Part 4; 1933). By keeping the animal in a fixed position while causing a current of water to flow past it at the rate of two feet per minute (the normal rate of swimming of the shrimp), the movements of the appendages under approximately normal conditions can be observed. The author has also employed the polygraphic process, that is, taking photographs about 20 per second, by means of which the movements of the limbs can be recorded. He states that the commonly accepted view that *Chirocephalus* feeds chiefly on suspended particles is incorrect; its chief food consists of detritus. The larger food particles, for example, filamentous algæ, leaves of mosses, etc., are not sucked into the median ventral groove between the appendages, but are pushed in by the endites and pushed towards the mouth by the spines and setæ on the basal endites or gnathobases, which may act in apposition. Suspended particles drawn into the median groove cannot settle there by reason of the increase in the rate of flow as the groove narrows, nor is it likely they can be caught by a secretion of mucus. The movement of the limbs is irregular and only roughly metachronial. Any account of feeding which demands precise co-ordination of the limbs is untenable. The exopodite, regarded as the chief swimming limb, functions as a propeller and not as a paddle. Sars's view, that the primary function of the phyllopod post-oral limb is respiratory, is upheld (see also p. 329 of this issue).

Fungi Imperfecti. Referring to a notice in NATURE of December 16, p. 936, of Mr. J. Ramsbottom's presidential address to the Quekett Microscopical Club, in which the suggestion was made that many of the Fungi Imperfecti are mutants from heterothallic strains, Mr. H. A. Dade, of the Gold Coast Department of Agriculture, in a letter to the Editor, describes some unpublished work of his which supports the suggestion. In 1928 he showed that the common tropical *Thielavia paradoxa* is the conidial stage of a *Ceratostomella*, *C. paradoxa*, which is heterothallic. So far, the perfect stage has been found only on the Gold Coast. After the publication of his account, he received numerous cultures from other countries which differed much in cultural characters though not sufficiently to merit specific distinction. Some few when mated with the original strains formed perithecia, others did not. Two vigorous Ceylon strains formed perithecia when crossed with the (+) and (−) Gold Coast strains, but not when mated together, the loss of this power presumably being due to mutation.

Practical Methods of Soil Heating. A good deal of attention has recently been focused on the question as to whether raising the soil temperature in glasshouses by artificial means would be a commercial proposition in Great Britain as it has been in Scandinavia. Investigations on the matter have been carried out at Cheshunt Research Station and the results recently described by Dr. W. F. Bewley (*J. Min. Agric.*, **40**, 1047). Cables consuming 1 kilowatt per hour at 240 volts were laid 16 in. below the surface of the soil. Heat was applied

from 10 p.m. until 6 a.m. for the first twelve weeks after planting. In the case of tomatoes, those grown on the heated soil showed more rapid growth, cleaner roots, earlier flowering and quicker fruit maturation than the plants on the untreated soil, and in 1929 the total crop was 20·7 per cent higher in the former case. Similar promising results were obtained with cucumbers. The chief problem, however, was cost. The cables, which are expensive, deteriorate rapidly, and further, the annual renewal of cucumber beds necessitates relaying the wires each season. Twisted strands of galvanised steel wire (14 S.W.G.), however, showed no corrosion after three seasons and proved considerably cheaper. The price of heating, even at ½*d.* per unit, also is high, since about 5 watts per square foot are required to raise the temperature 6° F. (from 66° to 72°). Another and cheaper method of soil heating which gave promising results was that derived from an underground extension of the ordinary hot-water pipe system. The temperatures found to give good results were 70°–75° F. Further advice on the subject can be obtained on application to the Director, Experimental and Research Station, Cheshunt, Herts.

Colour Photometry. The rapid extension of the use of coloured luminous electric discharge tubes for lighting and advertising purposes has raised into prominence the question of how best to measure the candle powers of coloured lights, and Mr. H. Buckley and his colleagues at the National Physical Laboratory have tested the methods available. The results at which they have arrived were communicated by Mr. Buckley to the Illuminating Engineering Society in a paper read before the Society on February 20. The original method of comparing the brightness of two sources of different colours is both difficult and unreliable, but the newer 'flicker' method is easy to carry out and reliable. The 'calculation' method, which depends on the determination of the energy distribution of the light source and on the effect which each colour produces on the eye, while it gives accurate results, is tedious and requires skilled work with a spectrophotometer. Mr. Buckley advocates the use of coloured screens the absorption of which throughout the spectrum is observed by the spectrophotometer and which when placed between a standard light and a photometer of either of the above types will give an approximate match with the coloured light to be measured. A small field of view seems an advantage.

Acid Catalysis in Non-Aqueous Solvents. A number of reactions are catalysed in watery solution by acids irrespective of the precise nature of the latter. R. P. Bell (*Proc. Roy. Soc.*, A, Jan.) has studied the catalytic effect of a number of acids in solution in chlorobenzene, benzene and some other solvents. The catalysis in such solvents must be due to the acid molecule and not to the other products formed in presence of a dissociating solvent like water. The reaction studied was the re-arrangement of *N* bromoacetanilide to form *p*-bromoacetanilide, and the reaction was followed by using the liberation of iodine from acid potassium iodide by the *N* bromoacetanilide. It was found that the catalytic power increased in the same order as the strength of the acids, as measured by their dissociation constants in water. Picric acid occupies an anomalous position, possibly because of tautomerism in the picrate ion. Quantitatively, the catalytic power increases less rapidly than the dissociation constant in water, the values being connected by a 0·3 power law. Very similar results were obtained from some less accurate measurements in benzene solution and from a few experiments in ethyl nitrate and ethylene chloride. The rates of reaction in chlorobenzene are 10^4–10^5 times less than those calculated on the assumption that every collision is effective that takes place between a reactant molecule and a catalyst molecule with the proper energy of activation.

Action of Solvents on Coal. Of the methods employed for studying the constitution of coal, none has been more popular than the use of solvents to separate constituents of different character. The range of solvents used by different workers is large and the report on "The Action of Solvents on Coal" (Fuel Research Board Technical Paper No. 37, H.M. Stationery Office, 4*s.* 6*d.* net) containing a critical survey of work in this new field, supplemented by experimental study, will be useful to all engaged in this branch. Unfortunately, the selective action of solvents is never clear-cut, and the character of coal shows infinite variety, leaving opportunity for great diversity of findings. Even since the writing of the book, new complications have appeared in the discovery that some solvents can, by reaction or condensation, produce resinous matter which has at times been attributed to the coal. Moreover, it has been shown that the portion capable of extraction can be considerably increased if the coal be first reduced to dimensions of the order of one micron.

Reinforced Concrete Structures. Steel, with its great tensional, and concrete with its great compressive, strength, possessing similar coefficients of expansion, seem to have been intended for combination in structures. Rules controlling the use of any form of construction must necessarily be framed on conservative lines in the absence of scientific data, and when wide application precedes detailed research caution is the more required, but experience gained shows that without impairing safety greater economy in the employment of these materials as re-inforced concrete is possible. To meet this national need and the requirements of the London County Council, which is revising the London Building Act, a committee was set up by the Department of Scientific and Industrial Research under the chairmanship of Sir George Humphreys to consider improvements in the regulations for re-inforced concrete work, and this committee with the information on the better and more scientifically prepared materials now obtainable before it, has produced a code of practice based on present-day knowledge which will admit of considerable economies being effected. An entirely new feature of these regulations is the permission of three grades of work allowing greater stresses, or, in effect, less material to meet the required stresses, where more care and skill is given as adjudged by the tests required on samples made as the work proceeds. The code defines the materials and details of construction allowed and gives the strengths to be shown by tests when called for. Though actually only applicable to the area administered by the L.C.C., it is expected that the code will form a standard for use throughout the country. During the work of the committee, the investigation at the Building Research Station under Dr. Stradling has proved a valuable asset.

Palestinian Prehistory

THE selection of archæological finds from the caves of the Wady al-Mugharet at the foot of Mt. Carmel, Palestine, now exhibited at the British Museum (see NATURE, Feb. 3, p. 169), repays careful inspection. By affording a comprehensive view of the results achieved since 1929 by the Joint Expedition of the British School of Archæology in Jerusalem and the American School of Prehistoric Research under the field direction of Miss D. A. E. Garrod, the exhibit fully confirms previous conclusions, based on the periodical reports, as to the importance of the excavations in these caves, not only for the prehistoric archæology of Palestine, but also for prehistory in general. The discovery of so large a number of skeletons of man of Neanderthaloid type, to whom Sir Arthur Keith would assign generic rank under the name of *Palæoanthropus Palestinensis*, and including the oldest known complete human skeletons, for which a geological dating as belonging to the Riss-Würm interglaciation is given, would alone place these investigations in the first rank of scientific importance; but in addition they have brought to light a new civilisation and a new race, the Natufian, of late palæolithic or mesolithic age, in which remarkable features of racial character and culture open up suggestive lines of thought in connexion with prehistoric custom and belief and racial distributions.

The exhibits include examples of the small flakes of the Tayacian, comparable with implements from La Micoque, the Upper Acheulean hand-axe, the leaf-shaped point of the Lower Aurignacian, hitherto known only from Africa, Middle Aurignacian scrapers, comparable with those of Western Europe, and characteristic scrapers and gravers from the Upper Aurignacian. The Natufian culture, of which the first evidence was found in the Wady el-Natufa, whence the name, is well represented, among the more striking features being the remarkably elaborate composite head-dresses of shells which were found on the human skeletal remains, and the evidences of the beginnings of agriculture in the form of sickle blades and hafts. The latter are further noteworthy as including among their number two hafts ornamented with carvings of animal heads. These with other gravings on bone or stone are the first and indeed the only known examples of the art of stone age man to be found in Palestine.

The human bones show evidence of cannibalism. Sir Arthur Keith, in reporting on the human remains, judged them to be unique in racial character, but found that certain features suggested affinities with pre-dynastic Egypt. The Natufian faunal remains include the true horse, the Persian fallow-deer and the spotted hyæna, now found only south of the Sahara. The frequent occurrence of remains of the gazelle point to a dry climate and open country, contrasting with conditions in late Mousterian times when the abundant remains of deer suggest a forested area with copious rainfall.

It will thus be seen that the exhibition covers the complete sequence of Palestinian prehistoric cultures from Acheulean to Bronze Age, the last named apparently following on immediately after the Natufian, or, in years, a period ranging from about 100,000 years ago to approximately 6000 B.C.

Future of Artificial Lighting

MR. C. W. Sully, president of the Illuminating Engineering Society, gave an interesting address at the British Industries Fair at Birmingham on February 22. He pointed out that although great progress has been made in illumination during the past fifty years, yet compared with some other applications of science, such as transport or telephony, its progress appears relatively slow. There is no occupation we can pursue and no recreation we can indulge, in which the eyes are concerned, that does not offer problems in lighting. Too frequently progress takes place in a succession of jerks. As an example, consider the headlights of a motor-car. With increased speed stronger lights were demanded. Concentrated beams, well directed towards the objects requiring illumination, served the driver of the car excellently. But it was soon found out that these beams were a menace to oncoming traffic and glare from headlights is still an outstanding problem.

New devices, new methods and new materials are constantly changing the technique of lighting and developing new sections of industry. The new methods of utilising gaseous tubes producing various colours, the new electric discharge lamps, the continually extending use of stainless steel for reflectors and the applications of the new synthetic plastic materials to lighting fittings may be mentioned. In some cases buildings like cinemas and theatres are expressly designed for use by artificial light. Natural lighting has become a minor matter and is in some cases entirely omitted. In the case of blocks of buildings in congested city areas, access of daylight is imperfect and so costly as to be almost prohibitive.

It is accordingly now being suggested that, in these circumstances, the effort to furnish natural lighting should be abandoned, and that efforts should be concentrated on the provision of adequate artificial lighting. The question arises as to whether there is anything inimical to health in this procedure. This is a question of moment to the lighting industry. The ever-increasing height of buildings and other developments will probably accentuate the need for artificial lighting at the lower levels.

The city of the future has been visualised as consisting mainly of immense flat-topped buildings, rising in terraces from the ground-level, the upper walks being reserved for pedestrians, who would be provided with connecting bridges crossing the roadways at intervals. Roadways at the ground level would be used exclusively for motor traffic. If this is the trend of development, then lighting at the lower levels would be mainly artificial. A suggestion has been made that football, athletic contests and other sports may, in the future, take place in vast covered stadiums where diffused artificial lighting, resembling light from the natural sky, would be attainable and where difficulties arising from our capricious weather would be largely eliminated.

Mr. Sully also discussed the lighting of schools and factories. In school buildings the natural and

artificial lighting is often very defective. In many recent factories excellent equipment is installed, but in some of the older buildings, antiquated and imperfect arrangements still persist. Britain, almost alone amongst the civilised countries, has even now no specific requirement of adequate lighting in its Factory Act, although this step was advocated twenty years ago by a Departmental Committee.

Mr. Sully thinks that street lighting lags behind modern requirements. In a factory, five foot candles is regarded as essential for fine work. According to the B.S.I. specification, one per cent of this is given as the candle power sufficient for a moderately lighted street. This only represents 1/10,000th of the average value of unrestricted daylight from an overcast sky. No wonder the accident risk by night is greater than that by day. The problem of public lighting is complicated by the fact that many roads now fulfil functions quite different from those for which their lighting was originally designed. In Mr. Sully's opinion, the lighting of the King's highway is a national rather than a parochial duty. The Ministry of Transport should assume a greater degree of responsibility for its illumination.

Association of Technical Institutions

THE annual general meeting of the Association of Technical Institutions was held in the Drapers' Hall, London, on February 23–24. During the first session Mr. Will Spens, Master of Corpus Christi College, Cambridge, and newly-appointed chairman of the Board of Education's Consultative Committee, who was elected president of the Association for the year 1934, delivered his presidential address.

At the outset, Mr. Spens suggested that he was unable to enter into a discussion how to enhance the value of technical education, since his knowledge of that, and of industry and commerce, was not very considerable. However that may be, his address demonstrated the closeness and profundity of his knowledge of the field of education generally. He insisted on the value of literary studies in teaching men to think: he would not, therefore, have traditional academic education weakened, although he thought too much emphasis had been placed upon it. He pleaded for research in applied science, but stressed the need for inculcation of scientific *method* rather than the simple acquisition of scientific knowledge.

Among the papers read during the following sessions was one on "Education for Commerce from the Employer's Point of View" by Mr. F. Hickinbotham, of Birmingham. He emphasised the point that commercial education lags behind other branches of technical education because of the fact that the need for specialised education for commerce arose later in commerce than in the sciences and skilled trades. It is impossible, for example, to practice chemistry, pharmacy, engineering, etc., without a body of specialised knowledge; but many branches of commerce do not require this specialised knowledge: hence educational facilities have developed slowly. The present need for systematic instruction, however, is occupying considerable attention. Mr. Hickinbotham believed that the efforts which are being made to introduce commercial subjects into the secondary school curriculum were mistaken. In the secondary school the pupil should receive a general education, and afterwards take a one- or two-year full-time course in a commercial college, where instruction given by teachers with commercial experience would be better than that given by teachers who acquire their knowledge merely from books. One of the greatest needs of the world is to break down the barriers of nationalism and to promote a spirit of internationalism. To this end the first essential is to know the language the other man is speaking. Languages, therefore, should find an important place in all commercial courses.

Mr. Hickinbotham's paper had a special interest since the thought now being given to commercial education is a reflection of some of the wider anxieties of our civilisation. The science of production has developed swiftly and efficiently: we have scarcely begun to understand the science of distribution. Those responsible for technical education are alive to their responsibilities in this connexion. Evidence of this was submitted as the meeting proceeded, when a "Report on National Certificates in Commerce", prepared by a joint committee of the Associations of Technical Institutions, of Principals of Technical Institutions and of Teachers in Technical Institutions, was accepted. While it does not yet seem possible to draw up a scheme for national certificates in commerce such as those applying to engineering, chemistry, etc., the report goes far to establish means by which it is hoped that national certificates in the full sense of the phrase may ultimately be available.

Dog Breeding for Show Points

"WE have bred dogs for all sorts of show points, but we have never considered whether our principles of breeding have been to the advantage of the dog itself. We have thought only of our own profit." So concludes the editor of the *Countryman*, who asks whether or not our dog breeding principles so far, judged entirely from the dog's point of view, are not a bit 'low down' and, further, why should not some breeding now be done for intelligence? In a series of articles now appearing in this quarterly review, these questions are considered by a number of people. Dr. Darling expends most of his space in proving to his own satisfaction that he is quite unable to decide as to what could be regarded as intelligence in the dog, and argues that in any event the experiment suggested has already been carried out with the working hill collie. But he agrees with the editor of the *Countryman* in stating that there can be no defence for many show points. The standard of the St. Bernard is merely acromegaly, that of the bulldog achondroplasia; the toy dog is hyperthyroidic, and terriers microcephalic. Prof. L. C. Dunn, of Columbia University, in a very well-written article, suggests that it is not intelligence that is

being discussed but educability, and that this, possibly, is not associated with originality and critical judgment. He then outlines the sort of experimental procedure which might be adopted if the experiment suggested were undertaken. Prof. Tait, of McGill University, following the lead of Prof. Dunn, replies without answering, which is perhaps just as well.

Surely, when the editor of the *Countryman* uses the phrase "principles of breeding" he means the objectives in breeding, for the principles are the same whether one breeds for intelligence or for intestinal length ; and what does he really mean by "the dog's point of view" ? Would a bulldog prefer to be an Alsatian, or the Pekinese a whippet ? Dr. Darling's views concerning the extravagant and the fantastic make him remarkable amongst men. It is solely because man has always been attracted by these that he has perpetuated them to produce such pleasing variety amongst domesticated birds and beasts. He may not like the Pekinese, but many people do, and so does the Pekinese, and he is far from miserable so far as we can judge. We have selected and fixed by breeding those characters of the dog that pleased or advantaged us ; quaintnesses of all kinds, as well as special abilities. Every kind of combination of form and behaviour exists. By segregation and recombination new breeds could be manufactured, and by continued selection most of the qualities exhibited by the dog could be emphasised. That such a great variety of types exists is merely a reflection of the fact that different people have different ideas as to what constitutes attraction in a dog. The world would be a much duller place if all the dogs in it were hill collies.

There is, however, the germ of a really serious question in the musings of the editor of the *Countryman*, for show standards commonly do tend to demand a grade of physiological extravagance that is distinctly undesirable and, in certain instances, even definitely pathological. Quite serious defects and derangements can easily be bred into a stock to its detriment : deafness in the bull terrier, cleft palate in the bulldog, disharmony between the size of pelvis and the size of fœtus in the 'toys'. The exceedingly long ear-flaps of the spaniel lead to the development of hæmatomata and canker ; the short bowed legs of the Scottie are associated with the development of interdigital cysts ; the short-faced breeds suffer sadly from respiratory diseases, for the reason, it may be assumed, that they lack a proper air filtering and warming apparatus ; and the fleece of the Old English sheep dog is the ideal home of external parasites. No show standard should be allowed to continue which inevitably demands a high lethality in the breed or an obvious discomfort to the individual.

University and Educational Intelligence

ABERDEEN.—Prof. James R. Matthews, professor of botany in the University of Reading, has been appointed regius professor of botany in succession to the late Prof. W. G. Craib.

LONDON.—Mr. David Brunt, since 1919 superintendent of the Army Services Division at the Meteorological Office, has been appointed University professor of meteorology (Imperial College—Royal College of Science) as from October 1, 1934. Dr. R. J. Lythgoe, since 1928 honorary lecturer at University College, has been appointed University reader in the physiology of the sense organs at the College as from October 1, 1933.

The title of 'Fellow of University College, London' has been conferred on the following, among others : Mr. C. B. Collett, chief mechanical engineer of the Great Western Railway ; Dr. E. Mallett, principal of the Woolwich Polytechnic and head of the Electrical Engineering Department, formerly reader in electrical engineering, City and Guilds (Engineering) College ; Mr. H. J. Page, in charge of the Imperial Chemical Industries Experimental Station for Agricultural Research at Jealott's Hill, formerly head of the Chemical Department of the Rothamsted Experimental Station ; and Dr. A. S. Parkes, a member of the staff of the National Institute for Medical Research, Mount Vernon, Hampstead, formerly Sharpey scholar and honorary lecturer in physiology, University College, London.

The title of 'Honorary Fellow of University College, London' has been conferred on the following : Prof. Karl Pearson, professor of applied mathematics and mechanics at University College, London in 1884–1911 ; Galton professor of eugenics in the University of London in 1911–33 ; and Sir Flinders Petrie, Edwards professor of Egyptology at University College, London, in 1893–1933.

OXFORD.—At the meeting of Congregation held on February 20, a decree moved by the Master of Balliol postponing the operation of certain portions of the Forestry Statute which was passed by Congregation on February 13 until August 1, gave occasion to a further discussion on the merits of the Statute. Prof. R. V. Southwell opposed the decree on the ground that the new Forestry Committee should have the opportunity of expressing its opinion on the question of the site. He also pointed out that under the new Statute it was uncertain whether the professor of forestry would be able to exercise an effective control. Moreover, under the conditions of the Statute, the security of tenure of the staff of the Institute was incompletely provided for. The honour of the University would not have been compromised by the rejection of the Statute, inasmuch as Congregation had a perfect right to a free vote on the matter.

Dr. H. V. Denham, director of the Institute of Agricultural Engineering, said that the experience of his department showed that the new forestry scheme might be expected to work successfully. Prof. F. A. Lindemann complained that the Boards of Faculty concerned had not had the opportunity of seeing the Statute before it was proposed. The Master of Balliol, replying on the whole debate, reminded the House that objections to the Statute should have been brought in the form of amendments, and not have been deferred until the Statute had passed.

The Vice-Chancellor having ruled that even if the decree were thrown out, the existing Board of Governors, and not the new Forestry Committee, would be concerned in the question of the site, the opposition was withdrawn, and the decree passed without a division.

At the same meeting of Congregation, the gift by the Royal Society of £200 for astrographic work in the University Observatory was gratefully accepted.

In the *University Gazette* of February 21, the Hebdomadal Council gives notice that it has appointed a committee to collect evidence of the probable future building requirements of the University.

Science News a Century Ago

Polarisation of Light from the Sky

At a meeting of the Cambridge Philosophical Society on March 3, 1834, the Rev. Temple Chevalier described experiments which he had made on the polarisation of light from the sky. The general results were that light from the clear sky is polarised : that the effect begins to be sensible at points 30° distant from the sun, and that the maximum of polarised light proceeds from points at 90° distance from the sun ; a fact which seems to indicate that the reflection which occasions the polarisation, takes place at the surface of two media as nearly as possible of the same density.

On March 10, Prof. Airy gave an account before the Society of experiments on the same subject. It appeared that the light is polarised in a plane passing through the sun, and that the plane of polarisation is not reversed in approaching the sun, as had been formerly suggested by M. Arago. Prof. Airy found that he could observe the polarisation within 9° of the sun, in a horizontal direction, but that above and below the sun the traces disappeared at a distance considerably greater. It was found in the course of these experiments that very rough surfaces, as a stone wall, a gravel walk, a carpet, produced some polarisation by reflection ; and that the plane of polarisation in all cases passed through the point of reflection and the source from which the light came.

Forests of Holderness

On March 4, 1834, John Phillips, then keeper of the York Museum and professor of geology in King's College, London, read a paper to the Yorkshire Philosophical Society on the ancient and partly buried forests of Holderness. The country of Holderness, he said, was a large triangular district, bounded on one side by the "German" Ocean, on another by the estuary of the Humber, and on the third by the declining plane of the chalk. It was not properly a level but rather an undulating low district with isolated hills and devious ridges. The winding hollows which embrace the hills in the southern part of Holderness were generally filled with sediment from the tide which, if allowed free access, would cover them five, ten or more feet deep.

Phillips's paper had been written as a result of two visits to the district when a large drain nearly parallel to the River Hull had laid bare a considerable number of plant accumulations at a level greatly below that of the water of the Humber.

Hydro-Oxygen Microscopic Exhibition

On March 5, 1834, a hydro-oxygen microscopic exhibition was opened at Mr. Stanley's Rooms in Old Bond Street. Speaking of the exhibition, the *Times* declared it to be the most interesting the metropolis could boast, and one which to the man of science and the searcher after the mysteries of Nature was invaluable, by opening up sources of knowledge which, but for the powerful agency employed, must otherwise remain closed against all attempts at investigation. For those readers who had not seen the microscope, it was explained that it magnified the common flea to a size considerably greater than the largest elephant. The objects exhibited included the wings of insects and crystals of saline substances ; special interest being displayed in some beautiful crystals of chromate of potash. "The ingenious gentlemen who superintend the exhibition likewise display some examples of the polarisation of light, which exhibit all the colours of Newton's scale of tints. These experiments attracted much attention from the scientific gentlemen who were present."

Royal Society, March 6, 1834

On this date the reading of a paper was commenced (Mr. Brunel in the chair), entitled : "On the Structure and Functions of tubular and cellular Polypi, and of Ascidiæ" by Joseph Jackson Lister, F.R.S. The reading was resumed and concluded (Mr. J. W. Lubbock in the chair) on March 13, following. [Sir Joseph (afterwards Lord) Lister, who was one of the four sons of Joseph Jackson Lister, wrote the biography of his father in the "Dictionary of National Biography".] The paper was published in full, under a revised title, with four plates, in the *Philosophical Transactions* for 1834. Its modest opening sentences run thus :—"The more obscure functions of vitality are of such difficult investigation, and possess at the same time so high an interest, that anyone contributing, in however small a degree to increase our information regarding them, may hope to meet with indulgence. Having observed the existence of currents within the tubular stem of a species of *Sertularia*, their investigation led to additional particulars relating to that family of Zoophytes, and other compound animals more or less resembling them, some of which it is hoped may be new in physiology". The drawings in illustration were traced by a camera lucida slid over the eyepiece of the microscope ; and the author recommended its use to other observers because of the facility with which correct graphic records and measurements might be obtained.

Sir Edward Parry in Australia

Admiral Sir Edward Parry, the distinguished arctic explorer, was as well known for his philanthropy as for his discoveries. The care of those under him was always a matter of great concern. After making three voyages in search of the North-West Passage, and holding for four years the office of hydrographer to the Navy, he was appointed Commissioner of the Australian Agricultural Company in New South Wales. This concern had been incorporated by Royal Charter and granted a million acres of land, for the purpose of promoting the production of fine merino wool and other agricultural produce. Its affairs, however, had been sadly mismanaged, and with the sanction of the Admiralty, Parry accepted the office of Commissioner. He left the Thames in July 1829, landed at Sydney in December, and shortly afterwards took up his residence at Carrington, on the harbour of Port Stephens, about ninety miles north of Sydney. Here he found full scope for his activities and it was afterwards said : "At Port Stephens he found a wilderness but left it a land of hope and promise". He laboured incessantly to improve the lot of the settlers, the convicts and the aborigines, opening schools, promoting games, and himself frequently conducting divine service. On March 9, 1834, he preached a farewell sermon which led his successor, Colonel Dumaresq, to remark to a friend : "I have travelled a great deal during my life, and mixed much with men, but," pointing to Sir Edward, "in all my travels I never met with his equal."

Societies and Academies

LONDON

Royal Society, February 22. A. S. PARKES and M. HILL: Effect of absence of light on the breeding season of the ferret. Bissonnette's discovery that additional illumination would induce œstrus in anœstrous ferrets has naturally led to speculation as to what controls the onset of the breeding season in the normal ferret. An obvious interpretation of Bissonnette's results was that the beginning of the breeding season of the normal female ferret in April is due to the increasing duration of daylight. This hypothesis was put to experimental test by keeping ferrets in darkness from the latter part of anœstrus onwards. From the results it is concluded that while additional light will induce œstrus in anœstrous animals, the onset of the breeding season in the spring is not dependent on the increasing length of daylight. L. E. S. EASTHAM: Metachronial rhythms and gill movements in relation to water flow in the nymph of *Cœnis horaria* (Ephemeroptera). By means of the oscillatory movements of four pairs of gills, the nymph produces a flow of water across the body from one side to the other, the current being reversible. The gills rise and fall in periodic motion, and in so doing they traverse an elliptical path and, by a pivoting movement, move at an angle with their own path of motion. The metachronial rhythm in the movements of the gills along each side of the body is from before backwards, but the gills of one side in motion are always out of phase with those of the other. A transverse rhythm therefore exists across each pair of gills, which rhythm is in the direction of the water flow across the body. It is reversed when the direction of the water current is reversed. Reversal of flow is associated with changes in the method of pivoting of the gills; their manner of overlapping as members of pairs; the direction of the transverse rhythm over the gills. F. J. W. ROUGHTON: The kinetics of hæmoglobin (4–7). The methods of Hartridge and Roughton for the study of the velocity of rapid reactions were first applied by them to the reaction between hæmoglobin and oxygen. The present papers extend the work to the 'sister' reactions of hæmoglobin with carbon monoxide. Velocity equations have been arrived at for (i) the combination of carbon monoxide with reduced hæmoglobin, $CO + Hb \rightarrow COHb$; (ii) both phases of the reversible reaction, $CO + O_2Hb \rightleftarrows O_2 + COHb$. The results do not accord theoretically with a chemical mechanism of the type $Hb_n + nCO \rightleftarrows Hb_n(CO)_n$, but can in part be interpreted by Adair's intermediate compound hypothesis, according to which the reaction of oxygen or carbon monoxide with hæmoglobin takes place in successive stages. New possibilities are, however, brought to light, notably when trying to explain the paradoxical observations that *p*H is almost without effect upon either phase of the reversible reaction $CO + O_2Hb \rightleftarrows O_2 + COHb$.

PARIS

Academy of Sciences, January 8 (*C.R.*, 198, 129–212). J. COSTANTIN: The varieties of wheat resistant to rust. After summarising the unsuccessful efforts to produce rust-resisting wheats by hybridisation, and recalling the favourable results in combating sugar cane disease by employing plants of mountain origin, the author directs attention to the important work of Burton in Kenya on the effects of high altitude on producing rust-resisting wheats. D'OCAGNE: The idea of the instantaneous circle in the theory of plane motion. LOUIS DE BROGLIE: The nature of the photon. JEAN LOISEAU: Curves admitting one or several infinite families of circumscribed triangles equally between themselves. E. J. GUMBEL: The moments of the final distributions of the first and last value. N. ARONSZAJN: The invariants of transformations in the domain of n complex variables. ALBERT PORTEVIN and MICHEL CYMBOLISTE: A method for the study of the elastic deformations in metallic pieces submitted to external stresses. J. BAUBIAC: The transitory regimes in the movement of liquids and the beginning of the turbulent regime. D. BARBIER: The eccentricity of double stars of very long period. MME. G. CAMILLE FLAMMARION and F. QUÉNISSET: Photographs of the variations in the brightness of the star RS Ophiuchi. MAURICE LAMBREY and S. KRAUTHAMER: The working of the bigrid frequency changer. ILIE C. PURCARU: Contribution to the experimental study of the electric discharge. Results obtained with a kinematograph with very rapid film. MLLE. THÉRÈSE MEYER: The electrical conductivity of insulating or feebly conducting liquids in thin layers. The variations with temperature. MLLE. O. JASSE: Measurements of the refractive indices of water by an interference method. The refractive index of water for four wavelengths is given for temperatures between 0° C. and 93·5° C. P. ROUARD: The change of phase by normal reflection on very thin gold layers. CHARLES LAGNEAU: The acyclic terpene alcohols, $C_{10}H_{20}O$, in the essential oils of citronella, geranium and rose. V. HENRI, CH. WEIZMANN and Y. HIRSHBERG: The action of the ultra-violet rays on glycocol. The first stage of the reaction is the formation of ammonia and glycollic acid. The gaseous products include a large proportion of carbon monoxide. P. LEBEAU and P. CORRIEZ: The electrical resistivity of the peranthracites. The resistivities of peranthracites, always greater than graphite, are, however, much smaller than those of true anthracites and coals. J. PERREU: The equation of solubility of hydrated salts. F. BOURION and E. ROUYER: The determination of the total hydration of the ions of calcium chloride. CH. LAPP and MLLE. G. ZALC: The rotatory dispersion of sparteine in aqueous solution. MME. M. DEMASSIEUX and EDWIN J. GRELIS: Some complex halogen salts of lead. Study of the system lead bromide, ammonium bromide, water. P. CARRÉ: The mobilities of the organic radicals in their bromosulphites. ROBERT LESPIEAU and JOSEPH WIEMANN: Syntheses of dulcite and of allodulcite. L. ROYER: The foreign materials which, added to the mother liquor of a solution, are susceptible of modifying the facies of the crystals of the dissolved substance. LÉON BERTRAND: The relations of the primary axial zone of the Pyrenees and that of the north Pyrenees zone. M. BLUMENTHAL: The existence of antibetic thrusts in Andalusia. ROBERT LAFFITTE: The presence of the Albian in Aurès (Algeria). RENÉ VANDENDRIES: The sexual barriers in *Lenzites betulina*. MME. HUREL-PY: Researches on the *p*H conditions necessary to obtain the germination of pollen grains, and the vital coloration of their vacuoles. A. and R. SARTORY, J. MEYER and ERNST: The inhibiting influence of radium on the growth of the rootlets of *Lens esculenta*: modification of the minimum hindering dose under the influence of antagonistic ions. L. MAUME and J. DULAC: Differences due to variety in the absorption of water,

phosphoric acid and potash by wheats which have reached the same physiological period in the same medium. F. MARCEAU and L. ACOLAT: A new very sensitive cardiomyograph, with elastic wire, with both mechanical and optical amplification. A. PAILLOT: A new type of disease with an ultra-virus in insects. E. BRUMPT: Seasonal frequency and larval diapause of the fly, *Lucilia bufonivora*. G. MOURIQUAND and A. LEULIER: The calcium-phosphorus ratio in the genesis of experimental rickets and human rickets. The greater tendency to rickets shown by infants fed on cows' milk compared with those fed on human milk cannot be explained by the change in the calcium-phosphorus ratio, since this is nearly the same in both milks.

CAPE TOWN

Royal Society of South Africa, October 18. A. OGG and E. N. GRINDLEY: Declination at the University of Cape Town Magnetic Observatory: August 1932–August 1933. A full programme of photographic recording of the declination, the horizontal intensity and the vertical intensity by two sets of la Cour instruments has been maintained at the Observatory during the year. The daily variation curves of declination for each month, which have been determined, show interesting changes from month to month. The curve for August 1933 is exactly similar to the curve for August 1932, with a secular variation of 4·2 minutes. B. F. J. SCHONLAND and B. DELATIZKY: Continuous recording of cosmic ray intensities. Instruments for obtaining continuous hourly measurements of the intensity of the cosmic radiation have been installed at the University of Cape Town. The records are obtained automatically. The station forms part of the international scheme for the study of variations in intensity of the rays with time organised by a European committee, and is the only one in the southern hemisphere. The station has been in continuous operation since February 1933, and will be carried on for another year. The accuracy of observation is 0·1 per cent. D. M. BEACH: Phonetics of the Hottentot language. The paper is based on the analysis of the pronunciation of more than a hundred Hottentot speakers, representative of all the Nama tribes, as well as Bergdama, Korana and Griqua. The Nama dialect is taken as a standard and described in detail. Hottentot is a tone-language of the Chinese type, and there are six inherent tonemes of roots. H. A. SHAPIRO and H. ZWARENSTEIN: A rapid test for pregnancy on *Xenopus Laevis*. Early morning urine from women is precipitated with 96 per cent alcohol. The precipitate is extracted with ether to remove œstrin and toxic substances, and the residue is then dissolved in distilled water. 2–3 c.c. of the aqueous extract is injected into each of four female South African clawed toads. 12–18 hours later a positive reaction is indicated by either (*a*) extrusion of macroscopic ova through the cloaca, or (*b*) post-mortem examination of the animal (in the absence of ovulation), when one ovum or more will be seen in either or both of the oviducts respectively. Correct positive tests have been obtained as early as 20 days after the first missed menstrual period.

GENEVA

Society of Physics and Natural History, November 2. C. E. GUYE: Molecular dissymmetry and micellar dissymmetry. The author refers to the works of Curie on this subject. The action of the isolated molecules or of the large directed molecules should be favourable to the production of dissymmetry in the medium which surrounds them, and hence the molecules have more numerous possibilities of action in this medium. In this connexion, the author considers the results of work carried out on colloids by Lumière, De Vaux and others, who have shown that the vital element of the cell or of the serum would not be the micelle element but rather the molecular element. He quotes a certain number of facts in favour of the molecular theory of the vital element. A. SCHIDLOF: The constitution of heavy nuclei. J. WEIGLE: A precision method for measuring rhombohedral lattices. A method of extrapolation of the experimental results gives an average of the exact values of the X-rays for the constants characterising non-cubical lattices. This method applied to sodium nitrate gives for the wave-lengths of the edges of the elementary rhombohedron $6{\cdot}3108 \times 10^{-8}$ cm. and 47° 15′ 59″ for the angles which they form between them. H. SAINI: The thermal expansion of silver by X-rays. The author has determined the coefficient of expansion of silver by X-rays between 20° C. and 300° C. using a Seeman-Böhlin chamber specially constructed for the study of expansions. Results: lattice constant of silver at 18° C., $a = 4{\cdot}0772 \times 10^{-8}$, coefficient of expansion $(19{\cdot}1 \pm 0{\cdot}2)10^{-6}$ degrees^{-1}. E. FRIEDHEIM: Two natural reversible oxido-reduction systems: Lawson and juglon. The pigment of the sarcocarp of nuts. The Juglan walnut and the pigment of *Lawsonia Inermis*, Lawson, or henna, are systems of reversible oxido-reduction. Their normal potential is for *p*H 7·0 at 20° C., $E = +0{\cdot}033$ (Juglan), $E = -0{\cdot}139$ (Lawson). Since the juglon in the living plant is found essentially in the reduced state and the Lawson in the oxidised state, the oxido-reduction potential of the plant cells in question is determined by the two values indicated. E. FRIEDHEIM: Concerning the mechanism of the respiratory catalysis by systems of reversible oxido-reduction. The two reversible natural pigments, Lawson and juglon, increase the respiration of the red corpuscles of the rabbit by about 600 per cent, juglon forms methæmoglobin but Lawson does not. The respiratory catalysis of the red corpuscles by systems of reversible oxido-reduction is thus independent of the formation of methæmoglobin as would follow from the theory of Wendel and Warburg. The formation of the methæmoglobin is in fact concomitant, depending on the oxido-reduction potential level and in addition, on conditions of kinetic order. J. J. PITTARD: Observations concerning the proportion of gold in the water courses of the Canton of Geneva. The author has proved that the stream is richest in gold in the middle part of its course in Swiss soil.

December 7. R. WAVRE: Some remarks on the theory of harmonic functions. The author presents three notes: a reciprocal of Green's theorem, the unity of a potential defined by its line of ramification and its period function, and the development of Poisson's integral in a series of powers of the distance from the centre; if the Fourier coefficients are taken only on an arc ψ_1 and ψ_2 from the circumference, the harmonic function given by the integral admits the two points ψ_1 and ψ_2 as points of ramification. G. TIERCY: The new 40-cm. reflector of the [Geneva] Observatory. F. BATTELLI, D. ZIMMET and P. GAZEL: The muscular contraction of the discharge after the passage of continuous current.

SYDNEY

Linnean Society of New South Wales, October 28. T. G. SLOANE: Notes on the Australian species of the family Paussidæ. This paper has been prepared by H. J. Carter from notebooks of the late T. G. Sloane which are now in the Linnean Society's possession. Various groups of the genus *Arthropterus* are tabulated, and notes given on a number of species described in 1924 by H. Kolbe. Five species are described as new. H. M. R. RUPP: The genus *Pterostylis* (Orchidaceæ). A new scheme of classification, with notes on the distribution of the Australian species. The primary sections are two in number, based upon the character of the labellum—laminate or filiform-terete. The latter section contains two species only, strikingly distinct from all others in other features besides the labellum. The much larger laminate section is divided first into subsections based upon the character of foliation. T. L. BANCROFT: Further observations on the rearing of *Ceratodus*. Attention is directed to the variations in size found in young fish of the same age and to the errors that may consequently appear in embryological work when length is used as an indication of age. LILIAN FRASER: An investigation of the sooty moulds of New South Wales (1). Historical and introductory account. There are two types: (*a*) perennial moulds which develop on shrubs and trees, and (*b*) annual moulds which develop on annual herbs attacked by aphis and often precede the perennial moulds on trees and shrubs. G. H. HARDY: Miscellaneous notes on Australian Diptera (1). Thirteen species are described as new in various families of the Brachycera; generic keys are given to subfamilies Hermetiinæ and Pachygasterinæ, and a key to the genus *Pelecorrhynchus*. Two species of Scenopinidæ are the first to be described from Australia.

Forthcoming Events

[*Meetings marked with an asterisk are open to the public.*]

Saturday, March 3

ROYAL INSTITUTION, at 3.—Lord Rutherford: "The Transmutation of Matter" (succeeding lectures on March 10, 17 and 24).

Monday, March 5

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—D. Dilwyn John: "The Second Antarctic Commission of R.R.S. *Discovery*".

Tuesday, March 6

ROYAL SOCIETY OF ARTS, at 4.30.—Sir Wilfred Grenfell: "Newfoundland and Labrador".

Wednesday, March 7

ROYAL SOCIETY OF ARTS, at 8.—J. W. Ryde: "Electric Discharge Lamps".

ROYAL ENTOMOLOGICAL SOCIETY OF LONDON, at 8.—Prof. P. A. Buxton: "*Glossina* and Climate; Studies in the Laboratory".

Thursday, March 8

ROYAL SOCIETY, at 4.30.—Dr. J. Chadwick, Prof. P.M.S. Blackett and G. Occhialini: "Some Experiments on the Production of Positive Electrons".

G. Temple: "The Quantum Theory of the Neutron".

EAST LONDON COLLEGE, at 5.30.—Prof. J. Kendall: "Elements, Old and New".*

Friday, March 9

ROYAL SOCIETY OF ARTS.—D. G. Harris: "The Recent Progress of Irrigation in India".

ROYAL INSTITUTION, at 9.—Sir Claude Hill: "Society and Caste in the India of To-day".

INSTITUTE OF METALS, March 7–8.—Twenty-sixth annual general meeting to be held at the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1.

March 7, at 10.—Dr. H. Moore: Presidential Address.

Official Publications Received

GREAT BRITAIN AND IRELAND

Grading Rules and Standard Sizes for Empire Hardwoods intended for Shipment to the United Kingdom. Prepared by the Advisory Committee on Timbers, Imperial Institute. Pp. 17. (London: Imperial Institute.) 1*s*.

Lecture on "Electrometric Methods in Physical and Analytical Chemistry". By Dr. Samuel Glasstone. Pp. 39. The Chemist as a Directing Force in Industry. By Dr. Herbert Levinstein. (The Fifth S. M. Gluckstein Memorial Lecture, 1933.) Pp. 22. (London: Institute of Chemistry.)

Department of Scientific and Industrial Research. Report of the Water Pollution Research Board for the Year ended 30th June 1933; with Report of the Director of Water Pollution Research. Pp. iii+50. (London: H.M. Stationery Office.) 1*s*. net.

The Scientific Proceedings of the Royal Dublin Society. Vol. 21 (N.S.), No. 3: Abnormal Cones of *Fitzroya* and their Bearing on the Nature of the Conifer Strobilus. By Joseph Doyle and Mary O'Leary. Pp. 23–35+1 plate. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 1*s*. 6*d*.

OTHER COUNTRIES

The Indian Forest Records. Vol. 18, Part 13: Entomological Investigations on the Spike Diseases of Sandal. (12): The Life-History and Morphology of *Eurybrachys tomentosa* Fabr. Fulgoridæ (Homopt.) By N. C. Chatterjee. Pp. iv+26+2 plates. (Delhi: Manager of Publications.) 12 annas; 1*s*. 3*d*.

Bibliography of Lac. By A. C. Chatterjee. Pp. 129. 2.8 rupees. Bulletin No. 16: *Aspidiotus* (*Furcaspis*) *orientalis*. Newstead (Coccidæ), its Economic Importance in Lac Cultivation and its Control. By P. M. Glover. Pp. 23+1 plate. 1.4 rupees. (Ranchi: Indian Lac Research Institute.)

Borough of Durban: Durban Museum and Art Gallery. Annual Report for Municipal Year, 1932–33. Pp. 12+4 plates. (Durban.)

An Outline of the Physiography, Geology and Mineral Resources of Nyasaland, 1932. By Dr. F. Dixey. Pp. 34. (Zomba: Geological Survey Department.)

N.Z. Department of Scientific and Industrial Research. Bulletin No. 43: Report of the Hawke's Bay Earthquake (3rd February 1931). Pp. 116. 2*s*. Seventh Annual Report for the Year 1932–33. Pp. 82. 2*s*. 6*d*. (Wellington: Government Printer.)

Obras completas y correspondencia cientifica de Florentino Ameghino. Vol. 11: Ungulados, aves y desdentados. Dirigida por Alfredo J. Torcelli. Pp. 917. (Buenos Aires: El Gobierno de la Provincia de Buenos Aires.)

Report of the United States National Museum, 1933. (Part 2 of the Report of the Secretary of the Smithsonian Institution to the Board of Regents for the Fiscal Year ended June 30, 1933.) Pp. 69–194. (Washington, D.C.: Smithsonian Institution.)

The Nosu Tribes of West Szechwan: Notes on the Country and its Peoples and on the Diseases of the Region. By Dr. E. R. Cunningham, Dr. Leslie G. Kilborn, Dr. James L. Maxwell, Dr. W. R. Morse, Dr. Harrison J. Mullett and F. Dickinson. (Supplement to the *Chinese Medical Journal*.) Pp. iv+56+8 plates. (Shanghai: Henry Lester Institute.)

U.S. Department of the Interior: National Park Service. Fauna of the National Parks of the United States: a Preliminary Survey of Faunal Relations in National Parks. By George M. Wright, Joseph M. Dixon and Ben H. Thompson. (Contribution of Wild Life Survey, Fauna Series No. 1.) Pp. iv+157. 20 cents. History and Present Status of the Breeding Colonies of the White Pelican (*Pelecanus erythrorhynchos*) in the United States. By Ben H. Thompson. (Contribution of Wild Life Division, Occasional Paper No. 1.) Pp. vii+84. (Washington, D.C.: Government Printing Office.)

State of Connecticut: State Geological and Natural History Survey. Bulletin No. 52: Fifteenth Biennial Report of the Commissioners of the State Geological and Natural History Survey, 1931–1932. (Public Document No. 47.) Pp. 24. (Hartford, Conn.)

U.S. Department of the Interior: Office of Education. Bulletin, 1933, No. 12: The Education of Native and Minority Groups; a Bibliography, 1923–1932. By Katherine M. Cook and Florence E. Reynolds. Pp. v+57. (Washington, D.C.: Government Printing Office.) 5 cents.

CATALOGUES

Anepidem: for the Treatment of Influenza and the Common Cold. Pp. 2. Radio-Malt: the Vitamin Malt Food containing Standardised Amounts of Vitamins A, B_1, B_2 and D. Pp. 10. Radiostoleum (Standardised Vitamins A and D). Pp. 4. (London: The British Drug Houses, Ltd.)

Scientia Naturalis ante annum 1800. Pp. 60. (Berlin: W. Junk.)