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Science and Psychical Research

IT seems desirable from time to time to review the progress of scientific work and to estimate its value in terms of human knowledge and achievement. In certain directions progress has been rapid. Our knowledge of the physical world is increasing, and genetics and biochemistry are adding much to our understanding of living matter. Similarly, the adoption of the scientific method by anthropologists and archæologists has clearly shown what can be done in these directions ; and the same methods applied to the more difficult field of experimental psychology indicate where progress is likely to be made.

In at least two important departments of psychology, progress is not so easily discernible as elsewhere. In psychiatry the immense problems offered by the disordered mind are not yielding readily to examination, although we have got beyond the stage where such disorientation was considered to be due to 'possession' or 'obsession', terms which vividly suggest the ideas of the past. In the more obscure mental and physiological phenomena which constitute the subject-matter of psychical research, we can again perceive a lack of ordered understanding which, to a certain extent at least, can be directly traced to their historical antecedents. For these aspects of mind and body are not novel or entirely divorced from what is now known. They have occupied the attention of observers since the days of Ancient Egypt ; and the objections against their reality, such as urged by Cicero and Lucian, were, as now, based upon a feeling that no sound body of knowledge existed to which they might be attached.

Since those days, however, our acquaintance with primary psychological and physiological mechanisms has increased : and phenomena, which for centuries caused observers to labour under the mistaken beliefs of supernaturalism, have now taken their place in an ordered scheme and have become partly amenable to scientific treatment. Such abnormal conditions as can be perceived in the hypnotic state, in the ecstatic condition of 'entranced' persons, or in the various automatisms, are now fit subjects for post-graduate research ; and there can be little reason for supposing that our acquaintance with these phenomena is in any way complete.

The necessity for frank and fearless research in these matters is becoming increasingly apparent. It is abundantly clear that a failure to apprehend

their significance can be charged to official science. The result has been the growth of deplorable superstition fostered both by the desire for economic gain and by an appeal to the unsatisfied emotions of mankind in its search for a fuller and a more comprehensible life. Inquiry, therefore, has mostly fallen to the lot of those who wish to prove what they hope to be true, and the elusive nature of the phenomena themselves has provided the excuse to suggest a supermundane origin, the acceptance of which is apt to hinder exact observation. So early as 1908, the leaders of the Society for Psychical Research supposed that the method of the so-called "cross-correspondences" was being developed by discarnate entities, and they hoped to reach in due course a scientific demonstration of a future life. Although a quarter of a century has passed since then, their efforts even to demonstrate experimental telepathy under properly controlled conditions have not yet succeeded. Similarly in the investigation of the so-called physical phenomena, progress has not been apparent; and it is only quite recently that more satisfactory methods of inquiry have been evolved. As in so many other directions, there is a tendency to ascribe failure to a supposed inadequacy of the scientific method to deal with the phenomena in dispute.

The extension of our means for obtaining exact results, the utilisation of more delicate instrumental aids than heretofore, and the application of statistical analyses to data received—all these factors compel us to view these obscure and abnormal occurrences in a new light. Already they have become the subject-matter for serious research in various institutions of learning. In 1912 Thomas Welton Stanford made permanent provision at Leland Stanford University for the creation of a fellowship known as the Thomas Welton Stanford Fellowship for Research in Psychic Phenomena. In the same year a fund of 10,000 dollars was presented to the president and fellows of Harvard College for the purpose of forming a memorial to Richard Hodgson, through which, it was hoped, the investigation and study of these obscure occurrences might be forwarded. Again, quite recently the University of Leyden has arranged for the due recognition of this neglected branch of abnormal psychology and has appointed Dr. P. A. Dietz as lecturer. Similar appointments have been made elsewhere, and it would seem that the time is now ripe for such provision to be made in Great Britain.

It would, we think, be a mistake to suppose that such recognition implies any novel departure from accepted academic studies. It would be merely an appreciation of the fact that an extension of our knowledge in the field of abnormal psychology is as inevitable as elsewhere. With due regard to the history of the subject, it ought to be possible to avoid those errors which in the past have arisen from the acceptance of hypotheses which were not justified. Research should not be conducted with the aim of proving whether the phenomena are 'genuine' or 'fraudulent', but with the purpose of examining and describing accurately the more obscure accessory phenomena which accompany abnormal states of mental dissociation and similar conditions.

Within a reasonable time facts will emerge which will indicate not only what kind of research will be most fruitful but also in what direction that research should be made. A due recognition must be accorded to the more serious students of this subject who, whatever may have been the aims which inspired their work, have undoubtedly performed a good service in examining and demonstrating the various forms and sources of error which are peculiarly numerous in this subject. It need scarcely be pointed out that a detailed acquaintance with these matters is essential, although the evils inherent in 'dark séances' may soon vanish with the extended use of infra-red photography. Moreover, a patient examination of the form and substance of various automatisms, as they are demonstrated by persons claiming to be 'mediums', will undoubtedly provide us with a fuller understanding not only of psychological processes hitherto little understood but also of the operations of subconscious factors and the effect of culture and environment upon them.

It may well be that such unprejudiced examination by competent persons will add but little to what we already know. On the other hand, it is possible, and indeed probable, that a considerable extension of our knowledge may be expected, and existing hypotheses may have to be revised. This has been one of the commonplaces of science, and is indeed an indication of progress. It cannot be supposed that any university which thus recognises the claims of so vast and obscure a subject will find that the step it has taken is in any way derogatory to its dignity. Rather will it appear that such a free and unfettered determination to press the claims of science will add to its prestige as a centre of enlightened progress.

Max Planck's Philosophy of Nature

Where is Science Going? By Max Planck. Translated and edited by James Murphy. Pp. 234. (London: George Allen and Unwin, Ltd., 1933.) 7*s*. 6*d*. net.

Wege zur physikalischen Erkenntnis: Reden und Vorträge. Von Dr. Max Planck. Pp. x+280. (Leipzig: S. Hirzel, 1933.) 6 gold marks.

The Universe in the Light of Modern Physics. By Prof. Dr. Max Planck. Translated by W. H. Johnston. Pp. 110. (London: George Allen and Unwin, Ltd., 1931.) 4*s*. 6*d*. net.

THE scientific views and achievements of Prof. Max Planck have often been referred to in NATURE, his recent work being the subject of an article published on July 9, 1932. We believe, however, that Prof. Planck will be known to posterity not only as a man of science, but also as a philosopher of unusual insight and clarity of expression. The principle of causality and the value of our knowledge of the external world are his main interests in this field. The need for something different from the established order, which is a feature of our civilisation, has caused many thinkers to draw hasty conclusions from the revolutionary physics of the day. The quantum theory in particular has been used as a weapon for attacking the traditional principle of causality; and even Sir James Jeans interprets it as a theory which "destroys the case for absolute strict causation".

Against these extreme views, Prof. Planck claims that modern physics provides no means of disproving the existence of causation in the external world. According to him, it is not the principle of causation itself which has broken down, but rather the traditional formulation of it. Statistical causality, which is often spoken of as the opposite of strict causation, is really based, as are the principles of probability themselves, on the presupposition of strict causation in the individual cases considered by the physicist. All that is needed is a new formulation of the principle of causation which would integrate the latest experimental results of physical science.

It is important to mention here that Prof. Planck's belief in the objectivity of causation is based on his belief in the independent existence of the external world. He takes his stand firmly against the positivist theory that man is the measure of all things. Though nobody need object on logical grounds to the action of a person who measures all things with a human rule, and resolves the whole of creation into a complex of sensory perceptions, yet, as Prof. Planck says, there is another measure also which is more important for certain problems and is independent of the particular method used and of the measuring intellect itself. This measure, though not an immediate datum of experience, is almost identical with the 'thing' itself. "Science sets out confidently on the endeavour to know the 'thing' in itself; and even though we realize that this ideal goal can never be completely reached, still we struggle on towards it untiringly. And we know that at every step of the way each effort will be richly rewarded. The history of science is at hand to confirm our faith in this truth." ("Where is Science Going?", p. 139.)

The independent existence of the 'thing' gives little countenance to the positivist theory that there is no other source of knowledge except within the restricted range of perception through the senses. Indeed, this independent existence suggests at once two theorems which together form the cardinal principle on which the whole structure of physical science rests. "These theorems are: (1) there is a real outer world which exists independently of our act of knowing; (2) the real outer world is not directly knowable. To a certain degree these two statements are mutually contradictory. And this fact discloses the presence of an irrational or mystic element which adheres to physical science as to every other branch of human knowledge." ("Where is Science Going?", p. 82.) The fact is that the 'real thing' is essentially metaphysical, and as such is beyond each attainment of science. Yet it is just this striving forward that brings us nearer to our journey's end and gives us the fruits which are always falling into our hands. But it is the success which attends the seeking after truth rather than the possession of it, that enriches the seeker and brings happiness to him.

The belief in the presence of an irrational or mystic element in science suggests to Prof. Planck that there can never be opposition between religion and science. "It is from the co-operation of the understanding with the will that the finest fruit of philosophy has arisen, namely, the ethical fruit. Science enhances the moral values of life, because it furthers a love of truth and reverence; love of truth displaying itself in the constant endeavour to arrive at a more exact knowledge of the world of mind, and reverence, because

every advance in knowledge brings us face to face with the mystery of our own being." ("Where is Science Going?", p. 169.)

It is in the existence of such metaphysical values that Prof. Planck places the reality and all-pervasiveness of the principle of causality. Having once assumed the existence of an independent external world, science concomitantly assumes the principle of causality as a concept entirely independent of sense-perception. The foundations of causation are in the nature of things themselves, and not in our imagination. An analysis of the various sciences confirms this belief, which Prof. Planck extends even to the world of ethics, his argument being that if the human intelligence cannot forecast the actions suggested by free-will, yet a superior intelligence would no doubt be able to understand the succession of human actions according to a higher principle of causality. Causation appears to Prof. Planck to be an aspect of the orderliness of the whole universe.

These and other profound thoughts and theories are developed in the three books under review. The lectures and addresses translated into English can be found in the original text in the German work, which contains more material, all arranged in chronological order and including the Guthrie lecture on "Causality in Nature" delivered by Prof. Planck in June 1932 before the Physical Society of London. The book translated by Mr. Murphy closes with an interesting epilogue in the form of a Socratic dialogue between Einstein, Planck and Mr. Murphy, in which are expressed in a nutshell the philosophical opinions of the two great physicists. THOMAS GREENWOOD.

John Coakley Lettsom

Lettsom: his Life, Times, Friends and Descendants. By James Johnston Abraham. Pp. xx+498. (London: William Heinemann (Medical Books), Ltd., 1933.) 30*s*. net.

THIS fine volume by a well-known London surgeon is the outcome of four years' study which has been obviously and admittedly a labour of love. It will be difficult to find another work of medical biography which gives such a vivid and sympathetic picture not only of the principal character but also of his associates and times.

John Coakley Lettsom, the famous Quaker physician, who was born in the West Indian island of Little Jost Vandyke in 1744 and died in London in 1815, possessed many claims to distinction. Though he is best known as the founder of the Medical Society of London, which he created almost single-handed when only twenty-eight years of age, Mr. Abraham considers that his chief claim to be regarded as one of the great pioneers in medical science is that he founded the Royal Sea Bathing Hospital at Margate in 1796, whereby he became the father of all open-air sanatoria throughout the world and originated the idea that air and sunlight are the potent factors in the fight against tuberculosis. Lettsom was also largely responsible for the foundation of the Royal Humane Society in 1774 in association with Thomas Cogan and William Hawes, who had been inspired by the memoirs of the Dutch Society for the resuscitation of the apparently drowned. According to Mr. Abraham, it was largely due to Lettsom's enthusiasm and business capacity that the Humane Society survived its early years, when in Lettsom's own words "it excited more ridicule than patronage".

Lettsom was not on the staff of any great London hospital, but in 1770 he helped to found the Aldersgate Dispensary, which was the first of its kind. This institution afterwards (1844) changed its name to the Royal Dispensary and became merged with St. Bartholomew's Hospital in 1932. In a work entitled "Of the Improvement of Medicine in London, on the Basis of Public Good" published in 1775, Lettsom suggested that the dispensary should be used for the training of medical students, but the suggestion was not realised until after his death, when the Aldersgate School of Medicine was founded.

Special mention should be made here of Lettsom's contribution to the reform of prisons, which in his time were in a disgraceful condition and the hotbed of typhus fever. Like his friend John Howard, Lettsom threw himself whole-heartedly into the crusade to improve conditions, and induced the governors of his dispensary to supply drugs and dressings free to the prisoners, in addition to supplementing their food from his own table. At the request of the authorities, who became alarmed at the number of deaths from disease in the prison, including that of so eminent a man as Lord George Gordon, Lettsom carried out an inspection of Newgate and made a number of recommendations, including a supply of clean clothing, baths twice a week, a diet of fresh meat and vegetables, daily exercise of at least one hour

in the open air and the provision of iron cots instead of wooden beds. In his advocacy of baths, Lettsom was not only satisfying his philanthropic instincts but was also acting in accordance with the teachings of his sect, for, as Mr. Abraham informs us, the Quakers were probably the only people in England who kept themselves reasonably clean at that time.

In addition to his philanthropic activities, Lettsom was a vigorous fighter when the occasion demanded it. A special chapter is devoted to his campaign against quacks and particularly his attack on the German urine caster, Myersbach, who made, as Pettigrew remarks, a large income out of the credulity of the fashionable classes of English society. The controversy in which Lettsom engaged with Baron Dimsdale on the value of inoculation for smallpox and the support given to Jenner by Lettsom form the subject of an interesting chapter in which an excellent description is given of the early history of vaccination with sketches of its supporters and detractors.

Lettsom was a prolific writer. In addition to the works already mentioned, he collected in three volumes a number of previously published tracts under the title of "Hints designed to promote Beneficence, Temperance and Medical Science", which included such heterogeneous subjects as poverty, the discharge of prisoners imprisoned for small debts, infectious fevers, Samaritan societies, wills and testaments, the treatment of female servants, recovery of drowned persons, medical dispensaries, the Sea Bathing Hospital, substitute for wheat bread and the establishment of the Medical Society in London.

Lettsom was also the author of a work on the "Natural History of the Tea-Tree" which first appeared in Latin as his Edinburgh thesis in 1769 and was republished in English in 1772 and again in 1779. His most successful book, however, which was translated into French and German, was the "Naturalist's and Traveller's Companion", which deals with methods of collecting butterflies, moths, beetles, etc., the ways of preserving birds and other animals, the mode of bringing seeds and plants from distant countries, the analysis of medicinal waters, the contents of air, the collection of fossil substances and the taking of casts of coins and medals. A second part was added in a new edition dealing with botany, zoology, minerals, the methods of working mines, life in foreign countries and questions of commerce and manufacture.

Mr. Abraham gives a fascinating description of the house and grounds at Grove Hill, Camberwell, which in 1779 was a village, where Lettsom was able to indulge his botanical and horticultural hobbies in a similar manner to his friend and patron Fothergill. The house contained a library and museum which was open to members of the medical profession on Saturdays, while the extensive grounds laid out as a botanical garden with an amateur observatory were open to the public on other days. Both before and after the War of Independence, Lettsom made a special effort to acclimatise American shrubs and trees, and therefore kept up an extensive correspondence with American scientific workers, which led to his being made a fellow of the American Academy of Arts and Sciences in 1778, a fellow of the Medical Societies of New York and New Haven in 1779 and an LL.D. of Harvard in 1790. He had been elected a fellow of the Royal Society of London in 1773.

In the concluding chapter Mr. Abraham informs us that the name of Lettsom has died out, for the present descendants are all through the female line, including the great-great-grandson, Mr. Hugh Elliott, the head of the firm publishing this work and to whom it is dedicated. The text, which is beautifully printed, is freely interspersed with excellent contemporary portraits and other illustrations.

Fauna of France

Faune de France. (1) 23 : *Diptères chironomidæ IV.* (*Orthocladiinæ, Corynoneurinæ, Clunioninæ, Diamesinæ.*) Par M. Goetghebuer. Pp. iii+204. 45 francs. (2) 24 : *Tardigrades.* Par Prof. L. Cuénot. Pp. iii+96. 35 francs. (3) 25 : *Éléments d'une faune des myriapodes de France—Chilopodes.* Par H. W. Brolemann. Pp. xx+405. 100 francs. (Fédération française des Sociétés de Sciences naturelles : Office central de Faunistique.) (Paris : Paul Lechevalier, 1932.)

(1) THE family Chironomidæ, the 'midges', has already been the subject of three volumes, Nos. 13, 15 and 18, in this series, respectively on the subfamilies Ceratopogoninæ (considered by some authors to be a distinct family), Tanypodinæ and Chironominæ. The present volume on the remaining four subfamilies provides a systematic account of their twenty-three genera, and of their subgenera and species, which occur in France and in neighbouring countries ; there are carefully prepared keys and 315 illustrations.

(2) In 1929 the part of Bronn's "Tierreich" (Bd. 5, Abt. 4, Buch 3) on the Tardigrada, by Ernst Marcus, was issued as a treatise of 608 pages. The attention of workers on British species of tardigrades is directed to the present much shorter and less expensive work on the class by Prof. Cuénot, which is restricted to the consideration of the European species and will, for many collectors and students in Britain, be usually sufficient for the purpose of diagnosis of species and also as an account of the main features of the anatomy and biology. In twenty pages Prof. Cuénot describes the external features of tardigrades, the systems of organs, the development and habits. He gives a table of the genera showing those which are marine and those found on land or in fresh water, and provides a key to the forty-eight species which have been recorded from France. The characters of these species are stated and brief notes are added on the distinguishing features and distribution of about forty other species which have been recorded from other parts of Europe. The systematic and anatomical descriptions are supported by 98 figures in line.

(3) This useful systematic account of the Chilopoda recorded from France will be welcomed also by workers on the British species. Hints on collecting, preserving, preparing and determining these animals are followed by a general account of the external features, post-embryonic development, biology and distribution. The four orders—Geophilomorpha, Scolopendromorpha, Lithobiomorpha and Scutigeromorpha are successively considered, their external characters are described in some detail, a key is provided to the families and species which have been found in France, and the characters of the 30 genera and 101 species are clearly stated with the help of 480 line drawings. The work concludes with a short essay on the phylogeny of the Chilopoda and its suborders and a bibliography. This latter appears to terminate with the papers of 1928; the parts of "Das Tierreich" on the first two suborders, published respectively in 1929 and 1930, are not included.

Short Reviews

An Astronomer's Life. By Edwin Brant Frost. Pp. xi+300+8 plates. (Boston and New York: Houghton Mifflin Co., 1933.) 3.50 dollars.

Dr. Frost's autobiography was written for his children and grandchildren and is now published at the request of his many friends in the United States. An interesting picture is given of life in New England from the time of his ancestors, who took 53 days to reach Boston in 1635, down to his own early years. After leaving college he spent several years in Germany, and found an astronomical interest in translating Scheiner's "Spectroscopy". He returned as assistant professor to Dartmouth, until in 1898 he was appointed by Dr. Hale to be assistant at the Yerkes Observatory. Here he stayed, becoming director when Hale went to Mount Wilson, until he retired in 1932, when he was succeeded by Struve.

Astronomers are well acquainted with Frost's line of sight observations with the spectroscope on the Yerkes 40-inch refractor. They are greatly indebted to him for his long editorship of the *Astrophysical Journal* and for translations in it of important German papers on radiation. At Yerkes, he was associated with Burnham, Barnard, Schlesinger, Adams, Ritchey, Parkhurst, Ross and other distinguished astronomers. He accepted his blindness manfully, and continued to carry on with his work.

This autobiography shows the pleasure Frost took in flowers and birds before and after his blindness. He also gives his views on American politics and the War, and modestly refers to his efforts to relieve the distressed sufferers in Europe. The book concludes with a chapter on the progress of astronomy in the present century and one entitled "Fragments of Cosmic Philosophy", being the William Vaughan Moody lecture he gave to the University of Chicago in 1930. Dr. Frost has many friends on the east of the Atlantic who will welcome this autobiography.

Differential Equations for Electrical Engineers. By Prof. Philip Franklin. Pp. vii+299. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1933.) 15*s.* 6*d.* net.

This book is the outgrowth of a lengthy experience in training first-year electrical engineering students at the Massachusetts Institute of Technology. The earlier chapters discuss complex numbers, average values, Fourier's series and linear differential equations with constant coefficients. Chap. iv discusses partial differential equations and is more difficult, but the author gives clear explanations which should make the student's path easy. In Chap. v some of the partial differential equations which arise in engineering and physical problems are discussed. The telegraph equations, in particular Heaviside's distortionless circuit, heat flow in one dimension, liquid flow in two dimensions and vibration problems give excellent illustrations of the use of partial differential equations. Then we come to solutions of these equations which have to satisfy given boundary values.

Up to Chap. vii the subjects discussed are those which electrical engineers have to study and have

studied in the past to the great advantage of the electrical industry. We doubt whether the last two chapters on analytic functions and the convergence of Fourier's series are suitable as part of the mathematical training of electrical engineers, however valuable they may appear to the mathematician. They seem to be out of place in a book on differential equations. We would have overlooked this if the author had given in their place a brief account of elliptic integrals, Kelvin's ber and bei functions, and graphical methods of performing integrations and finding Fourier coefficients. We hope that these subjects are studied by electrical students at some period of their curriculum.

Inorganic Colloid Chemistry. By Prof. H. B. Weiser. Vol. 1: *The Colloidal Elements.* Pp. xi+389. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1933.) 28*s.* net.

PROF. WEISER has the intention of making a critical survey of the colloidal behaviour of elements and their inorganic compounds, with particular reference to the rôle they have played in the development of the theories and applications of colloid science. In the past, perhaps undue attention has been given to organic colloids, which enter so frequently into the study of biology and into chemical technology, but the inorganic colloidal behaviour is equally important. The use of metal sols in medicine and the phenomena of froth flotation of minerals are two aspects of inorganic colloid science which occur to one, and there are many others. The present volume deals with the elements.

The experimental side is the one which is emphasised throughout, although there are very clear and concise sections on such matters as precipitation, cataphoresis, colour, coagulation and protection. The treatment is admirably clear and practical, and the literature has been exhaustively covered to within a recent period. The elements are considered in the order metals and non-metals, the periodic order being followed. Detailed author and subject indexes are provided. This is an authoritative work which cannot fail to be useful both in research and industrial laboratories, whilst students will find it a very clear introduction to general colloid science.

Second Year College Chemistry. By Prof. William H. Chapin. Third edition, revised. Pp. xiii+374. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1933.) 18*s.* 6*d.* net.

THE third edition of this book is modified by the extension of the chapter on indicators, the earlier and freer use of the *p*H system, the simplification and extension of the chapter on chemical E.M.F. and the recasting of the chapter on solubility product so that much less emphasis is placed on the so-called non-ionised part. Some modification in the order of chapters has also been made. These changes all improve the book, which, both in the order and manner in which the subjects are treated, and the suggestive character of the numerous questions and exercises, is one which students beginning physical chemistry will find both intelligible and interesting.

The author has evidently made full use of original sources (many of which are given in references) and the result is a sound course of elementary general and physical chemistry, which avoids superficial treatment yet is not overloaded with detail. In future editions the author might usefully incorporate a little more detail on the modern theory of strong electrolytes, which is desirable even in an elementary work.

The Physiography of Burma. By Dr. H. L. Chhibber. Pp. xi+148. (Calcutta, Bombay, Madras and London: Longmans, Green and Co., Ltd., 1933.) 3.8 rupees; 5*s.* 6*d.*

DURING the last dozen years or so, very great advances have been made in our knowledge of the geological structure and history of Burma. One of the most active workers in this field has been Dr. Chhibber, now a member of the Geological Survey of India and formerly a lecturer in the University of Rangoon. A little book on the physical geology of the country from his pen is therefore welcome as an authoritative summary of progress in a region that has hitherto been little known except by a few Government or oil-field geologists. All the special features which make Burma a land of peculiar fascination are adequately dealt with, from its mountains and river systems to its mud volcanoes and limestone caves. Each chapter has an excellent bibliography; there is a satisfactorily detailed index; and the forty illustrations, including sketch maps and photographs, are clear and effective. Dr. Chhibber is to be congratulated not only on his own extensive contributions but also on the skill with which he has compiled material from a variety of out-of-the-way sources into a thoroughly readable and stimulating book.

Dix leçons d'astronomie. Par Ernest Esclangon. Pp. iv+110+21 plates. (Paris: Gauthier-Villars et Cie, 1933.) 25 francs.

IN this delightful little book, the Director of the Paris Observatory offers to the general reader a broad canvas on which are depicted the outlines of the recent important achievements of astronomy. As might be expected from the author's professional eminence, the book is up to date. A too brief account of the work of Lemaître and Eddington on the expansion of the universe is relegated to an appendix; this section might, with advantage, have been given somewhat greater prominence. A large number of well-reproduced photographs of celestial objects enhance the value of the book to the general reader.

International Status and Obligations of Science*

By PROF. A. V. HILL, F.R.S.

IN 1796, Britain being then at war with France, a French scientific sailor, Chevalier de Rossel, a prisoner of war in England evidently on parole, dined with the Royal Society Club in London on the invitation of Alexander Dalrymple, the Hydrographer to the Admiralty. The Navy, as well as the Royal Society, clearly regarded scientific standing as entitling its holder to civilised and friendly treatment, regardless of the misfortune of a state of war between the two countries.

Among the instructions issued by the Admiralty to the captain of H.M.S. *Rattlesnake*, in which Huxley sailed in 1846 as "a surgeon who knew something about science", was the following:

"You are to refrain from any act of aggression towards a vessel or settlement of any nation with which we may be at war, as expeditions employed on behalf of discovery and science have always been considered by all civilized communities as acting under a general safeguard."

Science and learning have for several centuries been regarded by all civilised communities as entitling those who follow them to a certain immunity from interference or persecution—provided that they keep to the rules. This view of the position of science in the world at large does not involve any lack of pride in, or affection for, one's own country; there is in fact as much to say for it from the point of view of old-fashioned chivalry as from that of modern internationalism. Science is a common interest of mankind: whatever the barriers or the difficulties or the struggles between them, civilised societies have accorded a certain immunity and tolerance to people concerned with scientific discovery and learning.

Why should science be singled out in this way? Merely by an ancient privilege based on an aristocratic and capitalistic tradition? Certain Russian colleagues, attending the International Congress on the History of Science in London in 1931, made a vehement and mass protest against the claim that the progress of scientific ideas as such deserves a better place in general historical study. According to them, science must be regarded not for its own sake but simply as the handmaiden of social and economic policy: probably they would protest even more vehemently against my present claim that, in a certain sense, science and learning are superior to and above the State.

Although, historically, privilege may have had something to do with the tolerance shown to science, there is a much better reason for the safeguards given it by decent nations. The reason is that its methods of thought, its direct appeal by experiment to a universal Nature, the new powers given to mankind in general by its application, so obviously do not depend upon the opinions, or emotions, or interests of any limited group, that any civilised people will admit that it transcends the ordinary bounds of nationality. Religion, literature, art depend in part upon customs, emotions, race, climate, age and sex; the religious instinct, the artistic sense, may be universal enough, but their expressions can be so different that they may lead sometimes to strife rather than co-operation. In science, however, although mistakes are common, one fact remains certain: its discoveries do gradually build up a structure which is approved by all sane men; in the last three hundred years the experimental method, which is universal, has produced results beyond all previous human achievements. It is this universality of its method and results which gives science a unique place among the interests of mankind.

If scientific people are to be accorded the privilege of immunity and tolerance by civilised societies, however, they must observe the rules. These rules could not be better summarised than they were 270 years ago by Robert Hooke. Among Hooke's papers in the British Museum, Weld records a statement, dated 1663, which was probably drawn up after the passing of the Second Charter of the Royal Society. It begins as follows:

"The business and design of the Royal Society is—To improve the knowledge of naturall things, and all useful Arts, Manufactures, Mechanick practises, Engynes and Inventions by Experiments—(not meddling with Divinity, Metaphysics, Moralls, Politicks, Grammar, Rhetorick or Logick."

and continues:

"All to advance the glory of God, the honour of the King . . . , the benefit of his Kingdom, and the generall good of mankind."

Not meddling with morals or politics: such, I would urge, is the normal condition of tolerance and immunity for scientific pursuits in a civilised State. I speak not with contempt of these—indeed the scorn with which some superior people talk of such necessities of social existence as morals and politics seems to me intolerably childish and stupid. The best intellects and characters, not the worst, are wanted for the moral teachers and political governors of mankind: but science should remain aloof and detached, not from any sense of superiority, not from any indifference to the common welfare, but as a condition of complete intellectual honesty. Emotion, entirely necessary in ordinary life, is utterly out of place in making scientific decisions. If science loses its intellectual honesty and its political independence, if—under Communism or Fascism—it becomes tied to emotion, to propaganda, to advertisement, to

* From the Huxley Memorial Lecture delivered at Birmingham on November 16.

particular social or economic theories, it will cease altogether to have its general appeal, and its political immunity will be lost. If science is to continue to make progress, it must insist on keeping its traditional position of independence, it must refuse to meddle with, or to be dominated by, divinity, morals, politics or rhetoric.

It is not always possible to avoid such meddling —as the life of Huxley showed. Much of Huxley's time was spent in battling with prejudice, in countering the attacks which were made upon the freedom of science to come to its decisions solely on scientific evidence. The traditional views of divinity, metaphysics and morals, aided by the resources of rhetoric, appeared in array against the Darwinian hypothesis and against evolution in general. Huxley realised the necessity of insisting on the independence of science, on the need of eliminating all other considerations in coming to scientific conclusions. The world, and his country in particular, owe to Huxley a great debt for the freedom he won for science and scientific thought.

Such freedom, however, though fairly and hardly won, is not a permanent and inevitable attribute of science. At intervals it has to be maintained by further struggle. The attachment of certain branches of science to competitive industry, desirable enough within limits, if it went too far might lead to the control of such science by industrial interests. The necessity of science in modern warfare might in some future Thirty Years' War give it a purely national instead of an international basis. Its use for propaganda might prostitute it before the world. The coercion of scientific people to certain specified political opinions, as in Russia, Germany or Italy, may lower the standard of scientific honesty and bring science itself into contempt. These possibilities must be watched, and from time to time some champion of scientific independence must stand out, like Huxley, to do battle for freedom.

The present emergency is that of the scientific men and scholars in Germany who have been persecuted, or dismissed, for reasons of race or of independence of opinion. We are witnessing to-day, all over the world but particularly in Europe, an extraordinary phenomenon, the growth of a peculiar kind of 'nationalism'. Now nationalism, like love of family, is a good thing when tempered with reason. To make your town or community happier, wiser, or more prosperous is a decent and worthy ideal: as I hold it is worthy to try to maintain the traditional hospitality of England to those in other countries who are persecuted for causes other than crime. When, however, nationalism leads to excesses of the kind we have seen in the last years, particularly in the last eight months, not in Europe alone, but all over the world, when violence and hatred are preached as its necessities by otherwise decent people, then indeed one begins to think of nationalism not as a pleasant virtue but as a hideous disease.

As a natural reaction, of course, to nationalism, we see internationalism developing. Internationalism needs no more to be flabby and without character than the puritanism of the seventeenth century, or the movement of the nineteenth to abolish slavery. The tendency to internationalism is displayed in the growth of international law. In literature and art internationalism first made itself felt. To write the history of any literature would be impossible without account of its foreign indebtedness. If the phrase "the republic of letters" is appropriate, "the republic of science" merely expresses a commonplace. International congresses, international measures of natural constants, geographical and navigational data, and to-day radio, are signs of the common interests of reasonable people in different countries.

As communication became easier and education more widespread, one might have expected that these common interests of mankind would have been more evident. It almost seems to be true, however, that the gods, when they offer one gift, send with it some counter gift to plague mankind. Nationalism in its present embittered form is one consequence of the very forces which—one might have hoped—would have made people realise their common humanity. It would not be difficult for a cynical observer, experienced in neurology, to find exact clinical parallels to those hysterical outbursts of nationalism which make all attempts at a reasonable solution of world problems so difficult.

If there be one single idea which, by common consent and with common applause, represents the contribution of England to the common welfare, that idea is freedom: freedom of action, freedom of belief, freedom of thought and speech. The American Commonwealth was founded by English people on the same idea. Often, it is true, Englishmen have sinned, sometimes grievously, in this respect, but a jealous tradition on one hand, and bitter experience on the other, have kept their country on the whole the freest in the world. Now freedom, like health, may be a citizen's birthright, but it needs safeguarding, it requires a constant effort. Those who will not fight for freedom do not deserve to be free; we must be ready—as Huxley was ready—to take part in the conflict ourselves.

To thinking people, the progress of knowledge, the advance of medicine, the improvement of health and happiness which can be—should be—the result of scientific and technical achievement, are among the major interests of mankind. It seemed that nations and governments were certain, gradually, to realise this, and so would encourage co-operation, at least in intellectual things. Private agencies have contributed very generously in recent times to this end. All over the world, not only in education and in fellowships, but also in field investigations of such diseases as yellow fever and malaria, the Rockefeller Foundation has been contributing (to use the terms of its charter) to the welfare of mankind throughout the world. Its work is done, not in any religious

fervour, not with flowery language, but as a matter of ordinary business and commonsense—not meddling, as Hooke wrote, with divinity, morals, politics or rhetoric. The voluntary migration of hundreds of young scientific workers under the auspices of the Rockefeller Foundation recalls the movements of earlier times among the universities of Europe. The Rhodes scholarships, the Commonwealth Fund fellowships, the Guggenheim fellowships, serve similar ends.

The history of science, since the War, has been largely of an effort to break down national barriers of mistrust or lack of understanding. It is quite certain that science cannot progress properly except by the fullest internationalism. Accepting freedom of thought and research as the first postulate, the second is that knowledge, however and wherever won, should be freely available for the use of all.

Up to the beginning of the present year one lived in hopes that reason was being restored. Disillusion, however, has been brought to many by the events of the last nine months. No country has excelled Germany in its contribution to science in the last hundred years, no universities were traditionally freer and more liberal than the German. One felt that the intellectual co-operation of Germany was a necessity in setting science on an international basis. I had intended, in this address, to urge an even closer co-operation. Germany, however, has lately rendered such intellectual co-operation impossible by offending the first and most fundamental rule, that providing freedom of thought and research. It seemed impossible, in a great and highly civilised country, that reasons of race, creed or opinion, any more than the colour of a man's hair, could lead to the drastic elimination of a large number of the most eminent men of science and scholars, many of them men of the highest standing, good citizens, good human beings. Freedom itself is again at stake.

The facts are not in dispute. Apart from thousands of professional men, lawyers, doctors, teachers, who have been prevented from following their profession, apart from tens of thousands of tradesmen and workers whose means of livelihood have been removed, apart from 100,000 in concentration camps, often for no cause beyond independence of thought or speech, something over 1,000 scholars and scientific workers have been dismissed, among them some of the most eminent in Germany. These have committed no fault: many of them are patriotic citizens who fought in the German armies in the War. Many of them are of families which have been in Germany for centuries: not all of them are Jews. It is difficult to believe in progress, at least in decency and commonsense, when this can happen almost in a night in a previously civilised State.

What can be done about it? The immediate answer is, of course, that suffering must be relieved and opportunities given for the continuance of their work to those who have been persecuted and deprived. A more important matter, however, is this: we must ensure that the same folly, the same fury, does not occur elsewhere. We cannot take the freedom, so slowly and hardly won, as a birthright: we must see to it that neither race, nor opinion, nor religious belief, nor the advocacy of theories unpopular perhaps at the moment shall cause disinterested able men to be deprived of the means of carrying on their work.

It is a gloomy outlook, and I can see little hope at present except by the strenuous co-operation of intelligent people of goodwill in the various countries. Of one thing, however, one can be certain; that in a civilisation tottering unsteadily on a foundation of applied science, it is necessary that people scientifically trained should take some part in affairs. That need not imply that Cabinet ministers should be fellows of the Royal Society, but rather that all educated men should have some appreciation, by direct contact, with the methods and ideas of science. It is perilous to disregard the scientific basis of modern civilisation or its dependence on international co-operation.

I do not suppose we can do very much, and I can imagine that *Homo sapiens* may ultimately destroy, by his irreconcilable folly, all he has built up. His idea of progress, powerful as it is at the moment, may be nothing but an extrapolation from a short portion of a curve. The pterodactyl's achievements in aviation did not prevent it from dying out: it had some fundamental unfitness which, for all its 'progress', put an end to its career upon earth. Mankind's amazing intellectual achievement in understanding and controlling the forces of Nature may be neutralised by the domination of his intellect by his passions, by his emotional inability to realise, what must be obvious to his intellect alone, the demands of a common humanity.

However, I venture still to think of science and learning, particularly science, which in its experimental method has an absolute means of deciding between opinions, as being the strongest links between the intelligent people of the world. Not many Englishmen, unfortunately, know much about the United States of America. Fortunately with scientific people it is otherwise: they have good reason to know that laborious scientific advances on one hand, or brilliant discoveries on the other, are just as likely to be achieved there as elsewhere: and they have that close personal contact with the unassuming friendly people who make these contributions to knowledge, which ensures that the scientific community at least would regard as utterly hateful any serious difference between their countries. This friendly rivalry between Britain and the United States, this sense of co-operation, is a stronger link than many may imagine. We scientific people are often poor, and generally without much honour or position: but in the end we exercise more influence than we know—for our fundamental faith is co-operation in the pursuit of an end outside and greater than ourselves.

Heavy Hydrogen*

By the RIGHT HON. LORD RUTHERFORD, O.M., F.R.S.

IN the history of physical science, it is a commonplace that a new discovery which at first appears to be of purely scientific interest, ultimately, within a period of twenty years or more, is found to have useful practical applications. This is well illustrated by the discovery of the rare gases in the atmosphere, neon and argon, which are now used in quantity for industrial purposes. The fundamental discovery in 1919 of the isotopic constitution of the majority of our elements, so largely due to Aston, at first sight appeared to be of purely scientific significance, but it may ultimately have wide practical consequences in many directions.

It is scarcely necessary to discuss in detail the history of the discovery and separation of heavy hydrogen, in which scientific workers in the United States have taken such a leading part. The proof that oxygen was not a simple element but contained two isotopes in small quantity of masses 17 and 18, indicated that there was a small discrepancy of about two parts in 10,000 between the measurements of the relative masses of hydrogen and oxygen found by Aston and those found by direct physical and chemical methods. Birge and Mendel suggested that this discrepancy might be due to the presence of an isotope of mass 2 present in ordinary hydrogen. This gave the necessary impetus to Urey, Brickwedder and Murphy to test whether the presence of H^2 could be detected by direct optical methods. The experiments were successful in showing a small trace of H^2, estimated initially at about 1 in 4,000 of the H^1 isotope. The wave-length of the α line of H^2 was found to be 1·79 A. greater than for H^1—a result agreeing closely with the theoretical value to be expected for an isotope of hydrogen of mass 2. The mass of the new isotope was directly measured by Bainbridge, using a modified type of mass-spectrograph, and found to be 2·0136, slightly less than the weight of the ordinary hydrogen molecule, 2·0156, in terms of O=16.

We have no definite evidence of the exact constitution of H^2, whether it should be regarded as a simple entity or built up of two or more constituents. It was at first natural to suppose that the H^2 nucleus might be made up of two protons and a negative electron, but the subsequent discovery of the neutron indicated that it might rather be a close combination of a neutron and a proton. Taking Chadwick's value of the mass of the neutron as 1·0067, the sum of the masses of the proton and neutron is 2·0145, while the mass of the H^2 nucleus is slightly less, 2·0136, indicating that the binding energy of the neutron-proton combination is less than one million volts. If this be the case, it is to be expected that the H^2 nucleus should be broken up by collision with a swift α-particle. In conjunction with Mr. Kempton, I have made experiments to test this, but have been unable to detect with certainty the presence of any neutrons when heavy water was bombarded by α-particles from polonium. The number of neutrons, if any, was certainly less than 1 per cent of the number of neutrons released from a sheet of beryllium under the same conditions. If the disruption of H^2 with an emission of a neutron occurs, it must happen very rarely compared with the number of violent collisions between the α-particles and the H^2 nucleus.

It is interesting to note here a suggestion made by Lawrence. He found in his experiments on the bombardment of matter by high-speed H^2 ions that a group of protons of nearly the same speed was released from a number of elements. In explanation, he suggested that the H^2 nucleus broke up into a neutron and proton either in the bombarded nucleus or in the strong field in its neighbourhood. For the conservation of energy to hold, it is necessary to suppose that the mass of the neutron is much lower than that found by Chadwick, namely, 1·0006 instead of 1·0067. On this view, the H^2 nucleus contains a store of energy corresponding to about five million volts, and this is occasionally released in nuclear collisions. Further experiments are required to test the validity of this idea.

It was of interest to me also to examine whether the fields of force near the H^1 and H^2 nuclei are the same. This was tested by comparing the distribution with the velocity of the recoil H^1 and H^2 atoms when α-particles pass through ordinary and heavy hydrogen respectively. While the recoil H^2 particles travel, as is to be expected, slightly farther than the H^1 particles, to a first approximation the number and distribution of the recoil atoms were about the same in the two cases. Since in a close collision the α-particles and the H^2 nucleus approach within 10^{-12} cm. of each other, these results indicate that the scattering fields are sensibly the same for H^1 and H^2 nuclei, even up to these very small distances.

Some success in concentrating H^2 was initially obtained by fractionating liquid hydrogen. Washburn and Urey noted that there was a greater concentration of H^2 in old electrolytic cells and found the H^2 was rapidly enriched in the residues after electrolysis. This general method was first used on a large scale by Lewis and Macdonald of the University of California in order to obtain a concentrated preparation of heavy water. By this method they have obtained quantities of heavy water of the order of several hundred cubic centimetres practically in a pure state. It has been concluded that one atom of H^2 is normally present with 6,500 atoms of ordinary hydrogen. Lewis

* Address delivered in opening a discussion on "Heavy Hydrogen" at the Royal Society on December 14.

and his collaborators find that the density of this new water is about 11 per cent higher than that of ordinary water, while its freezing point is 3·8° C. and its boiling point 101·42° C. The maximum density is found to occur at 11·6° C. instead of at 4° C. as in normal water.

It is of interest also to refer to another means of concentration carried out by utilising pure diffusion methods. Prof. Hertz informs me that he has been able to obtain the new isotopes in small quantity in a pure state by applying to ordinary hydrogen the elaborate diffusion method worked out by him. He states that he has obtained heavy hydrogen so pure that he has been unable to detect in its spectrum the α-line of ordinary hydrogen. Dr. P. Harteck, working in the Cavendish Laboratory, has been responsible for a preparation of about 25 c.c. of the new heavy water for use in experiments on the transformation of matter.

It is obvious that this new discovery opens up a wide and important field of work. On account of its greater mass, it is to be expected that the rate of diffusion and the rate of chemical reaction will differ when H^2 is substituted for H^1, while the compounds formed with the new isotope are to be expected in some cases to exhibit rather different properties from the normal hydrogen compounds. Similarly, this new discovery opens up interesting questions on the effect of heavy water in altering the normal physical and chemical processes in animal and plant life. A certain amount of information is already available in this interesting field of inquiry.

There is one question of much interest to me to which I should like to refer, namely, the use of H^2 nuclei as swift projectiles for studying the transformation of the elements. It was a happy coincidence that when Prof. Lewis had prepared concentrated samples of H^2, Prof. Lawrence of the same University had in working order his ingenious apparatus for obtaining high-speed ions corresponding to more than a million volts in energy. Lawrence found that the high-speed H^2 ions were much more effective in many cases than protons of equal energy in causing transformations of new kinds in a number of elements. For example, when lithium is bombarded with H^2 ions, α-particles are ejected with a speed considerably greater than the swiftest α-particle from radioactive substances. It is now clear that an H^2 particle occasionally enters the nucleus of lithium of mass 6, and the resulting nucleus then breaks up into two α-particles, escaping in nearly opposite directions. The correctness of this view is well shown by the Wilson chamber photographs of the tracks of the α-particles obtained by Dee and Walton.

The action of H^2 on the lithium isotope of mass 7 is even more complicated, for Oliphant and I have observed that α-particles are liberated over a wide range of velocities. In this case, it seems that the capture of H^2 by the lithium nucleus of mass 7 results in the break up of the system into two α-particles and a neutron. We estimate that the maximum energy of the ejected neutron may be as great as fifteen million volts. We have confirmed this conclusion by finding that neutrons can be detected in numbers corresponding to this mode of transformation using H^2 particles of energy about 200,000 volts. Lauritsen found that a copious supply of neutrons could be obtained by bombarding beryllium with H^2 particles, while Lawrence obtained large numbers from lithium with very fast H^2 particles, but he inclines to believe that most of the neutrons observed in his experiments arise from the break up of the H^2 nucleus into a neutron and a proton.

As already mentioned, Lawrence has observed that H^2 bombardment gives rise to one or more groups of fast protons from a number of elements. These observations have been confirmed by Cockcroft and Walton for several light elements such as lithium, carbon and iron, using H^2 particles of energy about 500,000 volts, but they have failed to observe proton groups from copper and gold. In general, it appears that the H^2 particle is remarkably effective in causing the transformation of many elements, resulting in a number of cases in the liberation of α-particles as well as protons and neutrons. There can be no doubt that this new projectile, as well as the proton, will prove of great service in studying the processes which take place in the transformation of the elements, and this will give further important information on the structure of nuclei.

It is obvious that this new isotope, which can be obtained in reasonable quantity in a pure state so easily, will prove of such great importance to science that it is desirable to give it a definite name. Urey has proposed the name 'deuterium' for the new isotope. It is important also that an appropriate title should be given to the H^2 nucleus, not only as a projectile for atomic transmutations, but as a possible constituent of atomic nuclei. Lewis has suggested the name 'deuton' or 'deuteron' for this nucleus. While we all realise that the first discoverer has a strong claim in suggesting an appropriate name for a new substance, the question of a suitable nomenclature is in this case of such general importance to scientific men that it deserves very careful consideration.

While the name 'deuton' is in some ways suitable, it has for me the objection that it is liable in the spoken word to be confused with neutron, and this difficulty is accentuated by the recent discovery that neutrons are liberated in many cases from elements bombarded by deutons. In consultation with some of my physical and chemical colleagues, some time before these names were announced, the name 'diplogen' (διπλοῦς, double) for heavy hydrogen, and 'diplon' for the nucleus seemed to meet with some favour. Whatever view may eventually be taken on this question, it is important that the new isotope should have a definite symbol allotted to it, and the symbol 'D' seems appropriate.

Richard Kirwan, F.R.S., 1733-1812

By DR. W. H. BRINDLEY

RICHARD KIRWAN, the bicentenary of whose birth falls this year, was known to his generation as a man of great understanding and charm; he became known, indeed, as the 'Nestor of English chemistry'. To succeeding generations, however, his exploits and his personality have not been fully revealed; for in spite of the high esteem in which he was held by his illustrious contemporaries, in spite of his numerous researches and his close association with learned societies, his career received little attention from the biographers of his time. In fact, no serious attempt was made to record even the salient features of his life until almost forty years after his death. By that time many details were probably beyond recall; even the exact date of his birth does not appear to have been published, though this omission is, perhaps, not surprising in view of the haphazard manner in which births and deaths were registered in Ireland prior to the nineteenth century. Donovan omits the date from his biographical sketch, whilst Thomson, in his "History of the Royal Society" (1812), states that Kirwan was born on August 1, 1735. The destruction of the Record Office in Dublin in 1922, and also of other records, make it unlikely that we shall ever know more than the bare fact that he was born in 1733.

Although Kirwan was an indefatigable writer, ever ready to express his opinions upon scientific and other matters, there is no evidence that he kept a detailed and systematic account of those personal experiences which would have thrown so much light, not only upon his own career, but also upon contemporary events and personalities. The failure of modern biographers to elaborate his life-story must therefore be attributed to a deficiency of authentic facts, rather than to a lack of interest in the study.

Born at Cloughballymore, Co. Galway, in 1733, Kirwan was a precocious child. At a very early age his desire for uninterrupted study was so keen that he was wont to read his books sitting among the branches of a tree. Leaving Ireland in 1750, he spent four years at an academy at Poitiers, where, despite his predilection for chemistry, he became a good Latin scholar and therefore did not entirely disregard the remarks of his mother: "I apprehend," she wrote, "that chemistry, or some such abstruse study, takes up your time and attention too much. . . . Write to me again about what books you want; if they be of chemistry, I'll never desire to know more of them."

Kirwan entered the Jesuit novitiate, either at St. Omer or at Hesdin, in 1754, this course being discontinued the following year, when he returned to Ireland to succeed to the family estates. At this time, and for some years to come, his career was unsettled, the Society of Jesus, chemistry and law, in turn, claiming his attention. Although he conformed to the established church in 1764, and ultimately became a Unitarian, his marriage, in 1757, was the immediate cause of his separation from the Society of Jesus, whilst an apparent discourtesy on the part of Black, in failing to acknowledge a number of communications from Kirwan on 'fixed air' and 'causticity', temporarily estranged him from chemical pursuits, the intervening period being occupied in studying law and in practising at the Irish Bar. But his zeal for chemical knowledge was such that it could not be quenched by Black's indifference; he gave up his legal practice, and in 1768 resumed those studies with which the name of Kirwan is chiefly associated.

In 1777 Kirwan settled in London, staying there until 1787, when delicate health compelled him to lead a more retired life, which he sought and found in Dublin. During those ten years he was in close contact with many kindred spirits, his home in Newman Street being the resort of Cavendish, Priestley, Banks, Horne Tooke, Burke and other eminent men. Distance alone must have prevented Black from attending the conversaziones, since he and Kirwan were now very friendly. Although Johnson does not appear to have been a member of this circle, he met Kirwan from time to time, probably in the company of Burke and other members of the Literary Club. On one occasion, when trade winds was the subject under discussion, Johnson, with his usual temerity, crossed swords with Kirwan, whose knowledge of the subject was vastly superior and his dialectic skill little inferior to those of his opponent. As Donovan points out, Johnson's vanity was so wounded in this skirmish that he ever afterwards refrained from entering into an argument with Kirwan.

Kirwan was elected a fellow of the Royal Society in 1780 and was adjudged Copley medallist in 1782 for a series of communications on chemical affinity; he became president of the Royal Irish Academy in 1799. He published a large number of papers on chemistry, geology, mineralogy, meteorology, philology and metaphysics, whilst his "Elements of Mineralogy" (1784)—the first systematic treatise on the subject in English—went through several editions, and was translated into French, German and Russian. His keen interest in this study was demonstrated by his securing the Leskeyan collection of minerals for the museum of the Royal Dublin Society and, above all, by the memorial which, in his capacity of honorary inspector-general of mines in Ireland, he presented to the Government, pointing out the economic importance of mineralogical science and requesting support and encouragement for its advancement. As Pickells remarked at the Cork

meeting of the British Association in 1843, Kirwan's work in this particular field was of national importance.

Kirwan's essay on the phlogiston theory, of which he was a leading exponent, attracted the close attention of his fellow-chemists, especially those of the French school, who paid Kirwan the compliment of marshalling their forces to refute his arguments; Lavoisier, Berthollet, de Morveau, de Fourcroy and Monge co-operating in this effort. The refutation was so complete that ultimately Kirwan was converted and proclaimed his conversion with characteristic grace. Priestley, now the sole exponent of the Stahlian theory, was greatly impressed by his friend's defection, and remarked that Kirwan had acquired more honour by his conduct than he could have done by the most brilliant discoveries.

In his later years, Kirwan devoted most of his time to metaphysical studies, though it cannot be doubted that he continued to pass many happy hours in studying Italian music, of which he had a profound knowledge. A true philosopher to the last, caring neither for riches nor for distinctions, he died at Dublin on June 1, 1812.

News and Views

European Civilisation and African Brains

DR. H. L. GORDON'S letter in the *Times* of December 8, recording the results of his calculation of the average skull capacity of 3,444 unselected adult male natives of Kenya Colony, and an examination of 100 brains of normal adult male natives, opens up a question of considerable scientific interest and of far-reaching practical importance. Dr. Gordon finds that the average cranial capacity of the natives measured is 1,316 cubic centimetres, as against the European average of 1,481 c.c. The element of uncertainty introduced by the fact that the cranial capacity, and inferentially the size of the brain, is calculated from measurements taken on the head of the living is neutralised in some degree by the examination of the 100 brains, which confirms the evidence of the cranial capacity, giving an average weight 150 gm. less than the average brain weight of the European. There is a further quantitative inferiority in the brain, in that, according to Dr. Vint, Government pathologist, the cortex shows a deficiency of 15 per cent in quantity, while the cells of the cortex are smaller, less well arranged and less well shaped than in the European brain. Thus both in quantity and quality the Kenya brain is shown to be inferior. Anthropologists have virtually abandoned any attempt to correlate size of brain with mental ability in view of the conflicting character of the facts; but if ability is regarded as in some way related to the quality of the brain, the inferiority of the Kenya brain is still significant.

THERE are many questions which the anthropologist would wish to ask before accepting these figures at their face value. He will wish to know more about the source from which they were obtained. While Dr. L. S. B. Leakey in the *Times* of December 13 inquires as to the provenance of the brains examined, others will wish to know the tribal affinities of the natives whose heads were measured. Among Kenya natives there are many differences, both physical and cultural, according as they are derived from nomad or settled, pastoral or agricultural groups. Further, it may be asked, how does the cranial capacity relate to other measurements, such as stature, and are the European figures comparable on this basis? Finally—a point frequently overlooked in a comparison of this nature—from what social class are the European figures derived, educated or uncultured? It would appear from the general tenor of Dr. Gordon's communication, and more particularly from his reference to the incidence of dementia præcox among natives who have received European education, that his investigations lead him to the conclusion that the character of the African, or Kenya, native brain is not such as to be adaptable to Europeanisation. If this could be shown to be the true view, it would seem to demand a native policy of prolonged, if not permanent, segregation, to allow native institutions to develop slowly along their own lines. Whatever may be the view taken of Dr. Gordon's results as they stand, they call for further investigation with official support, and on lines in accordance with strict scientific requirements, with the view of determining the facts and, if necessary, their practical consequences in relation to native policy.

Import of Dyestuffs into Great Britain

THE second reading of the Dyestuffs (Import Regulation) Bill was carried in the House of Commons on December 18. Dr. Burgin, Parliamentary Secretary to the Board of Trade, pointed out that the object of the bill was to place on a permanent basis the prohibition of importation into Great Britain of dyestuffs and intermediates. Such prohibition has been in force since January 1921 and has come up for consideration annually, being prolonged by the Expiring Laws Continuance Act of this year in order to give time for the preparation of the present bill. Dr. Burgin stated that conditions have changed greatly since 1920. The production of dyestuffs on the Continent is in excess of the world's requirements, and one of the first effects of raising the ban on such imports into Great Britain would be that the smaller British dyestuff makers, who render invaluable service to the consumer by the production of specialised colours not available elsewhere, would be driven out of business. On the advice of the Import Duties Advisory Committee, Treasury Orders coming into force on December 27 will be issued, removing dyestuffs to the free list and imposing additional duties, making the duty 20 per cent in all, on pigments which are synthetic organic colours or colouring

matters ; while the Board of Trade is issuing an open general licence from the same date for the importation of compounds, preparations and articles, not suitable for use in dyeing, manufactured from synthetic organic dyestuffs. A joint committee of makers and users to consider prices and supplies will be set up by the trade early in 1934.

Charles Babbage, F.R.S.

AT a meeting of the Newcomen Society held at the Science Museum on December 13, Dr. L. H. D. Buxton read a paper on Charles Babbage and his difference engine, during which he gave a sketch of the career of Babbage, explained the design of the famous calculating machine, and exhibited many manuscripts and an unpublished biography of Babbage compiled by Dr. Buxton's grandfather. Babbage was born in Teignmouth on December 26, 1792, and died in London on October 18, 1871. He was educated privately and went to Cambridge in 1811. He joined Herschel and Peacock in forming the Analytical Society, graduated in 1814, and in 1816 was admitted a fellow of the Royal Society. He assisted in founding the Royal Astronomical Society and the Statistical Society, and from 1828 until 1839 was Lucasian professor at Cambridge. Possessing ample means, Babbage was able to follow his own inclinations, and among these was to construct a machine for calculating mathematical tables. This led him to the construction first of a difference engine, secondly to the construction of an analytical engine, and then of another difference engine. The relics of his machines, none of them ever finished, are in the Science Museum ; his first difference engine was used by Dr. Buxton to explain Babbage's methods. Altogether Babbage spent some £6,000 of his own and some £17,000 allotted by the Government, on his first attempts, and then in 1842 the Government decided against any further expenditure. The failure of Babbage to bring to fruition his ideas was due to his constantly changing his mind, and being led off by some new scheme which promised better results, but which itself was only followed until a new idea arose.

Electrical Equipment of London's Latest Hotel

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meeting of the British Association in 1843, Kirwan's work in this particular field was of national importance.

Kirwan's essay on the phlogiston theory, of which he was a leading exponent, attracted the close attention of his fellow-chemists, especially those of the French school, who paid Kirwan the compliment of marshalling their forces to refute his arguments; Lavoisier, Berthollet, de Morveau, de Fourcroy and Monge co-operating in this effort. The refutation was so complete that ultimately Kirwan was converted and proclaimed his conversion with characteristic grace. Priestley, now the sole exponent of the Stahlian theory, was greatly impressed by his friend's defection, and remarked that Kirwan had acquired more honour by his conduct than he could have done by the most brilliant discoveries.

In his later years, Kirwan devoted most of his time to metaphysical studies, though it cannot be doubted that he continued to pass many happy hours in studying Italian music, of which he had a profound knowledge. A true philosopher to the last, caring neither for riches nor for distinctions, he died at Dublin on June 1, 1812.

News and Views

European Civilisation and African Brains

DR. H. L. GORDON'S letter in the *Times* of December 8, recording the results of his calculation of the average skull capacity of 3,444 unselected adult male natives of Kenya Colony, and an examination of 100 brains of normal adult male natives, opens up a question of considerable scientific interest and of far-reaching practical importance. Dr. Gordon finds that the average cranial capacity of the natives measured is 1,316 cubic centimetres, as against the European average of 1,481 c.c. The element of uncertainty introduced by the fact that the cranial capacity, and inferentially the size of the brain, is calculated from measurements taken on the head of the living is neutralised in some degree by the examination of the 100 brains, which confirms the evidence of the cranial capacity, giving an average weight 150 gm. less than the average brain weight of the European. There is a further quantitative inferiority in the brain, in that, according to Dr. Vint, Government pathologist, the cortex shows a deficiency of 15 per cent in quantity, while the cells of the cortex are smaller, less well arranged and less well shaped than in the European brain. Thus both in quantity and quality the Kenya brain is shown to be inferior. Anthropologists have virtually abandoned any attempt to correlate size of brain with mental ability in view of the conflicting character of the facts; but if ability is regarded as in some way related to the quality of the brain, the inferiority of the Kenya brain is still significant.

THERE are many questions which the anthropologist would wish to ask before accepting these figures at their face value. He will wish to know more about the source from which they were obtained. While Dr. L. S. B. Leakey in the *Times* of December 13 inquires as to the provenance of the brains examined, others will wish to know the tribal affinities of the natives whose heads were measured. Among Kenya natives there are many differences, both physical and cultural, according as they are derived from nomad or settled, pastoral or agricultural groups. Further, it may be asked, how does the cranial capacity relate to other measurements, such as stature, and are the European figures comparable on this basis? Finally—a point frequently overlooked in a comparison of this nature—from what social class are the European figures derived, educated or uncultured? It would appear from the general tenor of Dr. Gordon's communication, and more particularly from his reference to the incidence of dementia præcox among natives who have received European education, that his investigations lead him to the conclusion that the character of the African, or Kenya, native brain is not such as to be adaptable to Europeanisation. If this could be shown to be the true view, it would seem to demand a native policy of prolonged, if not permanent, segregation, to allow native institutions to develop slowly along their own lines. Whatever may be the view taken of Dr. Gordon's results as they stand, they call for further investigation with official support, and on lines in accordance with strict scientific requirements, with the view of determining the facts and, if necessary, their practical consequences in relation to native policy.

Import of Dyestuffs into Great Britain

THE second reading of the Dyestuffs (Import Regulation) Bill was carried in the House of Commons on December 18. Dr. Burgin, Parliamentary Secretary to the Board of Trade, pointed out that the object of the bill was to place on a permanent basis the prohibition of importation into Great Britain of dyestuffs and intermediates. Such prohibition has been in force since January 1921 and has come up for consideration annually, being prolonged by the Expiring Laws Continuance Act of this year in order to give time for the preparation of the present bill. Dr. Burgin stated that conditions have changed greatly since 1920. The production of dyestuffs on the Continent is in excess of the world's requirements, and one of the first effects of raising the ban on such imports into Great Britain would be that the smaller British dyestuff makers, who render invaluable service to the consumer by the production of specialised colours not available elsewhere, would be driven out of business. On the advice of the Import Duties Advisory Committee, Treasury Orders coming into force on December 27 will be issued, removing dyestuffs to the free list and imposing additional duties, making the duty 20 per cent in all, on pigments which are synthetic organic colours or colouring

matters ; while the Board of Trade is issuing an open general licence from the same date for the importation of compounds, preparations and articles, not suitable for use in dyeing, manufactured from synthetic organic dyestuffs. A joint committee of makers and users to consider prices and supplies will be set up by the trade early in 1934.

Charles Babbage, F.R.S.

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was suitable and so a clerk in the office had to act as a human 'repeater'. He repeated word by word the messages he received into a microphone connected with three small loudspeakers in the street. The police objected as the crowd blocked the thoroughfare, and so this early forerunner of broadcasting had a short life. Broadcasting began early in 1923, when a 500-watt station was installed at Oslo. In those days the ether was not, as now, jammed by high-power broadcasting stations and so the reception was excellent. It was at first proposed to put a tax on all receiving sets sold, but this was modified into an annual tax of 2–5 kroners on every set installed. As early as May 1923 it was demonstrated that it was possible to broadcast to the fishing fleet from the northern part of Norway. In the very early days, to receive a portion only of what was broadcast was considered satisfactory. Now not only is the complete message intelligible but the finer nuances of speech and music are transmitted over great distances without audible impairment. The small station at Oslo has been replaced by one of 100,000 watts. Marvellous progress has been made during the last ten years.

Archæological Research in the Indus Valley

ON December 8, Dr. E. J. H. Mackay delivered the Sir George Birdwood Memorial Lecture before the Royal Society of Arts. Dr. Mackay pointed out that until we are able to outline the history of the intervening centuries of darkness, the influence of the Indus Valley civilisation upon later times can only be tentatively discussed. He, therefore, preferred to indicate its relationship with other contemporary centres of culture. He welcomed the rejection of the earlier title 'Indo-Sumerian'. Commercial relationship almost certainly existed between the Indus Valley and the Middle East, but the culture displayed at Mohenjo-Daro must be regarded as distinct. He also supported the rejection of the title 'Chalco-Lithic'. Dr. C. L. Woolley, in seconding the vote of thanks to the lecturer, expressed the hope that Dr. Mackay will soon be able to resume his work, now that the Government has made it possible to obtain permission to carry out archæological researches in India.

Egyptian University's Excavations at Ma'adi

AN account of the excavations carried out last season at Ma'adi, the third season of excavation on the site, by the Geographical Department of the Egyptian University, is given in *Ancient Egypt* (pt. 4; 1932) recently issued. The excavations were conducted by Prof. Oswald Menghin and Prof. Mustafa Amer. More than 5,000 square metres were excavated. Among the more important finds was a complete square hut foundation, which throws light on Neolithic house construction in Egypt. A hoard of seven basalt vessels in a deep cellar hole cut in virgin soil is said to be "the biggest coherent find of prehistoric stone vessels made, so far, in Egypt". A vase of limestone had had red colour applied to it so that it resembled pottery. A large number of exceptionally fine worked flints included several big, oval and exceptionally thin scrapers, and a fish-tail lance. Among a group of wooden objects was a boomerang. Personal ornaments included a comb made of ox horn, the first of this material to be found at Ma'adi. A very large amount of pottery was found, more than a hundred vases being complete, many of them new types and bearing likeness to the ceramics of the Syrian third millennium B.C. No complete vessel of painted pottery was found, though a big fragment painted inside and out was saved. The painted pottery of Ma'adi has a peculiar style quite independent of any painted Egyptian ware. The importance of this Neolithic site, especially as a source of information bearing on the early relations of Egypt with Palestine and Syria, is becoming increasingly apparent and makes its complete excavation a matter of considerable moment.

Salmon Fisheries Research

IN the Ministry of Agriculture and Fisheries Report of the Salmon and Freshwater Fisheries for the year 1932 (London: H.M. Stationery Office. 1*s*. 6*d*. net), it is stated that the catch of salmon and migratory trout showed a still further increase over the very poor catches that were made in 1930. It is also satisfactory to read that in 1932 there was no considerable outbreak of furunculosis, a disease concerning the determining factors of which we need much more information. Thanks to the preliminary work which has already been carried out, it has now been shown possible to disinfect ova with acriflavine, which if carried into practice should eliminate one possible source of spreading infection. The need for continued and increased research into the life-history of the salmon is stressed as bearing on the formulation of fishery laws. It is not yet known how great a part is played by heredity in the determination of whether a fish shall be early- or late-running; if indeed, as some apparently believe, this characteristic is carried on from one generation to the next, it would be advisable to cease protecting those fish which ascend the rivers after the close season and are thus of no commercial value. The clearing up of this question would indeed be of far-reaching interest in the racial study of fishes in general. The salmon is a fish on which such an investigation can be carried out in practice, and information thus obtained might throw light on similar phenomena among our sea fishes, such as spring- and autumn-spawning herring. It is all the more regrettable therefore that the recommendations of the Committee appointed in 1930 by the Minister and the Secretary of State for Scotland on artificial propagation of salmon have had to be regarded as not feasible at the present on the grounds of economy.

The Qattara Depression and Water Power

THE Qattara depression in the north-east of the Libyan Desert has an area of 19,500 square kilometres, an average depth of floor of 60 metres below sea-level, and a maximum depth of 134 metres. Rather more than a quarter of the floor is covered

with a watery mixture of sand and salt, known as *sabakha*, which often has a crust over salty sludge. In the October issue of the *Geographical Journal*, Dr. J. Ball discusses in detail his proposal to utilise this depression for power production. He suggests the construction of four pipe lines to bring in the waters of the Mediterranean, which lies about fifty-six kilometres to the north. For a lake area of 13,500 square kilometres with a level below the sea of 50 metres, he calculates a permissible influx of 56,700,000 cubic metres a day. The level would be maintained by the heavy loss of water due to evaporation, which he calculates at 4·6 millimetres a day where the rainfall is not more than 20 millimetres a year. This process would, of course, lead to increasing salinity of the lake and the eventual filling up of the depression by saline deposits, but Dr. Ball calculates that this would not occur for many centuries. His plan foresees the gradual formation of a lake of the maximum depths extending over nearly two centuries. Dr. Ball has worked out his scheme in much detail and gives all the figures in his paper. It should be noted that the distance over which the power would need to be transmitted to the Nile delta is about 560 miles.

Ellsworth Antarctic Expedition

ONE of the major problems of the antarctic, the relation between the Ross Sea and the Weddell Sea, is the objective of the Ellsworth expedition which has sailed for the Ross Sea in the *Wyatt Earp*. The sole aim of Mr. L. Ellsworth and Mr. B. Balchen is to fly from the Bay of Whales, early in January, across to the Wilhelm Barrier in the south of the Weddell Sea on a course that will take them within about four hundred miles of the pole on the Pacific side. The *Geographical Journal* of November gives some details of the expedition. No landing will be made in the Weddell Sea and the party will return at once to the base. The double journey of a total of 2,900 miles should be made in about twenty hours. A Northrop low-wing monoplane has been built for the flight and tested in Canada and Norway. It is not contemplated that more than a week will be spent in the Ross Sea, though a year's supplies are being carried.

Journal of the University of Bombay

THIS journal is mainly intended for the publication of the results of researches carried out by the teachers and students of the University of Bombay. It is to be issued six times in the year; the parts issued in January and July are to be devoted to history, economics and sociology, the part for March to biology, the part for September to the physical sciences and mathematics, and the parts for May and November to arts and law. We have received the biological part, dated March 1933, which contains thirteen papers, three on botanical subjects, seven on zoology, and others on the rabbit ovulation test for pregnancy, the characters of the Indian pelvis and the biophysics and biochemistry of the blood in tuberculosis. The zoological papers include descriptions of the vascular system of the sea-slug, *Oncidium*, the skeleton of the globe-fish, *Tetrodon*, the reproductive and excretory organs of *Thalassema bombayensis*, and of the history of the thymus of the plaice. This last investigation was carried out in the University of Liverpool, but the others represent work done in Bombay. The papers are illustrated by line drawings in the text and by plates. Several of the line drawings are somewhat crudely executed; but the fault in some cases is in the original drawings, though in others a smoother paper would probably be more suitable for clear reproduction of details. At the end of the part are abstracts of four M.Sc. theses in Bombay for the year 1931–32.

Disappearance of 'Submerged Forests'

THE disappearance of the last traces of the 'submerged forests' at the old peat beds of the Lancashire and Cheshire coast, where the tides have now washed away all trace of the prehistoric tree stumps that littered the shores so abundantly at West Kirby, Hoylake, Dove Point and Leasowe on the Cheshire shore, and Hightown and Blundellsands on the Lancashire shore, has robbed geologists in particular of one of the most extensive of these collections on the British coasts. The submerged forests near Liverpool have perhaps been more closely studied than any others of these remains, and a generation ago the stumps that littered parts of the coast numbered many hundreds and were widely known. None now remains. Numerous remains of the antler deer (*Cervus elaphus*), wild oxen (*Bos longifrons* and *B. primigenius*), the metacarpel of a roe deer (*Capreolus capræa*) and of domestic animals as the horse, dog, and in 1873 the skull of *Homo sapiens*, have been taken from these submerged forests in the Liverpool area. Smith (*Proc. Historic Soc. Lancs. and Cheshire*, **18**) describes an unusually fine pair of horns of the larger form of the red deer taken at Leasowe, 1863, each antler forty inches long and the pair measuring seven feet from tip to tip, while Liverpool Museum received a large number from Hightown in 1916 (*Proc. Liverpool Geol. Soc.*, **14**). Roots of *Osmunda* and shells of *Buccinum*, *Turritella*, *Scribicularia*, *Tellina* and *Nutica* have also been obtained from the blue silt below the peat beds.

Botanical Society and Exchange Club of the British Isles

UNDER the editorship of the new secretary, W. H. Pearsall, this report (Arbroath: T. Buncle and Co, 1933) contains a mass of interesting information relating to British field botany. Lists and critical notes on many new varieties, subspecies and adventive species, and new county records are given. Articles on critical species and genera are contributed by the late Dr. Drabble on "*Ranunculus bulbosus* and its varieties in Great Britain" and "*Valeriana officinalis* and its allies in Great Britain". Mr. Pearsall gives a revision of the genus *Zannichellia* and new keys and descriptions of the British species of *Carex*. A. E. Wade contributes notes on the genus *Myosotis* and J. S. L. Gilmour writes on "The Taxonomy of Plants intermediate between *Medicago*

sativa and *M. falcata* and their history in East Anglia" and shows that *M. sylvestris* is of hybrid origin. Other articles include "The Adventive Flora of the Port of Bristol" by C. I. Sandwith, "Plant Nomenclature" by Dr. Sprague, and a well-illustrated account of environmental adaptation in various sand dune plants at Braunton Burrows by Dr. F. R. E. Wright.

Australian Entomology

INTEREST in the remarkable insect fauna of Australia began to be taken soon after Capt. Cook reached the continent in 1770. There has since arisen an increasing number of writings on Australian insect life. Of late, the stimulus given by applied entomology has led to a great and important literature on the insect pests of the economic animals and plants of the continent. In September 1932, a "Bibliography of Australian Entomology, 1775–1930", by Mr. Anthony Musgrave, was published by the Royal Zoological Society of New South Wales. In his capacity as entomologist to the Australian Museum, Sydney, Mr. Musgrave has listed the title of every known book, memoir and article bearing upon the subject. These are arranged under the authors' names, which are set out alphabetically. A feature of special interest is the series of biographical notes on many of the writers and collectors who have helped to build up our knowledge of Australian entomology. In the production of this bibliography, which runs to 380 closely printed pages, both the author and the Society have conferred a boon on entomologists throughout the world.

Hydrographical Observations from Danish Light-Vessels

THE recently published "Mean Values of Observations from Danish Light-Vessels" is a pamphlet issued as a special reprint from the Nautical Meteorological Annual, 1932, of the Danish Meteorological Institute. There are numerous tables summarising observations made at Danish light-vessels, such as the salinity at 8 a.m. of the sea-water at the surface and at various depths down to the ocean bottom, frequencies of horizontal visibility of the atmosphere between certain limits in miles, and frequency of ocean currents of various velocities, at different depths of the ocean. These are all long-period averages, mostly referring to 1901–30 or 1903–30, but for sea surface temperature going back to 1881, and for visibility beginning only in 1918, when the modern system of measuring visibility was introduced, and extending only to 1927. This is clearly not a work for the ordinary student of meteorological literature, but one for the specialist in hydrographic work and for the sailor, and even to those it must be mainly a work of reference. The number of individual observations on which it is based is very large, and the statistical value of the averages is proportionately great.

Revision of Ordnance Maps

IN the report of the Progress of the Ordnance Survey for the year 1932–33 (London: H.M. Stationery Office, 1933. 3*s*. 6*d*. net), attention is directed to the difficulties and delay in revision of the sheets owing to financial restrictions. The reduced staff available for field work on large-scale plans means that revision has to be limited, more and more, to areas completely altered or built over since the last edition of the sheet. Field work thus tends to become original survey and the time needed for each sheet increases. While the yearly output of 25-in. plans was more than two thousand in 1923, it has now fallen to about seven hundred. In the earlier year the number of man-days spent in the field upon the revision of one 25-in. sheet was about eleven; it is now about fifty-two. The delay is thus progressive as time goes on, and has already become very serious. Since the revision for the one-inch sheet is based on large-scale plans, the new edition of small-scale maps is seriously impeded. Whereas in 1913 a one-inch reviser could do 96 square miles per month in open country or 40 square miles in close country, he can now do only 18 per month in country round London. Nevertheless, the new relief edition of the one-inch map is making steady if slow progress.

Water Flow of the Nile

Two further volumes of the Egyptian Government's work on the Nile Basin have been published ("The Nile Basin". By H. E. Hurst and P. Phillips. Vols. 3 and 4. Cairo: Government Press. 10*s*. each). Vol. 3 deals with the gauge readings of the Nile and its tributaries taken at about a hundred stations between El Leisi, a few miles above Cairo, to stations on Lake Victoria and Lake Albert. Most of the data begin within this century, but it is of interest to note that on Roda Island the Nile levels have been recorded each year since the Arab conquest of Egypt. Records of other Arab nilometres are also known but are of little value as their relation to present levels cannot be determined. Vol. 4 records ten-day and mean monthly discharges of the Nile and tributaries at about forty stations, which have been computed in various ways.

The 'Iconoscope' for Television

AN article under this title appeared in NATURE of October 21, p. 648. A paper by Dr. V. K. Zworykin has now appeared in Great Britain (*J. Inst. Elect. Eng.*, No. 432). He describes clearly the theory, characteristics and mode of operation of his system, which has now reached the commercial stage. The device used for the registration of the image is called an 'iconoscope'. It consists of a vacuum tube, an electron-emitting 'gun' and a photo-sensitive surface of a unique type. This surface is scanned by an electron beam from the gun which serves as a type of inertialess commutator. The principle of operation permits the storing of energy and very largely increases the output as compared with the ordinary types of television scanners. The reproduction of the image is accomplished by another cathode ray tube with a fluorescent screen called the 'kinescope'. It modulates the impulses from the

electric beam and this in turn is transformed by the fluorescent screen into variations of light. The scanning is linear and is synchronised at the end of each line, the impulses being transmitted through the same channel as the picture signal. The whole system is completely automatic and is almost as easy to operate as an ordinary radio receiver. The practical details have been all worked out and it looks as if a high grade television transmission set of this type will soon be on the market.

Glass Windows and Ventilation Engineering

IT is well known that the windows of houses exposed to the sun's rays act like heat traps. They permit most of the radiant energy from the sun to pass into the building but block the low temperature radiation from inside surfaces passing out. Science Service has issued a report of results obtained by research physicists of the American Society of Heating and Ventilating Engineers in their laboratories. Formerly it was thought that glass absorbed only about ten per cent of radiation at low temperatures. The experiments show that a temperature of 550° F. must be reached before any appreciable amount of the radiation passes through plate glass. Even at 1,000° F., only a small amount passes through. Glass obviously acts as a very efficient heat trap and this has to be taken into account by the ventilating engineer. In many modern buildings, a side built almost entirely of glass is exposed to the sun's maximum radiation. On a hot summer day, the glass permits the heat from the sun to enter and practically none of it escapes. Indoors, therefore, it becomes unbearably hot. The cost of keeping a building of this nature cool is practically prohibitive. Awnings which deflect the light and are hung outside the windows are perhaps the most efficient. Shades and blinds are of little value as the heat passes through the glass, heats the blind and is convected upwards, thus heating the room. Tests proved that there is no practical difference in efficiency between clear and coloured glass.

Sorting Foods by Reflection of Light

IT seems that the sorting out of foods by the reflection of light will soon be used in regular commercial practice. It is certainly quite feasible for sorting out foods the quality or maturity of which depends on their colour. Science Service has issued a description of a bean elevator that sorts out white pea beans by means of a photoelectric tube. The device is in use in Lowell, Michigan, and it is said that the plant could be adapted for the sorting of peanuts, coffee, almonds and other foods in which colour is the determining factor when making a selection. It is also possible to sort red kidney beans, green peas and other food crops as easily as white beans are now sorted. A battery of a hundred photoelectric cells is used in the Lowell elevator. It operates with such precision that even although the discoloration of the bean is barely discernible to the human eye, it is rejected with high precision. The individual machine is quite small, consisting of a drum with a series of small holes in the rim. Each bean passes in review before a photoelectric cell. The cell accurately measures the reflection of the light from the bean on it. If the light varies, an electric impulse is transmitted to a thyratron tube which permits sufficient current to pass to operate an electromagnet with a trigger-like hammer at one end. Beans not of the proper colour are dislodged from the vacuum drum by the hammer while good white beans pass into a hopper. The sensitivity of the amplifier can be adjusted until practically only white beans pass undisturbed. Each machine can do as much work as six girls hand-picking beans. A similar device might probably be used for sorting out buttons and other coloured objects.

Physical Tables

VOL. 88 of *Smithsonian Miscellaneous Collections* constitutes the eighth edition of the "Smithsonian Physical Tables", the first edition of which appeared in 1896. The preparation of the new edition has been carried out by Dr. F. E. Fowle, of the Smithsonian Astrophysical Observatory, who has availed himself of suggestions and data furnished by authorities in the different fields. The volume has been enlarged to nearly 750 pages and it now contains 871 tables and an index of 22 pages. Where necessary a table is preceded by a short account of the laws relating to the subject, adapted from the writings of some authority to which a reference is given. In cases where recent advances have been rapid and fundamental, the tables and introductions have been supplied by a recognised authority, as for example those on the series relations in atomic spectra, which are by Dr. H. N. Russell. In addition there are ample references to further sources of information. The volume will be welcomed by all who have to search for reliable values of physical constants.

Medical Research in South Africa

THE annual report for 1932 of the South African Institute for Medical Research, Johannesburg, by the director, Sir Spencer Lister, recently received, gives an account of the work, research and routine, conducted during the year. A quantitative study of the blood-complement in man has been commenced, and in pulmonary tuberculosis and leprosy a considerable proportion of the cases tested showed very small amounts or no complement in the blood. An investigation of South African strains of rabies virus was begun, and nearly every case of human rabies investigated was found to have been caused by the bite of the yellow mongoose or genet cat, and not by a dog bite. Antivenomous serum of exceptional potency for the treatment of snake-bite has been prepared by the use of massive doses of venom modified and rendered atoxic by means of formalin, with subsequent concentration of the serum so obtained.

Study of Canadian Coals

A STRIKING feature of Canada's fuel problem is the absence of coal in the central areas where population

is densest, so that fuel has to be imported from the United States and Wales, or transported from Nova Scotia via the St. Lawrence—navigable only in summer. This has led the Canadian Department of Mines to give special study to the nature, preparation and storage of coals from the Sydney Area, Nova Scotia, described in a recent report by R. E. Gilmore and R. A. Strong (*J. Canadian Mining and Metallurgy*, p. 317; 1933). Storage in Canada is a greater problem than in Great Britain. Observations are recorded on coal piles of depth reaching 40 ft. Even at this depth, the coal was safely stored. Washing was found to reduce the tendency of the coal to heat. The ash of these coals is fusible and therefore special attention has been given to the relation between the fusibility of the ash and the behaviour of the coke from the coal, when burnt in domestic boilers.

Birds and Earthquakes

The Long Beach earthquake of March 10, 1933, began at 5.55 p.m. with the most severe of a succession of shocks which continued for twenty hours. At this time, about sunset, a flock of a hundred Brewer blackbirds (*Euphagus cyanocephalus*) had retired to roost in some medium-sized trees. M. P. Skinner records that although no preliminary shocks were felt by human beings, these birds became uneasy before the severe shock (*Condor*, 35, 200; 1933). During the shock the birds began to leave the roost, and rose slowly in ascending spirals above the trees to a height of about 140 ft. They then descended slowly and settled noisily in the roost; thereafter throughout the minor shocks they showed no sign of disturbance. At their usual time near dawn, meadow-larks and mocking-birds began to sing and kept up their morning songs in spite of the tremors that were occurring almost every minute.

Nature of Saturn's White Spot

WRITING from Ocean Island, Central Pacific, a correspondent, whose name we regret to be unable to decipher, suggests that the white spot recently observed on the planet Saturn might consist of water which has been raised from lower levels into a region where it would solidify into ice-floes or snow-fields. He adds, "The white spot may represent the result of a widespread heating of the lower Saturnian atmosphere and consist of a continent of ice floating in air, buoyed up above its normal level by rising air beneath it."

American Association for the Advancement of Science

THE ninety-third meeting of the American Association for the Advancement of Science will be held at Boston on December 27–30 under the presidency of Dr. H. N. Russell, professor of astronomy and director of the observatory in Princeton University. The title of the address of the retiring president, Prof. J. J. Abel, formerly professor of pharmacology in Johns Hopkins University, will be "On Poisons and Disease, and some Experiments with the Toxin of the *Bacillus tetani*". On December 30, Prof. Harlow Shapley, director of the Harvard Observatory, will be presented with the Rumford medal of the American Academy of Arts and Sciences; his address on this occasion will be entitled "The Anatomy of a Disordered Universe". The vice-presidential addresses in the several sections will be delivered by the following: A (Mathematics), Prof. H. H. Mitchell, University of Pennsylvania; B (Physics), Prof. D. L. Webster, Stanford University; C (Chemistry), Prof. F. C. Whitmore, Pennsylvania State College; D (Astronomy), Dr. P. W. Merrill, Mount Wilson Observatory; E (Geology and Geography), Prof. W. H. Hobbs, University of Michigan; F (Zoology), Prof. A. S. Pearce, Duke University; G (Botany), Prof. H. L. Shantz, University of Arizona; H (Anthropology), Prof. C. H. Danforth, Stamford University; I (Psychology), Prof. W. S. Hunter, Clark University; K (Social and Economic Sciences), Prof. W. F. Ogburn, University of Chicago; L (Historical and Philological Sciences), Dr. W. G. Leland, American Council of Learned Societies; M (Engineering), Prof. D. C. Jackson, Massachusetts Institute of Technology; N (Medical Sciences), Prof. C. R. Stockard, Cornell University; O (Agriculture), Dr. J. H. Gourley, Ohio Experiment Station; Q (Education), Prof. S. A. Courtis, University of Michigan.

Announcements

THE following officers of the Royal Society of South Africa have been elected for 1934: *President*, Dr. A. W. Rogers; *Treasurer*, Dr. L. Crawford; *General Secretary*, A. J. S. Goodwin; *Editor*, Prof. R. S. Adamson; *Librarian*, Prof. E. Newbery.

"CLASSICS OF SCIENCE" is the title of Catalogue 29 of Messrs. E. P. Goldschmidt and Co. Ltd., London, W.1. Its 220 items contain many rare and important original editions of works outstanding in the progress of scientific discovery. Some early books on astronomy, optics and magnetism are of special interest.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant lecturer and demonstrator in geology in the University College of South Wales and Monmouthshire—The Registrar, University College, Cardiff (Jan. 1). An inspector for the purposes of the Diseases of Animals Acts, 1894–1927, in the Ministry of Agriculture and Fisheries—The Secretary, Ministry of Agriculture and Fisheries, 10, Whitehall Place, London, S.W.1 (Jan. 4). A water engineer at Liverpool—The Town Clerk, Municipal Buildings, Liverpool, 2 (Jan. 9). Examiners and assistant examiners for the School Certificate Examination of the Central Welsh Board—The Clerk to the Central Welsh Board, Cardiff (Jan. 12). A plant pathologist at the Waite Agricultural Research Institute, Adelaide—The Secretary, Universities Bureau of the British Empire, 88a, Gower Street, London, W.C.1 (Jan. 15). A special lecturer in aeronautics in University College, Hull—The Principal.

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.*]

Sources of Atmospherics and Penetrating Radiation

SIMULTANEOUS directional observations have been made of the arrival of atmospherics and of penetrating radiation, using a wireless cathode-ray direction finder and a pair of Geiger-Müller counters. The radio installation was the standard frequency-conversion direction finding apparatus[1] developed and used at the Radio Research Station, Slough, for investigations of the direction of arrival of atmospherics. The arrival of an atmospheric from a particular direction is indicated by the momentary deflection of the beam of a cathode-ray oscillograph in a corresponding direction, and is recorded photographically on film moving continuously in a vertical direction at a speed of 1·25 cm. per second. The counters recording penetrating radiation were arranged to receive particles coming from an easterly direction. Simultaneous discharges of the two counters were selected and used to impress a small unidirectional deflection on the beam of the oscillograph used in the direction finder.

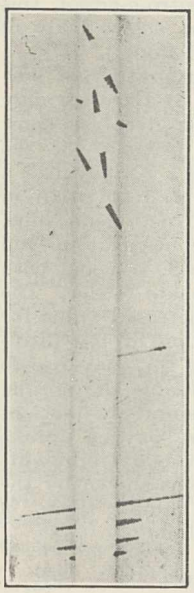

FIG. 1.

In the accompanying figure is shown a sample length of film enlarged three times. The vertical direction corresponds to the north-south line. Near the middle of the record is seen the unidirectional impulse indicating the arrival of penetrating radiation. Before and after it are atmospherics from different directions.

In runs lasting 960 minutes a total of 407 coincident discharges were observed and atmospherics were recorded at a mean rate of 4·21 per second. An analysis of the data obtained shows that :—

(*a*) The number of coincidences between the arrivals of atmospherics and penetrating radiation is no greater than would be expected from a chance distribution.

(*b*) In the intervals 0–1, 1–2 and 2–5 seconds before and after the arrival of penetrating radiation the rates of incidence of atmospherics are as exhibited in the accompanying table, where the factor c is the ratio of the mean rate of incidence of atmospherics in the interval under consideration to the mean rate.

	Before			After		
Interval	2–5 sec.	1–2 sec.	0–1 sec.	0–1 sec.	1–2 sec.	2–5 sec.
c	1·007±0·015	1·024±0·030	1·007±0·029	1·080±0·031	1·062±0·028	1·000±0·012

Each of the quantities c should be unity if there is no correlation between the arrival of penetrating radiation and atmospherics.

In each interval before the arrival of penetrating radiation the factor does not differ from unity by more than probable error. But in the two seconds immediately following, there is an excess amounting in the first case to about $2\frac{1}{2}$ times probable error, and in the second case to twice probable error. The interval, 2–5 seconds following, shows no such excess.

If, as we believe, atmospherics come from thundercloud discharges, our results are in agreement with those of Schonland and Viljoen[2] who found that the number of discharges of a single counter is greater in a small interval before a lightning flash than during a similar interval afterwards. They also support the original theory of C. T. R. Wilson[3] that "runaway" electrons are projected upwards from the intense fields in thunderclouds and are returned to earth by the action of the earth's magnetic field. On the other hand, we have no evidence of simultaneity of incidence of atmospherics and ionising particles as was observed by Schonland and Viljoen.

The whole of the observations of Schonland and Viljoen were made on thunderstorms within a distance of 70 km. The present observations were made in south-east England on quiet autumn days when the atmospherics originated at much greater distances, the sources of those on which measurements were made being possibly at distances between 2,000 and 3,000 km. It is probable that particles produced during a lightning discharge (that is, during a time of decaying moment) would be of lower energy than those produced immediately before a flash, when the potential difference is a maximum ; the absence of coincidences between the arrival of atmospherics and penetrating radiation would then be due to our being beyond the area within which these particles of low energy are bent back to the ground by the earth's magnetic field.

It was hoped that the directional observations would indicate the location of those storms effective in producing the relation between atmospherics and penetrating radiation indicated above, but sufficient data have not yet been accumulated to give definite information on this point.

We are indebted to the Director of the National Physical Laboratory for permission to use the cathode-ray direction finder at the Radio Research Station, Slough, and also to the staff of the Radio Department of the Laboratory—in particular Mr. R. A. Watson Watt and Mr. J. F. Herd—for so generously putting their experience of the instrument at our disposal.

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Dec. 9.

[1] Watt and Herd, *J. Inst. Elec. Eng.*, **64**, 611 ; 1926. "The Cathode-Ray Oscillograph in Radio Research", H.M. Stationery Office, 1933.
[2] Schonland and Viljoen, *Proc. Roy. Soc.*, A, **140**, 314 ; 1933.
[3] Wilson, *Proc. Camb. Phil. Soc.*, **22**, 534 ; 1925.

Cystine Requirements of Fleece Growth

THE considerable sulphur content of clean wool, and its presence substantially in the form of a cystine nucleus, has led to much inquiry into the question of cystine being a limiting factor in wool growth. Various estimates of the cystine requirement for the fleece production have been made, on the assumption that this is given by the quantity of cystine recoverable in the wool.

Of the total cystine intake, a certain proportion is katabolised, and metabolised other than in follicle activity, but certain estimates have indicated that the total intake so nearly reaches the wool cystine yield (and in some estimates is actually exceeded by it), that Rimington and Bekker[1] have suggested that the sheep is an exception to the generally accepted view that cystine must be preformed in the animal diet. This is rejected by Woodman and Evans[2], who claim that their pasture analyses, quoted by Rimington and Bekker, provide, on their interpretation, an adequacy of cystine for the clean wool yield.

It seems clear that the present available methods for cystine estimation, as applied to foodstuffs, are too uncertain to permit of any definite conclusion on this fundamental point. Also it has apparently not been realised that it is fallacious to regard the cystine content of the wool as being identical with that utilised by the follicle population, so that it cannot therefore be regarded even as a minimal requirement.

The follicle mechanism is as much concerned in elaborating the inner root sheath as the fibre proper. In fact, on the cystine gradient postulated by us[3], the inner root sheath would have priority in call upon the cystine supply. This inner root sheath is dissipated by fragmentation, and goes to join other products, for example, wool fat and suint, which form the non-wool fraction of the whole fleece, and is therefore excluded from the chemical analysis of the clean wool.

With certain observed cases of diminished fibre growth, accumulation of this inner root sheath material (no doubt contaminated with ordinary epidermal 'scurf') has occurred, which has provided sufficient material for qualitative tests. It gives, with Sullivan's reagent and the lead acetate test, strongly positive reactions for cystine. (Also the Pauly test reacts positively for tyrosine.)

It is hoped to determine with more precision the cystine content of this material ordinarily lost; meanwhile, however, it would not be unreasonable to assume that it is at least no less than that of the fibre proper.

In any event, the cystine absorbed in inner root sheath formation, and ultimately disappearing from the food cystine–wool cystine balance sheet, becomes significant in a degree depending upon the relative rates of production of inner root sheath and fibre. Approximate estimates of these relative proportions are being sought.

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Nov. 15.

[1] Rimington and Bekker, NATURE, **129**, 687, May 7, 1932.
[2] Woodman and Evans, NATURE, **130**, 1001, Dec. 31, 1932.
[3] King and Nichols, *Trans. Faraday Soc.*, **29**, 272; 1933.

Acceleration of Tissue Respiration by a Nitrophenol

WHILST it has been known since 1885 that certain nitrophenols can cause a remarkable increase in the metabolism of the whole animal, the mechanism of this action is still little understood. Experiments with perfused limbs led Magne, Mayer and Plantefol[1] to the view that 1 : 2 : 4-dinitrophenol ('thermol') causes a direct stimulation of cellular oxidations with increased carbohydrate consumption. Proof of this idea is now given by the experiments described below, in which it is shown that a nitrophenol can cause a large increase in the respiration of thin slices of surviving rat tissue when added in suitable concentration to the medium in which they are respiring.

The measurements were made in the Haldane-Barcroft-Warburg apparatus, and respiratory quotients were determined in bicarbonate-containing salt solutions by the method of Dickens and Simer[2]. The nitrophenol used was 4 : 6-dinitro-*o*-cresol, this being pharmacologically the most active body of this type so far tested (Dodds and Pope[3]).

Dinitro-*o*-cresol increases the respiration of surviving kidney tissue. According to Barron[4], only those tissues which have an aerobic glycolysis show an increased respiration in the presence of the reversible dyestuff methylene blue. Kidney has a very low aerobic glycolysis, and its respiration in glucose is slightly decreased by methylene blue. Yet dinitro-*o*-cresol in 10^{-5} m. concentration will cause increases of respiration up to 80 per cent with kidney in lactate-containing phosphate media. The respiration is maintained at the increased value for at least one hour following addition of the nitro-body. Under these conditions, the Q_{O_2} may rise to so high as 60, that is, to about double the normal value for rat retina in glucose. Respiratory quotient determinations show that the extra oxygen uptake caused by the presence of the nitro-body represents complete oxidation of foodstuff, as is shown by the following experiment with rat kidney slices in lactate-containing bicarbonate medium :

	R.Q.	Q_{O_2}	$Q^{O_2}_{CO_2}$
Control	0·78; 0·78 (duplicates)	−28·7; −29·6	−3·4; −4·6
With 10^{-5} M. dinitro-*o*-cresol	0·87; 0·86 (duplicates)	−46·0; −46·7	−8·6; −8·0

Taking means of the duplicate determinations, the extra oxygen uptake due to the dinitro-*o*-cresol was $Q_{O_2} = 17{\cdot}2$; whilst the extra carbon dioxide production was $Q_{CO_2} = 17{\cdot}2$. Hence the extra oxygen burnt the metabolite at *R.Q.* unity. With rat brain cortex, which normally has *R.Q.* unity, the respiration was still maintained at a carbohydrate quotient when the oxygen uptake was increased about 40 per cent by dinitro-*o*-cresol. Respiration is also increased in pyruvate-containing media, being maintained at the theoretical *R.Q.* for pyruvate oxidation (1·2).

The respiration of kidney in the presence of glucose is increased in bicarbonate but not in phosphate-containing media. Whilst work is being undertaken to elucidate this surprising difference, it should be mentioned that Friedheim[5] found with pyocyanine quite the reverse effect. With this catalyst the respiration of kidney was increased in phosphate but not in bicarbonate Ringer, but the magnitude of the increase is not stated.

10^{-5} m. appears to be roughly the optimal concentration for dinitro-*o*-cresol. With 10^{-4} m. and higher concentrations the respiration is inhibited.

As to the mechanism of the action of this nitrophenol, nothing can at the moment be said. On the other hand, the experiments lead us strongly to the view that normal tissues, even when saturated with oxygen, have their respiration limited by the oxygen-transfer catalysts and not by the substrate-activating enzymes.

The action of dinitro-*o*-cresol on tumour tissue, that is, tissue with defective carbohydrate oxidation, is still under investigation.

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Dec. 5.

[1] *Ann. Physiol.*, **8**, 1; 1932.
[2] *Biochem. J.*, **25**, 973; 1931.
[3] *Lancet*, Aug. 12, 1933, p. 352.
[4] *J. Exp. Med.*, **52**, 447; 1930.
[5] *Naturwiss.*, **20**, 171; 1932.

Conservation Laws and β-Emission

THE recent development of Dirac's theory of the electron has made it possible to compare the radioactive β-transformation with a process in which a pair of differently charged electrons is produced in the neighbourhood of the nucleus, the positive of which is captured in order to increase the nuclear charge by one unit. In addition to an investigation on this kind of process, which has already been described[1], a more general application of the conservation laws, characteristic for the theory, may now be described.

If A be a mechanical quantity for which a conservation law is expected to hold, and ΔA the difference of the respective quantities referring to the initial and the final state of the nucleus being transmutated by β-decay; let A refer to the negative, and A' to the positive electron assumed to be produced in the process; then the conservation law takes the form

$$\Delta A = A\,(+)\,A' \qquad (1)$$

(1) corresponds, however, only formally to a conservation law. The quantity A' corresponding to the positive electron assumed to be captured by the nucleus is lost. (It has been suggested that the quantities A' be ascribed to an unknown particle which it is proposed to call a 'neutrino'. There is, however, at present no need to assume the real existence of a neutrino, and the assumption of its existence would even be an unnecessary complication of the description of the β-decay process.) Applying (1) to the energy relation, then

$$\Delta E = W + W' \geqslant 2mc^2, \qquad (2)$$

where the energy W and W' of the negative and positive electrons is understood to include the rest energy mc^2, and ΔE represents the energy difference of the two nuclei. (2) evidently describes a continuous spectrum of the energy W, varying between the limits mc^2 and $\Delta E - mc^2$. It is easily seen, from the relation $W' \geqslant mc^2$, that in every process an energy loss takes place which is greater than the rest energy of an electron.

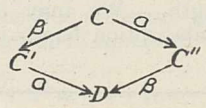
Applying (1) to the momentum balance of the process, we obtain

$$\vec{\Delta p} = \vec{p} + \vec{p'} \qquad (3)$$

Thus the momentum relation is violated by the quantity $\vec{p'}$ in every process. Taking into account that the wave-lengths of the electrons assumed to be produced are comparable with the dimensions of the region where the production takes place, it is seen, without detailed calculation, that the angle between $\vec{p}$ and $\vec{p'}$ will be statistically distributed uniformly in all directions.

It may be noticed that (1) applies even to the change of statistics occurring during the β-decay process if A is understood to symbolise the statistical character of the particles in question.

(2) can be checked with the experimental data available for both sides of a radioactive branch:



According to (2), we obtain for both sides of the branch

$$(W + W' + E_a)_{CC'D} = (E_a + W + W')_{CC''D} \qquad (4)$$

Though the energy set free by the $CC'D$ and the $CC''D$ transmutation will as a rule be different, the same value would be expected on both sides of the branch, if the upper energy limits of the respective β-spectra are introduced. The experimental data for the thorium branch have been recently discussed by Ellis and Mott[2] and have been found to agree with (4). For the other branches the upper energy limits are not all measured, but can be roughly obtained from the rates of decay by extrapolation of the two curves measured by Sargent[3] and taking into account the favourable case of the two possibilities.

Radium-branch:

Ra C → Ra C′	$= 3{\cdot}2\times10^6$	Ra C → Ra C″	$\cong 5{\cdot}5\times10^6$
Ra C′ → Ra D	$= 7{\cdot}8\times10^6$	Ra C″ → Ra D	$\cong 5{\cdot}0\times10^6$ *
	$11{\cdot}0\times10^6$ e. volts		$10{\cdot}5\times10^6$ e. volts

Actinium-branch:

Ac C → Ac C′	$\cong 0{\cdot}4\times10^6$ †	Ac C → Ac C″	$= 6{\cdot}7\times10^6$
Ac C′ → Ac D	$= 7{\cdot}5\times10^6$	Ac C″ → Ac D	$= 1{\cdot}5\times10^6$
	$7{\cdot}9\times10^6$ e. volts		$8{\cdot}2\times10^6$ e. volts

* Extrapolated from Sargent's second curve (Ra E, etc.)
† Extrapolated from Sargent's first curve (Ra B, etc.)

This agreement can be regarded as an argument in favour of the relations (1) and (2), though our relations are more general than the usual form of the conservation laws. In order to obtain, however, the shape of the continuous β-spectra, a more detailed investigation is required, which has been given in the theory quoted above and also gives an interpretation of Sargent's curves.

Applying (2) to the β-branch of uranium X_1, suggested by several authors, we find a striking disagreement of the energy values on both sides of the branch. This seems to confirm the view that uranium Z may not be a branch product, but a derivative of a still unknown isotope of uranium.

G. BECK.

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University, Copenhagen.
Nov. 13.

[1] Beck and Sitte, *Z. Phys.*, **86**, 105; 1933: Beck, *Z. Phys.*, **83**, 498; 1933: Sitte, *Phys. Z.*, **34**, 627; 1933.
[2] *Proc. Roy. Soc.*, A, **141**, 502; 1933.
[3] *Proc. Roy. Soc.*, A, **139**, 659; 1933.

Remarkable Optical Properties of the Alkali Metals

WOOD[1] has shown that the alkali metals become highly transparent in the ultra-violet region, there being for each metal a definite wave-length above which the metal becomes opaque. Kronig[2] has used the quantum theory of the optical properties of metals previously developed by him[3] to account qualitatively for the phenomenon, and has suggested that it is due to the absorption bands caused by the periodicity of the lattice. Hill[4] has made a similar suggestion. The purpose of the present note is to show that if the electrons are treated as free (moving in no field), we can not only account qualitatively for the phenomenon observed by Wood, but also can predict correctly the approximate values of the critical wave-length. We may deduce that the influence of the absorption bands is small.

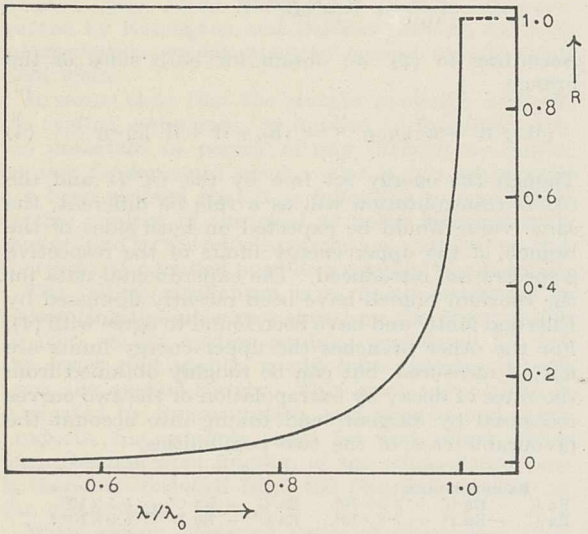

FIG. 1. Reflectivity of a metal using the free electron gas model.

Kronig has shown that, for free electrons, quantum and classical theories give the same result; and, moreover, that for the frequencies in question the resistance of the metal can have little influence, since the time between collisions of the electrons with the lattice (greater than 10^{-14} sec.) is greater than the period of oscillation of the electric field. We thus have for the polarisation P of the electron gas:

$$P = -(Ne^2/4\pi^2 m\nu^2)\, E,$$

where N is the number of electrons (or atoms for the alkalis) per unit volume, ν is the frequency of the light, and E is the effective field (not $E + 4\pi/3\, P$, as in the theory of the polarisation of a dielectric, cf. Tonks, NATURE, July 15 and Nov. 4, 1933, pp. 101, 710, or Norton, NATURE, Oct. 28, 1933, p. 676, who discuss the polarisation of the Heaviside layer). The dielectric constant ε is then

$$\varepsilon = 1 - Ne^2/\pi m\nu^2$$

There is a critical frequency ν_0 or wave-length λ_0 when ε is zero, that is, at

$$\nu_0^2 = (c/\lambda_0)^2 = Ne^2/\pi m \qquad (1)$$

When $\lambda > \lambda_0$, light is totally reflected, and when $\lambda < \lambda_0$, the proportion R of light reflected is

$$R = \left(\frac{n-1}{n+1}\right)^2$$

where n, the refractive index, is equal to $\varepsilon^{1/2}$. The dependence of R upon λ is shown in Fig. 1, and has the general characteristics found by Wood.

The point λ_0 in the spectrum at which transparency commences is given by Wood as follows: Cs, 4400 A.; Rb, 3600 A.; K, 3150 A.; Na, 2100 A.; Li, 2050 A. Equation (1) gives for λ_0 the following values: Cs, 3600 A.; Rb, 3200 A.; K, 2900 A.; Na, 2100 A.; Li, 1550 A.

CLARENCE ZENER.

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Bristol.
Nov. 11.

[1] Wood, NATURE, **131**, 582, April 22, 1933. *Phys. Rev.*, **44**, 353; 1933.
[2] Kronig, NATURE, **132**, 601, Oct. 14, 1933.
[3] Kronig, *Proc. Roy. Soc.*, A, **124**, 409; 1929; **133**, 255; 1931.
[4] Hill, *Rev. Sci. Inst.*, **4**, 525; 1933.

Raman Spectrum of Fluorobenzene

BRADLEY[1] has studied the Raman spectra of $CHFCl_2$ and CF_2Cl_2, which appear to be the only fluorine compounds so far investigated. I have recently studied mono-fluorobenzene, and its Raman frequencies are found to be (in cm.$^{-1}$):

$$\nu_R = 243(5),\ 424(1),\ 521(3),\ 617(3),\ 757(2),\ 808(5),\ 1012(7),\ 1065(1),\ 1157(4),\ 1220(4),\ 1275(1),\ 1413(1),\ 1600(5),\ 3074(7).$$

The numbers within brackets indicate the approximate intensities in arbitrary units. The prominent frequency of 1220 cm.$^{-1}$ seems to be characteristic of the aromatic C – F binding. This value agrees well with $\nu_R = 1236$ cm.$^{-1}$ calculated, in the well-known manner, from the corresponding heat of dissociation.

Another characteristic feature of the spectrum is the large shift of the two prominent benzene frequencies 991 and 3063, produced by the fluorine substitution; indeed, the shifts are the largest so far noticed for these frequencies in benzene derivatives.

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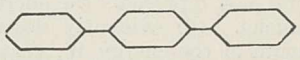
[1] *Phys. Rev.*, **40**, 908; 1932.

Molecular Orientations in *p*-Diphenylbenzene Crystal

IN recent papers[1] we have shown how a correlation of the principal diamagnetic susceptibilities of an organic crystal with those for the *molecules* of the substance, offers a convenient method for determining the orientations of the molecules in the crystal lattice. The crystal of *p*-diphenylbenzene, the



structure of which has recently been analysed by X-ray methods by Miss Pickett[2], is a very suitable substance for determination of molecular orientations by this method. The crystal belongs to the monoclinic system and is found by Miss Pickett to contain two molecules in the unit cell. The molecule has a centre of symmetry; the three benzene rings lie in a plane, and their centres are in a line.

The principal magnetic directions of the molecule are evidently (1) along the line joining the centres of the three benzene rings, (2) along the perpendicular direction in the plane of the rings, and (3) along the normal to the plane of the rings. The susceptibilities along these directions can be calculated from the known values for the benzene molecule (or from those for benzene and for diphenyl molecules) and are found to be

$$K_1 = K_2 = -91$$
$$K_3 = -254$$

respectively, in 10^{-6} c.g.s. e.m.u. per gm. mol.

The principal susceptibilities of the crystal are, in the same units :

$$\chi_1 = -94$$
$$\chi_2 = -203$$
$$\chi_3 = -139.$$

χ_3 is the susceptibility along the b axis ; the χ_1-axis, in the (010) plane, is found to lie in the acute angle β, making an angle of 14·3° with the c axis.

From these data the orientations of the two molecules in the unit cell can be deduced in the same manner as was described for diphenyl in a previous communication[3]. It is thus found that the lengths of the molecules lie in the (010) plane, in the acute angle β, making an angle of 14·3° with the c axis, while the planes of the two molecules are inclined at + 56·6° and − 56·6° respectively to the (010) plane. These values are in good agreement with the values 15·3° and ± 56° obtained for these angles by Miss Pickett from her X-ray data.

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[1] NATURE, **130**, 313, Aug. 27, 1932 ; and **131**, 653, May 6, 1933. *Phil. Trans.*, A, **231**, 235 ; 1933.
[2] *Proc. Roy. Soc.*, A, **142**, 333 ; 1933.
[3] *Phil. Trans.*, A, **231**, 256 ; 1933.

Reversed Fine Structure of the α-Rays

THE fine structure of the α-rays, discovered by Rosenblum and studied by him and by Lord Rutherford and his co-workers, was explained by Gamow's supposition that some of the α-particles escape from the nuclei with energies smaller than normal by certain discrete quantities. The difference of the energies remains in corresponding nuclei in the form of energy of excitation of other α-particles. As such excited α-particles are unstable, they fall to the ground-level and radiate the surplus of energy as γ-quanta.

Such excited α-particles can not only fall to the ground-level, but have also a certain probability of penetrating the potential barrier. By this means they give rise to groups of α-rays with energies greater than normal by the same quantities by which the energies of the fine structure groups of the preceding nuclei were less than normal. Such reversed fine structure groups can form only a small part of the main group, for all the elements that produce such phenomena (that is, all the elements following those that show fine structure) have comparatively small decay constants, and the probability of escape from the excited levels of nuclei must be much smaller for the excited α-particles than the probability of falling to the ground-level with emission of γ-quanta.

The relative intensity of the 'reversed' group is

$$N = P \frac{l_{\alpha'}}{g(\nu)}$$

where P is the proportion of the excited nuclei (or the relative intensity of the corresponding fine structure group of the preceding element), $l_{\alpha'}$ is the decay constant of the excited α-particles (calculated from the Gamow-Houtermans equation) and $g(\nu)$ is the probability of emission of γ-quanta of frequency ν, which according to Taylor and Mott is nearly proportional to V^3 for dipole radiation and to V^5 for quadrupole radiation.

For example, the fine structure group of An must give the reversed group of AcA with relative intensity

$$N \sim 0{\cdot}23 \frac{3{\cdot}2 \times 10^3}{10^{11}} = \sim 0{\cdot}8 \times 10^{-8}.$$

(This value was obtained by assuming for calculating $l_{\alpha'}$ that the radius of the excited level is the same as that of the normal one ; as actually it is greater, this value gives only the lower limit.) This intensity is not far beyond the sensitivity of modern methods.

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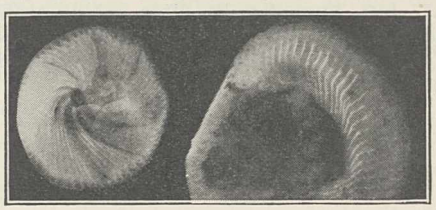
Change of Orientation of a Barnacle after Metamorphosis

IT is known that immediately after settlement, the cypris larvæ of the acorn barnacle can move about for a short time before they metamorphose ; and that they tend to collect in cracks along which their long axis is usually orientated. I am not aware, however, of any record of a change of orientation occurring once the larva has metamorphosed.



(*a*) (*b*)

FIG. 1. (*a*) × 5. (*b*) × 4.

I obtained recently a specimen of *Balanus improvisus*, Darwin, var. *assimilis*, which was growing in the glass outlet pipe of one of the aquarium tanks here. The base of the barnacle, together with its radially running pores, was clearly visible through the glass (Fig. 1*a*), and these pores were curved instead of, as normally, straight. Now since each of these pores corresponds with a parietal pore in the walls, and since the basis, which is added to at the edge only, cannot rotate on the substratum to which it is attached, it follows that the lower edges of the walls must have rotated as the animal grew. Further, since the parietal pores in the walls were vertical and not oblique, it follows that the whole wall, up to the apex, must have rotated correspondingly—in this case through about 90°.

Of seven specimens of this variety from the plaice-

hatching apparatus, only one showed straight radial pores in the base. Several had grown on a curve to a certain point, and then assumed a straight radial direction: but it is remarkable to note that the change was abrupt and not gradual. Part of one of these specimens (in which the centre was slightly damaged) is shown in Fig. 1*b*.

Finally a number of specimens of the typical form of this species from an outside pond were examined, and all had normal straight basal pores.

There seems to be a definite correlation between this change of orientation and the situation of the animal in a current of water of constant direction of flow. The specimen shown in Fig. 1*a* seems from the orientation of the earliest visible part of its shell to have settled with its long axis along the tube, that is, in line with the current. This is consistent with the elongated shape of the larva. When examined it had swung through almost a right angle so as to lie across the current.

The following table shows the mean angular deviation from the direction of flow of the current, in relation to size, for 192 specimens from the edges of boards in the hatching ponds which were subject to an intermittent current of constant direction.

Length in mm. . .	0–1	1–2	2–3	3–4	4–5
No. of specimens	6	94	60	26	6
Mean deviation from current . .	27°	49°	60°	75°	70°

Some of these specimens were removed, and most showed curved growth in the base. A sample from the flat side of the boards where there was no current, showed no change of orientation in the larger individuals, and straight radial basal growth in all cases.

From these considerations it would appear that if a barnacle larva settles in a steady stream of water, it tends to attach itself so as to lie along the current, but immediately after metamorphosis it commences to rotate, and continues to do so until it lies across the current, in which position it then remains.

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Electromagnetic Mass

BY the modifications of Maxwell's field equations recently proposed[1] it is possible to revive the old idea of the electromagnetic origin of inertia. The mass of the electron can then be calculated from its charge and the constants of the field equations (the velocity of light c, and the absolute field a^{-1}). It can be shown that the Lorentz equations for the motion of an electron in an external field are approximately true, and that the energy is given by mc^2. (The disagreement of these quantities stated in the Royal Society paper referred to above turned out to be a mistake.) The tensor S, the components of which are Maxwell's stresses, density of momentum and of energy, can be represented in two different forms, one using the Lagrangian,

$$L = a^{-2}\{1 - [1 + a^2(B^2 - E^2)]^{\frac{1}{2}}\},$$

the other the Hamiltonian,

$$\mathrm{H} = a^{-2}\{[1 + a^2(B^2 - E^2)]^{-\frac{1}{2}} - 1\},$$

where E is the electric and B the magnetic field vector. For example, the 44-component of S, representing density of energy, is given by

$$S_{44} = L + DE = -(\mathrm{H} + HB),$$

where the vectors H, D are connected with B, E by

$$H = \frac{\delta L}{\delta B}, D = \frac{\delta L}{\delta E} \text{ or } B = \frac{\delta \mathrm{H}}{\delta H}, E = \frac{\delta \mathrm{H}}{\delta D}.$$

For an electron at rest ($H = B = 0$) the mass m is related to the total energy by the equation

$$mc^2 = \frac{1}{4\pi}\int \mathrm{H}dV = \tfrac{2}{3}e\varphi(0) = 1{\cdot}2361\frac{e^2}{r_0},$$

where $r_0 = \sqrt{ae}$ and

$$\varphi(0) = \frac{e}{r_0}\int_0^\infty \frac{dx}{\sqrt{1+x^4}} = \frac{e}{r_0}\int_0^{\frac{\pi}{2}} \frac{d\alpha}{\sqrt{1-\frac{1}{2}\sin^2\alpha}} = \frac{e}{r_0}1{\cdot}8541\ldots$$

is the value of the potential at the centre of the electron. By integrating the conservation law for S, we obtain the Lorentz equations of motion for external fields which contain only those wave-lengths which are large compared with r_0.

From this it follows that Dirac's wave equation is the adequate expression for the quantum-mechanical laws of motion of the electron in external fields of this kind. Further, the mass appears here to be self-energy which justifies the suppression of the corresponding terms occurring in the quantum mechanical laws of interaction of several particles.

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[1] NATURE, **132**, 282, Aug. 19, 1933. *Proc. Roy. Soc.*, In the press.

Raman Spectrum of Heavy Water

(BY CABLE)

THE Raman spectrum of heavy water has been obtained by 2536 excitation of 8 c.c. of 18 per cent heavy water in a quartz tube 35 cm. in length in contact with a quartz mercury vacuum tube. Two Raman bands were obtained with an intensity ratio of one to four, the new one having a mean wave-length of 2713 A. due to water molecules containing one atom of heavy hydrogen. The frequency difference was 2577, against 3420 for ordinary water. Cross and Van Vleck (*J. Chem. Phys.*, June) have calculated a Raman frequency difference of 2720 for heavy water vapour, but a lower value is to be expected for the liquid, which Dieke has calculated as agreeing with my value within four per cent. There appeared to be slight indication of the band due to molecules containing two atoms of heavy hydrogen, but the faint continuous background made any certain measurements impossible. The heavy water was prepared by John W. Murray, of the Department of Chemistry.

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Dec. 16.

Research Items

Kent's Cavern. In "The History of Kent's Cavern, Torquay", by Mr. H. G. Dowie (W. F. and J. W. Powe, Kent's Cavern, Torquay), an account is given of the stratification of this important station, which supplements previously published information in the light of recent excavation. The oldest known deposit, as yet incompletely examined, appears to be a silt passing below the breccia in the Bear's Den and elsewhere. So far as known, it is almost barren of animal and human remains. Of the same phase is a floor of stalagmite completely broken up by later disturbance. Then follows the deposit of 'breccia' divided into two distinct deposits, a concreted bone bed and an incoherent grit, the latter nearly barren. The deposit known as the Middle Stalagmite floor was followed by a period of disturbance, carrying in the cave earth containing a fauna consisting of hyænas and their prey. Above that, during a period of calm, the Upper or Granular Stalagmite floor was formed, on which accumulated the Black Mould, in part perhaps of æolian origin, containing the remains of existing species of animals. There would appear to have been three periods of calm, during which the stalagmite was laid down, and three periods of disturbance, during which the principal deposits were introduced into the cavern. Of the artefacts which have been found in the cave, the Chellean tools are probably very early, and show no very considerable evolution beyond the prototypical rostro-carinate. They seem to belong to the deposits of the subterranean river rather than to the incoherent grit with which they were swept up. They may be claimed as older than any implement so far discovered in any cave in Europe.

Population Map of Great Britain. A map showing the density of population in Great Britain on the basis of the 1931 census is being published by the Ordnance Survey in two sheets, price 1*s.* 6*d.* each, and the northern sheet has been issued. It covers the whole of Great Britain north of lat. 54°, that is to say, the country north of a line from Morecambe Bay to Bridlington Bay; Ireland and the Isle of Man are left blank. The Shetlands appear as an inset. The scale is 1 : 1,000,000 and the foundation map is in the style of the international map of that scale. Density of population is shown by white (0 to 1 per square mile) and eleven tints of deepening colour ranging from light brown through darkening browns to dark greys and black. The last is for 'very congested' population of 76,800 or more per square mile. The colour printing is excellent and on this relatively small scale the tints give a satisfactory impression of gradations. Place names, in black, used with wise discrimination and names of water features, in blue, avoid any suggestion of crowding even in the most densely populated areas. County boundaries are shown but county names are given only in an inset. Marginal numbers and letters provide index facilities.

Nesting Season of Birds in relation to Food. It would appear that the span of the nesting season amongst birds may bear some relation to the nature of their food. At any rate, three years' intensive observations in Butte County, California, have led William B. Davis to these conclusions (*Condor*, 35, 151; 1933). Nesting activities begin in February, reach their peak in the last two weeks of April and decline rapidly after May 15. The flesh-eating birds as a rule began nesting first and had the longest span of nesting season; vegetable and seed-eating birds, as a group, began nesting last and had the most concentrated span of season; and omnivorous and insect-eating birds were intermediate in both these respects. The order in which the four groups followed each other in nesting activities suggested that a positive correlation existed between the availability of food used for young birds and the time of nesting.

Sheep Blowfly in Australia. Blowflies, directly and indirectly, are among the most serious afflictions with which the Australian pastoralist has to contend. In bad years these insects entail losses upwards of £4,000,000 per annum. Under the title "The Sheep Blowfly Problem in Australia. Report No. 1" a comprehensive account of the whole subject, edited by Drs. R. J. Tillyard and H. R. Seddon, has recently been issued by the Council for Scientific and Industrial Research acting in conjunction with the New South Wales Department of Agriculture. This report brings the latest information together and includes both published and unpublished observations made by numerous investigators. The great frequency of the blowfly trouble is attributed largely to (1) the breeding of a type of merino sheep that is specially susceptible to attack and (2) to the accidental introduction and spread of the fly *Lucilia cuprina*, which is responsible for most of the primary infestations on the sheep. The report lays stress on the fact that sheep blowflies are divisible into primary and secondary species. Primary flies initiate the attack on the living sheep, whereas secondary flies follow after the attack of the primary species, although the effects may be even more severe. Notwithstanding the large amount of investigation already done, the problem is still to a large extent unsolved, and an extensive scheme for future work has been adopted.

Life-History of *Ambystoma*. G. K. Noble and M. K. Brady (*Zoologica*, Scient. Contr. New York Zool. Soc., vol. 11, No. 8, 1933) record observations on the life-history of the marbled salamander, *Ambystoma opacum*, which lays its eggs under leaf mould or other cover in situations which will be flooded by the winter rains. The breeding female is not at home in the water and will drown if confined in water. An account is given of the behaviour of the males and females at the breeding time and the spermatophore is described as being about 5 mm. in height, 2 mm. wide at the base and having a quadrangular summit. The female lays about 150 eggs, each of which has four capsules and can withstand desiccation without destruction. After laying, the female usually remains with the eggs for a period of at least several weeks. Eggs hatch on land as well as in water; moisture facilitates development. Hatching is accomplished by the digestive action of a series of unicellular glands scattered over the head of the embryo. The terrestrial stage in the life cycle of *A. opacum* is an adaptation permitting the species to compete successfully in the same region with other species of *Ambystoma*.

Chromosomes in Insect Eggs. Besides important observations on vertebrate embryology and cytology, on tissue culture and on comparative anatomy, the report of the Department of Embryology in Year Book No. 31 of the Carnegie Institution of Washington contains interesting summaries of work in progress on the study of chromosomes in entire eggs of insects. By applying the Feulgen reaction, Dr. C. W. Metz and Miss M. L. Schmuck have been able to stain the chromosomes so that they are clearly seen in entire eggs of the fungus gnat (*Sciara*). This eliminates the elaborate sectioning technique and adds to the accuracy with which their structure and relative position in the egg can be determined. Dr. A. M. Du Bois has found that, at the fifth cleavage in the egg of *Sciara*, one or two chromosomes remain in the middle of the spindle, are not included in the daughter nuclei, and eventually disappear. The supernumerary chromosomes may be eliminated in one cleavage or more; they may be seen to be eliminated in the seventh, eighth or ninth cleavages. "That any of these supposedly indispensable bearers of the genes may be thus spared is a matter of great theoretical interest. The period during which the chromosomes are eliminated (fifth cleavage) is an important one, being the time at which the first two germ-cells differentiate and locate in the posterior end of the egg. From then on the germ cells divide actively but no longer synchronously with the somatic cells."

Electrical Phenomena and the Rise of Sap in Plants. An account of the beneficial effects of external electrostatic and electromagnetic fields on the growth of certain plants has recently been given by Marinesco ("Actualités scientifiques et industrielles", 37, Exposés de biophysique I, Hermann et Cie, Paris, 1932), in a brief review of research carried out by himself and other workers. Connected with the existence of a Helmholtz double layer in woody tissues, at the surface of separation of sap and cell wall (the sap being negatively, and the wall positively, charged), a series of interesting phenomena occurs. A potential difference placed across electrodes, either inserted in the stem or even situated entirely outside the plant, causes a variation of the rate of flow of sap between relatively wide limits, according to the sign and magnitude of the applied potential difference. If the higher electrode is positive with regard to the lower, then the flow of sap is increased considerably; if the higher electrode is negative, then the flow is impeded and can even be reversed, while an alternating E.M.F., applied across external electrodes, always causes an increase in the rate of ascent, by a process briefly explained in the paper. The most beneficial results are obtained by intermittent treatment. The author has obtained experimental results which suggest that the controlling factor in the normal flow of sap is the natural atmospheric potential gradient.

Tapioca in Malaya. The tapioca crop is important in many tropical countries, but its economic relations with the rubber plantations of the Straits Settlements and the Federated Malay States have called forth a monographic study by Messrs. V. R. Greenstreet and J. Lambourne ("Tapioca in Malaya". Dept. of Agriculture, Straits Settlements and Federated Malay States General Publications No. 13, pp. 1–76; 1933). The history of the introduction of the plant *Manihot utilissima* into cultivation is traced, and the numerous varieties at present in commerce are described and classified in detail. Tapioca is grown on small-holdings and on large plantations, but its greatest importance lies in the fact that it can be used to fill up a rubber plantation in the early stages. Indeed, it is possible to defray the cost of establishing a rubber plantation by growing tapioca between the trees. Large amounts of manure must be applied to the inter-crop, however, as it makes great demands on the soil nutrients. The manufacture of tapioca products is described, and the economics of the crop and the refined articles are discussed at length. Pests and diseases receive a short but adequate treatment, and an extensive bibliography is appended.

Stocks for Rose Bushes. A paper of outstanding interest to rose growers and scientific gardeners appears in the *Journal of the Royal Horticultural Society* ("A Botanical Study of Rose Stocks", by Miss J. Ferguson. Vol. 58, Pt. 2, pp. 344–371. Sept. 1933). The history of rose culture is traced briefly, especially as it relates to the readily-propagated stocks upon which the choicer varieties may be budded. Twenty species and varieties of roses suitable for stocks are described in detail and a key for their determination is given. One section deals with propagation both by cuttings and by seed, whilst another part describes the cytology of the various plants, many of which are polyploids. The list does not cover all the rose stocks in common use, but the knowledge set forth by Miss Ferguson has been keenly desired by rose-growers for some time. A summary at the end of the paper enumerates the characters most desirable in a rose stock for British conditions, and emphasis is laid upon the necessity for vegetative propagation, as seed-propagated stocks are rarely uniform.

Charnockite Series of Uganda. At the meeting of the Geological Society on December 6, Dr. A. W. Groves described the mode of occurrence and characters of a charnockite suite in Uganda. The charnockitic facies range from ultra-basic to acid rocks, and grade imperceptibly into the surrounding orthogneisses from which, chemically, they are indistinguishable. Altered dolerites which are magmatically unrelated to the suite under discussion become charnockitic heteromorphs within the charnockitic areas, while outside the latter they occur as amphibolites. This noteworthy evidence, combined with the general inversion of the order of Bowen's reaction series, indicating mineral reconstitution of the rocks in the solid state, leads to the conclusion that the Uganda charnockite series has originated from very deep-seated metamorphism of pre-existing rocks. This is in accord with chemical evidence, which shows that the rocks belong to the calc-alkali series and do not differ in any significant way from non-charnockitic examples of the series. Ten rocks and eight minerals have been analysed, and it is pointed out that the barium content of the rocks is localised in the orthoclase and biotite.

Zululand Earthquake of December 31, 1932. We have received an advance proof of a report on this earthquake by Messrs. L. J. Krige and F. A. Venter, who contributed a paper on the subject to the Geological Society of South Africa on August 14. On the map of the earthquake, the courses of five isoseismal lines are shown, and these indicate that

the epicentre lay beneath the sea, its position as determined from seismographic records being in lat. 28° 30′ S., long. 32° 50′ E., or about twenty-five miles off the coast near Cape St. Lucia. Along a strip of the adjoining coast, several buildings were damaged. A remarkable feature of this earthquake was the extent of its disturbed area. The shock was distinctly felt at Johannesburg, more than 300 miles from the epicentre, and it is estimated that it must have been sensible over an area of about 300,000 square miles, or nearly equal to that shaken by the great Mino-Owari earthquake of 1891.

Sunspots and Depressions. A statistical study of the relative frequency of formation of depressions in different parts of North America at times of sunspot maximum and sunspot minimum, with the object of bringing out any relationship that may exist between the solar and terrestrial phenomena, is the subject of a recent paper by C. J. Kullmer, of the University of Syracuse ("The Latitude Shift of the Storm Track in the 11-year Solar Period". Smithsonian Miscellaneous Collections. Vol. 89, No. 2). The author is led to seek for a shift of latitude in the principal storm track on the grounds that there is, according to Spoerer, a striking latitude shift in the sunspot cycle, each new cycle of solar activity beginning in about 25° solar latitude and ending in about 10°. The method of study is, however, such as to bring out differences in longitude almost equally well: the whole country is divided up into units covering 2½° of latitude and 5° of longitude, and the frequency of occurrence of storm centres in each unit area during three years at sunspot maximum and three years at the preceding minimum are compared, beginning with the maximum of 1882–84 and ending with that of 1927–29, making five sets of figures that are presented cartographically. The resulting pattern of distribution shows distinct similarity in the five cases. The sunspot maxima show an area of pronounced excess of storm frequency that extends almost completely across the northern part of the continent around latitudes 45°–55°, with a southward extension that generally reaches the Gulf of Mexico. Eastward and westward of the upper part of the extension are areas of deficient storm frequency. A curious feature is a progressive eastward and northward shift of the whole pattern for three solar periods, and then a sudden return to an even more southerly and westerly position. It is clear that the permanent existence of such an orderly progression cannot be accepted without further data.

Ignition of Firedamp by Electric Light Filaments. The Safety in Mines Research Board has just issued Paper No. 80 (London: H.M. Stationery Office), which records experiments by G. Allsop and T. S. E. Thomas on the ignition of firedamp by the filaments of broken electric lamp bulbs. In the ordinary electric bulb the filament is heated to a temperature of 2,000° C., and as the capacity of the filament for retaining heat varies as the square of its diameter whilst the heat losses from the surface varies the diameter, it is obvious that thick robust filaments are the more dangerous. It is, however, shown that with voltages up to 6 and with currents of less than 1 ampere, a protective cut-out, operated when the bulb is broken, is relatively safe, especially with gas-filled bulbs. Even in the best cases, the protective cut-out must function within a period between 0·02 and 0·12 sec.

Atomic Weight of Potassium. Hönigschmid and Sachtleben have described (*Z. anorg. Chem.*, 213, 365; 1933) analyses of potassium chloride and potassium bromide by the ratio to silver. Eighteen determinations of the ratio KCl : Ag gave the value 0·691069, practically in agreement with the value of Richards and Stähler, 0·691073, and the atomic weight K = 39·096. Nine determinations of the ratio KCl : AgCl gave 0·520132, corresponding with K = 39·097. Six determinations of KBr : Ag gave 1·103197, in agreement with Richards and Müller (1·10319) and K = 39·097. The independent value of KBr : AgBr, 0·633720, gives K = 39·094. The mean of 39 determinations leads to K = 39·096. This value is in agreement with that found recently by Baxter and MacNevin (NATURE, 132, 790; 1933), namely, 39·094–39·095, and the earlier, higher, values found by Hönigschmid and Gobeau are not confirmed. The cause of the higher value is not explained.

Structures of Carbonyl Compounds. An examination of the structures of the molecules of compounds is possible by the method of electron diffraction. The electrons are diffracted from a beam passing through a jet of gas entering a chamber at low pressure and condensed by a trap immediately above the gas nozzle, the chamber being evacuated by a pump. The diffraction photographs are then examined by a recording microphotometer and the diameters of the diffraction rings measured on the enlarged photometer curves. The formula used in calculation is

$$I = k \, \Sigma_i \, \Sigma_j \, \psi_i \, \psi_j \, \frac{\sin x_{ij}}{x_{ij}}$$

where $x_{ij} = 4 \pi l_{ij} (\sin \theta/2)/\lambda$, I is the relative intensity of electrons scattered at the angle θ, k is a constant under the experimental conditions, ψ is the electron scattering coefficient, which may be replaced by Z, the atomic number, l_{ij} is the distance between the ith and jth atoms, and λ is the wavelength of the electrons. Dornte (*J. Amer. Chem. Soc.*, October) has investigated by this method the structures of carbonyl sulphide, chloride and bromide, and acetyl chloride and bromide. Carbonyl sulphide has a linear molecule, the distances being C—S 1·58 and C—O 1·13. The other carbonyl molecules have plane *Y*-structures, the angle between the halogen atoms of carbonyl chloride and bromide being 110°. The tetrahedral model was found for acetyl chloride and bromide. The C—O distance was constant and about 1·13 for all these carbonyl compounds; the other interatomic distances are given.

Accuracy of Analysis of Fuels. The reliability of laboratory measurements of the properties of fuels depends on the combined errors of sampling and analysis. In order to ascertain the share of analytical error in the total, an investigation of the "Accuracy of Analytical Determinations on Coal and Coke" has been carried out by H. V. A. Briscoe, J. H. Jones and C. B. Marson (Phys. and Chem. Survey of Nat. Coal Resources, Paper No. 29. H.M.S.O., 9*d*. net). A single sample of coal was divided into 64 samples each of which was subjected to the usual tests. The results were examined statistically to arrive at the probable error. The results for calorific value varied by ± 80 from the mean. Similarly the calorific value determined in twelve different laboratories showed a variation of ± 95. While these figures will not surprise anyone familiar with the problem, they suggest that measurements of fuel efficiency are all liable to an error of 1 per cent.

Chemistry of the Tanning Process

THE advance which has been made in recent times in the understanding of the chemical reactions which underlie the ancient craft of tanning was well illustrated by the papers given in the discussion held on September 12 in Section B (Chemistry) of the British Association meeting at Leicester.

In the opening paper, Dr. D. Jordan Lloyd pointed out that in using hides and skins as raw materials, the tanner has a material which by its biological structure possesses firmness and flexibility and is highly suited for a large number of social purposes, yet, owing to the chemical activity of the protein which forms the fibres and the large amount of water held in the skin, possesses a chemical instability towards its environment and a liability towards bacterial attack that makes it unsuitable for use in its natural condition. The problem confronting the tanner, therefore, is how to preserve the desirable mechanical features due to the micro-structure while removing undesirable chemical properties.

The protein of the skin fibres, namely collagen, consists of elongated molecules lying parallel to each other to form micro-crystals, and these are grouped together to form long fibrils which are drawn together into fibres and fibre-bundles. The protein molecules have their centres of hydration and of chemical activity on their side chains, which project from the main elongated backbone of the molecule. By the process of vegetable tanning, the active centres of the side chains of the collagen molecules react with active centres in the tannin molecules, and since the latter are colloidal, it is necessary before tanning to give the skins a pre-treatment which will open up channels in the structure sufficiently to allow the large colloidal molecules to pass in, not only between the fibres and fibrils but also between the individual molecules. Dilute alkalis have this action and suspensions of lime in water are usually used for this purpose. The interaction of tannin and collagen leads to the suppression of chemically active centres, to the elimination of water and to the protection of the polypeptide link in the collagen molecules.

The chemistry of the tannins themselves was dealt with by Prof. K. Freudenberg. The characteristic feature of a tannin molecule is that it is a large molecule with a high content of phenolic groups. The gallotannins are esters of glucose and gallic acid or glucose and ellagic acid, while the catechol tannins are polymerised catechins. The reaction between protein and tannin occurs between the amine and amide groups of the former and the phenolic groups of the latter. This reaction is also found between tannins and amines and amides of low molecular weight, but the more complicated the amides, the further the reaction proceeds. The reaction of tanning also involves a subsequent oxidation of the collagen-tannin compound. All tannins contain a hydrophobic nucleus surrounded by hydrophilic groups. Dr. P. Maitland gave a detailed account of the preparation and properties of the tannin from quebracho wood.

The fact that the peptide link of the protein molecules is involved in the tanning process was again emphasised in a paper by Prof. Max Bergmann. Proteolytic enzymes attack gelatin at a free surface, but only attack the chemically similar collagen of raw hides and skins at surfaces where the fibres have been cut across. After the liming treatment, however, trypsin is able to attack the fibres along their length as well as at their ends. The effect of tanning is to increase the resistance of the limed fibres to attack by trypsin. In vegetable tanning, however, the liability to digestion by trypsin is never completely lost in tanned hides, though the extent to which the tanned fibre may be attacked is influenced by the pre-tanning treatment and by the nature of the tanning materials used in the tannage; even the size of the tannin molecule may have an important effect on the resistance of the leather to digestion. The protection of the peptide link by the tanning reaction is, however, a very definite fact.

Mr. F. C. Thompson rather emphasised the importance of the reaction between tannins and the amino groups of the protein. Tannins are themselves acid bodies ionising in aqueous solution, and the amino groups of the collagen exist as basic centres carrying positive charges. The first reaction that occurs on mixing tannin and protein is, therefore, salt formation, and since tanning always takes place in acid solutions, there is elimination of free acid. Tannins can displace strong acids, such as hydrochloric acid, from combination with gelatin, and Mr. Thompson suggested that the formation of an insoluble salt between tannin and protein would be sufficient to account for this fact.

Dr. F. E. Humphreys brought the discussion back to the question of the importance of the molecular weight and the degree of hydration of the constituents of the more common vegetable tanning materials and showed that in general, high average molecular weight, as determined by depression of the freezing point, is associated with low average degree of hydration, as determined by the Gortner sugar method. These factors of molecular size and hydration are probably the basis of the property of tan liquors usually described by tanners as 'astringency'.

Dr. H. Phillips again emphasised the importance of the size and degree of hydration of the tannin molecules and pointed out that although interaction between gelatin in solution and tannins may be rapid, that between hide and skin and tannins is slow since the colloidal tannins have to penetrate the structure of the hide. The rate of this penetration depends on the size of the inter-molecular spaces in the hide, the size of the tannin molecules, the intensity of the electrical charge on the molecules of both protein and tannin and the degree of hydration of the tannin molecules. Hides and skins immersed in a simple solution of a tannin would only tan on their outer surfaces, which would become blocked with tan. The chemical properties of the tannins set limits to the extent to which the tanner can assist diffusion by widening the inter-molecular spaces in the hide through adjustment of the acidity of the liquors. For this reason the presence of substances, classed together as non-tannins, is important, as these substances, which are generally heavily hydrated, combine with tannins, producing complexes which are more hydrated than the original tannins. Because these complexes are more hydrated, they do not form water-resistant linkages with the collagen and can therefore penetrate right into the hide. The astringency of any tanning material is thus inversely proportional to its degree of hydration. Dr. Phillips showed how tannins and collagen both holding water

at their polar groups can come together and form hydrophobic compounds.

The interesting feature of this series of papers was the growing realisation on the part of chemists of the importance of structure, be it molecular, micellar or microscopic. Certainly the chemistry of the tanning process cannot be explained without taking structure into account. With the small molecules which usually enter into the better-known reactions of classical organic chemistry, the significance of their stereometric pattern is not very conspicuous, but as soon as large colloidal molecules, such as tannins and proteins, have to be considered, all grades of structure play an important part in controlling the coming together of the active centres of the two interacting components. The great importance of water as playing an active rôle in the chemical processes was also evidently in the minds of most of the speakers. The chemistry of tanning is the chemistry of turning the hydrated and putrescible material, collagen, into the dehydrated material, collagen tannate, with its active centres suppressed and the peptide links protected from the liability of putrefactive attack. D. J. L.

Eighth General Conference of Weights and Measures

UNDER the treaty known as the 'Convention du Mètre', made in 1875 and revised in 1921, 48 delegates, representing 29 out of the 31 nations now adhering to the Convention, assembled in the historic Salon de l'Horloge, at the Ministère des Affaires Étrangères in Paris on October 3, under the presidency of the French Minister of Industry and Commerce, M. Serre, for the opening session of the eighth Conférence Générale des Poids et Mesures.

At the subsequent meetings of the Conference, held at the Bureau International des Poids et Mesures, Sèvres, under the presidency of M. Cotton, member of the Institut de France, a varied programme of considerable importance to all concerned with precise measurement, whether from an industrial or scientific point of view, was transacted.

After receiving the report of the International Committee on the work of the Bureau for the six years which have elapsed since the meetings of the previous Conférence Générale, the Conference first authorised the issue of new certificates for those of the national copies of the metre and the kilogramme which had been found, on re-verification, to have varied by more than the amounts regarded as possibly attributable to experimental error. Incidentally, the recent researches of the Bureau have led to the conclusion that the differences between the coefficients of thermal expansion previously attributed to the various national copies of the metre were probably not real, and that it would be better to assume a uniform mean value of the coefficient for all bars constructed from the same melt of the 10 per cent iridio-platinum alloy of which they are made. The Conference therefore also sanctioned the issue of amending certificates giving effect to this change, which, since the bars originally were not actually compared at 0° C., leads also to certain small changes in their accepted values at this temperature.

The Conference was informed of the results of recent determinations of the length of the metre in terms of the wave-length of the red radiation of cadmium, both at the National Physical Laboratory in Great Britain, and at the Physikalisch-Technische Reichsanstalt in Germany, and referred to the International Committee for further study a proposal to adopt a wave-length of visible light as the basis for the future definition of the unit of length.

At the previous Conference a new series of specifications for the international (thermodynamic) scale of temperature was given provisional sanction, and has since been in general use by the principal national laboratories of the world. A number of errata in the text of these specifications were corrected by the recent Conference, which also arranged for the calling of a Special Thermometric Conference to be held under its auspices, at which the details of the specifications could be further considered with the view of their final ratification and adoption at the next general Conference to be held in 1939.

On the proposition of the International Committee, based on the recommendation of its special Consultative Committee for Electricity, the Conference took the important step of adopting, in principle, the eventual substitution of the 'absolute' C.G.S. system of electrical units for the present International System, leaving to the Committee the duty of fixing, in collaboration with the various national laboratories, the relationships between the old and new units, and the date when the change should become effective. As regards the volt and ampere, the changes involved are not large enough to be of commercial significance at the present time, and it is well that the change should be made before increased precision in everyday measurement makes these significant. As regards the ohm, the change in this unit amounts to a decrease of about 5 parts in 10,000, which is, of course, appreciable in relation to the possible accuracy of comparison of resistance coils, and will therefore need to be taken into account by the makers and users of such instruments.

The Conference adopted a resolution putting on record that it regards itself, by virtue of the 1921 revision of the Convention, as the natural successor to the London Conference of 1908 which fixed the present electrical units, and in consequence as having the necessary powers to amend the decisions of that Conference if and when this may be thought necessary.

Following another recommendation of the Consultative Committee for Electricity, the Conference authorised the International Committee to constitute a separate Consultative Committee on similar lines to deal with the subject of photometric standards. In the constitution of this new Committee care is to be taken to secure as close liaison as practicable with the Select Committee of the International Illumination Commission, and its functions will be strictly limited, at least for the present, to the coordination of the work of the various national laboratories. The adoption of a black body, at the melting point of platinum, as the ultimate standard of luminosity, is envisaged, but all technical details were left, in the first instance, for consideration by the Committee.

A proposal by the delegate of the U.S.S.R. to establish yet another Consultative Committee, to deal with questions of practical metrology, that is, everyday control of weights and measures for commercial purposes, was referred back to the International Committee for consideration. J. E. S.

The Mount Everest Expedition, 1933—Geological Impressions*

By L. R. WAGER

THE route taken on the outward journey by the recent Mount Everest Expedition was the same as that followed by the previous expeditions and covered a region which, in part, had been geologically investigated by Hooker, Mallet, Hayden, Prof. E. J. Garwood, Dr. A. M. Heron and Mr. N. E. Odell. During the return journey some of the party zigzagged along the junction between the metamorphic complex of the main range and the Tibetan sedimentary zone, and the data obtained on the two journeys made it possible to extend the geological mapping in the strip between Mount Everest and Phari.

Over this whole distance (120 miles) a limestone, about 2,000 ft. thick (Heron's ? Permo-Trias), could be traced with but few interruptions. A thick, dominantly pelitic series much injected by granite occurred below this limestone, and above was a quartzite and shale series which underlay typical Jurassic shales. In the Quartzite and Shale series on the Lachi Ridge, four miles north-west of the Donkia La in North Sikkim, a brachiopod fauna was found. A preliminary examination suggested that the fauna is Lower Permian in age. The thick limestone below the fossiliferous horizon, since it forms the summit of Mount Everest, is called the Upper Everest Limestone; it can probably be assigned to the Permo-Carboniferous or Carboniferous system, while the Everest Pelitic series and Odell's Lower Calcareous series must be older.

The structure of the northern border of the eastern Himalaya in eastern Nepal and Sikkim is simple, consisting of Permo-Carboniferous and lower beds dipping gently northwards under the Tibetan Jurassic and Cretaceous rocks (so far the existence of the Trias has not been proved). Outliers of the conspicuous Upper Everest Limestone were found on various peaks in the Everest district, and also, according to Dyrenfurth, on the Jongsong Peak. Granites injecting the Everest Pelitic series, the Upper Everest Limestone, and sometimes the Jurassic beds are probably Tertiary in age. It is believed that in a more southerly zone a distinction can be drawn between Tertiary gneisses and granites and gneisses associated with migmatite and amphibolite which are older and equivalent to similar rocks of Peninsular India.

In the Darjeeling district, Mallet's careful mapping proves large-scale inversion, as the Darjeeling gneiss rests on the chloritic schist of the Daling series which in turn overlies the Damudas and Tertiary beds. The Damudas are roughly contemporaneous with the Quartzite and Shale series or the Upper Everest Limestone, and thus it is probable that the Daling series should be correlated with the Everest Pelitic series. It is interesting to find that to the east of the Darjeeling district the Baxa series, including thick dolomites, occurs between the Damuda and Daling series, the rocks in that area showing, therefore, a close lithological similarity with those of the same age to the north of the main range.

The main Arun gorge and the Yo Ri, the Rongme, and the Jikyop gorges of the Arun River were visited, and Oldham's view, that they are due to uplift of the main Himalayan range subsequent to the establishment of the drainage system, is regarded as the most satisfactory explanation. It is believed that the form of the range after the main compressive movements had occurred can be accurately determined from the present river pattern. The northern part of Sikkim, including Kinchenjunga (28,146 ft.) and the Tista Valley as low as 4,000 ft., is isostatically equivalent to a continuation southwards of the Tibetan plateau at a height of about 16,000 ft. Without wishing to imply anything approaching complete isostatic balance in the region, it is suggested that the grooving by rivers of the edge of the extended Tibetan plateau has resulted in a local upward movement of the crust which has raised the peaks of the eastern Himalaya to their present eminence.

* Substance of lecture delivered before the Geological Society on November 8.

The Neutron

IN his Bakerian lecture delivered before the Royal Society on May 25 and recently published (*Proc. Roy. Soc.*, A, Oct.), Dr. J. Chadwick gave an account of recent work on the neutron. It is now well known that neutrons are produced by bombarding light elements with α-particles, and neutrons have been detected from all the elements up to aluminium, with the exception of helium, nitrogen, carbon, oxygen. These exceptions are to be expected from the general rules of nuclear structure, for in all known nuclei, the atomic mass A is equal to or greater than $2Z$ and this condition would be violated by the new nuclei formed by the disintegration of the elements named with emission of a neutron. Some elements, for example, aluminium and fluorine, may disintegrate, giving either a neutron or a proton, and since these elements are isotopically simple, these are really alternative processes.

The dependence of neutron emission on the velocity of the primary α-particles has been examined and in the cases of boron and beryllium it appears that α-particles of comparatively low velocities penetrate the nucleus by a resonance process, while fast α-particles can enter over the top of the nuclear potential barrier. The energy balance sheet for the disintegration is difficult to construct because the energy of a neutron can only be inferred from the energy transferred to a recoil atom when the neutron strikes a nucleus. In the case of beryllium, it seems probable that the disintegration may result in the formation either of a fast neutron, or of a slower neutron and a γ-ray of about 7 million volts, energy and momentum being conserved.

The energy relations for several neutron-producing disintegrations suggest that the mass of the neutron is about 1·007—slightly less than that of the hydrogen nucleus. The neutron may be an elementary particle of this mass or it may consist of a proton and an electron, and the arguments on this point are conflicting.

Turning to the collisions of neutrons with atomic nuclei, the interaction is very small except at very small distances, on account of the small external fields of the neutron. The collision radius for a number of elements has been calculated by Massey and measured experimentally by a number of workers—in the very interesting case of hydrogen the cross section found experimentally is too small for the theory, and Chadwick makes the suggestion that if either the neutron or the proton is a complex particle, there may be an exchange interaction between the particles which reduces the effective cross section. In addition to these elastic collisions between neutrons and nuclei, inelastic collisions, resulting in disintegration of the struck nucleus, have been observed. The production of positive electrons by neutrons has been reported, but more work is needed here to separate the effects of neutrons and γ-rays.

University and Educational Intelligence

CAMBRIDGE.—The Appointments Committee of the Faculty of Biology "B" will shortly proceed to appoint a University demonstrator in pathology, the appointment to commence on July 1, 1934. Particulars as to stipend and duties may be obtained from Prof. Dean at the Department of Pathology, to whom applications should be sent on or before February 1, 1934.

The Adam Smith prize has been awarded to B. P. Adarkar, of King's College.

READING.—Prof. Francis A. Cavenagh has been appointed professor of education as from September 30. Prof. Cavenagh is at present professor of education in University College, Swansea.

Mr. H. R. Dent has presented to the University Library a complete set of "Everyman's Library", about nine hundred volumes, as an expression of his appreciation of the growth and work of University College and the University of Reading, as recorded in Dr. Childs's recently published book "Making a University".

LORD WAKEFIELD has undertaken to provide funds for a special lecturer in aeronautics for a period of three years at University College, Hull. The salary offered is £450 per annum. Applications should be made to the Principal, University College, Hull.

SCIENTIFIC research in the University of Wisconsin is to be stimulated on a lavish scale by relieving thirty-six full professors of all teaching duties, for periods ranging from a semester to a year, to devote themselves to research in various fields of pure and applied science. This new departure in university policy is the more striking by reason of the source from which it is being financed, namely, the Wisconsin Alumni Research Foundation, a non-profit-making corporation holding the patents of many discoveries made at the University by members of the faculty and using the income derived from them to promote more research. Most famous among these patents is one relating to the Steenbock process by which the vitamin D potencies of cod liver oil and other substances have been standardised and raised by irradiation with ultra-violet light. An announcement of the scheme has been circulated by Science Service, of Washington, D.C.

Calendar of Nature Topics

A Christmas Bird Census

A happy custom, now widely spread through Canada and the United States, is the combination of a holiday outing on or about Christmas Day with a methodical census of the birds in the district. The results, which give numerical statements of the bird population at many different places, ought to be as useful in interpreting the winter relations between residents and migrants, and the effects of different kinds of winters upon the distribution of birds, as summer censuses in Great Britain are in fixing the density of breeding populations. An indication of the extent of the Christmas Bird Census movement is given by the records of the observations made in Canada in 1931, published in the *Canadian Field Naturalist* of February 1932. Sixteen field clubs, ranging from Vancouver Island to Montreal and Toronto, have contributed their observations, generally made by small parties of observers—Ottawa had twenty-one observers in ten parties in the field, the Brodie Club of Toronto thirty observers in eight parties working from 7.30 a.m. until 3 p.m.

The Toronto Club saw 1,989 birds belonging to 41 species, excluding the introduced English sparrow, the only uncountable bird, recorded simply as "abundant" by every party. The Ottawa census revealed the largest number of starlings (831) in any Ottawa Christmas census, the previous record being 608 in 1930, an indication that this introduced species is also finding conditions very favourable.

It is a striking fact that in both censuses these introduced birds far exceed in number any of the native species—the numbers are remarkable : Ottawa, English sparrow 997, starling 831 ; Toronto, sparrow "abundant" everywhere, starling 508 ; the native bird which most closely approaches these aliens in the Ottawa district is the eastern snow-bunting with 308 individuals, and in the Toronto area, the old-squaw duck with 285, closely followed by the herring gull with 275. Of ruffed grouse the 1931 number (14) was exceeded only in 1926 (16) ; the number of American golden-eyes (45) was beaten only in 1927 ; and the 167 black-capped chickadees of 1930 were exceeded only in 1927 and 1929. The standardising of the routes traversed by the parties each year may lead to results of more value for comparative purposes. The idea of the Christmas Bird Census might be developed with advantage in Great Britain.

Sea-Lion Breeding Season

From about the end of December until the end of January the pups of the southern sea-lion (*Otaria bryonia*) are born upon the Falkland Islands, and during the time when they remain with their mothers they undergo a training in aquatic habits. At first the pups, which from a very early age are tolerably active, play with each other upon the beach and later in shallow tidal pools, but J. E. Hamilton found that they avoided deep water and were only induced to leave the shallows by the deliberate enticement of the cows (*Nat. Hist. Mag.*, 4, 56 ; 1933). A cow swims off-shore, her pup following as a dog swims, head held high, flippers beating rapidly. When water of a suitable depth is reached, the cow sets an example of shallow diving, endeavouring to get the pup to follow, and if the tired youngster endeavours to find a haven of refuge upon its mother's

back, she slips it again into the water. The skill and elegance of the movements of a sea-lion in the sea are not instinctive, but are learned by constant practice, and diving is acquired only with difficulty. In these respects the sea-lions differ from the true seals, where the ability to swim and dive come more naturally and less laboriously, as befits creatures which are more perfectly adapted to aquatic life.

Winter affects Mackerel-Fishing

Although mackerel-fishing at Monterey in California is carried on throughout the year, there are two seasonal periods when the number of fish caught shows a marked decline. One such period begins in autumn and reaches its lowest in December. The decline is not associated with cessation of fishing owing to winter storms, for the Bay is usually calm enough to permit fishing regardless of season, but it is thought that cold superficial temperatures drive the mackerel to deeper water where they are difficult to catch (R. S. Croker in Fish Bulletin No. 40, Division of Fish and Game of California, 1933). The second period of poor fishing, reaching its climax in April, appears to be due to a different cause; then the mackerel "are said to bite poorly, possibly because of an abundance of food". The Californian mackerel fishery has developed since 1880, an important advance having been made in 1927 when canned mackerel became commercially important. Almost a million cases were packed in 1928 and 1929, and production in 1930 and 1931 had to be curtailed.

Movements of Irish Sea Fish

In the report of the Lancashire Sea Fisheries Laboratory (1919), R. J. Daniel has summarised results of trawling experiments off the Mersey Estuary, and Johnstone (1927) has described the periodicities in the abundance of young fish in the area. Plaice, marked and released in Red Warfe Bay, Anglesey, have been found near the Isle of Man and in the south St. George's Channel, off Wexford and off Cornwall. Young plaice come into the Irish Sea through the St. George's Channel for a 'nursery' stage off the Lancashire and Dee coasts, returning for spawning to the Channel; there seems no proof of a second migration north. Soles spawn in the deeper and central parts of the region between the Isle of Man and the English coast. Whiting occur very abundantly in the Mersey estuary in late winter and spring, and though cod come into the northern region of the Irish Sea, where there are good though local fisheries, they are not abundant south of the Isle of Man. Codling are mostly found on the small fish grounds near the Mersey and Dee in the late autumn and winter, whiting are more abundant in summer and autumn, and plaice and dabs seem abundant at any time. Sometimes there are very big catches of the latter; in 1893, 10,407 plaice were taken in one haul of a shrimp trawl, and 14,697 plaice were taken in one haul on another occasion (Johnstone). Plaice were relatively abundant about 1895, 1910 and 1919, and relatively scarce about 1905, 1916 and 1927. Soles were relatively abundant about 1898 and 1905 and scarce about 1902 and since. Dabs were abundant in the Mersey estuary in 1897, 1902–5, 1910 and 1924, especially 1909–11, when single catches of 2,000–5,000 were frequently made; whiting were abundant in 1902, 1910, 1918 and 1925.

Societies and Academies

LONDON

Mineralogical Society, November 9 (Anniversary meeting). P. L. DRAVERT: Shower of meteoric stones in the neighbourhood of the village of Kuznetzova, West Siberia, on May 26, 1932. Between 5 and 6 p.m. in a cloudless sky, ten detonations were heard, and one stone of 2 kgm. was seen to fall, making a small oblique hole and then rebounding. Eight stones with a total weight of 23 kgm. (the largest 16 kgm.) were collected. Two of them, found 300 metres apart, can be fitted together on their flat crusted surfaces. The stone is a greyish-white friable chondrite with inclusions of troilite and grains of nickel-iron. The troilite was thought by the peasants to be gold, which led to the destruction of some of the material. P. A. CLAYTON and L. J. SPENCER: Silica-glass from the Libyan Desert. Clear, greenish-yellow silica-glass has been found in considerable amount as wind-worn masses up to 10 lb. in weight over an area of 80 km. × 25 km. at about 500 km. south-west of Cairo near the border of Italian Cyrenaica. It is found lying on the surface of the Nubian Sandstone in the 'streets' between the north-south sand-dune ridges. Analysis by M. H. Hey shows SiO_2 97·58 per cent with small amounts of aluminium, titanium, iron, calcium, sodium and a faint trace of nickel. Specific gravity 2·206, refractive index 1·4624 (sodium light), hardness 6. Some pieces are cloudy, due to presence of minute (0·1 mm.) bubbles. Effective gem-stones have been cut from the material. It shows certain relations to tektites and also to the silica-glass from meteoric craters, but no craters have been recognised at the locality. L. J. SPENCER: Fictitious occurrences of iron silicide (ferrosilicon). Bright, steel-grey nodules of iron silicide (FeSi), very resistant to acids (except hydrofluoric acid) and to weathering, are sometimes present in the calcium carbide residues from acetylene lamps. This waste material has been found at times in strange situations, and has on two occasions been described as a new mineral. It has also been thought to be meteoric. Occurrences in the gold dredgings in British Guiana and in the diamond fields of South Africa are readily explained by the use there of acetylene flares. ARTHUR RUSSELL: (1) Occurrence of wulfenite at Brandy Gill, Carrock Fell, Cumberland; and of leadhillite at Drumruck mine, Gatehouse of Fleet, Kirkcudbrightshire. Wulfenite occurs here in small (1·5 mm.) honey yellow platy to scale-like crystals, often nearly circular in outline. Thirteen specimens were collected from an old trial level dump. Leadhillite, a single specimen showing six-sided tabular crystals up to 5 mm. in diameter, was collected during the working of the Drumruck mine in 1917. (2) Occurrence of harmotome at several new localities in the British Isles. The occurrence of harmotome at the following mines is described: Snailbeach mine, Minsterley, Shropshire; Cwm Orog mine, Llangynog, Montgomeryshire; Settlingstones mine and Stonycroft mine, Fourstones, Northumberland; Whitespots mine, Newtonards, Co. Down, and Foxrock mine, Glendasan, Co. Wicklow. C. E. TILLEY and A. R. ALDERMAN: Progressive metasomatism in the flint nodules of the Scawt Hill contact zone. The flint nodules of the Chalk of the Scawt Hill contact zone provide striking examples of progressive metasomatism. Various stages—of which analyses are given—from an original nodule composed wholly of quartz

to an assemblage built up essentially of wollastonite, melilite and alkali-pyroxene can be traced. In the successive stages of replacement the characteristic shape and form of the nodules is preserved. The assemblages thus provide a particularly convincing illustration of a replacement process unaccompanied by volume change. The nature and source of the replacing solutions is discussed. F. COLES PHILLIPS: (1) Some relationships between the reflectivities of sulphide ore-minerals. A review of the reflectivity data now available for a large number of opaque minerals has shown that the relative reflectivity of simple sulphides, selenides and tellurides increases with atomic number. 'Molecular refractivities' of more than forty complex sulphides calculated from the measured reflectivities agree well with values computed from the 'molecular refractivities' of the constituent simple sulphides, assuming additivity. This relation indicates a method of calculating the reflectivity of an ore-mineral and also affords a useful check on the specific gravity quoted in the literature. The 'molecular refractivities' of sulphur, selenium and tellurium calculated from reflectivities also agree with values derived from a study of transparent ionic compounds. (2) A critical list of the specific gravities of the sulphides and allied ore-minerals. Variations in the values of the specific gravities of ore-minerals quoted in the literature are due to misprints, determinations on impure material or mixtures, and actual variation in composition of specimens owing to solid solution. The probable correctness of a specific gravity determination can be checked by comparison of calculated and computed 'molecular refractivities', by direct specific gravity determination of the synthetic mineral, and by the X-ray method. These criteria govern the author's choice of critical values, when correllated physical and chemical data on the same specimen are lacking. They are tabulated together with the maximum range of variation recorded in the literature.

PARIS

Academy of Sciences, November 6 (*C.R.*, **197**, 1009–1072). H. DOUVILLÉ and TILHO: The geology of the region north of the Tchad. P. A. DANGEARD: Observations on the vacuome of the Cyanophyceæ. Studies of vacuome formation in the Blue-green Algæ, utilising the two colouring matters, neutral red and cresyl blue. The conclusion is drawn that in the Cyanophyceæ the properties and evolution of the vacuome are not different from those already observed in other plant and animal cells. A. ROSENBLATT: The application of Picard's method of successive approximations to the study of certain non-linear equations of the fourth order. N. SALTYKOW: Semi-gauche functional groups, incomplete. ANDRÉ MACHIELS: Concerning an explanation of the outward velocities of nebulæ. Criticism of the use of a modified Doppler-Fizeau formula by H. D. Curtis: the conclusions drawn by the latter are, according to the author, invalid. G. BRUHAT and A. GUINIER: Photoelectric measurements of magnetic rotatory dispersion in the ultra-violet. The apparatus previously described by the authors has been applied to the measurement of the magnetic rotatory dispersion of heptane, heptene and heptine. A. A. GUNTZ: The theory of the phosphorogen. The concentration of phosphorogen is not sufficient, by itself, to characterise a phosphorescent body. A. ROUSSET: The diffusion of light and the rotations of molecules in liquids. A. DA SILVEIRA: The Raman effect of aluminium salts. MLLE. C. CHAMIÉ: Contribution to the study of ThC″. The special method used for the purification of the material is described and a curve is reproduced showing the quantity of ThC″ collected on the receiving plate as a function of the field between 100 and 700 volts/cm. The period was determined as 3·1 minutes. E. TOPORESCU: The corrosion of iron. Experiments on the corrosion of iron in which the oxidation is not due to differential aeration, but depends on the surface tension. LETORT: The influence of traces of oxygen on the thermal decomposition of the vapour of acetaldehyde. The kinetic study of the thermal decomposition of acetaldehyde vapour showed irregularities which were ultimately traced to the effect of oxygen leaking in, and hence the effect of the presence of traces of oxygen has been systematically studied: traces of oxygen act as a catalyst. MLLE. SUZANNE VEIL: The electrical conduction of gelatine. Curves are given showing the change of electrical conductivity of gelatine as a function of the time and as a function of the applied electromotive force. PIERRE TAUZIN: The domain of inflammation of detonating gas at low pressure. The experimental results are given graphically. EDOUARD RENCKER: The point of transformation and softening of glass. The temperature of transformation coincides with the temperature at which the glass commences to soften. The sudden variation of the temperature coefficients of the physical properties is probably explained by the appearance of the viscous state. L. BERTHOIS: The presence of barytes in the sand of Alençon (Orne) granulite. JACQUES BOURCART: The existence of *Bubalus antiquus* in the muds of Oued Imar'ir'en (Marrakech Haut-Atlas) and the palæontological significance of this find. RAYMOND FURON: Presentation of a stratigraphical scale for the palæozoic strata of western Africa. J. P. ROTHÉ: Magnetic observations at Scoresby Sound during the polar year. MLLE. MADELEINE FRIANT: The affinities of *Issiodoromys*, a rodent from the European Oligocene. PIERRE LESAGE: Contribution to the study of the hereditary modifications produced in plants by heat. The precocity of plants grown under glass, or in a warm climate, is hereditary: the seeds sown in the open air show precocity for several generations. PAUL CHABANAUD: Do the great subdivisions of the order of h erosome fishes admit of a discriminating criterion? MLLE. ELIANE LE BRETON and GEORGES SCHAEFFER: The total utilisation of the heat of combustion of ethyl alcohol by the homeotherm with thermal neutrality. L. SILBERSTEIN: Sulphur in the animal organism. Summary of the results of determinations of sulphur in 27 species of animals. The figures range from 3·63 per cent in horse-hair to 0·04 per cent in the shells of Mollusca and Crustacea. E. and H. BIANCANI and A. DOGNON: Measurements of intensity in an ultrasound field of small extent.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, **19**, 803–878, Sept. 15). W. S. STALLINGS, JR.: A tree-ring chronology for the Rio Grande drainage in northern New Mexico. The cultural span covered is from ruins of the Pueblo III horizon of south-western archæology (A.D. 1300) through later Pueblo and Spanish buildings to the present. The trees used are yellow pine (three-quarters of the records),

piñon and Douglas fir; the dating is by matching annual ring patterns in timber with those of recently cut trees. IAN CAMPBELL and JOHN H. MAXSON: Some observations on the Archean metamorphics of the Grand Canyon. Field work indicates that the great body of the Vishnu schist is sedimentary in nature, probably laid down in a shallow, subsiding geosyncline. The higher degree of metamorphism found may be due to contact rather than to regional effects. WILLIAM ALBERT SETCHELL: A preliminary survey of the species of *Zostera*. A discussion of the diagnostic features of the eel-grasses, with a provisional key. F. ZWICKY: Remarks on superconductivity. Superconductivity is connected with the structure-sensitive properties of crystals, and the occurrence of characteristic lengths of the order of 10^{-4} cm. and of one or more sharp transition points (co-operative phenomena). These phenomena can be discussed in terms of the interaction of ion-lattice and electron-lattice in a metal. F. A. MCJUNKIN and C. D. HARTMAN: Concentration and purification of a growth inhibitor extracted from kidney: a preliminary report. B. F. SKINNER: The abolishment of a discrimination. DONALD D. VAN SLYKE, ROBERT T. DILLON and ALMA HILLER: Crystallisation of a compound of hæmoglobin and carbon dioxide. BERWIND P. KAUFMANN: Interchange between *X*- and *Y*-chromosomes in attached X females of *Drosophila melanogaster*. G. F. SPRAGUE: Pollen tube establishment and the deficiency of waxy seeds in certain maize crosses. It has been shown experimentally that 'waxy' pollen takes longer to germinate and establish a pollen tube than 'non-waxy' pollen. E. M. EAST: The effect of homozygous genes for self-sterility. So-called incompatible matings in *Nicotiana* have been overcome by pollination of immature flowers; self-sterility was due to retardation of pollen-tube growth. It is concluded that self-sterility allelomorphs behave as ordinary non-lethal mutations, though playing a physiological rôle analogous to certain immunological reactions. CHARLES N. MOORE: On criteria for Fourier constants of L integrable functions. G. A. MILLER: Groups whose operators have no more than three distinct squares. H. BATEMAN: Logarithmic solutions of Bianchi's equation. LESLIE HELLERMAN, MARIE E. PERKINS and W. MANSFIELD CLARK: Urease activity as influenced by oxidation and reduction. Three types of reaction have been studied: effect of preparations of cuprous oxide and phenylmercuric hydroxide; aeration; effect of iodine. The results suggest that many observations on aspects of urease activity are linked with the oxidation and reduction of the sulphydryl groups of the enzyme. L. O. BROCKWAY and LINUS PAULING: The electron-diffraction investigation of the structure of molecules of methyl azide and carbon suboxide. The results indicate a linear structure for the azide group of methyl azide, with the methyl group at an angle of 135° to the axis of the azide group; carbon suboxide is represented as a linear structure with bonds intermediate between double and triple bonds, thus: O=C=C=C=O. L. O. BROCKWAY: The electron-diffraction investigation of the molecular structure of cyanogen and diacetylene (with a note on chlorine dioxide). A criticism of Wierl's models; linear models, in which the single bond plays the most important rôle, are preferred. HENRY BORSOOK and GEOFFREY KEIGHLEY: Oxidation-reduction potential of ascorbic acid (vitamin C).

Forthcoming Events

Thursday, December 28

ROYAL INSTITUTION, at 3.—Sir James Jeans: "Through Space and Time" (Christmas Lectures. Succeeding lectures on December 30 and January 2, 4, 6 and 9).

Official Publications Received

GREAT BRITAIN AND IRELAND

The Scientific Proceedings of the Royal Dublin Society. Vol. 20, N.S., No. 41: The Trees of Ireland, Native and Introduced. By H. M. Fitzpatrick. Pp. 597–656. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 3*s*.

The H.E.A. Year Book: the Annual Publication of the Horticultural Education Association. Vol. 2, 1933. Pp. xxxiv+126. (Wye: South-Eastern Agricultural College.) 3*s*. 6*d*.

The Farmer's Guide to Agricultural Research in 1932. Pp. ii+236. (London: Royal Agricultural Society of England.)

The Pharmaceutical Society of Great Britain: Codex Revision Committee. Report of Pharmaceutical Chemistry Sub-Committee: Summary of the Principal Standards for Chemical Substances recommended by the Pharmaceutical Chemistry Sub-Committee and accepted, provisionally, for inclusion in the British Pharmaceutical Codex, 1934. Pp. 51. (London: Pharmaceutical Press.) 2*s*. 6*d*.

The Journal of the Chemical Society. November. Pp. iii+1421–1532+viii. (London: Chemical Society.)

The Quarterly Journal of the Geological Society of London. Vol. 89, Part 4, No. 356, November 28th. Pp. 357–526+x+plates 34–50. (London: Longmans, Green and Co., Ltd.) 7*s*. 6*d*.

British Medical Association. Report of Committee on Nutrition. Pp. 48. (London: British Medical Association.)

Philosophical Transactions of the Royal Society of London. Series B, Vol. 222, B 489: On some Pteridospermous Plants from the Mesozoic Rocks of South Africa. By Dr. H. Hamshaw Thomas. Pp. 193–265+plates 23–24. (London: Harrison and Sons, Ltd.)

OTHER COUNTRIES

U.S. Department of the Interior: Geological Survey. Water-Supply Paper 639: Geology and Ground-Water Resources of the Roswell Artesian Basin, New Mexico. By Albert G. Fiedler and S. Spencer Nye. Pp. xii+372+46 plates. (Washington, D.C.: Government Printing Office.) 1 dollar.

Bulletin of the National Research Council. No. 90: Physics of the Earth. 6: Seismology. Pp. viii+223. (Washington, D.C.: National Academy of Sciences.) Paper, 2 dollars; cloth, 2.50 dollars.

U.S. Department of Agriculture. Farmers' Bulletin No. 1712: The Harlequin Bug and its Control. By W. H. White and L. W. Brannon. Pp. ii+10. (Washington, D.C.: Government Printing Office.) 5 cents.

University of California Publications in Zoology. Vol. 40, No. 2. Review of the Recent Mammal Fauna of California. By Joseph Grinnell. Pp. iii+71–234. 1.25 dollars. Vol. 40, No. 3: Mammals of the Pocatello Region of Southeastern Idaho. By Wayne B. Whitlow and E. Raymond Hall. Pp. iv+235–276. 35 cents. Vol. 40, No. 4: The Growth of some Young Raptorial Birds. By E. Lowell Sumner, Jr. Pp. iii+277–308. 50 cents. (Berkeley, Calif.: University of California Press; London: Cambridge University Press.)

Journal of the College of Agriculture, Tokyo Imperial University. Vol. 12, No. 1: On the Distribution of Decapod Crustaceans inhabiting the Continental Shelf around Japan, chiefly based upon the Materials collected by S.S. *Sôyô-Maru* during the Years 1923–1930. By Yu Yokoya. Pp. 226. (Tokyo: Maruzen Co., Ltd.) 3.00 yen.

Royal Observatory, Hong Kong. Magnetic Results, 1884–1931. Prepared under the direction of C. W. Jeffries. Pp. 18. (Hong Kong: Government Printer.)

Ceylon Journal of Science. Section G: Archæology, Ethnology, etc. Vol. 2, Part 3. Edited by S. Paranavitana. Pp. 149–240+plates 77–92. (Colombo: Colombo Museum; London: Dulau and Co., Ltd.) 3 rupees.

The Indian Forest Records. Vol. 15, Part 8: Multiple Yield Tables for Deodar (*Cedrus deodara* Loudon). By H. G. Champion and I. D. Mahendru. Pp. vii+116+11 plates. 4.8 rupees: 7*s*. 6*d*. Vol. 18, Part 11: Investigations on the Infestation of *Peridermium himalayense*, Bagchee, on *Pinus longifolia*. Part 2: *Cronartium himalayense*, n. sp., on *Swertia* spp.; Distribution, Morphology of the Parasite, Pathological Study of the Infection, Biological Relationship with the Pine Rust, and Control. By Dr. K. Bagchee. Pp. iv+66+18 plates. 4.4 rupees; 7*s*. Vol. 19, Part 3: Regeneration and Management of *Sal* (*Shorea robusta*) Gaertn. f.; a Survey of the Problems presented and Proposals for necessary further Investigations. By H. G. Champion. Pp. v+159+24 plates. 5 rupees; 8*s*. 3*d*. (Delhi: Manager of Publications.)

Report of the Department of Industries, Madras, for the Year ending 31st March 1933. Pp. 84. (Madras: Government Press.) 10 annas.

Western Australia. Annual Progress Report of the Geological Survey for the Year 1932. Pp. 12. (Perth: Government Printer.)

U.S. Department of Agriculture. Circular No. 277: The Oriental Moth (*Cnidocampa flavescens* Walk.) and its Control. By C. W. Collins. Pp. 8. (Washington, D.C.: Government Printing Office.) 5 cents.

Bulletin of the American Museum of Natural History. Vol. 67, Article 3: Glossary and Correlation Charts of North American Tertiary Mammal-Bearing Formations. By George Gaylord Simpson. Pp. 79–121. (New York City.)

Forty-eighth Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, 1930–1931. Pp. v+122. (Washington, D.C.: Government Printing Office.) 2 dollars.