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Museums and the Schools *

A SMALL pamphlet recently prepared by the Board of Education is of greater importance than its appearance might suggest, in that it brings the whole weight of the Board to bear in favour of the more extended use of museum materials by the various educational establishments of England. The pamphlet begins with a short historical summary, leading to a condensed survey of the present position ; it then illustrates its aim by examples from the United States, Germany, Scandinavia, England, and Wales ; and finally it indicates methods of co-operation already followed in isolated places as worthy of general adoption. Since no one seriously interested in either museums or practical teaching need grudge the small sum asked or the short time required to buy and study the booklet, it would be inadvisable to prevent him by any more detailed abstract of its contents. The publication does, however, suggest comment on a few of the broader matters involved.

The general question is the use of actual concrete objects in teaching as opposed to mere words. This has of late years been termed ' visual instruction '—obviously an inexact phrase, for ' visual ' applies equally to book learning but does not apply to the handling of objects by the blind, which is merely an extreme case of the handling recommended for all pupils by the pamphlet. The use of this concrete method has undoubtedly spread with increasing rapidity during the past half-century, both up from the kindergarten and down from the laboratory. As regards the extremes of the educational scale, not much requires to be said : they have recognised their needs and have provided for them. It is for the intermediate region that missionary work and practical assistance are now desired.

The museums formed by various departments of universities, by art schools, and by technical and commercial colleges serve adequately the wants of those special students for whom they are designed. It is, however, suggested that the material in those semi-private museums might sometimes be made more accessible to the public, and that there might be more co-operation between those institutions and the public museum of the locality At present it is the schools of art, craft, and trade that make most use of the public museums ; the curators welcome visits from such students, and occasionally receive in turn some help in their installations from

* Board of Education. Educational Pamphlets No. 87 : Memorandum on the Possibility of increased Co-operation between Public Museums and Public Educational Institutions. Pp. 45. (London : H.M. Stationery Office, 1931.) 9*d*. net.

the art people. With scientific material the case appears to be different. Curators would no doubt be grateful for more of such help in the determination and classification of their specimens as university professors could render; but when there is a question of a *quid pro quo* it is found that methods of exhibition well adapted to the serious student are not always such as appeal to the public, while it is dangerous to admit pupils—and, sometimes, even professors—to the run of the cases and the free handling of material. With good will and a sympathetic understanding of each other's difficulties, much more could be done to mutual advantage, but in general the best plan is to have distinct collections for distinct purposes.

It is, however, the utilisation of museum material by the secondary and elementary schools that demands chief consideration. It is assumed that almost every school subject, even the teaching of a foreign language (living or dead), may be enlivened by the introduction of illustrative objects. The first question, then, is the provision of such objects. The richest and, in many cases, the only possible source of them is a well-stocked museum; and thus the problem becomes the best means of bringing the class and the collections into profitable contact. Either the school may send its pupils to the museum, or the museum may send specimens to the school. There is much to be said for and against both methods.

Consider, first, visits to a museum. It is plainly the main duty of a curator to place and keep in good order the specimens in his charge. So far as their educational use is concerned, it is his business to display attractive series that shall by arrangement or labelling tell their own story. One consequence of this is that the lesson of the specimens is most easily apprehended in a museum, where also each exhibit is, or should be, seen in its due relation to allied material. The pupils may at the same time be stimulated by the visit, and may be impressed by the surrounding neatness and order. On the other hand, it is maintained by some that the unfamiliar surroundings are distracting, and that the multiplicity of objects hinders concentration. Some museums, therefore, remove objects to a room set aside for teaching, and this enables the specimens to be handled, but only if they are duplicates provided for the purpose. By this compromise the pupils lose some advantages of a museum visit, while the curator and his collections are wrested from the primary purpose of the ordinary museum. The real objection, however, lies in the difficulty of bringing the classes, especially those from a distance, to the museum, and in the impossibility of each pupil coming to the museum often enough for the visit to take its desired place as a normal part of the curriculum.

We seem, then, to be thrown back on the other method, that of circulating small collections and specially designed exhibits to the schools. Started in Great Britain half a century ago, the method has received remarkable extension in the United States. If it has not grown in Britain in like degree, that is largely due to the lack of interest shown by education authorities. The Museums Association has lately sought to arouse them to a sense of its value, and the present benediction of the Board will doubtless help it forward. Admirable work is being done by several museums on these lines, and success is found to follow expenditure of thought rather than of money. But here again, if every school is to have a supply of material available at the right moment for the appropriate lessons, the number of circulating collections must be multiplied a hundred-fold. At present the collections serve as occasional stimuli, of great value, but far from satisfying the everyday demand. This method, moreover, makes a still greater call on the time of the museum staff, and usually necessitates the acquisition of fresh specimens for the particular purpose. To obviate some of its disadvantages, the Commercial Museum of Philadelphia has replaced circulating loans by gifts of large numbers of identical cases.

Thus we are led to a third method, the formation of school museums. There are many school museums, some excellent, several disreputable, but few on the lines required. What is needed is a collection formed in each school with definite reference to the curriculum. In the establishment of such a collection the pupils themselves should help; guidance and some material can be obtained from the regional museum, and there are other sources from which appropriate specimens can be drawn, but, above all, every teacher should make use of it.

The last remark reminds us that, whatever method be adopted, the immediate task is to teach the teachers. Teaching is their business; it is not the curator's. The use of illustrative objects is more and more being inculcated in the training colleges, and to those who are thus trained the curator can explain the material he sends out and can suggest its use.

To sum up: the scheme that seems to be most practicable and promising the best results is a combination of all three methods:—The museum of

the school, in which the school should take a pride, and which should be used to the full in class teaching as well as for spare-time hobbies: circulating loans to illustrate some particular, temporary subject, in supplement to the school collections: finally, as a reward and additional stimulus, a visit (if possible once a term) to the regional museum; this should be prepared for and should be under trained guidance. It will be long before such a scheme can be in working order, but it is the goal we would set before our educational museum enthusiasts. Meanwhile there are many things that can be done, on which space forbids us to dilate here. Some of them will be found in the excellent pamphlet that is our text.

Science and Human Life

(1) *World Chaos: the Responsibility of Science.* By William McDougall. Pp. vi + 119. (London: Kegan Paul and Co., Ltd., 1931.) 3*s.* 6*d.* net.

(2) *The Scientific Outlook.* By Bertrand Russell. Pp. 285. (London: George Allen and Unwin, Ltd., 1931.) 7*s.* 6*d.* net.

(3) *What Dare I Think? The Challenge of Modern Science to Human Action and Belief, including the Henry La Barre Jayne Foundation Lectures (Philadelphia) for 1931.* By Julian Huxley. Pp. ix + 270. (London: Chatto and Windus, 1931.) 7*s.* 6*d.* net.

IN these three books a psychologist, a mathematical philosopher, and a biologist discuss the relation of science to human life. It is common ground that the application of scientific method has conferred enormous material benefits upon mankind—Prof. Huxley's account of the triumphs of applied biology is particularly well done—but in all three writers one discerns a feeling of uneasiness lest science become too powerful and affect prejudicially the harmonious development of man's mind and character.

(1) Prof. McDougall roundly asserts that the physical sciences are mainly responsible for the present world chaos, for they "have produced a complexity of our civilization which far outruns our present understanding and power of control". He would seek a remedy in more science, but in science of a different kind: in a thorough study of social and economic problems from a definitely psychological point of view. This point of view would be completely different from that of the physical sciences—McDougall entirely rejects the mechanistic treatment of life and mind as inadequate, and substitutes his own conative or hormic conception. His book is vigorously written, and his remarks on the present world crisis are extremely apt and timely.

(2) Mr. Bertrand Russell has much more faith in the value of mechanistic methods in biology and psychology, and in effect denies that any other method is scientific. His psychological gods appear to be Freud and Pavlov. We venture to think that he has been over-impressed by the claims of mechanistic biologists, and that with greater knowledge would come a less dogmatic attitude. His book is an interesting one, and deals in a skilful way, and not without a certain dry humour, with the principles of scientific method. Chapters on scientific metaphysics and science and religion give him an excellent opportunity, of which he takes full advantage, to criticise Jeans and Eddington in their excursions into philosophy.

The most significant part of the book, in our opinion, is the short last chapter on science and values. It follows a vivid presentation of what the world State of the future might be like if it were organised on purely scientific lines: a picture which, Mr. Russell agrees, is in some aspects nightmarish and depressing. Already in his introduction Mr. Russell had pointed out that if "a scientific civilization is to be a good civilization it is necessary that increase in knowledge should be accompanied by increase in wisdom", meaning by wisdom a right conception of the ends of life. Science by itself can give no guidance as to values or ends. A society deliberately constructed on scientific principles, without regard to values, might then be a very bad society.

If we read Mr. Russell aright, he views the possibility of a scientific world State with grave misgiving, and this because the power over Nature which science gives may come to be regarded as an end in itself. The love of knowledge, from which science springs, has, Mr. Russell tells us, a twofold origin. "We may seek knowledge of an object because we love the object or because we wish to have power over it. The former impulse leads to the kind of knowledge that is contemplative, the latter to the kind that is practical. In the development of science the power impulse has increasingly prevailed over the love impulse" (p. 270). "The scientific society of the future as we have been imagining it is one in which the power impulse has completely overwhelmed the impulse of love, and this is the psychological source of the cruelties which it is in danger of exhibiting" (p. 273). Power cannot legitimately be regarded as one of the ends of life, but merely as a means to

what the Greeks knew as 'the good life'; if science, which is power, subserves the proper ends of human life, well and good; if it does not, disaster will follow.

(3) These views, with which all thinking men will agree, are closely paralleled in Prof. Huxley's discussion of scientific humanism. He agrees with McDougall that the rapid increase in scientific knowledge and the spread of the scientific spirit—meaning by this the predominantly materialistic method—are largely responsible for the chaos in thought which is characteristic of the present day.

"The multiple contradictions sum up along these lines—that in the sphere of control over environment and destiny, man is through science being given fabulous and undreamt-of powers, yet is by no means agreed as to how to employ them. And that in the sphere of thought, while the scientific picture of the universe, in which naturalism and determinism rule, grows ever more triumphant and complete, yet it becomes ever more sharply set off from the world of values in which the human spirit inevitably has its being. Science, in a word, both in the outer and the inner life, has come up against human nature, and each seems in a strange confused way to be barring the progress of the other. Science and human nature—there lies the chief unresolved antinomy of the present stage of our civilization" (p. 124).

The reader will find much to interest him in Huxley's extended treatment of this theme and in his sketch of a non-theistic religion compatible with evolutionary science.

The problem raised in different ways in these three books is by no means a new one. It is certain that if science continues along purely naturalistic lines, if it rests content with the abstract and schematic treatment of reality from which it has derived so much of its practical power, it must remain apart from, and opposed to, the world of values.

Science can in no case become an arbiter of values, but we may suggest that the antinomy of which Huxley speaks may possibly be overcome if a more concrete, more objective method establishes itself in biological and psychological research. If, for example, it can be shown that conation and perception are indispensable concepts in the study of animal behaviour, the way is opened towards a less abstract and analytical treatment of some at least of the problems of biology, and a bridge built across to the sciences of human psychology and sociology, upon the importance of which for the future development of civilisation McDougall rightly lays such stress.

E. S. R.

International Geology

International Geological Congress. Compte rendu of the XV Session, South Africa, 1929. Vol. 1. Pp. xiv + 314 + 42 plates. Vol. 2: *Scientific Communications.* Pp. x + 688 + 97 plates. (Pretoria: Wallach's, Ltd., 1930.) 2 vols., 40*s*.

THE two handsome and beautifully illustrated volumes which record the proceedings of the fifteenth session of the International Geological Congress, held in South Africa during July and August 1929, and the scientific communications there presented, constitute a worthy account of a meeting which was of outstanding importance because of the interest and success of the excursions and the high quality of the papers read. The first volume is occupied by minutes and official memoranda, and by long accounts of the excursions, enriched with a liberal photographic record. Those who attended the Congress will turn with renewed pleasure to these pages, while those who were unable to make the long journey will find in them verbal and pictorial compensation. The second and larger volume contains 78 papers, dealing with special subjects chosen for discussion and with general geology. In addition to the usual English, French, and German, two newly admitted languages, Spanish and Italian, appear on this occasion, accompanied, however, by summaries in English or French. The sections devoted to pre-Pleistocene glacial periods, the Karroo system, and rift valleys are of leading importance, and all contain contributions that substantially advance the boundaries of geological knowledge, particularly as regards the areal and historical geology of Africa.

Of all countries, so far as we know at present, South Africa is the richest in its evidences of early glaciations. Rogers summarises the indications of glaciation in the Witwatersrand and Transvaal systems and directs attention to a pre-Nama tillite in Namaqualand. A glacial band in the Table Mountain series is described by Haughton. The world-famous Dwyka glaciation is appropriately dealt with by du Toit in a summary account that is a model of its kind. He shows that there were several glacial phases which probably began about the end of the Lower, and died out not later than the close of the Upper Carboniferous. Turning to Asia, Norin records the discovery in 1928 of late-Palæozoic glacial deposits in the mountains bordering the Tarim Basin on the north, and Backlund describes a probable tillite of similar age from the northernmost Urals. These lend weight to Gortani's

contention that no amount of continental drift will serve by itself as a primary explanation of pre-Pleistocene glacial epochs, even though the drift hypothesis may be necessary to provide an escape from the obvious geographical difficulties. Gortani favours fluctuations of solar radiation as the fundamental cause of terrestrial climatic variations. Lower Cambrian tillites occurring in the Yenisei Ridge of Siberia were examined in 1927–28 by Nicolaev, who presents a convincing and well-illustrated account of their glacial characters.

The Karroo rocks of Africa and their correlation are ably dealt with by Dixey. In the South African basin, these formations reach a thickness of 26,800 feet. In the Shire–Lower Zambesi area, 18,000 feet is reached. This province of the Karroo is admirably described by Dixey in a separate paper. The Rhodesian basin (Wankie–North Nyasa) contains a maximum thickness of only 4200 feet; this area, and the Tanganyika basin near Tanga, where 10,000 feet of Karroo sediments occur, are also described by Mennell. Teale shows that the so-called 'Tanganyika system' includes Karroo rocks, and possibly Waterberg and Transvaal formations. The basin of the Belgian Congo, which encloses the largest known outcrop of the Karroo in Africa, is dealt with in great detail by Fourmarier.

The Abyssinia–Somaliland occurrences are mentioned by various authors, and notably by Stefanini. Range describes the Karroo of South-West Africa with special reference to its flora and fauna. Borges and Mouta give an account of the Angola representations of the system, accompanied by a coloured geological map of the south of Angola. The widespread prevalence of the Stormberg basalts, with rhyolites in association in many areas, is a remarkable feature that is well brought out by the papers and maps of this section. A short review of the Karroo flora is given by du Toit, with a hypothetical continental restoration showing the distribution of the chief genera in the various members of Gondwanaland. Walkom compares the fossil floras of Australia with those of South Africa, and Haughton deals with the Karroo Reptilia.

A most important discussion of the African rift valleys is contributed by Wayland, with a tectonic map of Uganda. He finds the tension hypothesis to be untenable, and gives much additional evidence supporting the alternative hypothesis, for which he was originally responsible, that the Western Rift and the uplifted massif of Ruwenzori are the result of deep-seated compression. A valuable systematic study of the geomorphological aspects of rift-faults by Johnson provides a series of pictures of all the leading possibilities, which should aid the field geologist to find the critical evidence required for correct interpretation in any particular case. The European *graben* are discussed by Seidl and Seidlitz, the latter adding much new information about those of Syria and Erythria. Van Rhedan deals with the buried graben of South Limburg. Harrison describes the Magdalena trench of Colombia; this is 400 miles long by 40 miles wide, and is 4000 feet deep. It broke in during the early Tertiary, and volcanic activity has been prevalent, and still continues, along the western edge.

The section on magmatic differentiation is disappointing in that no new conclusions of petrogenetic significance are reached. Niggli gives a general discussion; Reuning presents a chemical study of the magmatic provinces of South and South-West Africa; and Vardabasso deals with the Predazzo province. The latter is interesting in that it provides evidence that masses of Permian quartz-porphyries were probably regenerated as granite in Tertiary times. In the General Section a study of the noritic lopolith of Sierra Leone is recorded by Junner, with many new analyses by Harwood and Theobald. The structure and mineralisation of the Kambone copper mine in Katanga is described with a wealth of illustration by Schuilling, and the copper zone of the Katanga-Rhodesian frontier is dealt with more broadly by Thoren.

The geology and tectonics of North Africa and adjacent regions are considered in a series of papers by Russo on the relations of the Rif to the Atlas and the Betic Cordillera; Neltner on Morocco; Maddelena on the Jurassic submarine volcanic rocks of Sicily and the tectonics of Sicily and Tunisia; and Solignac on Tunisia as a whole. French Indo-China is well described by Blondel; Portuguese East Africa by Freire d'Andrade; and the Central Massif of France by Demay.

In the section on petroleum, Sacco again suggests an inorganic origin for the petroleum of Italy, basing this view on the association with plutonic and volcanic rocks and, in Sicily, with beds of sulphur. Fabian records his belief that the petroleum of Sicily has a deep origin, and that it migrated during the Pliocene through highly folded and faulted pre-Triassic rocks that are otherwise impermeable. Other papers deal with the geological work of micro-organisms, and with the modern floras of the Pretoria and Vryburg districts in relation to the local geology.

An announcement of the greatest interest is made by Kovaloff in the course of an account of the present spectacular activities of the Russian Geological Committee. For 1932–33 the Five-Year Plan allows nearly £6,000,000 for geological work, and 1300 field parties are expected to be engaged in survey and economic investigations. A doubt is expressed as to the possibility of finding the number (3200) of qualified geologists required. In 1928–29, 950 geologists were at work, and the practical results already achieved demonstrate, on a scale hitherto unprecedented, that geological research is a fundamental necessity to national welfare in general and to industrial progress in particular.

Experimental Teratology

Connecting Laws in Animal Morphology: Four Lectures held at the University of London, March 1929. By Prof. Hans Przibram. Pp. 62 + 8 plates. (London: University of London Press, Ltd., 1931.) 4*s.* 6*d.* net.

THE future historian of biology will doubtless count among the more important tendencies of the first quarter of this century the extended application of the experimental method to all kinds of biological problems. More especially the phenomena of growth and form, which previous generations had, for the most part, been content to observe unfolding in Nature, are now studied in the modifications induced under artificially controlled conditions. In this department of research, Prof. Hans Przibram has been one of the pioneers. Some twenty-five years ago he founded in Vienna a Biological Experiment Station, provided with arrangements for keeping large numbers of living animals under constant and carefully adjusted conditions. A long series of important researches have since been carried out at this institution by him and his pupils.

In 1929, Prof. Przibram gave a series of four lectures in University College at the invitation of the University of London, and he has now published these under the title "Connecting Laws in Animal Morphology". Those who had the good fortune to hear these lectures, and many who had not, will welcome in this permanent form the exposition of what this distinguished representative of the experimental school regards as the most significant results obtained by the experimental method.

The first lecture, on "Organisation", deals with 'the increase in differentiation' as shown in the modelling of a limb out of a formless mass of undifferentiated cells in the regeneration of a crustacean's claw. The 'reversal of asymmetry', discovered by Przibram in 1900 to take place after the removal of the large claw in certain prawns, is interpreted as showing "the advantage of an earlier start". In those decapod Crustacea in which the claws are of different form and size on the two sides of the body, the larger, more specialised claw has simply outstripped in growth its smaller, more primitive partner. If it is sent back to the starting-point by amputation or autotomy, the smaller claw takes the lead and, with increased size, attains increased differentiation.

This example serves to show at once the strength and (as it seems to an old-fashioned systematist) the weakness of the experimental method. It will not be disputed that Przibram has made good his claim to have discovered a 'connecting law' in animal morphology. His experiments have defined one of the conditions under which asymmetry reveals itself. He shows that, other things being equal, increasing size is accompanied by increasing differentiation. So far as they go, his conclusions rest on a secure basis of fact. But, do they go very far? Have we really learned anything as to the origin or the nature of asymmetry? The systematist, studying the bewildering complexity and variety of the forms assumed by the large claw of the alpheid prawns, for example, will feel little satisfaction in the explanation that it is more complex because it is bigger than its fellow. Is the very indistinct photograph of *Alpheus* which the author thinks good enough to illustrate his results a symbol of his undue simplification of the problem?

The lecture on "Growth" discusses the fact that in a number of arthropods the ratio of increase in linear measurements at each ecdysis is approximately 1·26, that is to say, $\sqrt[3]{2}$. Przibram is so impressed with this evidence of the doubling of mass (confirmed in some cases by weighing) that he calls 1·26 "the magic number". "Doubling of mass in the living being we may then assume to be the counterpart of chemical mass-action: the product of reaction being proportionate to the molecules involved." Perhaps the biochemists may find this statement satisfying. What the simple zoologist fails to understand is why this doubling of mass should be associated with ecdysis. The association is not invariable. Przibram, it is true, dismisses as abnormal the cases of starved or injured animals which go on moulting without increase (or even with diminution) of mass. But is the correlation so close

and so invariable even in normal growth ? If it is not, a good deal of the magic will have faded from $\sqrt[3]{2}$.

Prof. Przibram in his preface mentions " quantitative formulation " as one of the prime necessities for the building up of biological theories. We are reminded of Eddington's remark : " by the time the serious application of exact science begins we are left with only pointer readings ". But all pointer readings are not necessarily significant, and the half-mystical contemplation of numerical relations has before now led biologists into the wilderness.

The other lectures similarly leave one with the impression that experimental morphology (or experimental teratology) does indeed provide conclusive answers to the questions dealt with, but fail to convince one that these questions are always of primary importance. At all events, there is no need, yet awhile, to lay aside as useless the older methods of comparative morphology and taxonomy.

W. T. C.

An American Palæontologist

Cope, Master Naturalist : the Life and Letters of Edward Drinker Cope ; with a Bibliography of his Writings classified by Subject ; a Study of the Pioneer and Foundation Periods of Vertebrate Palæontology in America. By Henry Fairfield Osborn, with the co-operation of Helen Ann Warren. Pp. xvi + 740 + 24 plates. (Princeton, N.J. : Princeton University Press ; London : Oxford University Press, 1931.) 22*s.* 6*d.* net.

THE modern school of vertebrate palæontology in North America has achieved such remarkable results that its history cannot fail to be of interest. When this is combined with the life-story of perhaps the most brilliant of the three pioneers who started it, the narrative becomes still more absorbing. We are therefore much indebted to Prof. H. F. Osborn for the labour he has bestowed on the handsome volume in which he describes the life and labours of Edward Drinker Cope and determines his place in American science.

Cope, who was born in 1840 and died so long ago as 1897, was an observant naturalist from early childhood, and, until misfortune overtook him in the 'eighties, was well provided with means to follow his inclinations. Even then his enthusiasm never failed, and a call to a professorship in the University of Pennsylvania enabled him to pursue his researches to the end. He began his studies of fossils just after Darwin had convinced the scientific world of the truth of the doctrine of organic evolution, and he was always trying to recognise pedigrees among the successive extinct animals which were revealed by the fossils he collected. In a general pioneer way he met with much success, and his two volumes on " The Origin of the Fittest " (1887) and " The Primary Factors of Organic Evolution " (1896) summarise the many new facts and ideas with which he enriched palæontological science.

Prof. Osborn begins with an interesting chapter on the early students of American vertebrate fossils who preceded Leidy, Cope, and Marsh. He then tells the story of Cope's life and work, mainly by well-arranged extracts from Cope's own letters to his family. A chapter follows on " How Cope earned the Title of Master Naturalist ", and this affords an opportunity of discussing the main features of Cope's contributions to natural science, with some reference to his attitude towards education, sociology, politics, and religion. The next chapter is devoted to the personal reminiscences of Prof. Osborn during his twenty years' association and friendship with Cope. The last hundred and fifty pages are occupied with a useful list of Cope's very numerous writings, classified under subjects.

Cope was associated with Philadelphia for the whole of his life, and belonged to the Quaker community. Most of his letters reflect his upbringing, and some portions are beautifully expressed. His quarrelsome rivalry with Marsh, however, occasionally led to outbursts which he could scarcely have wished to be preserved in print, and our only criticism of the book is that the account of the Cope-Marsh controversy might have been judiciously curtailed.

A. S. W.

Colloids

Colloids. By Dr. Ernest S. Hedges. Pp. vii + 272. (London : Edward Arnold and Co., 1931.) 12*s.* 6*d.* net.

DR. HEDGES' book is by way of being a *tour de force*. He has taken a subject the development of which has involved the use of a not inconsiderable mathematical apparatus, and has discussed it, lucidly and very fully, without the use of a single mathematical symbol, save when, on occasion, he quotes a formula as a shorthand way of stating a result.

There is much to be said for the method. We are apt nowadays, when gazing full of awe at an

imposing mathematical structure raised on a few premises of doubtful validity, to forget the truth that underlay Sir William Hamilton's attitude towards mathematical studies. After all, mathematics can become (and very often confessedly is) a mechanical routine, designed to save thought rather than to promote it. Such a mechanical exercise is a dangerous habit for a student of physics. True, the opposed habit of picturing mechanical models and 'explaining' phenomena in terms of them is not without its dangers, but, tried by a pragmatic test, it probably comes off best. Dr. Hedges' attitude is well summed up in his own statement that a mental image of the processes involved is best obtained "not by regarding the colloidal system as the unit, but rather by considering the processes from the point of view of the colloidal particle itself. Only by getting down to the colloidal particle . . . in imagination can this vivid picture, which is essential to the proper understanding and appreciation of colloid chemical principles, be obtained."

From this point of view Dr. Hedges discourses on polyphase systems, the formation of colloid particles, the general characteristics of colloid systems, methods of colloid investigation, the electrical properties and the stability of colloids, hydrophobic and hydrophilic colloids, and the detailed properties of gels. These last-named properties are discussed at considerable length, inasmuch as "natural colloids appear more often in the form of gels than sols, and biological and other reactions normally take place in gels".

The volume closes with a short chapter, which we should like to see considerably extended, dealing with such practical applications of colloidal principles as may be included under the headings clays and soils, dyestuffs, leather, milk, wool, water purification, sewage disposal, and so forth. It will be seen that flotation processes are not discussed, and, if we may venture a criticism, the sections which deal with surface forces are more sketchy than any others in the book and might very well be elaborated.

The book as a whole may be commended. It would be a mistake, in a new edition, to destroy its essentially non-mathematical character; nevertheless, we hope that, should a new edition be called for, Dr. Hedges will, for the benefit of the weaker brethren, add a mathematical appendix which shall deal briefly with such topics as adsorption, the Brownian movement, and surface energy.

ALLAN FERGUSON.

Short Reviews

Newton: the Man. By Lt.-Col. R. de Villamil. Pp. vi + 111. (London: Gordon D. Knox.) 3*s.* 6*d.* net.

THIS book has two outstanding and most valuable features. Col. de Villamil has, by a piece of fortunate and painstaking research, found the detailed inventory of Newton's effects that was compiled by virtue of the Commission of Appraisement under the seal of the Prerogative Court of Canterbury on April 18, 1727. To the student of Newton the book is fascinating reading, throwing as it does the most intimate light on the later environment of England's greatest man of science. The dominant note is crimson frugality! Luxury and æsthetic taste are conspicuously absent. We know from Humphrey Newton that Newton was the reverse of self-indulgent, and also that in matters of personal appearance he was careless, not to say definitely untidy. The inventory suggests that these general characteristics persisted all his life, even in his later years of affluence.

Perhaps the most important item in the inventory is the library. That catalogued in the British Museum and known as the Huggins Catalogue represents the books purchased by Huggins at the time of Newton's death. For nearly two hundred years all trace of this library has been lost, but, thanks again to the industry of Col. de Villamil, a very large part of it has been rediscovered and examined. He had the good fortune to find the Musgrave Catalogue of a library that comprised a large number of volumes from the original Newton library purchased by Huggins.

A careful comparison of these two catalogues shows that many volumes which appear in the Huggins are absent in the Musgrave Catalogue. What has become of them is a complete mystery, but one most important fact emerges from the later discovery. The books in the Musgrave Catalogue (compiled about 1760) have all been carefully 'press-marked'; consequently, the appearance of this 'press-mark' in any isolated volume is sure evidence that it originally formed part of this library. In fact, Col. de Villamil has already been able to identify one stray volume by this particular evidence.

The book is a real contribution to the literature of the history of science. V. E. P.

Chaucer on the Astrolabe. With the Original Illustrations. Second and abbreviated edition revised by R. T. Gunther. Pp. iv + 92. (Oxford: R. T. Gunther, 5 Folly Bridge, 1931.) 7*s.* 6*d.* net.

THIS is a reprint in a separate form of Dr. Gunther's modernisation of Chaucer's treatise on the astrolabe, which formed part of vol. 5 of his series, "Early Science in Oxford", reviewed in NATURE for April 12, 1930 (p. 556). A few verbal alterations have been made, and the work has been entirely reset, so that his description of the work as a second edition may pass, though it is not bibliographically accurate. The book is of

importance, as its appearance coincides with that of the first modern astrolabe, and it is of interest to compare Chaucer's treatise with that of Prof. Jenkin, who is responsible for the new instrument. Dr. Gunther may justly claim a share in the revival of the astrolabe, and we may account it not the least of his services to science.

The instrument, as it is now offered to the public, is much simplified. It consists of a metal plate some eight inches in length to which is attached a circle with the various graduations and arcs of the 'mother', substantially as described by Chaucer. Concentrically with this, a transparent plate with its appropriate graduations and circles revolves over it. Finally, a revolving transparent rule with ebony sights enables an observer to read off the angular altitude of any object on the scales of the astrolabe. On a previous occasion we have remarked on its utility—"nearly every instrument used for observation in Physical Astronomy is a part of a perfected astrolabe"—and though the modern instrument is by no means as decorative as a medieval astrolabe, it should, under the direction of a competent teacher, be a first-rate introduction to the practical study of astronomy.

The placid ignorance with which the modern city-bred man contemplates the heavens is a standing reproach to our schools and colleges. Dr. Gunther's work reminds us of the estimation in which a knowledge of the subject was once held; let us hope that his efforts will reinstate it in the favour of our educational authorities.

Communication Networks. By Prof. Ernst A. Guillemin. Vol. 1: *The Classical Theory of Lumped Constant Networks.* Pp. xii + 425. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1931.) 25*s.* net.

WE think this book will help forward the theory of the steady and transient currents which occur in communication networks. The author is obviously thoroughly at home in higher mathematics. He points out that, if research is to progress, new methods of attacking the network problems that occur in practice must be devised. After starting with general remarks on mathematical methods and analogies, he inserts two chapters on the simple mesh circuit before he gives the fundamental principles. Although perhaps illogical, it is an excellent method of introducing the subject, as the reader can then see the reasons for the procedure in the general case.

No proof is given of Heaviside's formula, as it would presuppose too great a knowledge of advanced theory. The author points out that Heaviside's formula is not a quick method of getting the complete solution. It involves the same amount of mechanical labour as the classical method. But it is an extremely compact method from the point of view of analytic form. In practice it is not much used, but in research work, when the properties of complicated networks have to be investigated, it is very useful owing to its compactness. We are looking forward to the second volume, where the author will discuss the classical theory of lines, cables, and filters.

Die Schädlingsfauna Palästinas: unter besonderer Berücksichtigung der Grossschädlinge des Mittelmeergebietes. Von Dr. F. S. Bodenheimer. (*Monographien zur angewandten Entomologie: Beihefte zur Zeitschrift für angewandte Entomologie*, herausgegeben von Prof. Dr. K. Escherich, Nr. 10.) Pp. xv + 438. (Berlin: Paul Parey, 1930.) 42 gold marks.

THIS volume forms a comprehensive monograph on the injurious insects of the eastern Mediterranean region. It is based in the main upon the author's own experience, during the past eight years, in dealing with the insect enemies of cultivated plants in Palestine. A very large number of individual pests are noticed, and the more important are discussed at length, with accounts of their biology and methods of control. The introductory chapters are concerned with general principles, and special reference may be made to those dealing with ecological and climatic factors. There are also sections dealing with the insecticides, pests of stored products, forest pests, and beneficial insects. A book of this kind should form a valuable stimulus to entomology in the Near East, and it can be recommended as being reliable and up to date in character. It is exceedingly well indexed and fully illustrated.

Genetics and Eugenics: a Text-Book for Students of Biology and a Reference Book for Animal and Plant Breeders. By Prof. W. E. Castle. Fourth revised edition. Pp. x + 474 + 66 plates. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1930.) 12*s.* 6*d.* net.

SIX years have passed since the third edition of this work appeared, but so rapid are the additions to knowledge of genetics, and so rapid also the changes of opinion of geneticists, that several alterations are noticeable. Polyploidy, parthenogenesis, artificial mutations, selection are all treated anew, and more is said of heredity amongst mankind; there is a fresh chapter on biometry and its calculations, and the bibliography of selected papers covers sixty pages. But the book is so well known as a concise and clear exposition of its subject, that it need only be said that the fourth edition improves upon its predecessors.

The Mediæval Latin Versions of the Aristotelian Scientific Corpus, with Special Reference to the Biological Works. By S. D. Wingate. Pp. x + 136. (London and Leamington Spa: The Courier Press, 1931.) 10*s.* 6*d.* net.

THIS scholarly essay on a very important question of history will be welcomed by all those who are interested in the development of science and philosophy. Dealing with actual facts, the author explains how the works of Aristotle came to be known to the West in the Middle Ages. He traces the Latin translations of the "Aristotelian Corpus" through the Arabic, Byzantine, and medieval versions, and discusses their merits and their influence.

T. G.

The Cause of Cancer

DR. W. E. GYE,* rightly we believe, thinks that the problem of the causation of cancer is at present most likely to be solved by studying the malignant tumours of fowls first described by Rous twenty years ago. Ordinary mammalian tumours, either arising spontaneously or induced by tarring or other irritating procedures, can be transmitted from one animal to another only by transplanting living tumour cells. The Rous tumours are peculiar in that they can be transmitted by means of dead cells, by cell-free extracts, and by such extracts after they have been passed through fine filters which will detain ordinary bacteria. In other words, the filtrates contain some carcinogenic agent which resembles an ultramicroscopic virus, and Drs. Gye and Purdy now give an account of the multitudinous experiments which they have made in an attempt to ascertain the nature of this agent.

In Gye's original paper published in 1925, he advanced the view that the agent is made up of two factors: one, the virus, can be killed by chloroform or acriflavine; the other, the specific or intrinsic factor, is a labile unorganised substance easily destroyed by gentle heating. An extract inactivated by chloroform could be reactivated by the addition of an extract inactivated by heat. He also found that an extract of a Rous tumour which had been chloroformed could be activated by a heated extract of several mammalian tumours, and would produce a Rous tumour on inoculation into a chicken. Whence he concluded that there was a general non-specific virus which might cause any tumour if it could co-operate with the specific factor which was responsible for the maintenance of the characteristic histological constitution so definitely characteristic of all transmissible neoplasms. The virus was looked upon as an independent organism coming into the body from outside, the specific factor as something arising in the cells of the affected animal.

As the result of a great deal of further work, in which his exacting standard of technical rectitude is fully maintained, Dr. Gye is still of opinion that this interpretation is in the main correct, but he admits that its original experimental basis has proved less secure than he had supposed. Extracts can be inactivated with certainty and regularity by mild heat, but he has found that the actions of phenol, acriflavine, and chloroform are less dependable and that extracts which have been treated with these antiseptics in such a way that they can be relied upon to be inactivated every time the experiment is tried cannot be reactivated by heated extract. "Antiseptics", as he says, "kill the virus only a very little more readily than they destroy the intrinsic substance." Hence it is impossible to get a long series of consistent clean-cut results which will convince the sceptic, though the mass effect leaves the author's own opinion much as it was.

Dr. Gye then turns to immarological observations and describes a long series of experiments on the properties of the blood serum of animals which have been injected with tumour extracts. This section of the book (p. 307 onwards) contains a great number of important and interesting data in a field which has been little explored, and their apprehension is greatly helped by exceptionally clear diagrams. A detailed summary is impossible, but the chief conclusion which emerges is that the sera of the inoculated animals contain two different antibodies, one of which renders an active tumour extract ineffective after it has been heated to 55° C. for half an hour (that is, in bacteriological language, in the absence of complement), while the other neutralises the extract only if fresh serum (complement) is present. If there are two antibodies, there are presumably two antigens: which confirms the original hypothesis of a dual agent.

A second discovery of moment is that the sera of goats repeatedly injected with extracts of normal chick embryos will neutralise active extracts of Rous tumour in the presence, but not in the absence, of fresh serum, and that this property can be abstracted from the sera by adsorption with minced chick embryo. Embryo also removes the antibody which needs the presence of fresh serum from the sera of goats inoculated with Rous extracts, but has no effect on the antibody which is active in the absence of fresh serum: the former is the antibody to the specific factor, the latter to the virus. Anti-Rous sera also inactivate extracts of other fowl tumours of quite different histological structure, which therefore presumably contain the same virus; in one instance this does not happen in the absence of fresh serum, and hence the virus is judged to be different.

Such in brief are Dr. Gye's main results and inferences. He has much evidence in their favour, but there is obviously a good deal that needs further explanation, and the experiments do not always seem consistent among themselves. As he himself says, the method of testing by inoculating fowls is at best calculated to reveal only coarse differences, and the effect of some tumour extracts is complicated by the presence of elusive "inhibitory substances". The serum from normal guinea-pigs, goats, and fowls occasionally neutralises active extract; ducks injected with Rous extracts yield sera on which complement has no effect; rabbits generally produce no antibodies; goats generate both antibodies; a horse showed both antibodies and indications of a third. A goat immunised with Rous filtrates was bled on July 25 and the serum tested next day was found to be active only in the presence of complement (p. 344); serum obtained from the same animal on June 30 and tested on Aug. 29 neutralised well in the absence of complement.

It may be that curiosities and apparent dis-

* The Cause of Cancer. By Dr. W. E. Gye and W. J. Purdy. Pp. xiv+515. (London, Toronto, Melbourne and Sydney: Cassell and Co., Ltd., 1931.) 30*s*. net.

crepancies such as these are the necessary consequences of not having always an infecting extract of standard strength against which to test the sera, but it is difficult to get rid of a suspicion that the distinction made between the two antibodies is quantitative rather than qualitative, and that their relation to fresh serum is not that of immune body and complement as known in bacteriology. The whole narrative needs, deserves, and will doubtless receive detailed critical analysis: it is fortunate that the data are presented on such an ample scale that this is possible. The interpretation seems also in places to be inconsistent. Thus on p. 354 it is pointed out that two goats injected with heated extract (that is, containing virus only) produced sera which were active only in the presence of complement and therefore contained antiviral bodies only, and that this assumption is in accordance with general bacteriological experience. It is difficult to see how this fits with the fact (p. 361) that anti-normal-embryo sera are also active only if fresh serum is present. On p. 421 the antibody which operates in the absence of fresh serum is definitely identified with the extrinsic factor, that is, the virus. Nor is it possible to subscribe to Dr. Gye's suggestion that his immunological experiments demonstrate that extracts of fowl tumours contain some antigen which cannot have originated in the fowl and must therefore be an extrinsic virus which he thinks is widely disseminated about the world. Immunological differences between proteins depend on differences in chemical structure rather than on differences of biological origin, though in a rough way the two generally go together. Antigens from different species may be indistinguishable (blood serum of sheep and goat, egg albumin of duck and hen, various caseinogens), while antigens from the same species may be different (for example, the proteins of blood plasma or egg white) and the proteins of the lens of the eye may be antigenic in the individual to whom the eye belongs.

It seems evident that this part of Dr. Gye's argument will not carry anything like the weight that he has put on it. What his observations do seem to show quite clearly is that part at any rate of the agent is intrinsic—a conclusion in good accord with the old-fashioned view that cancer is a local autochthonous disease.

Scientific Research and National Life*

THE sixteenth Annual Report of the Department of Scientific and Industrial Research covers the period Aug. 1, 1930–July 31, 1931. It includes the brief report of the Privy Council, signed by the Right Hon. Stanley Baldwin, and the longer report of the Advisory Council, over Lord Rutherford's signature, which surveys the development of the Department and emphasises the need for scientific method in industry. Summaries of the work carried out by the National Physical Laboratory, the Chemical Research Laboratory, the research associations, and under the direction of some forty-five research boards and committees are attached, together with appendices dealing with finance, publications, and the personnel of the various boards and committees. The report presents an impressive picture of the contribution which science is making to the major needs of the population, promoting not merely material development, but also the growth of a better and healthier social order. Not only the research associations, but also the long list of committees and boards, many of whose distinguished members are rendering voluntary service which is little recognised, may be regarded as a great general staff organised for the application of science to the myriad needs of modern society.

In view of the curtailment of expenditure by the Committee of the Privy Council, particular attention is attracted to the expenditure detailed in the present report. The gross estimate for the year is £740,520, of which £30,340 is for headquarters administration, but receipts amounting to £184,829 bring the net expenditure to £555,691. Grants for research account for an expenditure of £40,610, gross, the Geological Survey and the Museum of Practical Geology for £67,714, and grants to research associations for £75,655. The National Physical Laboratory represents a gross expenditure of £208,964, of which slightly more than half, £104,706, is recovered as receipts from outside bodies and firms, the Air Ministry, and other government departments or special research funds. The Chemical Research Laboratory represents a charge of £19,993 net, building research, £30,421 net, fuel research, £87,411 net, radio research, £12,066 net, water pollution, £10,020 net. More than three-quarters of the expenditure of £50,060 on food investigation is borne by receipts, the net cost to the State being £11,693. Receipts amounting to £6936 similarly reduce the expenditure on forest products research to £36,376.

The expenditure on research associations, of which twenty-one received grants during the year, is of special interest. The seven largest grants, of £15,800, £8452, £8000, £7500, £6500, £4800, and £4750, are those paid to the Cotton, the Scientific Instruments, the Non-Ferrous Metals, the Wool Industries Research Association, the National Federation of Iron and Steel Manufacturers (Industrial Research Council), the Cast Iron Research Association, and the Research Association of the British Paint, Colour, and Varnish Manufacturers. The British Photographic Research Association was liquidated on Nov. 7, 1930, and its functions have now been taken over by the research establishments of the rationalised photographic industry. Thus the total expenditure of £26,597 spread over twelve years has in this instance fully realised the objects of the Government scheme, and paved the way for

* Department of Scientific and Industrial Research. Report for the Year 1930–31. (Cmd. 3989.) Pp. iv+186. (London: H.M. Stationery Office, 1931.) 3s. net.

the future development of the research by the industry itself independently of financial assistance from the State. The report states: "There can be no doubt that the important scientific investigations carried out by the research association during the period of its existence have materially contributed to the marked improvement in the quality of the photographic materials and accessories produced by British firms in recent years, and the Department has received an assurance that provision will be made under the new regime for the continuance of researches of this character".

The Wool Industries Research Association anticipates that the voluntary levy scheme will be working on normal lines next year. The Research Association of the British Motor and Allied Manufacturers is also being wound up, and its place is being taken by the Research and Standardisation Committee of the Institution of Automobile Engineers, which will receive grants from the Department up to a maximum of £2500 per annum for three years on a pound for pound basis in respect of income raised by the industry above £3000 a year. A further departure was the formation in November 1930 of the Printing Trades Research Association, which, however, is not in receipt of a grant.

Viewing the work of the research associations as a whole, the opinion is expressed that their achievements thoroughly justify the expenditure incurred, but the outstanding difficulty experienced by the research associations is that of bringing home to their members the practical significance of their work. This difficulty is being overcome, sometimes by the establishment of development departments, sometimes by the appointment of liaison officers.

Space does not permit even an outline of the work of individual research associations, and reference can only be made to a few features. The Cast Iron Research Association has developed the 'Silal' heat resisting alloys which are finding successful use in industry, and the application of the knowledge of moulding sands and refractories acquired as a result of the Association's investigations represents an estimated annual saving to the industry of about £100,000 a year. The Non-Ferrous Metals Research Association has been responsible for important advances in the investigation of aluminium castings and in the comparative study of a range of bearing metals and their interaction with representative lubricants. Investigations carried out by the British Refractories Research Association to improve the durability of refractory materials have an interest not only to the ceramic but also to the iron and steel and other industries concerned with high temperature operations, while much of the work carried out by the Electrical and Allied Industries Research Association is definitely related to matters of public safety and economy, for example, in the factor of safety and design of overhead transmission lines in the 'grid' system, and in the laying of electric cables at considerable depth.

The Scientific Instruments Research Association records the interesting discovery that the effect of polishing the surface of any glass, almost without exception, is to raise the refractive index of the immediate surface layer, an observation which should yield considerable information about the mechanism of polishing. The Paint Research Association has been concerned with the practical methods developed for the measurement of colour and the determination of colour fastness of pigments, and a table of fastness based on the quantitative methods developed is rapidly being accepted by the industry as the basis of colour valuation of pigments. X-ray methods are also being employed for the investigation of the structure of pigments, steels, metal deposition, and scales on steel.

The Cotton Industry Research Association has undertaken a long programme of fundamental studies on the physico-chemical nature of dye solutions and of the dyeing process, and these co-ordinated researches should fill a gap of much technical importance in our knowledge of the relation of the nature of dye solutions to the mechanism of cotton dyeing and the properties of the dyed material. In addition, laboratory work on the effect of various finishing processes such as bleaching and mercerising, and on the properties of cotton dyed with different dyes, is already yielding results of industrial value, and technical control of the bleaching process has been considerably improved. In a search for new uses for wool, the Wool Industries Research Association has obtained from a mixture of cellulose, leather, rubber, and wool, various products which closely resemble leather and for which uses are being explored. The Launderers' Research Association has succeeded in developing graded washing processes in which by technical control cleaner fabrics can be more rapidly obtained without increased cost of materials than by the casual processes commonly used, and methods for the economical cleansing of greasy fabrics are being evolved.

The Leather Manufacturers' Research Association has made an important contribution to public safety by the development of a method of disinfection which can be used by any tanner as a routine method of liming his goods and at the same time sterilising them against anthrax; attention is now being directed towards the development of a method by which the dry hides and skins may be disinfected at the port of entry into Great Britain. The Boot, Shoe, and Allied Trades Research Association is carrying out studies on the physical properties of leather which are intimately connected with the comfort and waterproofness of shoes. The Rubber Manufacturers' Research Association is assisting that depressed industry by discovering new uses for rubber, and particularly by studies on the use of vulcanised rubber for resisting corrosion and on the problem of securing satisfactory adhesion of rubber to metals, while the Research Association for the Cocoa, Chocolate, Sugar Confectionery, and Jam Trades has elaborated practical methods for preventing fatty bloom on chocolate and for overcoming the tendency of boiled sweets to become sticky on storage.

The above points, culled at random from the

summarised accounts of the activities of the research associations, represent in themselves an impressive and important contribution to public as well as to industrial progress. They are, however, only a fraction of the work for which the Department of Scientific and Industrial Research is responsible. Reference has already been made to the National Physical Laboratory, a feature of the work of which is the assistance rendered to industry by investigations and routine tests for industrial firms. Each of the seven main divisions of the Laboratory — Physics, Electricity, Metrology, Engineering, Metallurgy, Aerodynamics, and the William Froude Laboratory—is making valuable contributions to industrial progress, sometimes directly, sometimes through work carried out for a research board or association. The erection of equipment for the production of artificial fogs has much facilitated work in progress for the Atmospheric Pollution Research Committee, while the Engineering Department has carried out for the Ministry of Transport work of such obvious practical importance as tests on concrete for roads, skidding experiments with a motor-cycle and side-car and with a small model four-wheeled vehicle. The investigations on the spinning of aeroplanes, air-screw pressure and flutter, flutter of aeroplane tails, the wind resistance of ships, as well as the influence of waves on resistance, propulsion, and pitching, are only a few of the further ways in which the work of the National Physical Laboratory reflects on the question of transport and safety which is so vital in modern society.

The work carried out under the Fuel Research Board has received a considerable amount of attention recently, particularly that concerned with the hydrogenation of coal. Equally important, however, are the physical and chemical survey of the national coal resources, the investigations on carbonisation, gas production, treatment of tar to produce satisfactory fuel oils and motor spirit, coal-cleaning, and heat transfer which are proceeding quietly but steadily.

Transport, fuel, and atmospheric pollution are only three of the fields in which the work of the Department impinges broadly on daily life and needs. Important undertakings like the Southampton Docks and Water Supply, London Underground Railways, Battersea Power Station, the Millwall Drainage Tunnel, the Haweswater Reservoir Scheme, the Thames Tunnel, and the Mid-Scottish Ship Canal have resorted to the Geological Survey for information during the year.

The Building Research Board continues its efforts to substitute a science of building for empirical methods of trial and error, and has succeeded in formulating generalisations for the laying of wood block floors, as well as indicating causes of failures of paint coatings in buildings. Measurements of creep in the ageing of concrete have been supplemented by observations on actual structures, and other investigations endeavour to improve the efficiency of buildings from the point of view of the user. Research on steel structures has assisted in standardising practice for the design of steel-frame buildings and also in the application of electric welding to structural work in Great Britain. Certain of the investigations under the Forest Products Research Board are of interest in the same field, notably those concerned with specifications for building timber, wood preservative, and the study of dry rot and the death-watch beetle, while metallurgical research on the effect of corrosive media on boiler steel under relatively severe plastic deformation is obviously of interest in regard to public as well as industrial safety.

Similarly, the public and industrial interests of work carried out under the Water Pollution Research Board are not easily separated. The investigation on beet sugar factories' effluent had already led to modifications in the factory processes, the cost of which was at least counterbalanced by resultant economies in other directions. Laboratory work has now indicated that certain organisms are of special value in the purification of waste waters containing sugar, while the surveys of the river Tees and the Firth of Tay have indicated that polluting matter is not readily carried out to sea unless it is in the surface layer when it reaches the estuary. The scarcity of living organisms in the middle section of the Tees estuary cannot be attributed solely to pollution, and observations are being recorded on the migration of salmon and sea trout smolts. Some of the work on water pollution is linked up with investigations at the Chemical Research Laboratory, where it has been found that base-exchange materials remove from water traces of undesirable metals such as lead, copper, and zinc, which may be present in solution. Apart from its other investigations on corrosion, low-temperature tar, etc., the Chemical Research Laboratory has also been responsible for investigations on a series of fluorene derivatives containing arsenic and a new group of arsenicals analogous to trypansamide, both of which possess promising therapeutic activity.

Much valuable radio research has been carried out on the propagation of waves, aerials for transmission and reception, direction finding, and atmospherics, the significance of which is obvious to an increasingly large proportion of the population, while lubrication, illumination, and dental research, and, until April 1, 1931, the preservation and restoration of exhibits in the British Museum are among other activities of the Department the public significance of which is obvious. In regard to the latter work, which has now been transferred to the Trustees of the British Museum, mention may be made of services rendered at the Persian Art Exhibition, the use of chloramine-T for removing stains produced by mould and mildew in water-colour drawings and engravings, as well as the use of vinyl acetate for strengthening porous and friable material.

No summary, however brief, of the work of the Department is complete without reference to the work of the Food Investigation Board. Some account of the investigations of this Board has recently appeared in our columns, and it is unnecessary to add more than that the work of the Food Investigation Board represents the only

serious scientific study of the possibilities of low temperature gas-storage of fresh fruit and vegetables, and its success has already led to the erection of several commercial gas-stores for apples. Problems connected with the corrosion of cans by fruit juices and syrups have been surveyed; the transport and storage of bacon and pork as well as freezing and storage of meat and eggs are all receiving attention, while it has also been found that temperatures below 0° F. are required for the storage of brine-frozen haddock. Other investigations at the Torrey Research Station are concerned with the design of plant for the extraction of liver oil on steam-trawlers at sea and for the smoke-curing of fish, and it is not too much to claim that the national importance of the food investigations of the Department alone justify a large proportion of the whole expenditure on scientific and industrial research. Certain it is that few fractions of the national income are more wisely administered or expended with more profit both to society and to industry than the comparatively small sums which are entrusted by Parliament to the Department of Scientific and Industrial Research.

Obituary

PROF. R. STENHOUSE WILLIAMS

PROF. R. STENHOUSE WILLIAMS, first director of the National Institute for Research in Dairying, who died on Feb. 2 at the age of sixty years, went to Reading in 1912 equipped for the study of the dairying industry with a thorough knowledge of bacteriology, a science for which he had the greatest reverence and the status of which he jealously guarded. His profession as a physician and his academic career assisted him in the broad outlook which he brought to bear on the industry of his adoption. As a medical man he realised the importance of the nation's milk supply; as a bacteriologist he was scandalised by the conditions which were associated with milk production, and as a teacher he deplored the apathy and ignorance which tolerated such conditions.

With a characteristic thoroughness, Prof. Stenhouse Williams set himself to study the position, and brought his science and personal observation to bear on every stage in the passage of milk from the cow to the consumer. He did not content himself merely with working out scientific technique for the production of a clean and safe milk supply; he also realised the difficulties of the practical side and the necessity of keeping down the cost of production. It was here that his special gift of inspiring efficient social service came into full play. He became the friend of the farmer and of the milk distributor, inspiring in all with whom he came in contact the right mentality for their especial duties. Every grave error in the handling of milk he treated as a mistake which could be overcome by care and co-operation, and no hour of the day was too early or too late for him to give help and advice in cow byre or distributing centre.

Prof. Stenhouse Williams realised the necessity for technical education in all branches of the milk industry, and was active in the organisation of lectures, classes, and competitions with the view of increasing both the knowledge and efficiency of the workers. He was a man of very clear vision. He saw the foundations on which the unique nutritional value of milk is established in the order of Nature, and demonstrated on a large and convincing scale that pure and safe milk could be produced as a practical proposition. He emphasised that the work of the research institute for which he was responsible should rest on the firm foundations of fundamental science, and he stressed the necessity for a very thorough further study of the nutritional value of milk, including all possible effects produced by heat treatment. In his fight to maintain an open door for raw milk, many have crossed swords with him who could not have realised the soundness of his contention that the present necessity of harnessing the milk supply of our large towns to any processing machine is an expedient which must not exclude the recognition of a possible clean and natural milk supply under better conditions of social service.

Great and lasting as is his achievement in this work, it was the character and personality of Stenhouse Williams himself which endeared him to those who knew him well. To others, who differed from him, he presented an uncompromising front, for he was by nature a fighter.

PROF. W. H. WATKINSON

WE regret to record the death, on Feb. 14, of William Henry Watkinson, emeritus professor of engineering and director of the Walker and Harrison Hughes Engineering Laboratories of the University of Liverpool.

Prof. Watkinson, who was in his seventy-second year, was born at Keighley. His early training in the University of Glasgow brought him under the direction of Lord Kelvin, and, under the latter and Prof. Fleeming Jenkin, he aided in the manufacture, testing, and laying of trans-Atlantic cables. For a time he held a scholarship under Kelvin, and in 1888 was put in charge of the Engineering Department of the Central Science School, Sheffield. In 1893 he was appointed to the chair of engineering in the Glasgow and West of Scotland Technical College.

In 1905, Watkinson was appointed to the chair of engineering in Liverpool, and was largely responsible for the growth of that school. His efforts for engineering resulted in the building and equipment, in 1912, of the beautiful laboratories which he later directed. He was also instrumental in the foundation of the chairs of naval architecture and thermodynamics in Liverpool.

Watkinson's personal investigations related in particular to pioneer work on gas engines and air

heaters and superheaters for boilers. For twenty-one years he was a member of council of the Liverpool Engineering Society, and for a time served as president to the Society. He served also as chairman of the North-Western Branch of the Institution of Mechanical Engineers and as a member of its Council.

Watkinson will long be remembered for the kindness of his disposition and for the ceaseless efforts which he made to further the welfare of his School and the interests of his pupils.

WE regret to announce the following deaths:

Dr. W. D. Dye, F.R.S., principal assistant in the Electrical Standards Department of the National Physical Laboratory, on Feb. 18, aged forty-four years.

Dr. James Mercer, F.R.S., fellow and lecturer in mathematics at Christ's College, Cambridge, on Feb. 21, aged forty-nine years.

Sir William Somerville, K.B.E., honorary fellow of St. John's College, Oxford, and emeritus professor of rural economy in the University of Oxford, on Feb. 17, aged seventy-one years.

Prof. J. A. Udden, director of the University of Texas Bureau of Economic Geology, known for his work in the development of the mineral resources of Texas, on Jan. 5, aged seventy-three years.

Prof. Ernest Wilson, emeritus professor of electrical engineering at King's College, London, on Feb. 17, aged sixty-eight years.

News and Views

Centenary of Jean François Champollion

ON March 4 occurs the centenary of the death of Jean François Champollion, the distinguished French Egyptologist, who first deciphered the hieroglyphics. Born on Dec. 23, 1790, at Figeac, in the Department of Lot, he was the younger brother of Jean Jacques Champollion-Figeac (1788–1867), the archæologist and librarian. He was sent by his brother to school at Grenoble, and while there came under the influence of the mathematician Fourier, who had accompanied Napoleon to Egypt, and it is said that the sight of some Egyptian figures first aroused Champollion's intense interest in the East. From Grenoble he went to Paris to study Arabic and Coptic, at nineteen years of age he returned to Grenoble as a professor of history, and in 1811–14 published his work "L'Égypte sous les Pharaons", covering the whole history and geography of ancient Egypt. He was afterwards robbed of his chair for a time for political reasons, but, continuing his researches, in 1822 he wrote his important memoir on the hieroglyphics, which was read to the Institute, and two years later he was enabled by Louis XVIII. to visit Italy to study the collections of Egyptian antiquities. His "Précis du système hiéroglyphique" appeared in 1824, his catalogue of Egyptian manuscripts in the Vatican in 1826, and his account of the discovery of the hieroglyphic alphabet in 1827. The following year, with some assistants, he made an expedition to Egypt itself, and on his return in 1830 was appointed to a newly founded chair of Egyptology in the Collège de France. His death took place at the early age of forty-one years on March 4, 1832, and he was buried close to Fourier in the Père Lachaise cemetery.

New Physics Building at Leeds

THE new physics building of the University of Leeds, described in NATURE of Jan. 9, p. 64, was formally opened by Sir William Bragg on Feb. 18. In introducing Sir William, the vice-chancellor of the University, Sir J. B. Baillie, referred to the brilliant work carried out by Sir William Bragg during his tenure of the Cavendish chair of physics at Leeds. He also stated that although the greater part of the £60,000 spent on the laboratory was generously contributed by the public to the general building fund, two specially generous donors specifically ear-marked their gifts for physics—Sir James Roberts and Messrs. Courtaulds. Sir William Bragg, in his address, discussed the change of attitude on the part of the general public during the past eighty years or so towards the work of the physical laboratory. There has been increased interest in the progress of natural knowledge and also in its application to everyday needs. At one time private benefactors alone founded and maintained learned institutions; nowadays, such institutions receive public grants. John Citizen has realised the value of the advance of knowledge by experiment, and is willing to pay for it. Sir William would now like to see him in the laboratory itself, and suggested that every opportunity should be taken "to demonstrate visually to John Citizen the slow unfolding of Nature's laws by patient research, the discovery of unsuspected beauties of order and adaptation, the origin of the new conception of the universe, and, not least, the skilful handling of new knowledge for the service and delight of man". Prof. R. Whiddington, in moving a vote of thanks to Sir William Bragg, said he felt sure the new building would for a long time function efficiently and, by virtue of its internal conveniences and appearance, induce the right atmosphere for teaching and research. He felt one regret in leaving the old building to its fate: there was a hallowed corner where his famous predecessor, Sir William Bragg, had made historic experiments—this place would soon be covered by the Brotherton Library. He felt sure that it would be possible to mark the spot suitably when the library is built.

Presentation to Prof. W. W. Watts, F.R.S.

ON Feb. 3, a representative gathering of past and present members of staff of the Geological Department of the Imperial College of Science met for the purpose of presenting Prof. W. W. Watts with his portrait, painted by Sir William Rothenstein. A medal, to be known as the Watts Medal, was also struck as an additional mark of the occasion. This

medal, executed by Mr. Percy Metcalfe, is to be awarded annually to the best student in geology in his final year, but the first copy was presented to Mrs. Watts. In making the presentations on behalf of the fifty members of staff who have served in the Department of Geology during the last twenty-five years, Prof. P. G. H. Boswell recalled Prof. Watts's high distinction as an original investigator, and referred to the great influence he has exercised on British geology in his time. Geology generally has benefited by Prof. Watts's well-known capacity for organisation and administration and by his genius as a teacher, in which field he is *felicissime princeps*. Prof. Watts, in returning thanks, acknowledged the encouragement and help he had received from his teachers and associates, and took the opportunity of announcing the establishment of a prize-fund in memory of his predecessor, Prof. J. W. Judd. In a characteristically happy speech, he charged his old students and staff with having used, when they turned their microscopes on him, only low powers and parallel nicols, so that they saw a gorgeous display of colour, but failed to observe his angle of extinction.

Geology in International Affairs

ON Feb. 18, Prof. H. H. Read, George Herdman professor of geology in the University of Liverpool, delivered his inaugural address. In discussing certain aspects of geology, both national and international, Prof. Read stated that the importance of mineral deposits in national and international affairs arises from three main factors, namely, the irregular distribution of minerals among the nations, their character as irreplaceable wasting assets, and the gigantic acceleration in their consumption. A survey of the present and future mineral position shows that the British Empire, provided it remains a unit of intelligent type, and the United States are together overwhelmingly dominant. The Empire's chief lack is petroleum, a circumstance giving added importance to the production of oil from coal. The dominance of these two units leads to the consideration of schemes for the prevention of war, similar to those suggested by Sir Thomas Holland. A mineral sanction, or an agreement by the United States and the British Empire not to export key minerals to disturbers of the peace would prevent, stop, or at least limit, war.

Blind Reading Print by Sound

SEVERAL devices have been invented with the view of enabling the blind to read ordinary print instead of Braille. As mentioned in NATURE of Jan. 9, p. 52, the ' optophone ' was invented by Dr. Fournier d'Albe and the ' phonopticon ' by Prof. F. C. Browne. These two instruments convert ordinary type directly into sound signals ; but according to Dr. Ernest Whitfield, of the National Institute for the Blind, London, neither is in use in any institution for the blind. We understand also that there is no alphabet requiring more training than one which converts printing into sound. The ' photoelectrograph ' of MM. Thomas and Conland, as announced in our note, involves touch ; but since the Braille type part of the machine would necessitate the printing of books in special type, it would involve a cost beyond the reach of the average blind person. We have also been reminded of other instruments for aiding the blind, including the ' optograph ' of Dr. J. Butler Burke, which involves the use of a photoelectric cell to convert typewritten or printed matter into Braille, and also sets up type automatically ; this instrument was exhibited at the Exhibition of Inventions in October 1929. Another instrument is the ' visagraph ' invented by Mr. Robert E. Naumburg, of Cambridge, Mass. This latter involves touch, a ray of light passing over the printed page, and the letters are reproduced in embossed type on a sheet of aluminium foil. It may be remarked that embossed ' roman type ' preceded Braille, and Dr. Whitfield states that it was very successful. The ' visagraph ' is being used successfully in America, thus showing that ordinary type is suitable for reading by touch with reasonable speed.

New Political Fellowship

THE present state of party politics has given an impetus to non-party movements such as the New Political Fellowship organised by Mr. A. G. Pape, though it is perhaps premature to predict as the ultimate outcome the formation of a centre group in our Houses of Parliament. Party politics are apparently insufficient for the present emergency. The co-operative methods advocated by the New Political Fellowship, based on a definite planning of national and international life which is determined by an impartial study of the facts, not by political prejudice, are much more in harmony with the methods and outlook of scientific workers. The Fellowship, which already has a basis in some thirty countries, claims to break with useless traditions, and to substitute for the narrow, national jealousies a broad outlook and a spirit of co-operation which will enable existing international machinery, such as the League of Nations, the International Labour Office, etc., to function smoothly. However idealistic certain of the points in this policy may appear, they undoubtedly spring from the conviction that leadership must be based primarily on knowledge and no longer on prejudice or vested interests. In this the Fellowship can justly ask the support of men of science, without whose support its efforts indeed are likely to be largely sterile. It is only the solutions reached under the guidance of the calm impartial spirit of science that will have permanent value and authority in the era of co-operation which the Fellowship seeks to promote.

Charles II. Exhibition in London

THE period of Charles II. is so intimately connected with the beginnings of some of our principal scientific institutions that it is satisfactory to record that the Royal Society, the Greenwich Observatory, the Old Ashmolean Museum, Chelsea Hospital, and Hudson's Bay Company, all dating from his reign, should be joining in contributing contemporary exhibits to the Loan Exhibition now being held at 22 Grosvenor Place, London. The scientific exhibits include the

reflecting telescope of Isaac Newton, a full-sized model of Hooke and Boyle's pneumatic engine or air-pump, Sutton's 16-inch planisphere, quadrants, and the adding machine invented by Sir Samuel Morland and presented to Charles II. in 1666, from the Lewis Evans Collection in the Old Ashmolean at Oxford. Viscount Knutsford is showing his interesting screw-barrel microscope and 6-foot vellum-draw telescope by William Longland. The Royal Society has sent portraits of Sir Isaac Newton, Pepys, Evelyn, and Wren. Further attractive features are the fine clocks and watches made by Edward East with his apprentice Henry Jones, Fromanteel, Robert Seignoir, and Joseph Knibb. The medical and surgical practice of the time is rather inadequately represented by a barber-surgeon's bowl and several drug-pots, but Capt. Collins's "Coasting Pilot", exhibited by the Lords of the Admiralty, reminds us that the first hydrographic survey of the British Isles was also a product of the reign of Charles II. The exhibits are well arranged, and, not being crowded, can be well seen.

New Pyramid at Giza

THE discovery of a fourth pyramid at Giza, as reported in the *Times* of Feb. 18 and subsequent issues, is likely to provide Egyptologists with a historical puzzle, as well as presenting some peculiar and interesting features in itself. The method of construction would appear to be unusual, for it is said that the southern face, which looks on the valley and is much weathered, is cut out of the sandstone. Another remarkable feature is the enormous granite slabs lining the passage which leads to the interior of the pyramid, and equally interesting are the two windows facing east, which open from the entrance chamber. These, it is suggested, may be connected with the enhanced influence of sun-worship usually attributed to the fifth dynasty. The most striking feature, however, is the fact that the names and titles of the owner of the large chamber cut out of the rock on the south-east of the pyramid show that it belonged to Queen Khent Kawes, "King of Lower and Upper Egypt". The name is not enclosed in the usual cartouche, but is ensigned with a royal uræus. This title is not known to have been applied to any other queen of the Old Kingdom. The official communique suggests that, while not the actual ruler of Egypt, she may have been regent during her son's minority. It goes on to point out that it is possible that she may have been connected by birth with the fourth dynasty; but that otherwise it is singular that a pyramid should have been erected for her at Giza at the time of the fifth dynasty, which resided at Abusir.

Gallium, a Commercial Product

ALTHOUGH the presence of the metal gallium has been detected in a great variety of minerals, it occurs in such minute amount even in zincblende, which is its chief source, and its isolation is so laborious, that until quite recently only very small quantities were available. The *Chemiker-Zeitung* for Jan. 2 announces that the Vereinigte Chemische Fabriken at Leopoldschall, Stassfurt, manufacturers of the rare element rhenium, have succeeded, after lengthy experimental trials, in isolating gallium by a method which enables them to produce the metal at one-twentieth of its former cost, which a year ago stood at about 175 gold marks per gram. Thus the way to the commercial development of this remarkable metal is at last opened.

CONSIDERABLE attention has already been given to the properties of gallium, chiefly on account of the long thermal range of stability of its liquid phase. Thus the pure metal melts at about 30° C. and boils at a temperature above 2000° C. It has therefore been used for filling quartz thermometers for registering temperatures above 500° C. Some of these have already been sent to the Physikalisch-Technische Reichsanstalt for standardisation. Gallium can also be used to replace mercury in vapour arc-lamps for use in analytical work. Indeed, its application in this direction should lead to important results, on account of the wide range in frequency in the lines of its spectrum, which extend from the ultra-violet to well into the red region. It has also been used in the form of alloys with other metals to replace the dental amalgams, which are said to have produced some harmful results. Satisfactory results from gallium alloys have been reported. Gallium and some of its alloys can also be used for the production of special optical mirrors, and no doubt many other applications will be found now that the metal has become an article of commerce.

Earth Pressures

AT the Friday evening discourse at the Royal Institution on Feb. 19, Prof. C. F. Jenkin discussed the mechanics of shifting sand. Prof. Jenkin explained why experiments intended to measure the pressure exerted by granular material, such as sand, fail, and showed that the failure is due to arching, a necessary consequence of the property of dilatancy, discovered by Osborn Reynolds. The latest design of apparatus for measuring the forces on a retaining wall was shown, and the results of a test made with it were described. With this apparatus the old earth pressure theories have been tested and the truth in them separated from the error. As a result, a revised wedge theory has been formulated. The apparatus was shown to be capable of measuring the forces not only on plane walls, of any batter, but also on stepped walls and on L-shaped walls, and also of measuring the forces under water. Finally, by an ingenious device, a wall of sand has been tested and the true friction angle between two sand faces measured. The reaction, that is, the force exerted by the wall on the sand, was described and its importance illustrated by an account of the partial failure of a great weir in Australia. The apparatus described can only deal with one-quarter of the whole problem of earth pressures; it cannot measure the forces under a foundation, and it cannot measure either horizontal or vertical forces exerted by clay.

International Co-ordination of Locust Research

SOME time ago the Imperial Institute of Entomology in London organised, with the financial support of the

Empire Marketing Board, special investigations on the distribution, breeding areas, migration routes, ecology, and bionomics of locusts in tropical Africa and Asia. An appeal was made by the British Government to the governments of other countries interested in the locust problem to help in these studies, and the Italian Government came forward with a suggestion to call together a meeting of experts to discuss the ways and means for a unified attack of the problem. The meeting, in which British, Italian, and French experts participated, took place in September last in Rome, and its resolutions, which have just been published, constitute the first step towards an effort to solve the locust problem on an international scale. The meeting expressed a definite opinion that the best and most economical method of preventing the ravages of locusts consists in the discovery of permanent breeding areas, and in the study of ecological conditions which lead to the outbreaks and invasions of cultivated areas.

SINCE in their migrations locusts do not respect political boundaries, the necessity of centralising all research on locusts in one institution was stressed at the meeting in Rome, and it was recommended to all the governments concerned that the Imperial Institute of Entomology should be recognised as the international centre of locust investigations. This decision has since been accepted by the Italian and French authorities. All current information on the appearances, breeding, and migrations of locusts are to be submitted periodically to the Institute, which will co-ordinate the data for the whole area of distribution of each locust species and study them in order to throw light on the factors governing the outbreaks and the main lines of migrations. All governments not represented at the Rome meeting, but interested in the locust problem, will be invited to co-operate with the central Institute; and annual meetings of experts will be arranged to discuss the progress made in each country in the study of locusts, and the programmes of future work. The next meeting of this kind is planned to take place in Paris at the time of the Fifth International Entomological Congress in July.

The Lapel Microphone

AT public meetings and at lectures, the microphone and loud speaker is often a great boon to both the speaker, who speaks practically in his natural voice, and to the audience, who hear him clearly. There are some, however, who forget that they are addressing a stationary microphone and move about freely, with the result that sometimes they can scarcely be heard. To get over this difficulty, the Bell Telephone Company has invented the lapel microphone, a description of which is given in its *Record* for January. The microphone is only about an inch in diameter and weighs one and one-half ounces. A thirty-foot length of flexible cord provides the connexion to the amplifier of the public address system. The diaphragm is made of thin aluminium in the shape of a cone of sufficient stiffness to cause it to vibrate as a unit throughout the required frequency range. A rubber covering for the microphone eliminates the disturbing noise which would otherwise result from rubbing against the speaker's clothing, or would be picked up through the clip which is provided for attaching it to the clothing. The best place to attach the clip is to the lapel of the speaker's coat. This device has been used very successfully in large auditoriums in America. It should prove useful to speakers who depend on gestures for effective delivery or who need to turn to explain lantern slides or use a blackboard.

Publications of the American Physical Society

COMMENCING with the first issue for January of this year, the *Physical Review* is publishing the titles of papers on physics that are appearing in a number of other journals. The value of this innovation is enhanced by the fact that arrangements have been concluded whereby many of these will furnish advance proofs of their tables of contents. The first list is fairly comprehensive, although one notices the omission of the *Proceedings of the Cambridge Philosophical Society*, and of a few others, which may, however, be rectified later. The American journals include, amongst others, the *Journals* of the Acoustical and Optical Societies, the *Journal of Rheology*, the *Review of Scientific Instruments* and *Physics*. This is the fifth comparatively recent change in the publications of the American Physical Society and follows the appearance of the *Physical Review* twice every month in place of twelve times in a year, the addition of a section in this for "Letters to the Editor", and the publication of the two new periodicals *Physics* and *Reviews of Modern Physics*.

Comité International d'Histoire des Sciences

THE fourth annual meeting of this Society, the second international congress of which, it will be remembered, was held in London last July, is to take place in Paris on May 13–16. The Council of the Society is convinced that one of the most important tasks confronting the historian of science is to study the development under Arabic influence during the period of its dominance, say from the date of the Mussulman conquest until the beginning of the sixteenth century. To promote and organise this study, the scientific sessions, as distinct from the business sessions which are confined to members, will be devoted exclusively to papers and discussions on Arabic science. In these sessions all those who are interested, members or not, are invited to take part and to submit papers. There will be five sessions, devoted to mathematics, alchemy, astronomy and physics, geography and cartography, and medicine respectively. The meeting will take place at the headquarters of the Society, Hôtel de Nevers, 12 rue Colbert, Paris, 2e; the permanent secretary, M. Aldo Mieli, will be pleased to furnish a programme and further details.

Progress of Agricultural Research

THE sixth of the series of annual summaries of scientific and economic research work in agriculture has been published by the Royal Agricultural Society of England, entitled "Agricultural Research in 1930". The survey which the volume contains is not limited to work done in Great Britain, but includes reference to the activities of experimental stations in all parts of the world, in so far as they have a bearing upon the

problems of British agriculture. The present volume follows upon the lines of the previous issues as to the seven departments of research covered, and each of these sections is compiled by an acknowledged authority on the subject. The volumes are issued free to members of the Society upon application to the Secretary, 16 Bedford Square, London, W.C.1, and at a nominal charge of 1*s.* 3*d.*, including postage, to the general public. The Research Committee, under the direction of which they are prepared, is desirous that the information contained in them should be drawn upon freely by county agricultural advisory officers and by the Press, so that it may receive a wide publicity.

Economic Research in Australia

THE *Journal of the Council for Scientific and Industrial Research* of the Commonwealth of Australia contains reports of many investigations of pressing economic problems, to some of which reference will be made under our Research Items. Here we simply wish to congratulate the Council upon the completion of its new Animal Health Laboratory, the result of a sum of £20,000 given by Mr. F. D. McMaster for that purpose. The Laboratory is placed within the grounds of the University of Sydney, alongside the buildings of the Veterinary Department, and the closest contact is maintained between the two staffs. The work already in progress in the building relates to internal parasites of sheep, including nutritional aspects of this problem, contagious mammites, certain aspects of foot-rot of sheep, and other problems. It is obvious that the Laboratory is in a position to play an important part in the study of those aspects of the Australian pastoral industry which are in great need of solution if the industry is to flourish. The building is of brick, with red-tiled roof, measures 155 feet by 43 feet, is two-storied, and has been constructed so that other stories or rooms may be added with the minimum of disturbance.

New Chief Entomologist at Rothamsted

THE position of Chief Entomologist at the Rothamsted Experimental Station, rendered vacant by the appointment of Dr. A. D. Imms as head of the new Department of Entomology at Cambridge, is to be filled by Dr. C. B. Williams, lecturer in agricultural and forest zoology, University of Edinburgh. Dr. Williams has had a distinguished career as entomologist in various parts of the British Empire; he received his training at Cambridge and then at the John Innes Horticultural Institution, Merton. After a period of travel in Canada and the United States, he was appointed to the Department of Agriculture of Trinidad, in charge of froghopper investigations, where he stayed for five years. He then became subdirector and afterwards director of the Entomological Section, Ministry of Agriculture, Egypt, and after six years' service was appointed entomologist to the East African Agricultural Research Station, Amani, Tanganyika. He is shortly proceeding to the United States of America to give a course of lectures at the Agricultural Department of the University of Minnesota, and will take up his duties at the Rothamsted Experimental Station on July 1.

Fellowship of African Research

IT is announced that a Rockefeller fellowship for research work in Africa has been awarded to Miss L. C. Mair. Miss Mair has worked with Prof. B. Malinowski at the London School of Economics as research assistant. She has already left for Uganda, where she will study native social institutions with special reference to the changes which have been brought about by European settlement. The comparatively highly organised character of the social institutions of the Baganda before they came into contact with Europeans, and the readiness the people have shown in adapting themselves in certain directions to European ideas, should make this a fruitful and particularly instructive field of inquiry, especially if opportunity should arise for comparison with other areas of East Africa in which contact with European civilisation has been neither so prolonged nor so intense.

The Cuba Earthquake of Feb. 3]

ACCORDING to the *Wire Reports* for Feb. 3 and 4 issued by Science Service, the epicentre of the Cuba earthquake of Feb. 3 lay in about lat. 19·5° N., long. 76·5° W., or about thirty miles from Santiago, on the northern edge of the Bartlett Deep. At the time of the earthquake, Prof. S. Taber was in Santiago, studying the seismology of the district. He has found faults near Santiago so fresh that gullies made by rain have not yet crossed them. The U.S. submarine *S-48*, carrying an international scientific expedition, left on Feb. 4 to study the depths and changes of depth in the Bartlett Deep, an inquiry that may add to our knowledge of the origin of the recent earthquake.

Announcements

THE thirty-seventh annual congress of the South-Eastern Union of Scientific Societies will be held in London, at the Civil Service Commission, Burlington House, W.1, by permission of H.M. Office of Works, on June 1–4, under the presidency of Dr. R. E. Mortimer Wheeler, Keeper of the London Museum.

ON March 7, the Hon. Henry McLaren, president of the Royal Horticultural Society, will unveil a plaque at Messrs. Hatchards, 187 Piccadilly, London, to commemorate the foundation of the Horticultural Society of London at Messrs. Hatchards on March 7, 1804. The Society received its royal charter on April 7, 1809, becoming the Royal Horticultural Society.

AT the annual general meeting of the Quekett Microscopical Club, held on Feb. 9, the following officers and new members of the committee were elected: *President*—J. Milton Offord; *Vice-Presidents*—Dr. G. H. Rodman, J. Wilson, C. D. Soar, and J. Ramsbottom; *Hon. Treasurer*—C. H. Bestow; *Hon. Secretary*—W. S. Warton; *Hon. Reporter*—A. Morley Jones; *Hon. Librarian*—C. H. Caffyn; *Hon. Curator*—C. D. Sidwell; *Hon. Editor*—W. S. Warton; *New Members of Committee*—J. T. Holder, C. H. Oakden, H. C. Payne, J. Richardson, W. P. Sollas, and Dr. C. Tierney.

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.*]

Possible Existence of a Neutron

IT has been shown by Bothe and others that beryllium when bombarded by α-particles of polonium emits a radiation of great penetrating power, which has an absorption coefficient in lead of about 0·3 $(\text{cm.})^{-1}$. Recently Mme. Curie-Joliot and M. Joliot found, when measuring the ionisation produced by this beryllium radiation in a vessel with a thin window, that the ionisation increased when matter containing hydrogen was placed in front of the window. The effect appeared to be due to the ejection of protons with velocities up to a maximum of nearly 3×10^9 cm. per sec. They suggested that the transference of energy to the proton was by a process similar to the Compton effect, and estimated that the beryllium radiation had a quantum energy of 50×10^6 electron volts.

I have made some experiments using the valve counter to examine the properties of this radiation excited in beryllium. The valve counter consists of a small ionisation chamber connected to an amplifier, and the sudden production of ions by the entry of a particle, such as a proton or α-particle, is recorded by the deflexion of an oscillograph. These experiments have shown that the radiation ejects particles from hydrogen, helium, lithium, beryllium, carbon, air, and argon. The particles ejected from hydrogen behave, as regards range and ionising power, like protons with speeds up to about $3{\cdot}2 \times 10^9$ cm. per sec. The particles from the other elements have a large ionising power, and appear to be in each case recoil atoms of the elements.

If we ascribe the ejection of the proton to a Compton recoil from a quantum of 52×10^6 electron volts, then the nitrogen recoil atom arising by a similar process should have an energy not greater than about 400,000 volts, should produce not more than about 10,000 ions, and have a range in air at N.T.P. of about 1·3 mm. Actually, some of the recoil atoms in nitrogen produce at least 30,000 ions. In collaboration with Dr. Feather, I have observed the recoil atoms in an expansion chamber, and their range, estimated visually, was sometimes as much as 3 mm. at N.T.P.

These results, and others I have obtained in the course of the work, are very difficult to explain on the assumption that the radiation from beryllium is a quantum radiation, if energy and momentum are to be conserved in the collisions. The difficulties disappear, however, if it be assumed that the radiation consists of particles of mass 1 and charge 0, or neutrons. The capture of the α-particle by the Be^9 nucleus may be supposed to result in the formation of a C^{12} nucleus and the emission of the neutron. From the energy relations of this process the velocity of the neutron emitted in the forward direction may well be about 3×10^9 cm. per sec. The collisions of this neutron with the atoms through which it passes give rise to the recoil atoms, and the observed energies of the recoil atoms are in fair agreement with this view. Moreover, I have observed that the protons ejected from hydrogen by the radiation emitted in the opposite direction to that of the exciting α-particle appear to have a much smaller range than those ejected by the forward radiation. This again receives a simple explanation on the neutron hypothesis.

If it be supposed that the radiation consists of quanta, then the capture of the α-particle by the Be^9 nucleus will form a C^{13} nucleus. The mass defect of C^{13} is known with sufficient accuracy to show that the energy of the quantum emitted in this process cannot be greater than about 14×10^6 volts. It is difficult to make such a quantum responsible for the effects observed.

It is to be expected that many of the effects of a neutron in passing through matter should resemble those of a quantum of high energy, and it is not easy to reach the final decision between the two hypotheses. Up to the present, all the evidence is in favour of the neutron, while the quantum hypothesis can only be upheld if the conservation of energy and momentum be relinquished at some point.

J. CHADWICK.

Cavendish Laboratory,
Cambridge, Feb. 17.

The Oldoway Human Skeleton

A LETTER appeared in NATURE of Oct. 24, 1931, signed by Messrs. Leakey, Hopwood, and Reck, in which, among other conclusions, it is stated that "there is no possible doubt that the human skeleton came from Bed No. 2 and not from Bed No. 4". This must be taken to mean that the skeleton is to be considered as a natural deposit in Bed No. 2, which is overlaid by the later beds Nos. 3 and 4, and that all consideration of human interment is ruled out.

If this be true, it is a most unusual occurrence. The skeleton, which is of modern type, with filed teeth, was found completely articulated down even to the phalanges, and in a position of extraordinary contraction. Complete mammalian skeletons of any age are, as field palæontologists know, of great rarity. When they occur, their perfection can usually be explained as the result of sudden death and immediate covering by volcanic dust. Many of the more or less perfect skeletons which may be seen in museums have been rearticulated from bones found somewhat scattered as the result of death from floods, or in the neighbourhood of drying water-holes. We know of no case of a perfect articulated skeleton being found in company with such broken and scattered remains as appear to be abundant at Oldoway. Either the skeletons are all complete, as in the *Stenomylus* quarry at Sioux City, Nebraska, or are all scattered and broken in various degrees, as in ordinary bone beds. The probability, therefore, that the Oldoway skeleton represents an artificial burial is thus one that will occur to palæontologists.

The skeleton was exhumed in 1913, and published photographs show that the excavation made for its disinterment was extensive. It is, therefore, very difficult to believe that in 1931 there can be reliable evidence left at the site as to the conditions under which it was deposited. If naturally deposited in Bed No. 2, the skeleton is of the highest possible importance, because it would be of pre-Mousterian age, and would be in the company of *Pithecanthropus* and the Piltdown, Heidelberg, and Peking men, all of whose remains are fragmentary to the last degree. Of the few other human remains for which such antiquity is claimed, the Galley Hill skeleton and the Ipswich skeleton are, or apparently were, complete. The first of these was never seen *in situ* by any trained observer, and the latter has, we believe, been withdrawn by its discoverer. The other fragments, found long ago, are entirely without satisfactory evidence as to their mode of occurrence.

We are, therefore, forced to the conclusion that the Oldoway man reached the position in which he was found by an artificial and probably a relatively recent burial, and should be glad to hear from Messrs. Leakey, Hopwood, and Reck on what grounds they have based their statement that there is no possible doubt that the human skeleton came from Bed No. 2.

C. FORSTER COOPER.

University Museum of Zoology,
Cambridge.

D. M. S. WATSON.

Department of Zoology,
University College,
University of London.

Segregation of Cementite from Austenite

THE formation of new phases in alloys by precipitation from solid solutions has recently been studied extensively.[1] These studies have given experimental evidence indicating that when a precipitate forms as plates within a crystalline grain, the crystallographic plane to which the plate lies parallel is determined, not only by the lattice structure of the parent solid solution, but also by the lattice structure of the precipitate.

Recently Hanemann and Schröder [2] have stated that the external form of the precipitate is determined only by conditions of diffusion, which, in turn, are determined only by the lattice structure of the parent solid solution. In proof of this contention, they state that Fe_3C (cementite) precipitating in alloys of iron and carbon between 0·9 and 1·7 per cent carbon from the solid solution of carbon in gamma iron (austenite) forms in plates parallel to octahedral and cube planes in the austenite, a behaviour identical with that shown by 'pure' iron (ferrite) precipitating in alloys with less carbon (0 – 0·9 per cent) from the same parent solid solution, though the crystal structures of the two precipitating phases are radically different.

This problem has been studied at the Naval Research Laboratory, with results different from those of Hanemann and Schröder. The analysis of the cementite structure is more difficult than that of other Widmanstätten figures. Iron-carbon alloys suffer a eutectoid inversion at 720°, and for this reason the matrix in which cementite plates are found embedded within each cell at room temperature is pearlite, with no residuum of the original austenite lattice. For this reason, the positions of the cementite plates cannot be directly compared with the positions of the crystallographic planes in the original austenite parallel to which the cementite plates form. Indirect methods, however, have proved useful.

A sample with 1·4 per cent carbon exhibiting several very large austenite cells—some a centimetre in diameter—and showing unusually large and well-formed cementite plates, was polished on three faces approximately at right angles in such a way that a chosen cell lay at a corner, extending well along each of the three sides. The angular positions in space taken by the individual cementite plates that could be seen to extend from one face around a 90° edge to another face were determined by measuring the angles formed by each separate plate trace with the edge. By a series of eight regrinding and repolishing operations, ninety-seven needles were successfully traced around an edge and measured. The angular positions in space of these plates were then plotted stereographically, as shown in Fig. 1, in which the plane of the projection is one of the polished faces, the normals to the cementite plates appearing as dots. It may be seen in this plot that the stereographic points group themselves in three circles. Symmetry considerations suggest that these points are grouped around three mutually perpendicular axes, and an approximation of the centre of each of the circles—the approximate centres of gravity determined by intersecting stereographic great circles—should give the approxi-

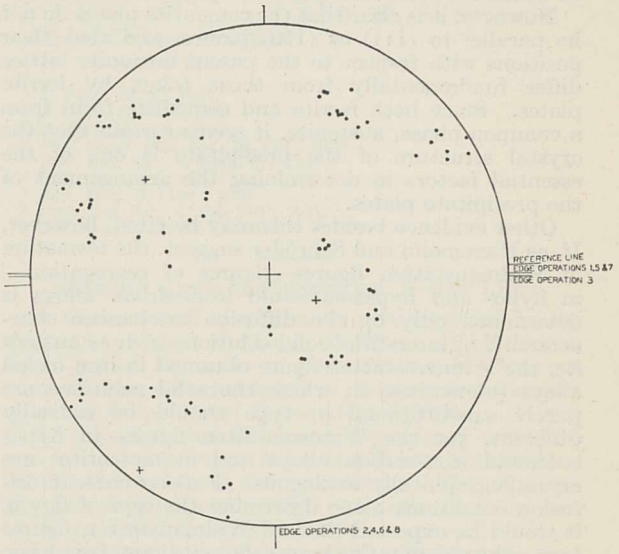

FIG. 1.

mate positions of these three axes. It was found that positions obtained in this way (the small crosses in Fig. 1) could be stereographically rotated into [100] directions of a standard cubic projection with surprising accuracy. Fig. 2 shows the result of this rotation, with [100] directions plotted as squares.

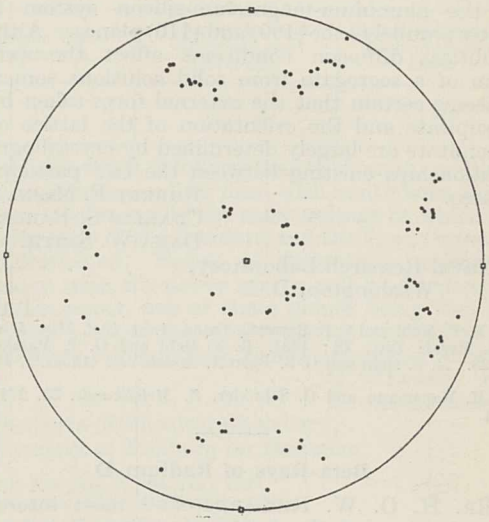

FIG. 2.

It seems quite certain that the [100] directions obtained in this way truly represent the [100] directions in the original austenite lattice—or equivalently, the stereographic projections of the (100) planes; cubic symmetry permits no other interpretation. The exact grouping of the projections of the cementite plates around these (100) positions, however, is difficult to interpret. A comparison with a standard projection shows that no one form of plane in the austenite lattice can explain the projections of all the cementite plates, for they scatter rather irregularly

on the circle about the (100) positions. When all the points shown in Fig. 2 are stereographically rotated into one quadrant, some slight evidence of grouping centreing around the projections of the (722) and (521) planes becomes evident, but this grouping is not sufficient to permit a choice of the austenite planes to which the cementite plates lie parallel.

However, it is clear that the cementite plates do not lie parallel to (111) or (100) planes, and that their positions with respect to the parent austenite lattice differ fundamentally from those taken by ferrite plates. Since both ferrite and cementite form from a common phase, austenite, it seems certain that the crystal structure of the precipitate is one of the essential factors in determining the arrangement of the precipitate plates.

Other evidence besides this may be cited, however. If, as Hanemann and Schröder suggest, the formation of Widmanstätten figures—figures of segregation—in hypo- and hyper-eutectoid iron-carbon alloys is determined only by the diffusion mechanism characteristic of interstitial solid solutions such as austenite, the Widmanstätten figure obtained in iron-nickel alloys (meteorites) in which the solid solutions are purely substitutional in type should be radically different, yet the Widmanstätten figures in hypo-eutectoid iron-carbon alloys and in meteorites are crystallographically analogous. Furthermore, if diffusion conditions alone determine the type of figure, it would be expected that all Widmanstätten figures formed by precipitation from solid solutions of one basic metal would be identical in form, yet the precipitation of the γ-phase from the aluminum-rich terminal solid solution in the aluminum-silver system leads to the formation of plates parallel to the (111) plane, that of the $CuAl_2$ phase from the aluminum-rich terminal solid solution in the aluminum-copper system forms plates parallel to the (100) plane, and that of the precipitate from the aluminum-rich solid solution in the aluminum-magnesium-silicon system forms plates parallel to the (100) and (110) planes. Although doubtless diffusion conditions affect the external form of a segregate from solid solutions somewhat, it seems certain that the external form taken by the precipitate and the orientation of the lattice of the precipitate are largely determined by crystallographic relationships existing between the two participating phases.

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CHARLES S. BARRETT.
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Washington, D.C.

[1] R. F. Mehl and C. S. Barrett: *Trans. Amer. Inst. Min. Met. Eng.*, Inst. Metals Div., **78**; 1931. R. F. Mehl and O. T. Marzke, *ibid.* p. 123. R. F. Mehl and C. S. Barrett, *Metals and Alloys*, **1**, 442-443; 1930.
[2] H. Hanemann and O. Schröder, *Z. Metallkunde*, **23**, 273, 297; 1931.

Beta-Rays of Radium-D

MR. H. O. W. RICHARDSON'S [1] most interesting investigations of the β-rays of radium-D induce me to make certain complementary remarks.

1. In the first place I should like to point out that the *experimental results* of the above-mentioned researches practically agree with the results of earlier investigations regarding the same problems. This fact is most clearly illustrated by Fig. 1, which compares the results of Petrowá's [2] measurements (2070 measured β-rays) with those found by Richardson (377 measured rays).

In these diagrams the abscissæ of the maxima correspond almost exactly and the difference in the relative intensity appears to be very small, especially if we consider Petrowá's statement that her first maximum is too low.

However, I am obliged to disagree with Richardson in the interpretation of his results. As a matter of fact, I do not agree with his supposition that the rays of 0·7 cm. ranges (in air) *do not correspond* with a real group of homogeneous β-rays. This group has not only been found by Richardson and Petrowá but also by Meitner,[3] and thus the existence of these rays has been proved by three different authors.

Now, if this group does really exist, *it must necessarily belong to the L-electrons*, as no other group of more feeble energy has been discovered in the photographs of the β-ray spectrum of radium-D.

If this statement proves to be exact, it is strongly opposed to some of Richardson's conclusions.

2. Hitherto it has been supposed that *all* the β-rays with ranges greater than approximately 0·7 cm.

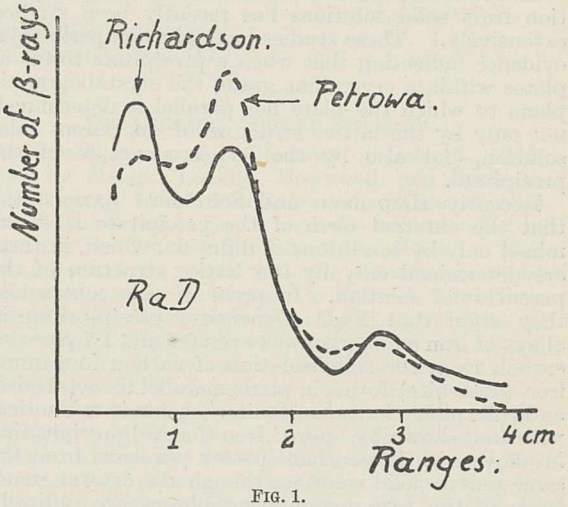

FIG. 1.

are of secondary origin. This opinion does not disagree with Richardson's results. If we suppose the short β-rays ($R<0{\cdot}6$ cm.) to be of tertiary (or perhaps primary) origin, it follows, from the numbers given by Richardson, that every 100 decomposed atoms emit about 115 secondary β-rays, which result confirms—within his limit of precision (20 per cent)—my [4] figures, namely, 97 β-rays per 100 atoms.

3. As to the number of gamma-rays emitted by radium-D, the work of Gray [5] used by Richardson as a basis for some of his calculations appears to me to have been superseded by two more recent investigations,[6, 7] which latter give a number of quants of 3 per cent, against 12 per cent according to Gray.

E. STAHEL.

University of Brussels,
Dec. 1931.

[1] H. O. W. Richardson, *Proc. Roy. Soc.*, A, **133**, 367; 1931.
[2] J. Petrowá, *Z. Phys.*, **55**, 628; 1929.
[3] L. Meitner, *Naturwiss.*, **14**, 1199; 1926.
[4] E. Stahel, *Z. Phys.*, **68**, 1; 1931.
[5] J. A. Gray, NATURE, **123**, 568; 1929.
[6] S. Bramson, *Z. Phys.*, **66**, 721; 1930.
[7] E. Stahel and G. J. Sizoo, *Z. Phys.*, **66**, 741; 1930.

WE take this opportunity of replying to the criticisms expressed in Prof. Stahel's letter printed above. Prof. Stahel has investigated [1] the β-particle emission of radium-D, using a point counter as was first accomplished by Riehl.[2] Through a collodion window of 0·8 mm. air equivalent thickness 0·83 particles per disintegration were registered. Stahel maintains that all these particles were photoelectrons produced by the known γ-ray of 47·2 ekv. energy. He bases this

contention (*a*) on Petrová's [3] interpretation of a range distribution constructed from Wilson chamber observations, and (*b*) upon certain control experiments made upon the absorption in the counter window in his own researches.[1]

(*a*) As has been suggested by one of us (N. F.),[4] Petrová's interpretation of the range distribution curve is neither self-consistent nor consistent with the results of range measurements by Wilson,[5] Ikeuti,[6] and Nuttall and Williams.[7] It is not self-consistent, since it is surely impossible, using any reasonable range-energy relation, to assign energies 30·9, 43·3, and 47 ekv., respectively, to homogeneous β-particle groups having mean ranges 0·80, 1·58, and 2·9 cm. in standard air, and, from the second viewpoint, the discrepancy is the more serious because in the three cases cited the energies of the photoelectron groups employed were known without ambiguity from the wave-lengths of the characteristic X-rays isolated for their production. The more recent and more extensive data of Williams [8] substantially confirm these earlier results, so that the only evidence in line with the interpretation of Petrová is to be found in 83 radium-D β-particle tracks measured by Meitner.[9] Knowledge of the energies in this case cannot be assumed independently of the very interpretation which is in question.

(*b*) Stahel examined the effect of placing a second and a third thickness of collodion in the path of the beam. He found that for every 100 particles transmitted by one, 88·5 were transmitted by two, and 76·2 by three such thicknesses of material. This almost uniform absorption apparently he regarded as indicating the absence, after passing the first absorber, of particles of less energy than that of the photoelectrons of the most intense group.

The question at issue may be put to direct numerical test. We assume the relation of Nuttall and Williams,[7] connecting mean range and energy, and the results of Williams [8] concerning transmission through thin foils. The latter, obtained by detailed analysis of β-particle tracks in oxygen, we assume, for rough calculation, to be directly applicable to the case of collodion, and, over the range of energies in question, we regard the form of the transmission fraction curve as independent of the initial energy of the particles. Then it is found that, for a beam consisting initially of 80 secondary electrons ($50\,L_{\text{I}}$, $20\,M_{\text{I}}$, $10\,N_{\text{I}}$) together with 10 tertiary electrons (M_{I}) from the γ-ray of 47·2 ekv. energy, 85·14 electrons are transmitted through the first absorber, 6·29 are lost in the second, and 2·24 in the third. This represents an absorption of 10 per cent in the second and third absorbers, compared with 23·8 per cent observed by Stahel. If, on the other hand, a hypothetical beam be taken such that 50 photoelectrons, secondary and tertiary, due to the above γ-ray, with 50 additional electrons of 12·5 ekv. energy, pass through a single thickness of absorber, a parallel calculation gives its intensity, after passage through two or three such absorbers, as 88·8 or 76·0 electrons, respectively. The "additional" electrons here postulated are in the form of a group of single energy for ease in calculation only; the low value of energy assigned to them is intended merely to suggest a continuous distribution extending to very low energies. Taken together, these two calculations provide evidence against the conclusion which Stahel has drawn, but, being intended solely as illustrating the possibilities of the case, they must not be regarded as capable of yielding a solution on the evidence at hand.

The problem of the primary β-particle emission of radium-D, it must be admitted, is still far from a complete solution, but we hold, and our reasons appear above, first, that in the experiments of Stahel, electrons other than those comprising the known photoelectron groups were counted, and, secondly, that the identification of these groups in the range distribution curves of Petrová is a mistaken one.

N. FEATHER.
Trinity College, Cambridge.
H. O. W. RICHARDSON.
King's College, London.
Jan. 18.

[1] *Z. Phys.*, **68**, 1; 1931.
[2] *Z. Phys.*, **46**, 478; 1927.
[3] *Z. Phys.*, **55**, 628; 1929.
[4] *Proc. Camb. Phil. Soc.*, **25**, 522; 1929.
[5] *Proc. Roy. Soc.*, A, **104**, 192; 1923.
[6] *C. R. Acad. Sci.*, **180**, 1257; 1925.
[7] *Phil. Mag.*, **2**, 1109; 1926.
[8] *Proc. Roy. Soc.*, A, **130**, 310; 1931.
[9] *Naturwiss.*, **14**, 1199; 1926.

Intensity Ratio of Fluorescent X-Ray Lines

IN the course of his extensive investigations on the magnetic spectra of X-ray electrons, H. Robinson found [1] that the ratio of the numbers of electrons emitted from different levels of an atom is dependent upon the frequency of the exciting radiation. It was to be expected that the same dependency would be met in the behaviour of secondary X-ray lines emitted by different levels of the same atom. This expectation has already been verified qualitatively in the case of the cerium L lines by Skinner.[2]

In view of the importance of this effect for chemical analysis by secondary X-rays and also for different theoretical problems, we have measured the intensity ratio of silver $L\beta_2$ and silver $L\beta_3$ lines excited once with an effective wave-length of 2·6 A. and then with 1·3 A. As is shown below, the variation in the wave-lengths of the exciting radiation influences the intensity ratio of the two silver lines to a very large extent.

Effective Wave-Length in A.	Intensity Ratio of Silver $L\beta_2$ and Silver $L\beta_3$.	Change in Intensity Ratio of the two Lines.
2·6	100 : 25	1 : 2·4
1·3	100 : 60	

From this result it follows that in chemical analysis, when exciting secondary lines with continuous radiation, we have to apply the same voltage at which the intensity ratio of the standard and the line in question was determined. Points of theoretical interest in connexion with the above results will be discussed in a detailed paper, one of these points being that the fluorescent yield of the total radiation emitted by the excited atom is dependent upon the exciting radiation.

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E. ALEXANDER.
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University of Freiburg im Breisgau.

[1] *Proc. Roy. Soc.*, A, **104**, 445; 1923.
[2] *Proc. Camb. Phil. Soc.*, **22**, 379; 1925.

Determinism

IN his address on the decline of determinism,[1] Sir Arthur Eddington enunciates a very curious equation. "If the atom has indeterminacy, surely the human mind will have equal indeterminacy: for we can scarcely accept a theory which makes out the mind to be more mechanistic than the atom." This statement will not bear too close an examination even from a non-quantitative point of view. Thus an attempt by myself to solve even a simple wave equation might lead to any of a large number of

results; a similar attempt by Sir Arthur Eddington would lead to the correct solution with a high degree of probability. I do not think that this proves that his mind is more mechanistic than my own, whatever that may mean. Actually it is generally regarded as a compliment to describe a person as reliable, that is, to suggest that his conduct is predictable.

Fortunately, however, quantitative data exist which seem to show that, as regards moral behaviour, some minds are decidedly more determined than are some atoms as regards radiative behaviour. Consider a given man M_1, and the probability p that between times T_1 and T_2 he will commit an action such as to lead to his imprisonment for a breach of the law. If we have no further information regarding M_1, p is in most communities a small number, less than 0·01. If, however, M_1 has a monozygotic twin M_2 brought up in the same environment up to the age of 14, and M_2 is known to have been imprisoned for crime between the ages of 16 and 40, we can infer with a fairly high degree of probability that M_1, who has an identical nature and a similar nurture, has been or will be imprisoned between the same ages. Judging from Lange's [2] results, p is about 0·875 in south Germany when we have the above amount of information. If we increase the amount of information, for example, by excluding cases where M_2 has suffered from head injury, the value of p is raised still further. Now, if it could be shown that with sufficient information p became unity in a case of this kind, we should, I take it, have proved the determinacy of some kinds, at least, of moral choice. Actually the most that scientific method can do is to prove $p>1-\epsilon$. If Sir Arthur Eddington is correct, then no matter how complete our information, ϵ tends to a finite limit which is not very small. Clearly no amount of observation could prove it to be zero. But if it could be shown to be less than 0·01, we could neglect it to a first approximation in ethical theory, and if it proved to be less than 10^{-6} we might hazard the guess that the behaviour of human beings showed no more indeterminacy than that of other systems composed of about 2×10^{27} atoms.

I think that it is a legitimate extrapolation from the existing data that if we used all the available data in the above case, ϵ would be less than 0·05. It seems unfortunate that any attempt should be made to prejudge, on philosophical or emotional grounds, the magnitude of a quantity susceptible of scientific measurement. But from the heuristic point of view the deterministic theory has the advantage that it could be disproved, and would be if ϵ tended to a finite limit as the amount of available information increased indefinitely. On the other hand, indeterminism cannot be disproved unless its supporters state the value of ϵ, which they have so far carefully avoided. When the truth about human behaviour is discovered, it will probably appear that philosophers of all schools had failed to predict it as completely as they failed to predict Heisenberg's uncertainty principle. Human behaviour is a subject for scientific investigation rather than *a priori* pronouncements.

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[1] NATURE, **129**, 240, Feb. 13, 1932.
[2] "Crime as Destiny", 1931.

Is it really necessary to appeal to anything so *recherché* as Heisenberg's Principle of Indeterminacy in order to justify anything so familiar as personal freedom of choice? This question arises on reading Sir Arthur Eddington's interesting address in NATURE of Feb. 13. Consider any one of the laws of physics commonly verified in the laboratory, say $T = 2\pi\sqrt{l/g}$ for a simple pendulum. If, while one student is observing the pendulum, another student were to knock it about, the observations might misfit the formula. And so in general: the accepted laws of physics are verified only if no person interferes with the apparatus. We cannot interfere with the moon, because it is so massive and so far away: and that is part of the reason why the motion of the moon is almost deterministic; the 'almost' referring to the extremely small Heisenbergian indeterminacy. But there is no great mass or great distance to prevent John Doe interfering with his own brain in the act of making his decision to buy a house from Richard Roe.

LEWIS F. RICHARDSON.

The Technical College, Paisley,
Feb. 13.

Catalysis in an Inert Solvent

IT is becoming increasingly clear that carbon tetrachloride is an ideal solvent in the sense that it allows reactions of varying kinetic type to proceed in it at the same rate as they do in the gaseous phase.[1] This lends great interest to the results of Lowry and Traill[2] on the kinetics of the mutarotation of beryllium benzoylcamphor in this solvent. The reaction in pure carbon tetrachloride is very slow, but when catalysed by pyridine or ethyl alcohol, unimolecular constants are obtained which are proportional to the concentration of the catalyst.

The change is thus essentially bimolecular, and its rate must depend on the number of encounters between molecules of catalyst and of beryllium benzoylcamphor. Assuming the reactant molecule to be activated by the kinetic energy of the colliding molecules, it becomes possible to calculate the energy of activation according to the method of Lewis [3]:

$$\frac{\text{Number of molecules reacting}}{\text{Total number of collisions}} = e^{-E/RT}.$$

By applying the gas formula to calculate the number of collisions,[4] taking the sum of the molecular radii as 7×10^{-8} cm., and $T = 298°$, we find the values of E given below. These agree within the limit of measurable uncertainty with the experimental values found by plotting ln. k against $1/T$.

Catalyst.	E (calculated).	E (observed).
Pyridine . .	18,840	18,850
Alcohol . .	18,410	18,690

Unless the agreement is accidental—and on the whole this seems most unlikely—the following points emerge: (1) The gas collision formula can be used to determine the number of collisions between two species of solute molecules present at low concentrations in an inert solvent. (2) Another example has been revealed of a reaction proceeding in solution at the same rate as theory would predict it to have in the gaseous phase. Deactivations by solvent molecules thus appear to be absent. (3) Lowry and Traill have succeeded, by the suitable choice of reactant, solvent, and catalysts, in examining a reaction which has all the characteristics of the simplest conceivable case of catalysis in solution.

E. A. MOELWYN-HUGHES.

Magdalen College, Oxford,
Jan. 27.

[1] Moelwyn-Hughes and Hinshelwood, *Proc. Roy. Soc.*, A, **131**, 177; 1931.
[2] Lowry and Traill, *ibid.*, A, **132**, 398; 1931.
[3] Lewis, *Trans. Chem. Soc.*, **113**, 471; 1918.
[4] Jeans, "The Dynamical Theory of Gases", p. 259; 1925.

Ancient Windmills

ACCOMPANYING this note are two windmill illustrations (Figs. 1 and 2), one from Ramelli's "Le diverse et artificiose Machine", 1588 (Brit. Mus., 48, f. 15), and the other from the great Chinese Encyclopædia or "Ch'in Ting Ku Chin T'u Shu Chi Ch'eng", vol. 32,

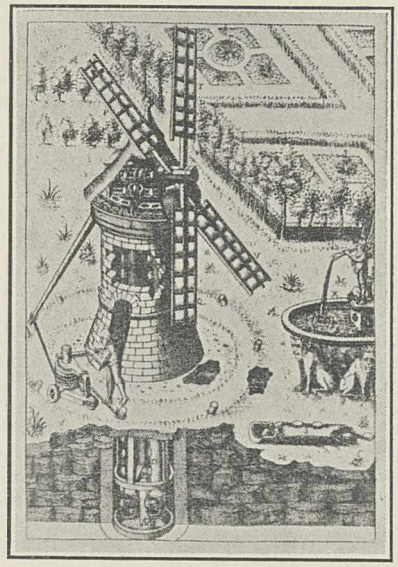

FIG. 1.—Windmill in Ramelli's "Le diverse et artificiose Machine" (1588)

sec. 245 (Brit. Mus., Oriental students' room). For the benefit of readers of NATURE who may not be familiar with the Chinese Encyclopædia, I may say that the only complete copy of the first edition out-

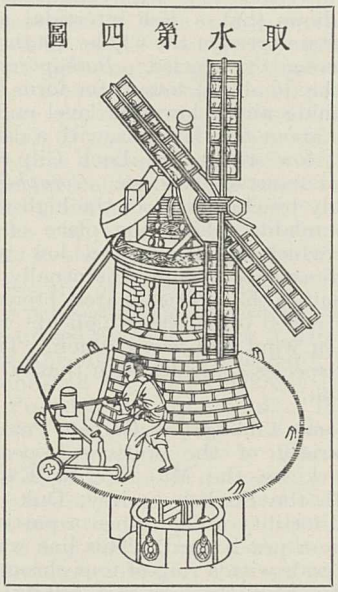

FIG. 2.—Windmill in the Chinese Encyclopædia

side China is in the British Museum, consisting of 750 bulky volumes fully illustrated, and that the work was completed about two hundred years ago.

The illustrations will be of interest to students of technological history, as they appear to indicate that the Chinese encyclopædist had access to European sources and made use of them when compiling this work. I may say that I have found European counterparts of other illustrations in the Encyclopædia, a number of horizontal windmill illustrations apparently having been copied with very slight modification from the "Machinæ Novæ Fausti Verantii" (Brit. Mus., 535, *i.* 16), published at Venice about 1692, and illustrations of sawmills, etc., from various European works of the sixteenth and seventeenth centuries. The most probable explanation seems to be that copies of these works were taken to China by Jesuit missionaries—Athanasius Kircher, for example.

HUGH P. VOWLES.

20 Ridgway Place,
Wimbledon, S.W.19, Jan. 30.

Heat of Dissociation of Oxygen

THE heat of dissociation of oxygen has given rise to some lively controversies in recent years. Mecke [1] concluded from the photochemical work of Norrish on NO_2 that $D_{O_2} = 128$ kcal., a view which was supported by V. Henri [2] from the interpretation of the predissociation spectra of NO_2 and SO_2. Birge and Sponer,[3] on the other hand, conclude, from the analysis of the Runge-Schumann bands, that the heat of dissociation in the excited state amounts to 162 kcal. Herzberg [4] was of opinion that the molecule in the excited state was made up of a (^3P) oxygen atom and a ($^1D_2$) atom, hence subtracting from Birge's figures the heat of excitation to the $^1D_2$ state, namely, 45 kcal., he gets the heat of dissociation of O_2 into two ^3P atoms as 117 kcal. This view seems to have been accepted by Franck, though Copeland [5] supports Mecke's value of 128 kcal. from his study of the heat of formation of the molecule from the atomised state in the discharge tube.

I have found that SO_3 vapour, in contrast with SO_2 vapour, which gives a band absorption, shows a continuous absorption with a long wave-length limit at $\lambda 3300$, corresponding to 86·7 kcal. From this data, assuming the reaction due to light to be given by $SO_3 + 86{\cdot}7 = SO_2 + O$ (atomic), I have calculated the heat of dissociation of oxygen with the aid of thermochemical data [6] for the heats of formation of SO_2 and SO_3. The thermochemical relations are

$$(SO_2) + 69{\cdot}3 = [S] + (O_2)$$
$$\text{and } (SO_3) + 91{\cdot}9 = [S] + \tfrac{3}{2}(O_2).$$

This gives with the above relation the value of D_{O_2} as 128 kcal. The value is thus in agreement with the results of Mecke, Henri, and Copeland and does not agree with that given by Herzberg.

ARUN K. DUTTA.

Allahabad University,
Physics Department,
Jan. 13.

[1] Mecke, *Naturwiss.*, **17**, 996; 1929.
[2] Henri, NATURE, **125**, 202, 275; 1930.
[3] Birge and Sponer, *Phys. Rev.*, **28**, 259; 1926.
[4] Herzberg, *Z. phys. Chem.*, B, **4**, 223; 1929: **10**, 189; 1930.
[5] Copeland, *Phys. Rev.*, **36**, 1221; 1930.
[6] "Landolt-Börnstein's Tables", p. 1494, 1923 edition.

A Symbol of the Space-Time Continuum

IF a strip of stamp edging is taken, given a half twist, and the ends joined, we have formed one of the well-known paradromic rings, having only one surface and one edge.

The figure occupies three dimensions in space, but like time has the feature of endlessness, or like Einstein's finite space returns on itself. I suggest, therefore, that it may well stand for a symbol of the space-time continuum.

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Research Items

Yuma Ethnography.—A report on the results of two visits of ethnographical investigation among the Yuma Indians in 1928 and 1929 by Prof. C. Daryll Forde is published as vol. 28, No. 4, of the University of California's *Publications in American Archæology and Ethnology*. The Yuma now occupy a reservation on the west bank of the Colorado River at the confluence of the Gila, which includes the greater part of the land which they occupied at the time of Spanish exploration. They have, therefore, suffered little disturbance; but owing to their assimilation of American culture, the material culture—basket-making, weaving and pottery-making—has disappeared, and so to a great extent has their social organisation. Their sense of tribal solidarity, however, is strong. Formerly they lived in scattered settlements near their patches of arable land and mesquite bushes. The men went naked, while the women wore a two-piece bark skirt. They resemble the other Indians of Colorado in their great stature. The people were agriculturists, depending upon the natural irrigation of the river overflow. They cultivated corn, beans, pumpkins, melons, and grasses. As a result of an intensive study of social organisation and ritual, it is concluded that the culture of the Yuma and other tribes of the Lower Colorado is remarkable in its divergence from that of the Pueblos and the Californians. Nor are they transitional groups. Although there are signs of fusion of south-western and Californian cultural traits, there are other elements which are strikingly individual. Thus, though they divide themselves into exogamous groups, these groups are patrilineal. Among the markedly individual traits is the subordination of wealth, hereditary right and ability, to the acquisition of supernatural power.

The Buffalo-Fly Danger in Australia.—The buffalo-fly (*Lyperosia exigua*) is not a native of Australia, but is supposed to have been introduced from the Indo-Malayan region with buffaloes imported by way of Melville Island, so early as 1825 (R. J. Tillyard, *J. Coun. Sci. Indust. Res.*, Australia, **4**, 234; 1931). With the development of the pastoral industry in northern Australia, the fly began to take its place as an economic factor; for although it does not carry disease and does not kill its host, it sucks its blood and produces serious loss of condition due to 'fly-worry'. The point when toleration is replaced by nervous strain is represented by a concentration of about a thousand flies to each beast. The creatures attacked in Australia belong to a wider range than the hosts in the Netherland Indies, and include buffaloes, cattle of all kinds, horses, mules, donkeys, and occasionally man himself; but the serious aspect of the problem is that the fly shows yearly a wider range of distribution, having moved with cattle herds until it has spread over all the settled portions of the Northern Territory north of the 20-inch rainfall line. By 1910 it had reached Kimberley, and has become the worst cattle pest there. Beyond this northern range it is unlikely to pass by natural extension, because of the barrier of a dry belt, but there is great danger that it may be transported to south-western Australia through the uncontrolled importation of cattle from Derby to Fremantle, where the fly did appear in 1928 but was eradicated. Efforts are to be made by the introduction of parasitic insects so to reduce the numbers of adult buffalo-flies that they fall below the level which causes economic loss.

Distribution, Ecology, and Classification of Tunicata.—Dr. Harold Thompson has continued his study of the distribution, ecology, and classification of the Tunicata of the Scottish area (Fisheries Board for Scotland, *Sci. Invest.*, 1931, No. 1, "The Tunicata of the Scottish Area. Part 2, The Styelids and Botryllids of the order Ptychobranchia"). The importance of physical environment in determining the distribution of the various species is stressed, and a list of records, with a chart showing the distribution, is appended to the description of the morphological characters of each species. The typical arctic, boreo-arctic, boreal, and south boreal forms are listed, with notes of the limiting conditions of temperature and depth of each type. Dr. Thompson maintains temporarily the separation of the Botryllidæ and Styelidæ until further investigations have been carried out on the methods of budding of the two families. The genus *Kukenthalia*, whilst having obvious affinities with the other genera of the family Styelidæ, appears to possess a brood pouch of similar origin to that of the genus *Botrylloides*, and when the nature of the affinities has been fully disclosed it is probable that the Botryllidæ will have to be subordinated as a subfamily of the family Polyzoidæ, which Hartmeyer includes with the styelids. A single species of *Botryllus*—*B. schlosseri* Pallas—is retained, the old *Botryllus aureus* being regarded as a species of *Botrylloides*, with which genus it agrees in the nature of the systems, presence of brood pouches, shape of testes, and position of vasa deferentia.

Zoning of Amphipod Species.—Mr. Richard Elmhirst, director of the Scottish Marine Station at Millport, in a paper entitled "Studies in the Scottish Marine Fauna.—The Crustacea of the Sandy and Muddy Areas of the Tidal Zone" (*Proc. Roy. Soc. Edinburgh*, Session 1930–31, volume 51, part 2 (No. 21)), shows that a rich intertidal amphipodan fauna in certain areas of the Clyde, notably Cumbrae, exhibits zoning by species. *Bathyporeia guilliamsoniana* is the dominant low water form in the clean sand, beginning about low tide level and extending seawards to about four fathoms, with a definite maximum about low water. In Loch Gilp it suddenly disappears at about one fathom. *Corophium volutator* in the muddy brackish area of the high water region is very abundant, taking the place of *Corophium crassicorne*, which is the typical low water mark species. *Haustorius arenarius* is usually confined to the upper half of the intertidal area, preferring rather loose sands which often occur high up on the beach as a result of wind and wave action. The distribution of this species coincides with that of the annelid *Nerine foliosa*.

Chromosome Linkage in Garden Peas.—When a Tibetan variety of the cultivated pea (probably brought back by the Mt. Everest Expedition) is crossed with the English variety, Duke of Albany, there is full fertility except when a particular 'line' of the Tibetan pea is used. This line was shown to produce hybrids with a ring of four chromosomes and semi-sterility, half the gametes failing to mature. A further genetical and cytological study of these forms has been made by Caroline Pellew and Mrs. E. Sansome (*J. Genetics*, vol. 25, No. 1). Two other cases of ring formation, accompanied by linkage of factors which are normally independently inherited, have been discovered in Swedish varieties of peas by Hammarlund and Håkansson. The chromosomes carrying the factors for round and wrinkled cotyledons are in the chromosome ring in the Tibetan variety, the plants heterozygous for these factors being usually semi-sterile, but there are about one in eight

exceptions in each class. The fertile sister plants have seven bivalents. A cytological study of chiasma formation in the meiotic chromosomes shows that the results are in accordance with Belling's hypothesis of segmental interchange. The ring of four on the heterotypic spindle separates so that adjacent chromosomes go to the same pole, or in other words, double non-disjunction takes place, in about half the cases observed. It is suggested that this gives rise to the non-viable gametes, as such gametes will show genic unbalance, having two members of one pair of chromosomes and lacking both members of another pair.

Timber Pit Props.—Apart from other dangers, the safety of the men working in coal mines is to a considerable extent dependent upon the strength of the pit props supporting the galleries. That this matter is one of primary importance becomes evident when it is remembered that timber is a very variable material. Work which has been carried out in this matter has been recently published in a brochure entitled "Tests on Timber Pit Props", by S. M. Dixon and M. A. Hogan (Safety in Mines Research Board, Paper No. 72. London: H.M. Stationery Office, 2*s*. net.) In these tests the writers say: "In one most variable batch of props the strength of the weakest prop was less than half the average strength and only about a quarter the strength of the strongest prop, though all the props were nominally similar". It is pointed out, a factor not always realised, that round untapered props are very rigid and comparable to rigid steel props. They therefore do not show an appreciable amount of shortening or 'give' before failure, and consequently are dangerous. To ensure the maximum 'give', which would render the approaching failure evident to the trained eye, it is suggested that the diameter of the small end of the taper should be half the diameter of the prop. These tests have covered a wide range and data have been obtained as to the average strengths of round props of home-grown and imported timber of various species; the average strengths of quartered and tapered props; the extent and nature of the shortening under load of untapered props and props with tapers of various forms; the effects of the rate of loading, repeated loading, and sustained loading; the effects of the moisture content of the timber; and the variations with time in the moisture content of props stacked in the open and under cover.

Jurassic History of North America.—One of the most detailed palæographical studies yet made, accompanied by fourteen maps of North America from the beginning of the Jurassic to the early Cretaceous, has been published by C. H. Crickmay (*Proc. Amer. Phil. Soc.*, Philadelphia, pp. 15-102; 1931). Each map represents the geography of a closely defined date, and the series is adequate to illustrate the culminations of all the notable geological events of the period. The results bring out the fact that there were four main marine transgressions: Liassic, Bajocian, Callovian, and Argovian. These seem also to have been world-wide transgressions, for they are represented in Europe and India. In North America the general surface was low and flat, and a comparatively slight down-warping would then cause wide marine expansion. Volcanic activity broke out vigorously in the Sonninian, in the later Middle Jurassic, and in the late Callovian; in each case in the extreme west from Alaska to California. Tectonic mountains (Agassiz orogeny) were built after the cessation of volcanic activity. The period ends with the more important Nevadian mountain building. North America was then mainly land with two areas of dominant continental sedimentation.

Hawaiian Earthquakes, 1929–30.—A review of the remarkable series of earthquakes in these two years is given in the *Volcano Letter* issued by the Hawaiian Volcano Observatory for Nov. 5, 1931 (see also NATURE, **124**, 851, Nov. 30, 1929). The total number of shocks recorded was 1516 in 1929 and 1070 in 1930. The large number in the former year was mainly due to the continued activity of a centre near the volcano Hualalai in the north-west of Hawaii, the numbers registered during the three weeks ending on Oct. 16 and Nov. 13 being 594 and 215 respectively. After the latter date their frequency declined, though, until the middle of March 1930, many tremors originated in the Hualalai centre. During the remainder of 1930 the seismicity of the island became normal, with a frequency of nearly a hundred shocks and tremors per month. It is suggested that the activity of the Hualalai centre was due to "lava flowing in under the volcano with an upward pressure, splitting open deep rifts, and preparing for eventual outflow somewhere to the north of the Mauna Loa centre".

High Speed Ions.—The first December number of the *Physical Review* contains an article by D. H. Sloan and E. O. Lawrence, of the University of California, describing a method for producing very fast heavy ions (see also NATURE, July 11, 1931, p. 83). This does not call for unduly high voltages or elaborate apparatus, the desired acceleration of the ions being obtained by repeated application of a relatively small impulse. The ions, which are conveniently drawn from a low-voltage arc, travel through a series of metal tubes in synchronism with an oscillatory electric field applied alternately to the tubes in such a way as always to accelerate the ions passing from one tube to another. Using thirty such steps and a high-frequency potential difference of 42,000 volts at a wave-length of 30 metres, a current of 10^{-7} amp. of 1,260,000 volt singly charged mercury ions has been produced. The success of the method depends on the focusing and synchronisation of the beam of ions in the accelerating system, but it is apparently not difficult to effect this. The authors of the paper express the opinion that the production of 10,000,000 volt ions is an entirely practicable matter. The method is less readily applicable to light ions or electrons, on account of the great length of the apparatus needed for these.

Electrical Protective Devices.—In the early days of electricity supply, the effects of dangerous currents were guarded against by using fuses in series with the circuit to be protected. This system proved quite satisfactory so long as the voltage was low and the power transmitted was small, but with high voltages the circuits need to be broken under oil. These oil circuit breakers are practically always of the automatic type. They are equipped with 'trip' coils or relays which, on the occurrence of abnormal conditions in the main circuit, release the energy stored in strong springs, and so the contacts separate in a small fraction of a second. In a paper read by C. L. Lipman to the Institution of Electrical Engineers on Jan. 8, improvements in the design of these relays are discussed. The advent of the national grid in Great Britain marks a new era in the history of British engineering, and particularly in the development of protective gear. The relays discussed are divided into classes. The first class includes those which prevent overload; the second prevents current leaking to earth, and the third prevents the current from running in the wrong direction. In the last case the relay prevents the generator acting as a motor and absorbing power from, instead of giving power to, a network. Mr. Lipman described a new relay which is very simple and trustworthy, and is

suitable for modern high power and high voltage circuits. Several hundreds of these devices have been in operation at places all over the world for five years and have given satisfactory service.

Adsorption.—As is well known, Langmuir has advanced the theory that adsorption of gases on surfaces normally proceeds with the formation of a unimolecular film, and there is experimental evidence for the validity of this assumption. The most direct type of experiment involves the use of a crystal face as a plane adsorbing surface, and Bawn (*J. Amer. Chem. Soc.*, Jan.) has described some measurements of the adsorption of some gases and of acetone vapour on cleavage plates of mica, which show that Langmuir's adsorption equation is closely followed in the cases of carbon monoxide and oxygen, a saturation value being reached which corresponds with one-third of the surface covered in the case of acetone. In no case was the film thicker than unimolecular, no evidence for capillary condensation being found for pressures up to one-thousandth of the saturation pressure. In the case of argon, no simple equation expresses the results. The pressures used in all the experiments were small and the temperatures low. The magnitude of the adsorption was found to be dependent upon the conditions of outgassing of the surface, which is explained on the basis of the concept of the activation energy for adsorption processes.

Reaction Velocity.—Harned and Samaras (*J. Amer. Chem. Soc.*, Jan.) have determined the velocity of hydrolysis of ethyl orthoformate to ethyl formate in presence of a constant acidity maintained by an acetic acid-sodium acetate buffer in various solvents. The results show that, with the exception of the glycine solutions, all the other series of measurements in aqueous solutions of methyl, ethyl, *n*-propyl, isopropyl, and *n*-butyl alcohols, acetone, glycerin, and glycine show the following dependence of the velocity constant on the dielectric constant: $\ln k_0 - \ln k = 0{\cdot}07(D_1 - D)$, where k_0, k are the velocity constants in water and the mixed solvent, and D_1, D the dielectric constants of the latter, respectively. In a theoretical paper, the same authors attempt to show that the kinetic factor for medium effects can be expressed in the form $e^{-W/kT}$ and to interpret W on the basis of electrostatics. They point out that the general problem is difficult, and confine their discussion to some important special cases. They start with a consideration of the energy change involved in the transfer of an ion from one medium to another of different dielectric constant, and with certain simplifications obtain an expression for the ratio of the activity coefficients in terms of the difference of dielectric constants. By introducing Hückel's equation for the activity coefficient of an electrolyte, they show in a number of cases that experimental results can be interpreted in terms of their theory, and conclude that the dielectric constant variation from solvent to solvent is the factor of greatest importance in causing changes in the velocity constant.

Astronomical Topics

Astronomical Notes for March.—The spring equinox occurs at 7h 50m P.M. on March 20: full moon occurs on March 22, only 1¾ days after the equinox, thus explaining the early Easter.

Mercury is well placed as an evening star during this month: it should be looked for low in the west in the later part of twilight; Venus may be used as a guide to it. The following table gives the difference of R.A. and Declination of the two planets:

	Mercury West	Mercury South
March 7	2h 0m	14·2°
12	1 48	12·0
17	1 40	9·8
22	1 38	8·3
27	1 45	7·8

The magnitude of Mercury is −1·3 on March 7, +0·3 on March 27. It is at its greatest elongation, 19° from the sun, on March 23. Venus is drawing away from the sun, and becoming brighter. It reaches elongation on April 19. The illuminated portion of the disc is 0·73 on March 1 and 0·61 on March 31. The magnitude changes from −3·6 to −3·8.

Jupiter and Neptune passed opposition in February, and are still well placed for observation. There is an eclipse of Jupiter IV. on March 14: it disappears at 7h 41m P.M., reappearing 35 minutes after midnight. III. is also occulted and eclipsed from 8h 7m P.M. on March 14 until 3h 5m A.M. on March 15. Satellite I. is occulted by IV. at 11h 59m P.M. on March 5; III. by IV. at 2h 33m A.M. on March 7. There is an interesting double occultation of IV. by I. at 7h 23m P.M. on March 14 and 4h 40m A.M. on March 15. See the British Astronomical Association Handbook for 1932 for a complete list of these phenomena.

There is an annular eclipse of the sun on March 7, and an almost total eclipse of the moon on March 22: both are invisible in Europe. The track of annularity in the former includes southern Tasmania shortly before sunset.

Only two occultations by the moon are visible during March in London; 38 B Aurigae (mag. 6·5) disappears at 9h 55m P.M. on March 14; τ Scorpii (mag. 2·8) reappears at 3h 41m A.M. on March 27, at angle 262° (near the west point of the disc).

A minimum of Algol at a convenient hour occurs on March 10 at 9h 43m P.M.

The zodiacal light may be looked for at the end of evening twilight on dates when the moon is absent at that hour. It follows, approximately, the direction of the ecliptic, which is roughly determined by drawing a line from Venus to a point between the Pleiades and Aldebaran.

Search for the periodic comet Grigg-Skjellerup (which is due at perihelion on May 18) may be begun in March: as it is likely to be faint in March, the ephemeris is not given here (see the British Astronomical Association Handbook, 1932).

New Solar Observatory of the Smithsonian Institution.—A *Bulletin* from the Smithsonian Institution, dated Feb. 1, announces that the solar observatory on Mt. Brukkaros, in South-West Africa, has been abandoned after a trial of five years; its drawbacks were haze and high winds. Several other mountains in South Africa were tried, also the Cape Verde Islands. Trial is to be made of Mt. St. Catherine, in the Sinai Range, 8540 ft. high. It is stated that the region is practically waterless and barren, and that the winds are light and come more frequently from the Mediterranean than from the desert, so that there should not be much dust.

The famous monastery of St. Catherine, where many valuable manuscripts were found, is not on this peak, but on the Jebel-Musa, some twelve miles distant. So much trouble has been taken by Dr. C. G. Abbot and his assistants in finding a suitable site, that it is to be hoped that their patience may at last be rewarded.

Block-Movements in the Boso Peninsula (Japan)

PROF. N. MIYABE has recently published two remarkable papers on the movements of crust-blocks (*Earthq. Res. Inst. Bull.*, vol. 9, pp. 256-272, 407-422; 1931). It is clear that if a crust-block is tilted as a whole, there must exist a simple geometrical relation between the amounts of tilting in two different directions. Conversely, if this relation is satisfied by the tilts along neighbouring pairs of lines, Prof. Miyabe regards the lines as lying on the same block. The papers are concerned with the crust-blocks of the Boso peninsula on the east side of Sagami Bay. The first survey of the district was made in 1898, the line of levelling being near the coast. It was repeated in 1924, shortly after the great earthquake of Sept. 1, 1923, and again in 1931, and the two papers refer to the displacements that occurred during the intervals between the surveys.

In the accompanying map (Fig. 1), the dotted lines represent the probable boundaries of the crust-blocks and the arrows denote the magnitudes and directions of tilting of the different blocks. The boundaries were drawn without any reference to geological maps, but several of them were found to coincide approximately with discontinuities in geological structure. These are shown as continuous lines. One of them is a well-marked tectonic line to the north of Kamogawa, and it will be noticed how different are the directions of tilting of the blocks to the north and south of this line.

The figures on the map denote the mean uplift of each block in inches between 1898 and 1924. It will be seen that there are three groups of blocks, in each of which the uplifts are approximately the same. In the south-west corner of the peninsula, they lie, as a rule, between 47 in. and 51 in., with two exceptional amounts of 55 in. and 61 in. To the north and east of this lies a group in which the uplift is confined between 23 in. and 31 in.; and, still farther, a third group in which the movements are between 8 in. and 12 in., with two exceptions of 18 in. and 22 in.

In the second paper, the changes of level that occurred between 1924 and 1931 are compared with those of the earlier interval. The curves representing them show that, on the whole, the vertical movement was reversed. For example, a block elevated by 45 in. in the first interval was depressed by nearly 4 in. in the second. Though the constituent blocks

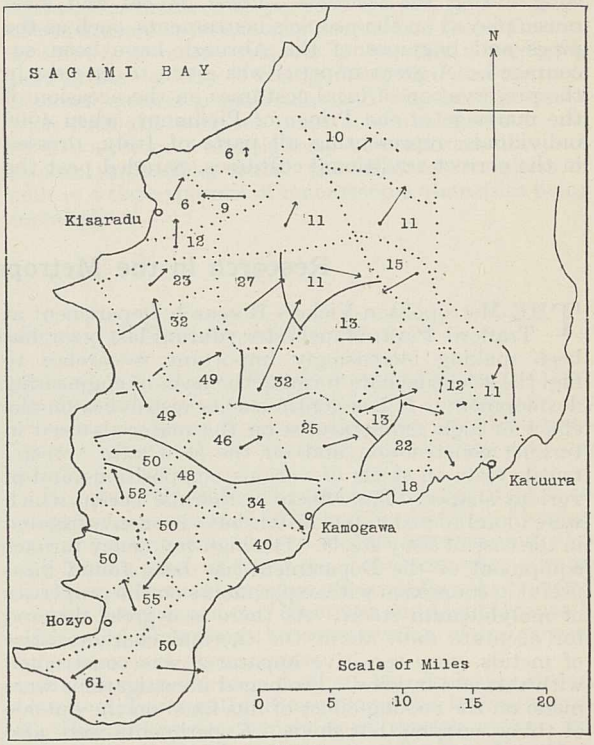

FIG. 1.

show a certain independence of movement, it would seem that the Boso peninsula underwent a general tilting towards the north-east in the first interval, and a return tilting towards the south-west in the second. C. D.

Preservation of Italian Folklore

IN Italy under the Fascist government every encouragement has been given to movements which quicken national self-consciousness. Those who value tradition, whether for sentimental or for scientific reasons, will applaud the efforts of the Opera Nazionale Dopolavoro (The Workers' Leisure Hours Institute) to preserve the festivals, music, and dancing of the folk, which are endangered by the industrial development of the country. Now that Russia no longer pays heed to her saints, no country in Europe is so rich as Italy in festivals, and nowhere have they been celebrated with more ritual and greater enthusiasm. It would have been a calamity had they been allowed to lapse. This probably would have been the fate of many, had it not been for the "Dopolavoro". Their continued existence now seems assured.

An excellent account of the work of the Institute in this field, for which the president, S. Enrico Beretta, is responsible, has been published recently.* The first section of the book, however, is devoted to a list of the *feste* which are observed in the various towns and districts of Italy. They are arranged calendrically, and brief descriptions of the essential features are given in each case. Many are illustrated by excellent photographs.

The *feste* are usually observed on the feast-day of the patron saint of the district, or on some festival of the Church; but pagan affinities are generally fairly easy to detect. The central feature is normally a procession, in which the image of the saint is carried round the district in a cart or on a platform. Sometimes the cart is buried in flowers; sometimes the place of the saint and cart is taken by obelisks or gigantic towers, such as the *Ceri* of Gubbio or the *Gigli* of Nolo (Naples). It is a reasonable conclusion that in ancient days the gods were carried along these same ways to purify the lands and secure the fertility of the fields of their votaries. At Easter the Scoppio del Carro of Florence betrays clearly the purpose of the rite. A mechanical dove released from the High Altar ignites the squibs set around the *carro* as it stands before the cathedral. A successful explosion is hailed as a sure index of abundance in the coming

* "Costumi, musica, danze e feste popolari italiane." Pp. 218. Roma: Editione Opera Nazionale Dopolavoro, 1931.) 10 lire.

harvest. An almost identical ceremonial opens the fire festival in one of the Pardons of Brittany. The Carnival even more surely points to its pagan origin in the celebrations described.

The success of the Institute in stimulating and renewing popular interest in the *feste* has been much assisted by the revival of the competitions for dialect songs, of which several are quoted. These are sung during the festivals. Local dances and local music played on the people's instruments, such as the pipes and bagpipes of the Abruzzi, have been encouraged. A great impetus was given to interest in the preservation of local costumes on the occasion of the marriage of the Prince of Piedmont, when 4000 individuals, representing all parts of Italy, dressed in the correct traditional costumes, paraded past the Prince and his bride. The programme, giving the list of costumes, with many illustrations, is repeated in the volume.

While the object of the Institute is practical so far as it aims at the promotion and preservation of popular art and festivals, it does not neglect the interests of the student of custom. Coloured photographs have been taken of all the peasant costumes and of a large number of the more important festivals. Some have also been filmed. A national committee is being set up in collaboration with the League of Nations for the scientific study of Italian folklore. In the meantime the student of folklore will find much to interest him in the Institute's publication, while he will register a debt of gratitude for its respect for tradition.

Research in the Metropolitan-Vickers Laboratories

THE Metropolitan-Vickers Research Department at Trafford Park, Manchester, during last year has been making increasingly important researches to find the scientific data forming the basis of engineering development. It has continued its researches on the effect of high temperatures on the materials used in turbine construction and on the slow rate 'creep' tensile tests on steels of various compositions and of various shapes. The effects of thermal action which were found to make steel brittle have been investigated in the case of alloy steels. The high-frequency furnace equipment of the Department has been found most useful in connexion with experiments on the properties of molybdenum steels. As there is a great demand for accurate data about the thermal characteristics of metals, very sensitive apparatus was constructed with this end in view. Prolonged investigations were made on the cooling effect of fins fixed on the outside of tubes carrying hot fluids. Experiments were also made on the converse problem of the cooling effect produced when cold water flows in the pipes causing convection currents of cold air.

Work has been continued on chromium plating, and the critical thicknesses of the nickel and chromium necessary to ensure protection of brass and steel have been determined. Considerable difficulty had been experienced in the plating of high carbon spring steel, but satisfactory coatings can now be obtained on this type of material. The application of cadmium plating as a corrosion resistant has been extended to various processes used in the shops.

Much electrical and magnetic research work has been done in the Metropolitan-Vickers laboratories. The heating of parts of steel structures due to the eddy currents induced in them by conductors carrying large alternating currents in their neighbourhood has been investigated and methods have been devised for avoiding the production of this local heating in the structures. Theoretical and experimental investigations have been carried out to settle questions which arise in the design of high-pressure voltmeters. Continuous research is also being carried out with regard to the cooling radiators used on transformers. The work on core losses has been carried out up to cores of 30,000 kva. Other problems discussed in connexion with transformers show the great demands made on the physical knowledge and mathematical skill of the experimenters. They discuss, for example, the distribution of the transient voltages in the coil windings, the effects of magnetic fields on the performance of precision current transformers, the design of high-frequency transformers and Petersen coils for the protection of overhead networks. A 50,000-volt 10,000-frequency transformer has been constructed and satisfactorily operated.

The research on the best heat treatment for magnet steels intended to be used in meters has been completed, and so also has the effect of current impulses on permanent magnets. Three experimental acoustical investigations have been completed for the engineers of the Mersey tunnel, and experimental work has been carried out on methods of preventing the noise made by fans. Preliminary tests were made on the 500-kw. valve used at the P.O. Radio Station at Rugby, and it was run up until its output was 520 kw. The use of radio waves of lengths about one metre—'quasi-optical' waves—is being actively investigated and is said to be promising.

Specificity in Catalysis

IN the thirty-third Robert Boyle Lecture, Sir Frederick Gowland Hopkins deals with the "Problems of Specificity in Biochemical Catalysis" (Humphrey Milford: Oxford, 1931). He points out that the isolation of biological products and the determination of their constitution are not the end-points of biochemical research, but rather steps on the path to the investigation of the dynamic events of metabolism in the living cell. In these events catalysts play an important part. Owing to their specificity it appears that there must be a large variety within the confines of a single cell: the acceptance of this conclusion presents to many an intellectual difficulty, which Sir Frederick considers may be profitably discussed anew in the light of the fresh facts which are now available.

After a brief reference to the hydrolytic enzymes, of which a great variety is known, usually one for each stage in the hydrolysis of any complex molecule, recent work on oxidation is reviewed. Many oxidations are carried out by dehydrogenases which activate the hydrogen in the oxidisable molecule so that it can be taken up by molecular oxygen or other hydrogen acceptor. The xanthine oxidase can transfer hydrogen direct to molecular oxygen: other dehydrogenases can transfer it direct to an acceptor such as methylene blue, but not to oxygen until the latter has also been activated. Keilin's cytochrome,

an iron-pyrrol compound, plays an important part here: activated by indophenoloxidase, it acts as an intermediate carrier of hydrogen to oxygen from the various substrates activated by the dehydrogenases.

Warburg considers that his respiratory enzyme, again an iron-pyrrol derivative, controls the whole field of oxidations. It shows no spectrum, in contrast to cytochrome, but forms reversible combinations with carbon monoxide as well as oxygen, the former of which is decomposed by light. By examining the effectiveness of different wave-lengths in restoring respiration after it had been inhibited by carbon monoxide, Warburg was able to determine the absorption spectrum of the enzyme, since light must be absorbed by the carbon monoxide compound in proportion to its effectiveness in dissociating it.

Another path for the transport of hydrogen to oxygen is that associated with the reduction and oxidation of glutathione. Quantitatively it is less prominent than the cytochrome path, but it is essential to the normality of the cell. The cytoplasm of the latter appears to be a lyophil colloidal system in which the micellæ or particles which form the internal phase must be diverse in respect of their surfaces, and probably no small proportion of these surfaces have catalytic properties. Considering the size of the cell and that as much as 75 per cent of cytoplasm is water, of which much is free, it may be assumed that diffusion, as known in macro systems, plays only a negligible part in the velocity of change here, and that contacts between substrate molecules and dispersed particles with catalytic surfaces must continually occur. In such a system a multiplicity of reactions does not appear impossible, whilst the immense numbers of cells in a tissue permit of macroscopic quantities being metabolised.

Sir Ambrose Fleming and the Physical Society of London

THE meeting of the Physical Society held on Feb. 19 marked an event which is probably unique in the history of learned societies. If we open the Society's first minute book (which has fortunately been preserved) we find that the young Society held its first business meeting on Feb. 14, 1874, when, 29 members being present, a list of officers was drawn up. Dr. J. H. Gladstone, F.R.S., father-in-law of the present Prime Minister, was elected to the presidential chair; Profs. Grylls Adams and Carey Foster were appointed as vice-presidents; Dr. E. Atkinson and Prof. A. W. Reinold were joint secretaries, and—the holder of an office which has fallen into abeyance—Prof. Frederick Guthrie was appointed as the Society's demonstrator.

The next record on the minutes must be transcribed *literatim*. It reads :—"A meeting of the Society was held in the Physical Laboratory, South Kensington Museum, at 3 P.M. on Saturday, March 21st [1874], Dr. Gladstone in the chair. There were about 35 members present. The chairman gave a brief description of the objects and organisation of the Society, and noticed the very favourable circumstances under which the Society originated as compared with those attending the origin of its parent, the Royal Society. He announced that 99 gentlemen had already expressed their desire to join the Society as original members."

"J. A. Fleming, B.Sc., read a paper on the new Contact Theory of the Galvanic Cell. . . . Professor F. Guthrie exhibited experiments illustrating the distribution of a galvanic current on entering and leaving a conducting medium." . . .

"Prof. G. C. Foster, Dr. Wright, and Dr. Gladstone took part in the discussion of the communications."

Can any other society produce such a record? It may be that a greater span of years separated Liveing's first and last papers read before the Cambridge Literary and Philosophical Society, but we know of no other instance in which the reader of the first paper at the first scientific meeting of a society has survived to communicate a paper to the society nearly sixty years later.

Inspection of the list of members published in 1930 shows that, of the founder fellows, four—Armstrong, Fleming, Schuster, and Unwin—are still with us. Lodge joined the Society in February 1875, and of those who entered the ranks in the 'seventies, fourteen still remained at the time of publication of the list consulted. President and Council have long since disappeared—Carey Foster was probably the last survivor of the original officers—but it would be interesting to know if any of the early members were present when "J. A. Fleming, B.Sc." presented his paper.

It is a far cry from the contact theories of 1875 to the wave mechanics of 1932, and Sir Ambrose Fleming has not only made history in this interval, but also still holds a place on the stage of contemporary events. He has read some thirty-five papers before the Society, and his latest paper, on "Electrons and Light Quanta", admirably illustrates the conservation of his powers as teacher and experimenter.

In his introductory section, Sir Ambrose states, clearly and succinctly, the fundamental facts concerning the antinomies, which, even though as yet unsolved, have almost ceased to perplex us. He calculates the value of the mean energy density of bright sunlight at earth distance, and, using four methods, he obtains: from the mean of 10 equidistant ordinates of the Planck curve, 48; from the solar constant, 45; from the Stefan constant, 54; from the integration of the Planck equation, 55: all expressed in micro-ergs per cubic centimetre. As the illumination of bright sunlight is about 13,000 candle-feet at normal incidence on a white surface, it is possible to estimate the radiation density of other light beams and the average number of photons per cubic centimetre.

Experimentally, Sir Ambrose proceeded to investigate the question, which he states thus: "If then a beam of light can in any way be regarded as a stream of photons or light quanta each having energy and mass, and if the wave energy is electromagnetic in nature, the question arises whether a stream of electrons moving along a beam of light would have their velocity increased or diminished according as they moved with or against the direction of propagation of the light".

As a preliminary experiment with an arc lamp showed no result, Sir Ambrose employed a powerful beam of X-rays. The source of electrons was a special form of Fleming thermionic valve with a dull-emitter filament and two grid anodes of rectangular section fixed on either side. Hence if "a beam of radiation was passed transversely across the valve the electrons on one side of the filament moved against the radiation and on the other side with it". A simple circuit was arranged which would show by means of a differential galvanometer whether the

incidence of the X-ray beam produced any steady variation from equality in the two electron streams to the two anodes of the valve. No change was detected, although the galvanometer was competent to show a change of 0·05 per cent of the anode electron-currents to the grids. ALLAN FERGUSON.

Archæology of Eastern Colorado

THE archæological survey of eastern Colorado carried out in the summer of 1930 by the University of Denver and the Colorado Museum of Natural History, under the direction of Dr. E. B. Renaud, with the assistance of a subsidy from the Smithsonian Institution, is the first systematic archæological work undertaken in that area, and links up the exploration of south-west Colorado on one side, and of Nebraska and States east on the other. Ten thousand miles were covered in ten weeks. A large number of surface finds were collected, but no excavation was possible in the time. The report of Dr. Renaud and his assistants (published by the University of Denver, Anthropological Department) states that few important sites were left unvisited, and the collections and notes, while not exhaustive, are fairly representative of the Indian culture of Colorado.

The area of closest settlement is in the north-west, in Larimer County, with thirty-eight sites. The contiguous counties, extending from the Rocky Mountains to the States of Nebraska and Kansas without a break, form a vast central group separated by a trough from the smaller and isolated north-west group.

The camp site is the most common (247). Here flaked artefacts and chips are fairly well grouped. Old fireplaces and tipi-rings—stone circles, on which the skins rested, marking the base of the tent—are the most certain criterion of a camp site. An unexpected number of the grinding-stones known as *mano*, or hand-stone, were found. The mano is smaller in the pueblo area. Pottery, previously accounted unknown or rare in the western plains, was recorded on fifty-five sites. Fifty-two workshop sites and fifteen rock-shelters were visited. Petroglyphs, rarely painted and most commonly pecked, were found on fourteen sites. Dr. Renaud has made a careful study of the stone implements, comparing them exhaustively with those of the stone age of Europe and other parts of America. The greater number are non-palæolithic, next in importance being Mousterian-like points, scrapers, and flakes.

In 1931, according to a communication we have received from the Department of Anthropology in the University of Denver, the expedition covered the archæologically rich area known as the "Spanish Diggings" in the neighbourhood of Cheyenne and Larimer. About two hundred Indian sites were visited and recorded, and a large number of artefacts were collected. The pictographs were fewer in number than was expected. Pottery was found on a number of sites, and a number of camps showed tipi-rings. The expedition was particularly impressed by the resemblance of old quarries, from which red chert, yellow jasper, and quartzite have been obtained, to the prehistoric quarries of western Europe, except for the fact that the latter had yielded flint. The relative age of these quarries is being investigated by the examination of the growth of lichen. A rapid excursion was made to north-east Wyoming, archæologically a much less interesting area; but it is anticipated that western Wyoming, when its turn comes for exploration, will yield interesting remains, especially in the form of pictographs.

University and Educational Intelligence

BIRMINGHAM.—In his report to the annual meeting of the Court of Governors held on Feb. 25, the vice-chancellor and principal, Sir Charles Grant Robertson, gives the figures for the number of students. The total for the past session was 1890, which approaches the maximum reached in the 'boom' period after the War. The new entries for the present session also show a marked increase. The postponement for a year (on account of national financial stringency) of the building of the new Hospital Centre and Medical School is a matter of grave concern, in view of the increasing congestion of the present buildings.

CAMBRIDGE.—A report of the Syndicate on the Scott Polar Research Institute recommends that steps be taken to proceed with the erection of a polar research institute on the Lensfield site. The generous gift of £4000 by the trustees of the Pilgrim Fund last year has now made up the capital of the building fund to £12,000, which is considered sufficient to provide for the cost, equipment, and maintenance of the institute which the Syndicate has in view. The financial board, while raising no objection to the recommendations, has expressed the hope that every effort will be made to increase the endowment of the institute.

LONDON.—Dr. G. F. J. Temple, at present reader in mathematics at the Imperial College, Royal College of Science, has been appointed to the chair of mathematics at King's College, as from Aug. 1.

The William Julius Mickle fellowship for 1932 has been awarded to Dr. Philip Eggleton, for his research on the labile compounds of phosphorus in muscle.

THERE will be an election to Beit fellowships for scientific research in July next. Applications, upon a form supplied upon request, must be received by April 12 by the Rector, Imperial College of Science and Technology, South Kensington, S.W.7.

THE annual examinations for a Faraday scholarship of eighty guineas per annum, tenable for two years in the Faraday House Electrical Engineering College and one year in a manufacturing works, and for a Maxwell scholarship of sixty guineas per annum, tenable for two years in the College and one year in a works, will be held at Faraday House on April 5–7. Further particulars may be obtained from the Registrar, Faraday House Electrical Engineering College, 62-70 Southampton Row, W.C.1.

THE Rockefeller Foundation's disbursements in 1930 amounted, exclusive of administration expenses, to nearly fifteen million dollars, of which universities and other educational institutions received more than six millions, research institutions and organisations more than two millions, whilst public health work absorbed nearly three, and fellowships and grants-in-aid more than one million. The field of the Foundation's activities embraces, in addition to its International Health Division in which expenditure since 1913 has amounted to 42 million dollars, work in the medical sciences, natural sciences, social sciences, and the humanities. In the International Health Division particular emphasis has in recent years been laid on field work, including the gathering of knowledge about widespread maladies such as hook-worm, malaria, pellagra, yellow fever, tuberculosis, and the common cold. All results of researches by members of the field staff of the Foundation or by persons working under its auspices are published (to the number of 57 in 1930)

in the medical journals. International Health Division fellowships are given to graduates in medicine of high professional standing and assured of positions in the public health services of their own countries. In 1930, 173 such fellowships were held by natives of 33 countries, including the United States and its dependencies (52), China (18), Canada (12), Italy (12), other European countries (47), Brazil (8), India (8). In addition, the Foundation supported 102 fellowships in medicine for the supplementary training of young graduate physicians, from 35 countries, in preparation for definite positions in research or teaching. Among enterprises aided by the Foundation are an institute of experimental biology in Copenhagen, an institute of cell physiology in the Kaiser Wilhelm Institute of Biology, and the Kaiser Wilhelm Institute for Brain Research.

Calendar of Geographical Exploration

March 2, 1705.—Coast of Northern Australia

Maarten van Delft sailed from Timor and surveyed the coasts of Melville Island and of the Coburg Peninsula, thus supplementing Tasman's chart of the region. One of the vessels penetrated some distance into Dundas Strait.

March 4, 1519.—Cortes in Mexico

Hernando Cortes landed in Mexico. The discovery of Mexico by Juan Grijalva led Velasquez to entrust to Cortes the exploration and conquest of the country. Starting from the coastal regions near the modern Vera Cruz, Cortes marched to the city of Mexico, sending a party to explore the snow-clad Popocatepetl *en route*. The city was captured in August 1521, and Cortes sent out exploratory parties in all directions, Alvarado making some conquests in Guatemala. Cristobal de Olid, who had been ordered to reach Cuba via Honduras, reached the southern shores of the gulf, but mutinied against Cortes. The latter left Mexico in 1524 and marched through Tabasco to the Gulf of Honduras. There he again sent out exploring parties from the town now known as Puerto Cortes and later from Trujillo.

March 4, 1791.—Islands of the Pacific

Capt. Edwards, in the *Pandora*, sighted Easter Island on a voyage undertaken partly in search of the mutineers from Bligh's vessel. These men had apparently appreciated life in the South Sea islands so much that they wished to remain. Some of them successfully settled in Pitcairn Island. Edwards discovered some small islands in the Low Archipelago, and later, in his search for the mutineers, covered much of the Pacific not usually touched in trading voyages, thus many previously unknown islands were charted. In the neighbourhood of Torres Strait the *Pandora* was wrecked; some of the crew were drowned, but others escaped in the boats and after terrible hardships reached Timor.

March 4, 1905.—Charcot Land

Dr. Jean Charcot in the *Français* arrived in Puerto Madrina, Argentina. Charcot had planned a voyage to the Antarctic to rescue Dr. O. Nordenskjöld, but this had been effected by an Argentine vessel. Charcot then, in the course of two summer cruises, surveyed parts of the west coast of Graham Land and reached Alexander I. Land. His vessel was delayed by ice and anxiety was felt about its possible fate, but in spite of severe damage it escaped. In 1908–10, Charcot returned to the Antarctic and discovered the land which now bears his name.

Societies and Academies

LONDON

Royal Society, Feb. 18.—**D'Arcy W. Thompson**: The geometry of the siliceous skeletons of the Radiolaria. The figures of equilibrium and minimal area which are assumed by soap-films in Plateau's experiments have proved helpful in explaining the configurations of various cells and simple tissues in plants and animals. Among the most curious and anomalous of cell-forms are those of certain Radiolaria. In some of these the skeleton resembles a minute spiked helmet with three curved lappets or straps below. Even such an anomalous configuration as this may be precisely imitated or reproduced by an artificial system of liquid films.—**H. W. S. Massey** and **C. B. O. Mohr**: The collision of slow electrons with atoms (1). The theory has been developed in which the zero approximation is not a plane wave but the wave representing the motion of the electron in the static field of the atom concerned. Exchange does not become very important until voltages lower than those obtained on Born's theory using the plane wave as first approximation. At lower voltages, strong interference effects occur between the incident and exchanged electron waves, giving peculiar angular distributions of the scattered electrons. These effects are observed experimentally. —**H. C. Webster**: The artificial production of nuclear γ-radiation. The production of nuclear γ-radiation by bombardment with α-particles has been observed for the elements Li, Be, B, F, Na, Mg, Al. Negative results were obtained with H, C, N, Ni, Cu, Sn. The absolute efficiencies of production of the various radiations range from about 0·5 quanta per million α-particles for magnesium to about 30 quanta for beryllium. In addition, the way in which the efficiency of production varies with the residual range of the α-particles was investigated. The processes probably responsible for the radiations are discussed: some appear to be due to the capture of an α-particle by a nucleus without proton emission, others are probably due to a secondary process following proton emission, others may arise from inelastic collisions without capture.

Geological Society, Dec. 16.—**J. E. Richey**: The Tertiary ring complex of Slieve Gullion (Ireland). This complex lies west of the Mourne Mountains and north-west of the Carlingford Peninsula. Topographically, it consists of a ring of curving ridges and hills, 7 miles in diameter, which is bisected by a mountainous belt extending to the north-west. The ring and the north-west belt mark the outcrops of a very simple ring-dyke complex and later Tertiary plutonics. The ring complex forms a complete ring, except to the south-west, where it is broken through by the north-west belt. The almost exact coincidence of the ring-fissure with the margin of the western portion of the Newry granite is perhaps its most remarkable feature. The constituent rocks of the ring are given.

PARIS

Academy of Sciences, Jan. 11.—**E. Jouguet**: Remarks on a theorem of Hugoniot relating to the flow of fluids.—**Maurice Hamy**: A property of the equation obtained by equating to zero the distance of two planets, P, P_1, which do not meet at real points.—**Paul Qvale**: Remarks on Thiele's semi-invariants.—**Georges Bouligand**: Various problems of infinitesimal geometry.—**N. Aronszajn**: The decomposition of uniform functions.—**W. Orlicz**: Some theorems on orthogonal developments.—**René de Possel**: *Étoilées* functions and ensembles of the

maximum type.—E. Kogbetliantz: The convergence of Hermite's series.—N. Abramesco: The determination of holomorph functions in given domains.—Marcel Guillot: Reade's iriscope and the aptitude of solid and liquid surfaces to be moistened by water. This method of testing the cleanliness of a surface is based on the condensation on the surface of a small quantity of water vapour and subsequent examination of the interference effects produced. Glass cleaned with hot sulphuric acid containing chromic acid is found to be clean only in certain spots. Only surfaces obtained by fracture, by fusion, or prolonged treatment with hydrofluoric acid were found to be perfectly clean when tested by this method.—E. Henriot and O. Goche: Cathodic sputtering in a magnetic field. Cathodic sputtering in a magnetic field produces a deposit on a screen, the position of which varies on reversing the field. This deposit is due to carbon, and is independent of the nature of the metal employed as the cathode. The origin of the carbon is discussed.—Georges Fournier and Marcel Guillot: The increase of absorption of the β-rays in molecules possessing certain linkages between the atoms.—André Chevallier and Pierre Dubouloz: The application of fluorescence to photometric measurements in the ultra-violet. J. and J. F. Thovert have proposed the utilisation of photoelectric cells with thin walls (the latter being covered with a thin layer of a fluorescent substance) for detecting radiations of short wave-length. This method has been studied in detail with special reference to the composition of the fluorescent layer. An emulsion of dextrin and sodium salicylate has been found to give the best results.—Marcel Godchot, Étienne Canals, and Mlle. Germaine Cauquil: The Raman spectrum of some cyclohexane hydrocarbons. Comparison of the Raman spectra of cyclohexane, methylcyclohexane, the three isomeric dimethylcyclohexanes, and of hexane. The spectra are generally similar, but there are differences to which attention is directed.—Henri Lafuma: The solution and hydration of quicklime in the presence of calcium sulphate.—E. Herzog and G. Chaudron: The methods of testing the corrosion of metals. Comparison of the effects of uniform and localised corrosion. Localised corrosion, in which no appreciable loss of weight of the specimen is noted, may have a marked effect on the mechanical tests.—G. Darzens and Georges Lévy: The method of preparation of phenols by the direct dehydrogenation of the corresponding hydroaromatic ketones. Application of the removal of hydrogen by heating with sulphur.—Charles Dufraisse and Léon Enderlin: The formula and constitution of a colourless hydrocarbon with a violet fluorescence, $C_{42}H_{26}$.—M. Battegay and J. Meybeck: The amino-sulphonamides. By the interaction of *N*-chlorosulphonylacetanilide, $C_6H_5(CO.CH_3).N.SO_2Cl$ upon dimethylamine, phenylaminodimethylsulphonamide ($C_6H_5 . NH . SO_2 . N(CH_3)_2$) is obtained. The dimethylamine can be replaced by other amines, giving the corresponding amino-sulphonamides.—Mme. Ramart-Lucas and Mlle. Biquard: The prediction and verification of the colour differences between isomers.—A. Marin and P. Fallot: The geology of the Punta Pescadores region (Spanish Rif).—A. Dauvillier: The theory of the polar aurora.—Robert Lemesle: A structural peculiarity in the various species of *Kadsura*. The presence of small crystals of calcium oxalate in certain tissues appears to be general in all species of *Kadsura*.—Pierre Chouard: The diversity of the generic characters of the flowers, bulbs, and seeds in the genus *Ornithogalum*.—P. Lebard: The influence of altitude on the tuber formation of the potato. The existence of an optimum altitude. Comparisons of tuber formation of the potato at altitudes of 214, 1500, 1650, and 2100 metres above sea-level. The alpine climate favours tuber production, the highest yields being obtained at 1500 metres.—A. Policard, A. Morel, and P. P. Ravault: The histospectrographic study of the localisation of calcium and magnesium in the human aorta, and their variations during atheroma.—Émile F. Terroine and Mlle. Marguerite Champagne: The influence of the acid-base ratio of diet on the magnitude of the nitrogen metabolism.—Émile Guyénot and Mlles. A. Moskowska and K. Ponse: The direct action of the hypophysis on the nuptial pad of *Bombinator pachypus*.—Mme. Y. Khouvine, G. Champetier, and R. Sutra: The X-ray study of the cellulose of *Acetobacter xylinum*.—René Legroux: Transmissible bacterial lysis. The principle producing lysis behaves towards antiseptics as a diastase. That it is a living organism is shown to be improbable.

MELBOURNE

Royal Society of Victoria, Dec. 10.—A. B. Edwards: The dacite-granodiorite contact relations in the Warburton area. A granodiorite of Upper Devonian age is found intruding a contemporaneous series of dacites in the Warburton area (Victoria), at Nyora (Mt. Tool-be-wong), and south of Warburton township. At Nyora the dacite is but slightly altered. At Warburton three members of the dacite suite enter the metamorphic aureole of the granodiorite, and are converted into ortho-schists and ortho-gneisses, with accompanying mineral changes. As the granodiorite is approached, hypersthene is replaced by biotite, which in turn gives place to green hornblende. A patch of anthophyllite-garnet rock is developed from the hypersthene-dacite, apparently by repeated metamorphism. Andalusite is developed in the metamorphosed argillaceous sediments of Silurian age which enter the contact aureole.—Elizabeth A. Ripper: Palæontological zoning of the Lower Ordovician near Ingliston. The Lower Ordovician slates and sandstones, three miles south-east of Ingliston, are shown by their graptolite faunas to belong to the uppermost zone of the Castlemaine series and all the Darriwil series, with the exception of the uppermost zone (*D.* 1). Passage beds between *D.* 5 and *D.* 4 with *Oncograptus upsilon* and *O. biangulatus* have been recognised. The area is the western limb of a geosyncline, of which the axis is unknown, since there is a passage from *C.* 1 in the west to *D.* 2 in the east, where beds of this age outcrop in the Werribee Gorge.—Frederick Chapman: Some palæozoic fossils from Deep Creek and Evans' Creek, Saltwater River, Victoria. A preliminary note on the Deep Creek fossils by the author, published in 1903, gave a Silurian (doubtfully Yeringian) age to the collection from that locality. The conclusions now arrived at are a Silurian age for both collections, with a leaning towards the lower or Melbournian stage.—Walter J. Parr: Victorian and South Australian shallow-water Foraminifera (2). This part deals with the remainder of the material studied in Part 1, together with some additional species discovered since. The new species are *Gaudryina hastata*, *Vaginulina vertebralis*, *Bolivinella elegans*, *Reussia armata*, *Discorbis australis*, *D. collinsi*, and *Anomalina nonionoides*.—S. Illichevsky: Does the flowering of plants of the Victorian flora repeat the order of their evolution?—Jean Heyward: The relation between flowering and degree of evolution.—Donald McCance: Weathering of the older basalt of Royal Park, Melbourne. A series of chemical analyses of different stages of decomposition of the rock, from the fresh basalt to the residual clay, are given. By means of a table based on these analyses the calculated losses of material, due to weathering, in the various stages, are compared. A

petrological description of the basalt is given, whilst the evidence points to the decomposition having been caused by infiltration of solutions from without.—F. A. Singleton: Studies in Australian Tertiary Mollusca (1). This paper deals with the status of fossils hitherto recorded as *Nucula obliqua* and *Limopsis insolita*. Included in the paper are descriptions of the following new species and sub-species from the Australian Tertiaries: *Nucula kalimnæ*, *Glycymeris granti*, *Limopsis chapmani*, *L. chapmani valida*, *Cucullæa corioensis prælonga*. — David E. Thomas: The Kerrie series and associated rocks. The Kerrie series of conglomerates and associated sandstones, to which various ages of basal Upper Ordovician and basal Silurian have been given, rests unconformably on the upturned edges of the Upper Ordovician. The Lower and Upper Ordovician of the area are conformable, and no stratigraphical break has been proved between the Upper Ordovician and the Silurian. On the similarity to rocks elsewhere in the State an Upper Devonian age is assigned to the conglomerate.

VIENNA

Academy of Sciences, Oct. 22.—R. Weiss and F. Müller: Triphenylmethanes the benzol nuclei of which are connected. (6) Trimethylene-triphenylmethane-triketone-4-carbonic acid and its reduction. —F. Wessely and F. Kallab: Substances contained in the root of *Pimpinella saxifraga*. Pimpinellin and isopimpinellin belonging to the coumarins and coumarone series.—F. Feigl and L. Popp-Halpern: The salts of *o*-, *m*-, and *p*-phenylene-diamine with organic acids.—G. Lock and F. Asinger: Steric inhibition in the saponification of benzal chlorides (1).—G. Machek: The anhydride of the symmetrical pyridine-tetracarbonic acid and some of its condensation products. —O. Dischendorfer and E. Fransevic: *P*-chlorbenzal-di-β-naphthol (sixth communication on condensation of aldehydes with phenols); also anthraquinone-2·1, 6·5-di-xanthon.—M. Pestemer and J. Cecelsky: Ultra-violet absorption of some aromatic hydrocarbons.—F. Werner: New Orthoptera collected during an expedition to Morocco undertaken with the help of the Academy in 1930.—R. Wagner: Mixed monochasiums of *Piriqueta sidifolia*. Curious inflorescences.—R. Weiss has deposited a sealed manuscript with the inscription "Stereochemie" and relating to racemic compounds with optically active substances.

Oct. 29.—K. Funke: Perylene and its derivatives. (33) The constitution of perylene-diamines.—P. Schebesta and V. Lebzelter: Anthropology of the pygmies of the Belgian Congo. In the years 1929–30 some 550 pygmies were measured. They were of various tribes, some more, others less, racially pure. Efe, Bambuti, Bakango, Aka, Bacwa, Batwa, Basua occupy different districts.

Nov. 5.—F. Arndt, J. Amende, and W. Ender: Syntheses with diazo-methane. The reactions of aldehydes and ketones.—F. Heritsch: The tectonic structure of the Carnic Alps.—E. Haberfelner: Geological survey between Kronhofgraben and Fuchsgraben.—W. Krassuski: Geological survey of the eastern Carnic Alps and of the western Karawanken. —I. Peltzmann: Graptoliths from Dellach (Zollner) Alm.—F. Kahler: Investigations on the Fusulinidæ of the Carnic Upper Carboniferous.—K. Metz: Detailed survey of the Nassfeld deposits in the neighbourhood of the Ahornach Alp.—H. Heritsch: Survey in the crystalline rocks of the Gail valley.—H. Tertsch: Cleavage measurements in the pressure planes of rock-salt and deductions concerning the cleavage process. The rhombododecahedral surfaces were tested in the same way as the cubic surfaces.—A. Brukl and B. Hahn: Heteropoly-acids of germanium.—B. Machan: New fish from Java.

Forthcoming Events

FRIDAY, FEBRUARY 26

ASSOCIATION OF ECONOMIC BIOLOGISTS (Annual General Meeting) (in Botany Lecture Theatre, Imperial College of Science and Technology), at 2.30.—At 3.—Dr. H. Tattersfield, F. R. Cann, and others: Discussion on Laboratory Tests of Insecticides.—At 5.30.—Presidential Address: Temperature and Humidity in Relation to Insect Control.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Meeting), at 4.30.—Dr. S. F. Grace: A Method for the Determination of the Tides of a Broad, Deep Sea, with Application to the Gulf of Mexico.—Dr. H. Jeffreys: (*a*) On the Stresses in the Earth's Crust required to support Surface Inequalities; (*b*) The Deformation of the Earth due to Asymmetrical Cooling.

BRITISH PSYCHOLOGICAL SOCIETY (at 54 Russell Square, W.C.1), at 8.30.—Dr. Susan Isaacs: Some Recent Advances in the Psychology of Children (Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. C. G. Darwin: The Uncertainty Principle in Modern Physics.

ASSOCIATION OF TECHNICAL INSTITUTIONS (Annual Meeting) (in Leathersellers' Hall, St. Helen's Place, E.C.).—Prof. R. W. Angus: Technical Education in Canada.—W. H. Quinn: Technical Education in the Bakery Trade. —P. G. Wilson: Teaching of Modern Languages in Technical Colleges.—J. Cameron Smail: The Report on Policy in Technical Education.—Sir Francis Goodenough: The Report on Education for Salesmanship.

SATURDAY, FEBRUARY 27

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Lord Rutherford of Nelson: Discovery and Properties of the Electron (1).

ASSOCIATION OF TECHNICAL INSTITUTIONS (Annual Meeting) (in Leathersellers' Hall, St. Helen's Place, E.C.) (*continued*).

TUESDAY, MARCH 1

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. L. J. Witts: The Pathology and Treatment of Anæmia (Goulstonian Lectures) (1).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. W. E. Garner: Detonating Substances (1).

WEDNESDAY, MARCH 2

ROYAL SOCIETY OF ARTS, at 8.—E. C. Gordon England: Motorless Flying.

THURSDAY, MARCH 3

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. L. J. Witts: The Pathology and Treatment of Anæmia (Goulstonian Lectures) (2).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. B. S. Haldane: Heredity in Man (3).

FRIDAY, MARCH 4

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society) (Annual General Meeting), at 3.—Presidential Address.

INSTITUTE OF MARINE ENGINEERS, at 6.—Annual General Meeting.

GEOLOGISTS' ASSOCIATION (in Architectural Theatre, University College), at 7.30.—Prof. W. G. Fearnsides: The Carboniferous Rocks of Derbyshire Derwent (Lecture). —W. Pulfrey: On the Occurrence of Radiolarian-bearing Nodules at the Base of the Edale Shales, near Calver, N. Derbyshire (In Abstract).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Harold Hartley: Michael Faraday and Electro-Chemistry.

SATURDAY, MARCH 5

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Lord Rutherford of Nelson: Discovery and Properties of the Electron (2).

Conference

MARCH 2 AND 3

CONFERENCE ON LIGHT IN ARCHITECTURE (Lighting Service Bureau, 15 Savoy Street, W.C.2).

Wednesday, March 2, at 10 A.M.—H. A. Lingard: Introductory Remarks.
At 10.15 A.M.—Dr. J. W. T. Walsh: Lighting Fundamentals.
At 11.15 A.M.—L. E. Buckell: Characteristics of Electric Lamps.
At 12.15.—Discussion.
At 2.15.—W. Maitland: Aims and Objects of Architectural Lighting. Discussion.
At 3.30.—Mr. Grierson: Electrical Services for Lighting.
At 4.15.—Discussion.

Thursday, March 3, at 10 A.M.—Sir John Brooke: Introductory Remarks.
At 10.15 A.M.—H. Lingard: Floodlighting. Discussion.
At 11.30 A.M.—W. J. Jones: Special Lighting Problems. Discussion.
At 2.15.—F. Marsh: Lighting Requirements for Commercial Buildings. Discussion.
At 3.30.—H. Robertson: Modern Tendencies in the Lighting of Theatres, Hotels, Restaurants, and Exhibitions. Discussion.

Official Publications Received

BRITISH

Recent Advances in the Fermentation Industries. By Dr. J. Vargas Eyre. (Streatfeild Memorial Lecture, 1931.) Pp. 20. (London: Institute of Chemistry.)

The Indian Forest Records. Entomology Series, Vol. 16, Part 8: New Indian Curculionidae (Col.). By Sir Guy A. K. Marshall. Pp. ii+16+1 plate. 6 annas; 8*d*. Entomology Series, Vol. 16, Part 9: The Life-History and Control of *Celosterna scabrator* F. (Col., Cerambycidae). By C. F. C. Beeson. Pp. ii+16+2 plates. 8 annas; 10*d*. (Calcutta: Government of India Central Publication Branch.)

Economic Advisory Council. Committee on Education and Supply of Biologists: Report. Pp. 68. (London: H.M. Stationery Office.) 1*s*. net.

Report on the Administration of the Meteorological Department of the Government of India in 1930-31. Pp. 26. (Calcutta: Government of India Central Publication Branch.) 8 annas; 10*d*.

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