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Science in the Public Press

THE desirability of promoting a more intelligent and more intelligible consideration of scientific work and thought in the public Press has often been urged in these columns ; and there are signs of increased attention to this need both from newspaper editors and from scientific workers. This is due to several causes. The public expenditure upon scientific research is now large. Government departments which spend money on research, and scientific workers who are supported by public money, feel that the public should understand the value of the work it is supporting. This motive of social self-justification penetrates far more extensively than is generally realized. The Department of Scientific and Industrial Research and the University Grants Committee provide funds which assist a large fraction of all the scientific research at present done in Great Britain.

The circumstances of scientific research in this country have undergone a profound change during the last fifty years. In the nineteenth century, the leaders of research did not consider that social justification of their work was necessary. Providence had placed them in fortunate situations where they were able to indulge their personal intellectual tastes, and though their labours might be of practical value to humanity, or profitable to themselves, this was regarded as a happy accident. They considered that the receipt of a comfortable academic salary or private income did not lay any very pressing obligation on them to use their talents for the extension of scientific knowledge to the community. This attitude was derived from an earlier stage of civilization, when humanity was forced to admire those who could exact support without rendering any corresponding service.

The Greeks despised Archimedes' contributions to mechanics because manual skill in a slave State was disreputable. Until recently a large part of scientific research was done by persons enjoying academic endowments or private fortunes. As they were not directly dependent on the public, they did not see why they should explain what they were doing. In extreme cases, such as that of Henry Cavendish, they did not explain what they were doing even to their friends. A scientific worker in direct receipt of a subsidy cannot reasonably adopt this attitude.

The policy adopted by large industrial corporations of supporting research in order to invent valuable new processes has provided another motive for the extension of public interest in science. Many corporations systematically publish accounts of their researches, partly as a form of advertisement to show their progressive character. They are interested in securing as much public discussion as possible of the scientific principles connected with the goods they wish to sell. In the United States especially, a large amount of advertisement is designed to appeal to the scientific interests of consumers.

The rapid increase in the number of scientific inventions, such as radio, aeroplanes, synthetic plastics, and thousands of other modern objects, attracts the scientific curiosity of the public. In addition, there are the results of decades of the teaching of science in schools, and the spread of the conviction that science is the chief characteristic of the present age. It can scarcely be admitted, however, that the present age is scientific, though science may be prominent in it. Indeed, the development of science throws into greater contrast the unscientific nature of the greater part of modern life. Nothing could be more unscientific

than the contemporary armaments race, and the existence of widespread poverty and malnutrition in a period of unparalleled development of the technique of production, and the study of the science of nutrition. An increasing number of citizens are looking to the public Press for explanations of these paradoxes.

It is not necessary to enumerate more reasons why the demand for news and information of science in the Press is increasing. The fact is known to every newspaper editor. Some are puzzled by it, and accept it merely on business grounds. Recent questionnaires on the popularity of different types of articles have shown that scientific articles are more popular than many editors with a literary training had believed.

While nearly everyone admits the increasing demand for news of science, there is general agreement that the demand is not being met satisfactorily. Scientific workers are irritated by inaccurate Press accounts of their activities, and the public is unable to hear of many matters it would like to know. Better methods of handling science in the Press are required. For various reasons the problem is difficult. The mere technical difficulty of explaining science in a style suitable for a newspaper, and yet not obnoxious to men of science, is considerable. The difficulty of popularization is generally underrated. Good popularization requires a breadth of culture in the writer which is not very common among scientific workers, or any section of the population. Few men of science are immediately capable of writing for the Press. In fact, it may be confidently asserted that it is more difficult to earn £300 per annum in writing satisfactory scientific articles for the Press than to earn an equal sum as a research worker. This is one of the explanations why so much newspaper matter relating to science is so bad.

The poor financial rewards of scientific journalism have repelled most able men from the work. The field has been left to a small group which contains an exceptionally large percentage of writers who, for one reason or another, do not fit in very well with the usual professions, where equivalent qualifications can usually command an income of £750 a year in an academic or industrial post. Until newspapers are prepared to pay such a salary for a full-time science editor, they will remain without a representative of science with standing equal to that of a literary editor. The problem is thus, to a large extent, economic.

The creation of a science news agency, like Science Service in the United States, seems to be a more immediately practicable, though less ideal, solution. But there are serious difficulties in creating such a service. The Press includes journals conducted on very different principles, and with very different points of view. The technique of writing for different types of journal varies greatly. Some writers are brilliantly successful with one type of journal, and are complete failures with others. Newspapers are very competitive. Editors in Great Britain always like to have some individuality or exclusiveness in their copy: they use matter from the Press agencies only when they are unable to get special material of their own. Thus a news service tends to start with the neutral characteristics of a stop-gap organization. But though there are difficulties confronting the establishment of a science news service, such a service is particularly necessary in the absence of adequate science reports in the Press, and will always have a useful function, for the same reasons which keep the various general Press agencies in vigorous existence.

Assuming that a science news service is desirable, the next point to decide is how it may best be organized. It would be wise to be clear from the beginning who should control the service. Should the predominance of the control be with science, or with the Press? Different answers might be given to this question in different countries and circumstances. There is little doubt that in Great Britain final control should at the beginning rest with representatives of science. The organizers of such a service should seek endowments from societies and individuals, and the control should be through a committee of eminent men of science. A staff of two or three scientific journalists, whose various styles will roughly suit the various types of journal, should be appointed. A sum of £25,000, or an endowment of £3,000 a year for ten years, might be sufficient for starting the organization under conditions that might lead to great and valuable success. The payment of fairly secure and satisfactory salaries would do much to attract able men to the staff of the service. Until this is done, the presentation of science in the public Press will not be improved, because the sort of ability necessary to solve the problems of the collection and presentation of science news will be much better paid in other fields of work.

Man and Forest in Prehistoric Europe

The Mesolithic Settlement of Northern Europe: a Study of the Food-Gathering Peoples of Northern Europe during the Early Post-Glacial Period. By Dr. J. G. D. Clark. Pp. xvi+284+8 plates. (Cambridge: At the University Press, 1936.) 25s. net.

THE passing of the last Ice Age left northern Europe open to human settlement; but the environment which the settlers encountered was still slowly changing. They had to adjust their equipment to land movements (including the opening of the Channel and the submergence of the Dogger Bank), to the change from a cold 'Pre-Boreal' to a warm continental 'Boreal' climate and then to a moister 'Atlantic' phase, to spread of forests, first of birch and willow, then of pine, then of mixed oak woods, and to consequent alterations in the country's fauna. Of these changes and of the geological, botanical and zoological evidence from which they are reconstructed, Dr. Clark gives a clear account, illustrated with maps and documented with copious references. The successive phases provide not only the background as adjustments to which human cultures must be interpreted, but also the chronological framework in which they must be arranged. Indeed, accepting at least the method of de Geer's geochronology, Clark provisionally offers absolute dates for the climatic phases: 6800-5000 B.C. for the Boreal, 5000-2500 for the Atlantic.

The first colonists are known almost exclusively from their flint artefacts, among which tanged points are the most conspicuous, but Rust and Schwantes found also their 'harpoons' and other tools of reindeers' antler near Hamburg just in time for inclusion in this book. A little later, axe-like and adze-like tools of reindeer antler illustrate men's first efforts at coping with the Boreal forests that were invading the tundras and steppes. Clark accepts Schwantes' thesis that these so-called Lyngby axes of antler are the prototypes of the later north European flint axes, but admits the possibility of their derivation from some still unknown culture to the south-east—a possibility that cannot be excluded while Russia remains almost unexplored. The familiar Maglemose culture (this name, signifying Great Moss, is retained for the whole complex, Mullerup being used for the facies peculiar to Zealand) can then be treated as a further adjustment to the forest environment, though the author insists that its

microliths are derived from the Tardenoisian, the spread of which round the fringe of the wooded plains is discussed in a special chapter.

Otherwise the principal novelties in the treatment of the well-known complex are the illustrations of the gravers, included among the relics from the type sites but ignored until Westerby noted them in 1927, and an accurate classification of the various bone points that constitute the best-known type-fossils of the complex. Independently of Bøe (whose work presumably appeared too late for mention), Clark exposes the inaccuracy of the conventional explanation of these as harpoons. He gives a very instructive map of the distribution of selected types from England to the Baltic States (but omitting the new Norwegian finds).

Clark's treatment convincingly establishes the underlying uniformity of culture prevailing throughout the region surveyed—a uniformity that really extends beyond it at least to the Urals. But the differentiation of local groups within this unity is no less interesting sociologically; for it must reflect the crystallization of distinct social units out of an ethnic continuum in Boreal times. It is graphically illustrated by the distribution of types 7 and 14 on Clark's map, and of the Vögtland club-heads and other types recently mapped by Germans. But still more striking is the rarity of axe-like tools in the forested plains east of the Baltic, suggested to the reviewer by a recent examination of Russian collections.

Regional differentiation is more emphasized in Atlantic times. Clark establishes very convincingly the continuity between the Maglemose and Ertebølle cultures in Denmark, and the contrast between the latter and its English and Scandinavian contemporaries. The differences between Maglemose and Ertebølle are due mainly to changed environment, between Ertebølle and say Lower Halstow to the isolation consequent upon land-sinking.

Its comprehensive bibliography, its tables of sites, of fauna and of flora, and its copious and beautifully executed figures and maps, make this book a standard work on the northern mesolithic. Its author's mastery of British as well as Baltic archæology should commend it even to the most insular local antiquary. As an objective record of human adaptation to changing environments and of the divergence of industrial traditions, it possesses a wider historical interest.

V. G. CHILDE.

Invisible Radiations of Organisms

Invisible Radiations of Organisms

By Prof. Otto Rahn. With an Introduction to the Physics of Radiation, by Sidney W. Barnes. (Proto-plasma-Monographien, Vol. 9.) Pp. x+215. (Berlin: Gebrüder Borntraeger, 1936.) 13.20 gold marks.

HERE we behold mitogenetic radiation masquerading as the legitimate offspring of biochemistry and the quantum theory, and the unwary reader, finding 'muscle radiation' casually mentioned in a purely physical account of the photo-electric effect, may well suppose the scientific status of the two phenomena to be identical. On reaching p. 55 he may begin to suspect that in reality mitogenetic radiation was quite differently conceived; but up to this point the emission of such radiation by living cells, and even by simple systems undergoing chemical reaction, is treated as a predictable phenomenon related to chemiluminescence, and is described with the same confidence as the dispersion of light by a prism. Even the too remarkable phenomena of 'secondary radiation', involving emission of fluorescent radiation of shorter wave-length and higher intensity than the incident radiation, and its propagation, by successive phases of absorption and re-emission, through an absorbing medium, are made to appear almost as inevitable as Newton's laws of motion.

From p. 55 onwards, apart from a fair discussion

of the physical detection of mitogenetic radiation, the book is biological, dealing largely with material which has already been adequately presented by Gurwitsch in his two monographs: the biological detection, phenomenology and significance of mitogenetic radiation. In addition to this, there are a few references to more recent work, accounts of experiments by the author and his collaborators, and some rather uncritical remarks about the alleged lethal effects of menstrual blood on yeast and bacteria.

A brief epilogue is devoted to the question of errors in the detection of mitogenetic radiation and to the attitude of those who remain unconvinced of its existence. Piously hoping for a *rapprochement* between believers and non-believers, Prof. Rahn does not seem to realize that his book is not likely to help in the attainment of that object. The critics ask only that a detailed re-examination of the original mitogenetic effect shall be undertaken by some of those who claim to be able to obtain positive results without difficulty; but Prof. Rahn and his Russian colleagues prefer to write redundant monographs on the ubiquity of mitogenetic radiation, to discuss it in relation to amphibian metamorphosis, parasitism, polyploidy in tomato plants, industrial fatigue, cancer and old age, and to invent queer chain reactions to hide its physico-chemical misbehaviour.

Properties of Iron

The Metal—Iron

By H. E. Cleaves and J. G. Thompson. (Alloys of Iron Research Monograph Series.) (Published for the Engineering Foundation.) Pp. xii+574. (New York and London: McGraw-Hill Book Co., Inc., 1935.) 36s. net.

TO the valuable series of monographs on the alloys of iron, issued by the Engineering Foundation, there has now been added a volume dealing with the production and properties of the parent metal in a state approaching purity. Although iron is used in far larger quantities in industry than any other metal, and is not obtainable commercially in such a pure condition as several other metals, such as aluminium and zinc,

our knowledge of its exact properties is still very imperfect. There are two main reasons for this fact. With its high melting point and great chemical activity, iron readily absorbs impurities when in the molten state, which are correspondingly difficult to remove, whilst its properties are exceptionally influenced by the presence of even very small quantities of foreign elements. The properties assigned to 'pure' iron in the text-books are mostly derived from commercial materials regarded as approximately pure, or by extrapolation from a series of samples with diminishing amounts of impurity. The results are in either case unsatisfactory.

The present work, by two members of the staff of the U.S. Bureau of Standards, covers the

subject very thoroughly, and the volume is indispensable to the scientific metallurgist. The methods used in the laboratory and on the technical scale for the purification of iron are described, and the properties of the purified products reviewed, the treatment being critical throughout, with a useful short survey of the results at the end of each chapter. Electrolysis is commonly resorted to for purification, and this method successfully removes most of the impurities, except nickel and cobalt, but when the deposited metal is brought into a workable form by melting, new opportunities of contamination occur. Published analyses are not a satisfactory guide. As the authors point out, the formidable list of impurities recorded by some workers using refined analytical methods may not indicate that their metal was less pure than other samples, but may be merely evidence of more scrupulous analysis. The work was completed just too soon to include the careful work of Adcock and Bristow, who obtained an exceptionally pure product, using a chemical method followed by repeated fusion in hydrogen and *in vacuo* in vessels of pure alumina.

Much engineering research has been carried out on ingot iron, a low-carbon variety of mild steel which is always segregated, and contains many inclusions. In recent years, carbonyl iron, prepared by decomposing the vapour of iron carbonyl and sintering the product without fusion, has become available, and is the purest form of iron commercially produced at present; but the cost is relatively high.

The chapters on the physical properties of iron, including the effects of small quantities of each of the impurities usually found in the metal, are most interesting. The allotropic changes occur in even the purest iron, and do not, as was at one time suggested, disappear on the removal of impurities. The magnetic properties are extremely sensitive to minute traces of foreign elements, but in a fashion which does not allow of extrapolation. The difficult subject of corrosion is discussed, the conclusion being drawn that the chemical composition is of less importance than external conditions. It is surprising, in view of the large amount of work included in this review, that the important researches of Bengough and his colleagues are not mentioned, and Bengough's name does not even appear in the excellent bibliography, arranged chronologically, and containing 1,081 references.

Pure iron is a very soft metal, and it is interesting to observe how small is the quantity of an added element which is necessary to give it appreciable hardness. It is this fact which gives to the metallography of iron a special importance, and the system iron-carbon, in particular, has attracted more workers than any other system of metallic alloys. In order to understand the properties of the alloys of iron, it is essential to know those of the pure metal, and the authors have rendered a service in making available a detailed and, on the whole, judicious survey of the whole of this difficult field of study.

C. H. D.

Science and Minerals in the U.S.S.R.

The Scientific Study of Soviet Mineral Resources
By A. E. Fersman. Edited by C. P. Dutt. Pp. 149 + 15 plates. (New York: International Publishers, n.d.) n.p.

THE purpose of this book, as stated in the introduction, is to give a brief outline of the achievements of mineralogists and geochemists in Soviet Russia during the last five or six years, in which achievements Fersman himself has played a prominent part.

In its plans for economic development, the Government of the U.S.S.R. early realized the importance of utilizing the mineral resources of the State to the fullest possible extent, and ample provision was made for the investigation and development of these resources. Mineral survey parties, organized on scientific lines, directed their attention to promising areas, and were strengthened

as required to carry forward the work of investigation.

One of the most productive of these exploratory parties was the one sent to the Khibin mountain area in the Kola Peninsula, within the Arctic Circle. Here, in an area occupied by nepheline syenites, extensive deposits of apatite were discovered, and as supplies of phosphate were required to meet the needs of Russian agriculture, steps to develop these deposits were taken without much delay in 1929. Within three or four years of the commencement of this undertaking, a carefully planned town had grown up around the apatite mines and quarries. The population of this town at present is about 40,000. The town has a central cinema seating 1,200 people, and has also a fine park.

Rivalling the remarkable mining enterprise at this locality, 2° within the Arctic Circle, is an equally remarkable agricultural enterprise, also

organized on scientific lines. Peat bogs have been cultivated, and by using nepheline and apatite powder as a fertilizer, forage grasses are being grown. One farm has a herd of a thousand cows, in addition to vegetable gardens. From the greenhouses of these gardens, the population is supplied with fresh cucumbers and tomatoes. It is hard to believe that life at this locality is free from inconveniences, but these do not enter into Fersman's account. Whatever these may be, the enterprise is indeed a remarkable one. With a present annual output of two million tons of mineral, and a prospective output of seven million tons in 1937, things look promising in this wonderful arctic town.

Among other discoveries and developments

mentioned all too briefly in this book are those of the potash deposits of Solikamsk in the Urals, and many other deposits the exploitation of which promises to have important effects not only in the U.S.S.R., but also in the world at large.

The book deserved to be edited, printed and published in better style; but even as it is, and in spite of its somewhat extravagant appreciation of the part played by Russian workers in the development of geochemistry, it will be welcomed as a useful account of tendencies of thought and practice among these U.S.S.R. workers, who are much to be congratulated on the vigorous efforts they are making to establish a stronger scientific foundation than has hitherto existed for the study of minerals and mineral resources.

Memoirs on Systematic Zoology

Temminckia:

a Journal of Systematic Zoology. Edited by Prof. Dr. H. Boschma. Vol. 1. Pp. v+320+9 plates. (Leiden: E. J. Brill, 1936.) 13.50 fl.

THIS new periodical is designed to afford a means of publication for memoirs on systematic zoology. It is named in honour of C. J. Temminck (1778-1858), one of the most distinguished naturalists that Holland has produced and the first director of the great Rijksmuseum van Natuurlijke Historie in Leyden. Its scientific standing is assured by the fact that the editor is the present director of the museum, Dr. H. Boschma, while the name of the publisher, E. J. Brill, is a guarantee of typographical and technical excellence. Unlike most journals of the kind, it will appear only in bound volumes, of which one or two, each of some 320 pages, will appear annually.

The first volume, besides many text-figures, includes nine plates, of which one is in colour. Of the seven memoirs published in it, five are in English and two in German. Four of the authors are Dutch, one German, one Austrian and one American. All the memoirs except one deal mainly with the fauna of the Dutch East Indies.

The first paper, by Dr. G. C. A. Junge, is a faunistic one, dealing with the birds of Simalur and some other islands off the south-west coast of Sumatra. It includes field notes by the collectors on habits and distribution of the species dealt with. C. J. Keijzer writes at length on "Variability in East Indian Foraminifera" and concludes that the supposed trimorphism and polymorphism of certain species have no real existence, but are due to

superficial observation of continuous series of variations superimposed on the well-known dimorphism. It is to be gathered from the paper, however, that the life-cycle of the Foraminifera is not so simple or so well-understood as might be supposed from the usual text-book accounts of it.

A revision of the flying lizards of the genus *Draco* by Willi Hennig is based on examination of the material in many museums, gives statistical analyses of measurements, and discusses the geographical relations of the various "Formenkreise".

A paper on the use of the generic names *Tethys* and *Aplysia* among the Mollusca is surely the most fully documented discussion on a point of nomenclature ever published, the list of references at the end extending to more than eighteen pages. The author, Dr. H. Engel, makes out a strong case for submission to the International Commission on Zoological Nomenclature for suspension of the rules in order that the traditional use of these two names may be retained.

Dr. Koumans describes, with statistical data, evidence for an increase in the number of scales during growth in a species of fish. As the number of scales has hitherto been regarded as a constant specific character, this conclusion will have important results for systematists. In the concluding two papers of the volume, F. Spaeth revises the Australasian beetles of the group Cryptonychini, and Austin H. Clark describes the unstalked crinoids of the *Snellius* expedition.

Every systematist knows that it is comparatively easy to find editors willing to accept short papers describing a few new species. Every such

addition to the *Systema Naturæ*, however, demands some modification, although maybe very little, in the diagnoses of previously recognized species, and there comes a time when a revision of a whole group, a genus or a family, must be taken in hand if the system is not to fall into confusion. When an author is courageous enough to attempt such a revision for an extensive group, it is often hard to find a periodical in which it can be published,

especially if it is to be adequately illustrated. It has not infrequently happened that such a revision has been laid aside for years after being completed in default of any means of giving it to the world. It is, therefore, a hopeful sign of reviving interest in systematic zoology that a journal should have been established in which important and lengthy memoirs of this kind may find a place.

W. T. CALMAN.

Indeterminism and Psychology

Déterminisme et variabilité dans le comportement des organismes

(Exposés de biométrie et de statistique biologique, 7.) Par Prof. W. J. Crozier. (Actualités scientifiques et industrielles, 261.) Pp. 57. (Paris: Hermann et Cie., 1935.) 15 francs.

THE physicists have gone on strike against determinism and have called on the psychologists to come out in sympathy, but the psychologists can see no logical connexion between the physical problem and the psychological problem. It appears that the physicist can never know the facts about a single electron and can only predict the behaviour of aggregates. An individual animal represents a large aggregate of electrons and other units, and the fact that the behaviour of the individual units cannot be predicted does not necessarily imply that the behaviour of the aggregate is not governed by laws as rigid as those which govern the behaviour of a similar mass of inanimate matter. The difficulties of prediction appear to be due to the complexity of the problem rather than to any fundamental obstacle to observation. The psychologist is presented with a glut of facts about each individual and can see no reason why he should not explain the processes which govern individual behaviour, but such knowledge is likely to play a less important part in the world than a knowledge of the behaviour of aggregates of animals. Prof. Crozier, of Harvard, who has devoted the last ten years to the study of the behaviour of aggregates of rats, has published the summary of his results now under notice.

The evidence may be illustrated by describing a typical experiment. A rat is placed on an inclined plane in the dark, and its movements are recorded by photographing the movements of a patch of luminous paint on the rat's back. The rat knows that a suitable reward awaits it at the top of the inclined plane, and it therefore runs uphill in a series of short straight dashes. The

angle between the movements of the rat and a horizontal line in the inclined plane (θ) measures the accuracy of the rat's judgment, which must depend on sensations in the muscles of the rat's legs. When the results obtained from a large number of rats are averaged, their behaviour is found to be governed by laws. For example, the component of gravity in the direction of maximal slope will be proportional to $\sin \alpha$. As the slope increases, the accuracy of the rat's judgment increases in such a way that, like other similar curves depending on sensation, the curve connecting θ and $\log \sin \alpha$ is shaped like a prolonged *S*, being approximately straight in the middle range.

The curve obtained from a homozygous colony of rats is constant and typical of that colony. If two colonies interbreed, the factors on which the position of the curve depends are inherited according to Mendelian laws. The variability of the animals was estimated by calculating the standard deviation of the observed values of θ . Various conclusions are reached regarding the correlation between variability and slope. Different homozygous colonies of rats showed characteristic different degrees of variability, the inheritance of which has been studied.

Prof. Crozier discusses the philosophical implications of his results, which he considers to be opposed to the opinions of those physicists who would extend the principle of indeterminism to vital phenomena. On the other hand, he does not claim to be able to predict the behaviour of an individual rat any more than the physicist can predict the behaviour of an individual electron. He can, however, predict the behaviour of the average rat just as the physicist can predict the behaviour of the average electron. If methods such as those of Prof. Crozier can be extended to predict the behaviour of the average man, they may play an important part in deciding the destinies of nations.

(1) La radiation cosmique

Par P. M. S. Blackett. 1 : Aperçu général. Pp. 23 + 4 plates. 10 francs. 2 : La méthode de la chambre de C. T. R. Wilson (commandée par compteurs de Geiger-Müller). Pp. 25 + 3 plates. 8 francs. 3 : L'action du champ magnétique terrestre. Pp. 20 + 2 plates. 7 francs. 4 : La perte d'énergie par ionisation. Pp. 21 + 7 plates. 10 francs. (Actualités scientifiques et industrielles, 230-233.)

(2) Rayons cosmiques

Par B. Rossi. (Exposés de physique atomique expérimentale, 4 : Actualités scientifiques et industrielles, 248.) Pp. 48. 12 francs.

(Paris : Hermann et Cie., 1935.)

(1) THESE small books constitute the only connected account of cosmic rays which is available; and although the lectures on which they were based were delivered two years ago, the account given largely represents existing knowledge, and the problems stated remain mostly unsolved. The first part contains a general and historical account; the second deals with the technique and results of the counter-controlled Wilson chamber introduced by Prof. Blackett. This part contains the account of shower production. The third part is specially valuable. It provides a simplified treatment of the paths of electrified particles in the magnetic field of the earth, and the consequent effect of the field on the distribution of cosmic rays over the earth. The original papers in which this theory was developed by Størmer, Lemaître and Vallarta and others are difficult and in some cases inaccessible. The fourth part deals with the behaviour of very fast particles passing through matter. The details of the processes involved are still uncertain both in experiment and theory. They are at present the subject of intensive investigation, and some progress has been made, particularly in connexion with shower production.

(2) This brochure is more limited in scope than those by Prof. Blackett; it is concerned very largely with Prof. Rossi's own experiments on the cosmic rays, by the coincidence counter method. The experiments include analyses of the rays by absorption and by azimuthal distribution, a study of the effect of the earth's magnetic field, and a study of shower production.

Index Generalis

Année 16, 1936. Annuaire général des Universités et des Grandes Écoles, Académies, Archives, Bibliothèques, Instituts scientifiques, Jardins botaniques et zoologiques, Musées, Observatoires, Sociétés savantes. Publié sous la direction de Dr. R. de Montessus de Ballore. Pp. vii + 2482. (Paris : Éditions Spes, 1936.) 225 francs.

THIS most recent edition of an extremely useful source of information concerning the universities, etc., of the world has the same format as its predecessors. All information has been obtained from official sources, thus marking the work as an authentic book of reference.

The first part of the volume gives details concerning the officers, professors and other teaching staff,

laboratories and attached institutes of the universities of the world, though, unfortunately, those of the U.S.S.R. are again missing. This is through no fault of the editor of the "Index", who states that he has made repeated efforts to obtain the necessary information. This section occupies 1,213 pages of closely printed type. The next section, occupying 97 pages, supplies information concerning the personnel, publications, instruments, etc., of the astronomical observatories of the world. This is followed by 291 pages concerning libraries and archives. The next 139 pages deal with scientific institutes, such as museums, botanical and zoological gardens, biological laboratories, meteorological and other stations, etc. Societies and academies (with names of members of the more important) occupy the remainder of the text (190 pages). The general name index at the end contains about 95,000 names—a veritable mine for reference purposes; there is also a general geographical index whereby it is easy to trace institutions.

We know of no other single volume publication which brings together in this way so much information regarding the learned world.

The Kātkāris :

a Sociological Study of an Aboriginal Tribe of the Bombay Presidency. By A. N. Weling. Pp. vii + 156 + 15 plates. (Bombay : The Bombay Book Depot, 1934.) n.p.

MR. WELING's sociological study of the Kātkāris, a criminal tribe of the Bombay Presidency, who survive in considerable numbers in the hilly districts of the Deccan, has appeared at an opportune moment. Not only has there been a tendency to confuse them with the Kunbi, from whom indeed it is not easy to differentiate them, but also, like other aboriginal tribes of India, their institutions are subject to influences which tend progressively in the direction of modification. This process is likely to be intensified rather than arrested among tribes, who still possess something of the hunting culture and of the animistic and magical beliefs, which are of an abiding interest for the anthropologist.

Guide to Philosophy

By C. E. M. Joad. Pp. 592. (London : Victor Gollancz, Ltd., 1936.) 6s. net.

THIS is one of the books which will help considerably the case of philosophy as a subject of fundamental interest and importance. It is held in many quarters that without some knowledge of philosophy, the education of a citizen is far from being complete. Those who oppose this view will no longer be able to point to the lack of reliable and interesting books on this subject; for Mr. Joad provides them now with a practical answer in his "Guide to Philosophy". The subjects discussed in this lucid and attractive work are too numerous and too complex for even a brief review. It will suffice to say that the beginner and the specialist alike should derive both profit and enjoyment from its perusal.

T. G.

Revision of Ordnance Plans from Air Photographs

By Colonel H. L. Crosthwait, C.I.E.

IN the Interim Report of the Departmental Committee on the Ordnance Survey, discussed in *NATURE* of May 2, p. 719, reference is made to the employment of air photographs as a means of speeding up the revision of the 25-in. Ordnance plans. It is proposed in this article to indicate in general terms how this can be done.

The area it is proposed to revise is divided up into rectangular blocks of about 10 miles side. The aircraft, carrying a camera* which automatically exposes a roll of photographic film at pre-arranged intervals, is flown to follow a straight course over the ground, and parallel strips are photographed so as to cover the area as shown in the diagrammatic illustration (Fig. 1). For this particular purpose a lens of 20-in. focal length is employed, from a height of about 8,000 feet, giving a scale of approximately 1/5,000. These photographs are afterwards enlarged without rectification to a scale of 25-in. to the mile or 1/2,500. During the flight, the exposure of successive photographs of a strip is so timed that they overlap each other in a forward direction by about 60 per cent, and the strips are arranged to have a lateral overlap of about 25 per cent. If the work is skilfully carried out, the whole area should be covered by strips of photographs without leaving any gaps. The chief object, among others, of giving the photographs an overlap of 60 per cent, is that adjacent photographs of the same strip may be viewed in a stereoscope, which gives an impression of the ground in relief, greatly facilitating the interpretation of objects which might otherwise be doubtful.

It will be noticed that each object is photographed at least twice. Only in the case of level ground where the exposure has been made with the axis of the camera pointing vertically downwards, and where the lens used covers the film

without distortion, will the resulting photograph give an accurate map representation of the ground as seen from the air. In practice, the two conditions of a vertical axis and level ground are scarcely ever realised, while lenses are now made practically



FIG. 1. Diagram illustrating how an aircraft covers the area to be photographed. By permission of Aerofilms, Ltd.

free from distortion within the limits they are required to cover. It becomes necessary, therefore, to subject the photographs to some form of rectification in order to counteract the effect of camera tilt, which should be kept as small as possible, and the deviation from the level of the ground. This can be done in several ways, but since we are only dealing with the application of air photographs to the revision of the 25-in. plans, we need only mention the method used for this particular purpose. There are few instances where there is not sufficient control on the old plan, in the form of unaltered detail, which can be recognised both on the plan and on the photograph. It is this control which is made use of in the epidiascope. Space will

* The camera used is known as the "Eagle", made by The Williamson Manufacturing Co.

not admit of a full detailed description of the method or instrument, but we can indicate, in general terms, how the revision is carried out with the epidiascope.

The enlargement, derived from the negative taken from the air, which is, as stated, approximately on a scale of 25-in., is carefully examined with the old plan, and new detail is inked up in red. In doing this the draughtsman is aided by the stereoscope, in which has been placed the pair of overlapping photographs relevant to the area under revision. He then selects suitably placed

ments have been simplified. It consists of a horizontally placed photo-board over which has been inverted an ordinary camera the back of which forms the plan-board. The photo-board is capable of being tilted about a horizontal and vertical axis. To it the photograph can be secured in any desired position under a sheet of plate-glass on which the two axes are marked. The photograph is set so that the base of the triangle to be revised coincides with the horizontal axis, with its mid-point at the intersection of the two axes. An image of the highly illuminated photograph is

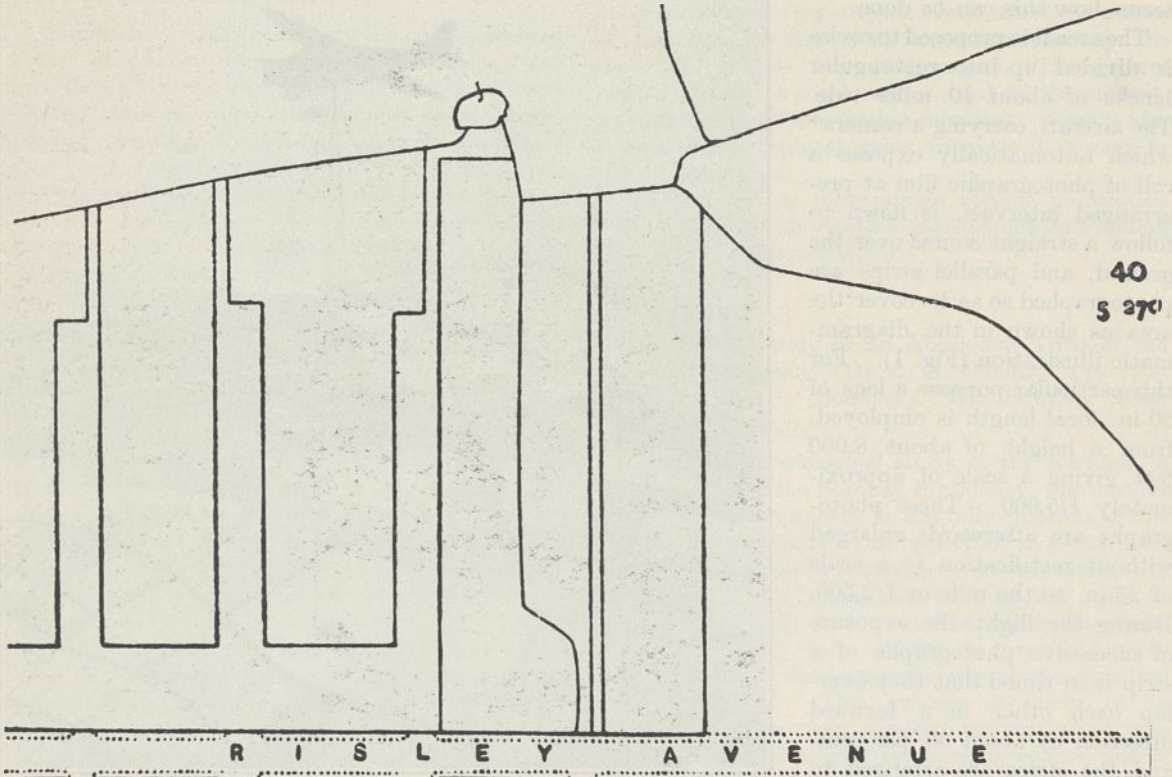


FIG. 2. Air survey of Tottenham. Reproduction of a section of a 25 in. Ordnance plan representing the area covered by the air photograph (Fig. 3). This plan was revised in 1913. Reproduced from the Ordnance Survey Map, with the sanction of the Controller of H.M. Stationery Office.

and well-defined points of detail appearing both on the photograph and the old plan, to form triangles covering the area, later to be fitted to the plan in the epidiascope.

The ideal triangle for rectification would be one which embraced an area on a uniform slope proceeding from the base of the triangle. With this object, points selected should be sited, if possible, on high ground and at the bottom of valleys. For this purpose the 6-in. contoured map can be consulted, assisted by the relief view of the area in the stereoscope. The Ordnance Survey employs a modified form of epidiascope* in which the move-

* For a full description of the epidiascope made by Messrs. Barr and Stroud, see "Surveying from Air Photographs", by Capt. M. Hotine, R.E.

formed on the matted surface of a sheet of drawing celluloid, on which has been printed, in grey, an impression of the old plan, placed on the glass camera back or plan-board. The image of the base of the triangle being revised is made to coincide with the corresponding base on the print of the old plan, any small difference of scale being adjusted by a slight movement of the camera lens. The photo-board is then tilted so as to make the triangles fit one to the other. The new detail, which has already been inked up on the photograph, is then drawn in on the celluloid print of the old plan. The same process is repeated, triangle by triangle, until the whole area has been revised. This drawing forms the 'field trace', but

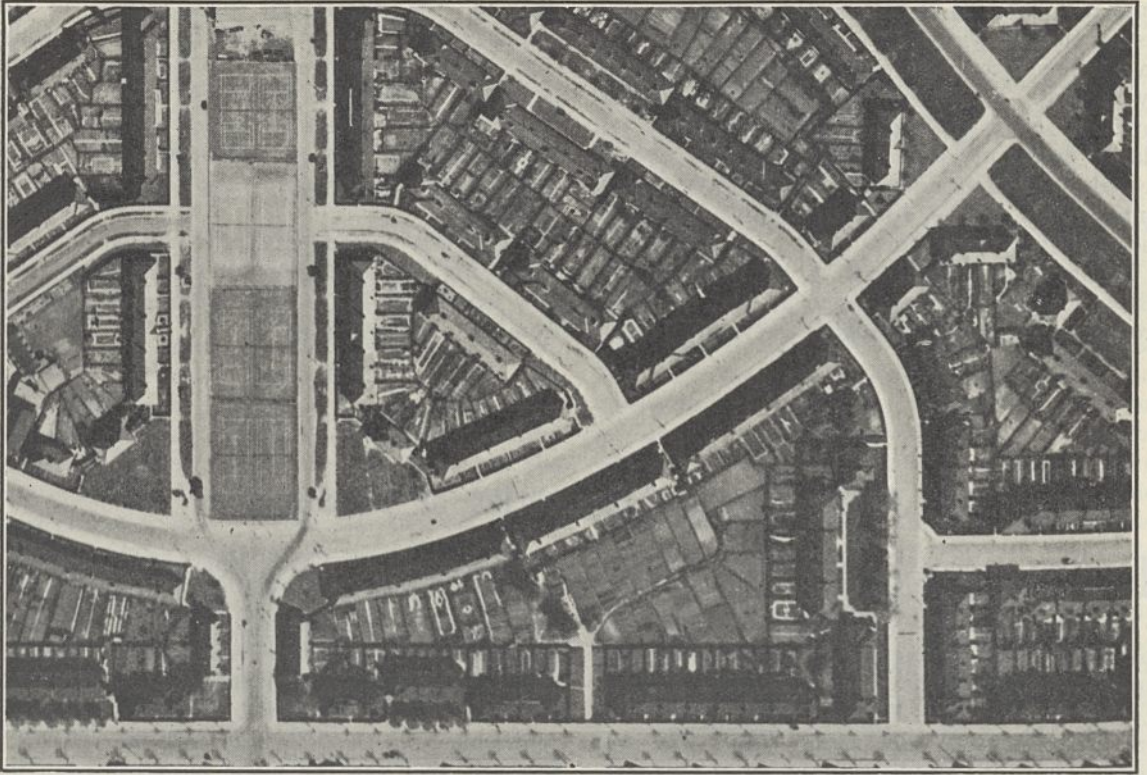


FIG. 3. Air survey of Tottenham. Vertical air photograph taken in June 1935 of same area as Fig. 2, scale 25 in. to a mile. By permission of Aerofilms, Ltd.

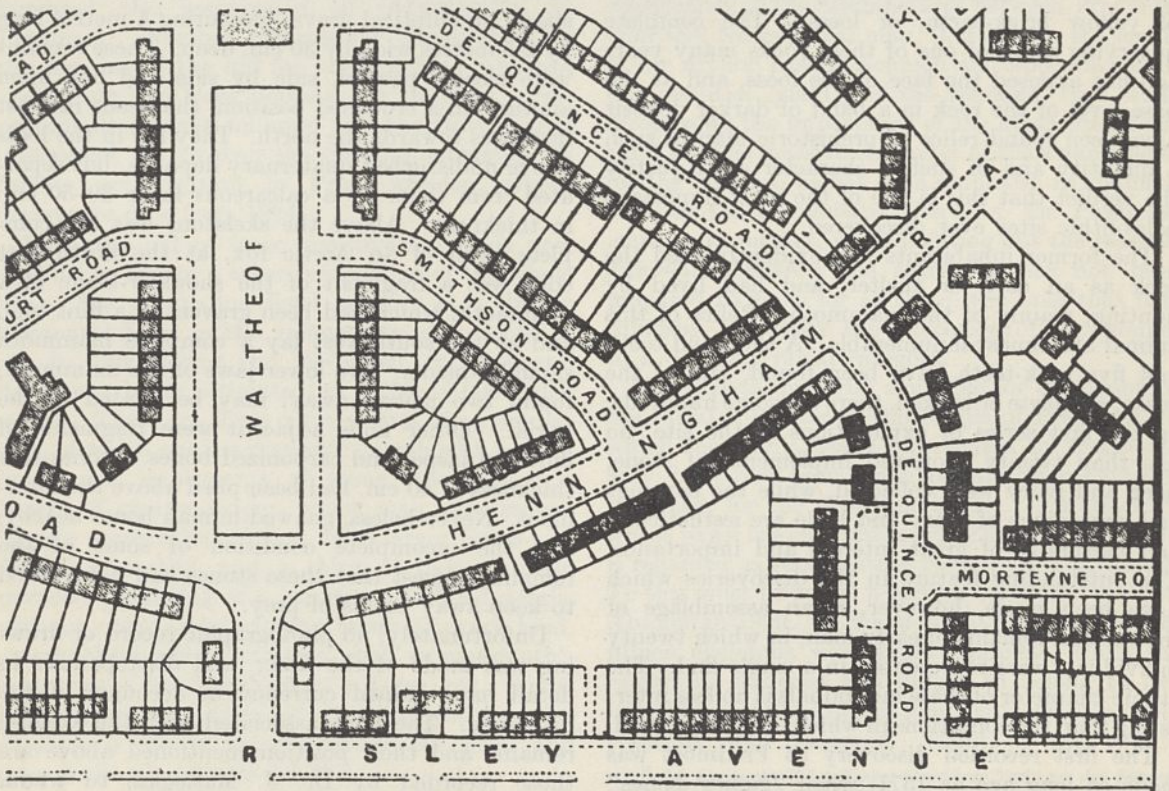


FIG. 4. Air survey of Tottenham. Resulting plan, scale 25 in. to the mile, plotted from photograph (Fig. 3). By permission of Aerofilms, Ltd.

since it is deficient in new names, boundaries and details such as wire fences, which fail to show up on the photograph, or which have been obscured by shadows, it is taken into the field for final revision. From it, when finally revised, the fair plan is drawn in the ordinary way. This, shortly described, without going into detail, is the process employed in revision from air photographs using the simplified epidiascope.

Owing to the small tilt of the photographs, which should not exceed some 2° , and the small area embraced by the triangles, the residual errors

due to the theoretical inexactitude of the epidiascope design are so small as to be negligible. The advantage of the modified machine is that it is cheap to construct, a consideration of importance where a good many of them are required to deal expeditiously with a large number of photographs; also it is simple to operate.

Fig. 2 is a reproduction of a portion of an old plan; Fig. 3 a photograph of the same area as it now exists and Fig. 4 the resulting plan plotted from the air photograph.

Archæological Discoveries at Předmost

THE site in Moravia known to archæologists as Předmost actually is, or was, a small hill to the west of the little village of Předmosti, which lies about two kilometres north of Přerov, a junction on the Central European line between Warsaw and Vienna. The hill rose to a height of forty metres above the marshy plain, and was known locally as "Hradisko" (oppidum), evidently having served the inhabitants as a place of refuge in time of war. The substructure of the hill consisted of two limestone rocks joined by a saddle of yellow brick-earth, or loess. The complete quarrying away of one of these rocks many years ago has exposed the face of the loess, and at the base level of the rock in a band of darker deposit have been found relics of prehistoric man in such a quantity and of such a character as to justify the verdict that this is one of the most important palæolithic sites ever discovered.

The former inhabitants had evidently used the rock as an *abri*, or shelter, and had lived by hunting, mainly of the mammoth. Relics of this animal are almost innumerable. A thousand teeth and five milk-teeth have been found, and of the tusks, complete or broken, there are some hundreds. In the first series of explorations of the site, no less than twenty thousand implements of stone, bone and ivory were collected, while the carvings and engravings of ivory and bone are æsthetically and culturally of great interest and importance. The outstanding feature in the discoveries which have been made, however, is an assemblage of the skeletal remains of early man, in which twenty individuals were represented in a single find. The ethnic character of these individuals is no less interesting than the conditions in which they were found.

The first recorded discovery at Předmost was made so long ago as 1571, when "giants' bones" were discovered by John Blahoslav; but it was

first recognised as a palæolithic station by Dr. J. Wankel in 1880 and 1881 as the result of an investigation which had begun in 1878. The great explorer of Předmost, however, was K. J. Maska, a schoolmaster, who first turned his attention to the site in 1882, and excavated it systematically and continuously in the ten years 1884-94. It was in this last year that he made his sensational discovery of human remains, when, as already mentioned, skeletons and parts of skeletons representing twenty individuals were found in a small space, an elliptical grave, measuring 4 metres long by 2.5 metres wide by 30 cm. deep. These remains were closely packed, side by side and one upon another, in a crouched position, the heads in most instances towards the north. They lay in the loess above undisturbed quaternary deposits, but separated from them by a calcareous layer 30-50 cm. in thickness. Above the skeletons was the complete skull of an Arctic fox, at the north-west edge was a fragment of the shoulder-blade of a mammoth, which had been graven by a flint tool, and at the south-west lay a complete mammoth shoulder-blade. Two lower jaws of the mammoth, found two metres away, may be related to the burial. Other finds adjacent were fragments of flint and jasper and carbonized bones. Stones to a thickness of 40 cm. had been piled above the interment. Nevertheless, gnawed human bones nearby, and the incomplete condition of some of the remains, suggest that these stones had not availed to keep away beasts of prey.

Unfortunately, no photographic record or drawing was made of the find; and discrepancies in detail have gained currency in accounts of the discovery. The finds associated with the skeletal remains and their position mentioned above are those recorded by Dr. J. Matiegka, to whom Maskra's material was entrusted.

This interment is evidently a communal grave, though whether it was the result of an epidemic or some other simultaneous catastrophe, or represents a succession of burials, thus accounting for the evident disturbance of the remains, there is nothing to show. There are sufficient close resemblances between individuals, some of them inherited, to warrant the conclusion that, if not all of one family as Maska thought, they were at least members of a single familial horde.

Maska's work was followed up by M. Kříž, a lawyer, who carried out excavations in 1894-96. The great collections formed by these two investigators have now been placed, with other valuable archaeological and palaeontological material brought together from different parts of the country, in the Provincial Museum of Moravia at Brno, where they are in the care of Prof. D. K. Absolon, curator of the Quaternary Collections.

Maska spent the remainder of his life at work on his material from Předmost; but his financial circumstances did not permit him to devote to it the time and attention it demanded. He died while his work was still incomplete in 1916, and Kříž died in the same year.

After the Great War, the interest aroused by the discoveries of early man in Moravia, evidently a 'gate of entry' for early migration into Central Europe, led to more systematic study. Chance favoured the resumption of investigation at Předmost. Further commercial exploitation of the remains of the hill for brick-making purposes opened up the loess deposits by trenches. Important discoveries followed and the Government intervened, taking over the site and entrusting its further investigation to Prof. Absolon, whose discoveries date from 1924.

With the aid of later investigation, it is now possible to obtain a truer perspective of the whole site. The occupation level appears as a darker horizontal band in the yellow clay at a depth of one to four metres and 20-70 cm. in thickness, its extent being estimated at 6,700-10,000 cubic metres. There are three main centres of accumulation, of which one is a domestic hearth with broken bones and implements of stone, the second a hearth of greater extent, which may have served for the preparation of food, with larger bones and finer implements, and a third of indeterminate purpose, consisting of a quantity of varied debris, without order and including bones of every kind, among them whole quarters, such as mammoth's feet, part of the backbone of a horse, etc. Some, however, show signs of arrangement, as for example a pile of thirteen mammoth tusks and four skulls placed side by side.

The vast wealth of objects which now form the collections from Předmost—implements of stone,

bone and ivory, carvings and engravings on ivory and bone, personal ornaments of various materials and the like, the human skeletal remains, as well as the remains of the mammoth and other quaternary fauna—reveal the mode of life of the primitive hunter in quaternary Europe in a manner and to an extent which cannot be equalled on any other site, though with it is comparable the site of the horse hunters of Solutré. The development of its art is especially noteworthy. Certain objects, especially a remarkable figure of a mammoth in ivory, are characterized by a naturalism, comparable with the best produced by palaeolithic man elsewhere. Here also are the characteristic corpulent figures, woman or divinity. In striking contrast is the work of another 'school', a school with a marked tendency to conventionalize, which culminates in a female figure engraved on a tusk, in lines which are entirely geometrical. It has been suggested that the two schools represent the influence of two distinct races, which met at this point.

The racial characters and affinities of Předmost man have been the subject of considerable discussion; but as such analyses have been based upon photographs and casts, certain features have been stressed unduly, and an authoritative and first-hand account of the remains has long been desired. Whereas many of the authorities concur in showing a tendency to attach too great a significance to the resemblances between Předmost man and Neanderthal man, it stands to the credit of Sir Arthur Keith's acumen and appreciation of the essential quality of the remains, that while recognizing the importance of the great size of the skull and the massive character of the attachments for the muscles, he has been emphatic in claiming an essentially 'modern' character for Předmost man; and further, while pointing out the marked difference between the sexes, he has not been prepared to go so far as those who hold that it is sufficient to justify the allocation of the woman to a different racial category.

The skeletal material available for discussion of the racial character of the people of Předmost, of which the crania, some represented by fragments only, have now been described, and their evidence analyzed, for the first time by Dr. J. Matiegka*, whose paper has only just recently become available, is regarded as representing twenty-six individuals. To this must be added a further discovery by Prof. Absolon in 1929. Of the material found by Maska, fifteen skeletons were fairly complete, while the remaining material was judged to belong to five individuals. Of the fifteen four were, comparatively speaking, well preserved. Eight of the twenty

* Česká Akademie Věd a Umění (Académie Tchèque des Sciences et des Arts). Trída 2: Anthropologica. Homo Předmostensis fosilní člověk z Předmostí na Moravě. 1: Lebky. (L'Homme fossile de Předmostí en Moravie. 1: Les crânes.) By Prof. Dr. J. Matiegka. Pp. 145+16 plates. (Praha: Česka Akademie Věd a Umění, 1934.)

were adult, three being female, two adolescent, one male and one female, seven were children less than ten years of age, and three were infants of under one year.

Of the adults, the two best preserved were a male and female between the ages of thirty-five and forty years. They are regarded as type specimens of the race. The two well-preserved adolescents approximate closely to them, due allowance being made for the difference in age. The adult male, in particular, shows the close resemblance to Neanderthal man in a number of characters, notably the prominent supraorbital ridge, or torus, the low retreating frontal bone, and so forth. Indeed in its approach to early palaeolithic man, this skull, Dr. Matiegka points out, is very near the border-line of the extreme lower range of 'modern' skulls. On the other hand, in certain features, such as for example the possession of a well-marked, if not prominent chin, and the absence of the characteristic prognathism, it is essentially modern.

All the individuals represented at Předmost, with one exception, are sufficiently homogeneous to be regarded as belonging to a single race. Dr. Matiegka stresses in particular their slender character, seen also in the long bones, their light weight, and in the bones of the skull their thinness, features in which they are distinguished from man of the earlier palaeolithic period, and to be viewed in relation to size and capacity. In virtue of pronounced Neanderthaloid characters, Předmost man may be regarded as standing morphologically midway between Neanderthal man and modern man, but not in any genetic sense.

In all its dimensions the Předmost skull, both male and female, is within or well above the average of the modern European. The head length ranges from 189 mm. to 201 mm. male, and 185 mm. to 191.5 mm. female; breadth 139 mm. to 145 mm.; height 133-136 mm. In relation to the great size of the skull, the figure for height appears low, but actually it is above the modern average. The cephalic index varies from 70.15 to 77.63, being slightly higher in the women and children than in the men. The contour is ovoid. The cranial capacity is high, 1,578 c.c. male, 1,520 c.c. female, as against 1,475 c.c. male and 1,300 c.c. female in the modern European.

The development of the supraorbital ridge, assuming in certain skulls the character of a torus, appears also in the women and is even perceptible in the children. The sutures are simple; but in all the skulls there are Wormian bones.

The face is high, especially in the upper part, lower in the woman than in the man. The orbits are low, quadrangular and set slightly on the bias in both sexes. The nose is narrow and prominent

in the men, broader in the women. The lower jaw is large, corresponding with the size of the skull, but notwithstanding its massive appearance, largely due to the disproportionate strength of the muscular attachments, it is slender in proportion to its size. The chin is slightly receding in relation to the alveolar projection, but there is a well-formed mental tubercle. The form of the jaw is modified by muscular pull. The teeth are well preserved. They are large. There is one apparent case of caries. At least two skulls have lost teeth during lifetime. The teeth are much worn down, the wear already beginning to appear in a boy of ten to twelve years. There is also evidence of a peculiar form of attrition of which the cause is obscure. It is more marked on the right side than on the left, and on that side in the upper jaw more than in the lower. It affects the first molar, the second showing it, if at all, only in a slight degree. It has been suggested that this is due to a custom of carrying a pebble in the mouth continuously, though for what reason is not apparent. In view of the cold climate and its continuous use, it could scarcely be for the purpose of alleviating thirst.

In considering the affinities of the crania of Předmost man with those of other forms of Quaternary man, too much importance must not be attached to the resemblances to Neanderthal man, which have been noted in the first-named. They do not warrant the conclusion at which some anthropologists have arrived that Předmost man represents the stage of transition in a series which extends from Neanderthal to modern man; nor are they the results of a cross between Neanderthal and Aurignacian man. They are due, it must now be held, to simple convergence.

Of the types of 'modern' man of Quaternary age to which the Předmost crania may be related, Grimaldi and Chancelade may be ruled out, notwithstanding affinities to the latter, which have been noted. Předmost stands with Brno I and Brno II, distinct from, but closely related to Oberkassel, with the female Oberkassel as a transitional form. In general terms, it is a simple variant of the Cro Magnon race.

This interpretation of the skeletal evidence is in sufficiently close agreement with the geological and archæological evidence. The fauna of the loess beds points to a rather cold climate of tundra type; while the culture of the settlement, which Maska thought to be Solutrean, is now regarded as developed Aurignacian, the Abbé Breuil would hold with strong Solutrean influence from Hungary, but which Prof. Absolon considers entirely Aurignacian, though of later date than Vistonice, the Moravian station which corresponds to the Upper Aurignacian of France.

News and Views

Native Policy in Africa

A MOTION by Mr. de Rothschild in Committee of the House of Commons on July 9 to reduce the Colonial Office vote initiated a debate on colonial administration with special reference to East Africa, and afforded Mr. Ormsby-Gore as Secretary of State for the Colonies an opportunity of making an important statement in reply, in which he touched upon a number of matters affecting native interests. As an earnest of a promised expansion in education when resources permit, he referred to the provision forthwith of a central institution in Uganda, which would extend facilities for higher education throughout East Africa. He also showed that he is fully aware of the necessity for considering the possibility of regulating the movements of emigrant labourers, to which attention has been directed recently, more especially by conditions in Nyasaland (see *NATURE*, June 6, p. 921). His most important pronouncement, however, was concerned with the difficult and controversial question of the allocation of land as between native and settler in Kenya. He announced that two orders arising out of the Morris-Carter Report are in contemplation. By one of these orders, some 48,000 square miles of territory will be reserved to the natives, this including the most thickly populated areas, in which 86 per cent of the natives are living; while in the second order, 16,000 square miles of the highland area will be assigned to non-natives, one quarter, however, being set aside for a permanent forest reserve. Before these become effective, however, Mr. Ormsby-Gore indicated that it would be necessary to deal with the question of the 'squatters', upon which he confessed frankly that he had not made up his mind. There are now, he pointed out, 150,000 natives in Kenya living on European farms under annual agreement. These hold from the farmer a house and land in return for 180 days labour per annum at a contract rate of pay. There are also other natives in the European area who are not squatters, but in course of time have acquired rights. Some of these have been dealt with already in accordance with the recommendation of the Morris-Carter report, and removed to an agreed location.

THE problem of the squatter is, indeed, difficult. Mr. Ormsby-Gore's dilemma, as he showed, is whether to permit a system to endure, which while it assures a certain amount of labour to the farmer, is open to abuse, as experience has shown, on both sides, or whether to require labour to be obtained from the reserves in conditions which would keep the native in touch with tribal institutions and discipline. In South Africa, where the squatting system has a long history, it is proposed under the new regulations for native lands that it should not further be permitted; while scientific study of native institutions and the

effects of the impact of white civilization on native life and morale would favour the stricter regulation of conditions of employment and intercourse, which the restriction of labour to natives from the reserves would make possible. The present mobility of labour in Africa, as recent events have shown, makes it eminently desirable that there should be some uniformity in native policy; and this is, no doubt, one of the considerations which the statesmen of the Union of South Africa have in mind in their expressions of opposition to any interference with present conditions in the mandated territories of South-West Africa and Tanganyika. It was certainly contemplated by Mr. Pirow, the South African Minister of Defence, when, at Nairobi on his way back to South Africa (*The Times*, July 10), he urged the importance of a common policy for native affairs, defence and customs, in the three groups into which he classified British Africa, from Kenya to the Union. A further important step in this direction is also to be noted in the amendments to the constitution of Southern Rhodesia. According to the draft regulations in the White Paper (Cmd. 6218), issued on July 9, the native reserves in future will be vested in a Board of Trustees, and there is to be a Native Department with a Chief Native Commissioner at its head who "in view of his very important responsibilities, may not be removed without the Secretary of State's consent".

Proposed Tribute to Prof. A. L. Bowley

IT is intended to mark the retirement of Prof. A. L. Bowley from the chair of statistics in the University of London by a recognition in some degree commensurate with his distinguished services. Prof. Bowley has not only given to the London School of Economics, since its beginnings in 1895, years of brilliant and devoted teaching; he has at the same time made contributions to social welfare that have been recognized throughout the world, by universities, by learned societies and by Governments. His published writings have given him an eminence all his own, and his kindness and geniality have endeared him to generations of students and to all who have had the good fortune to work with him. Over the signatures of Lord Kennet, Mr. J. M. Keynes, Prof. D. H. Macgregor, Prof. W. R. Scott and Sir Josiah Stamp, an appeal has been issued, since it is felt that past students and many others will welcome an opportunity to share in an expression of admiration for the work he has done. It is proposed that this tribute of esteem shall include a portrait of Prof. Bowley to be hung in the London School of Economics, and a scholarship or prize tenable in the University of London (at the London School of Economics) to assist a student pursuing undergraduate or postgraduate study in economic or social statistics. Sir William Beveridge has agreed

to act as treasurer of the fund, and all subscriptions should be addressed to him at the London School of Economics, Houghton Street, Aldwych, W.C.2, England.

Anglo-German Stork Experiments

THE present experiments on the migration of the stork (*Ciconia alba*) being carried out in England in conjunction with German ornithologists is evidence of the wider possibilities of international co-operation in field ornithology than have hitherto obtained. Earlier in the spring, eleven storks' eggs from German nests were sent to England and placed in heron nests in Surrey by the Haselmere Educational Museum, as the stork is no longer a British nester, and it was hoped the experiment would indicate whether or not the English-born birds under heron foster-parents would follow the same migration route as German birds. However, only one egg hatched, and after a week the stork chick was accidentally crushed to death by the foster parent. It is hoped to repeat this experiment next spring. In June, a further experiment was made when twenty-three nestling storks from East Prussia were distributed to artificial nests in Scotland, Kent and Surrey where they were hand-fed, and it is hoped that if reared, these birds, which are ringed, will shed further light on migration, and how far inheritance plays a part in it.

MUCH work on the migration of storks has been carried out on the Continent in recent years. The early experiments at bird-ringing were made by Brugmann in Holland and Mortensen in Denmark last century with storks (NATURE, Sept. 30, 1933), and later research showed that birds nesting east of the River Elbe used an Asia Minor route to the Natal winter quarters and those nesting west of the river a route through Spain and Morocco. Three years ago, young storks born east of the Elbe were ringed and released west of the river, but soon found their way back. The small percentage of stork rings recovered in Africa has lately been shown to be due to the Egyptian natives treasuring them as tokens for fertility, a barren woman who obtained one having worn it and given birth to children, and hence the superstition spread. Skougaard has reported a stork ringed in Jutland and believed to have lived between thirty and forty years.

Hadrian's Wall

EXCAVATION of the fort on the Roman Wall at Halton Chesters, near Newcastle-on-Tyne, by the University of Durham Excavation Committee, has made it possible to state definitely for the first time that the building of the wall was completed within a period of five years. A dedicatory tablet on the west gate of the fort has been found, it is stated in a report of the Committee (*The Times*, July 13), which bears the name of Platorius Nepos, the Governor of Britain in A.D. 122-126. As he also directed the first stages of building, the whole erection was completed within his term of office. The excavation has thrown much light not only on

the methods of planning and construction of the fort but also on that of the wall itself. It is evident that the original plan was not always followed. For example, the original ditch fronting the wall runs straight through below the existing fort, one of six, which projects 200 ft. north of the wall. The east and west gates of the fort are carried down the entire depth of the filled-in ditch and are built on massive foundations. There is evidence of two considerable reconstructions or enlargements. After the Caledonian invasion, the Emperor Severus rebuilt the fort in about the year A.D. 205, erecting a monumental fore-hall in front of the administrative building. No hall so fine as this, it is stated, has as yet been discovered in Britain, where, in any event, they are rare. It is shown by the foundations to have been 160 ft. long by 30 ft. broad, with a central entrance spanning the north-to-south street. About a century later the fort was increased in size by an enlargement towards the west behind the shelter of the wall. This structure gave the fort the peculiar L-shaped plan which has long been a puzzle to archaeologists.

Meteorology for Airmen in India

A COPY has been received of a new publication of the India Meteorological Department (M.O.A. Pamphlet 1936) entitled "Meteorological Organisation for Airmen". The purpose of this pamphlet is made clear in the introductory pages by the Director-General of Observatories, where the relevant part of the organization of the Department is described, together with the procedure to be adopted to obtain weather reports for the different parts of the area with which the Department is concerned; this area extends from the south-eastern half of the Persian Gulf across the whole of Baluchistan, India and Burma. It is admitted that the existing organization for the supply of weather reports and forecasts for such a vast area falls short of the standards recommended by the International Convention for Air Navigation, particularly in the south of India, the reason being the size of the area in relation to the permitted financial expenditure on the organization, which is less than what it was formerly in spite of the increased demands of aviation, a fact that has necessitated various reductions, including the closing down of the important forecasting office at Quetta.

THE different areas covered by the forecasting centres in India are shown on a key map, which indicates also the centres themselves, the different airship bases, the pilot balloon stations from which information about the winds of the upper atmosphere can be obtained, and the aeronautical wireless stations. More precise information about these centres is given in extensive tables, which, together with further tables giving the various weather codes in use in India, occupy the greater part of the fifty-one pages of the pamphlet. Information of the kind provided is of course practically essential to airmen flying in a part of the world subject to very violent disturbances, ranging from tropical hurricanes to duststorms and tornados and other local

phenomena that render aerial navigation dangerous to all classes of aircraft. A form is included, as a detachable page of the pamphlet, to be forwarded to the Director-General by anyone wishing to receive, free of charge, copies of all supplements and new editions as they are issued to cover the inevitable changes and growth of this meteorological service.

Yugoslav Cultural Progress

LITTLE notice is apt to be taken of the quiet constructive work or scientific developments that go on among the smaller nations. With this fact before it, the Society for Promoting Anglo-Saxon Culture in Yugoslavia has commenced the publication of an *Anglo-Yugoslav Review*, a quarterly to be devoted to the furtherance of the use of English among Yugoslavs and also to acquaint the British and American peoples with the educational, cultural and general progress of the South Slav nation. Its appearance coincides with the celebrations arranged for the eightieth birthday of Nicholas Tesla (born on July 10, 1856), which were held at the end of May. Tesla is a Yugoslav by birth, although most of his work and electrical discoveries on alternating and high-frequency currents were made at Paris and in America. A 15,000 horse-power plant of Tesla's conception was erected at Niagara in 1891 to supply power to Buffalo, 25 miles away—a remarkable feat at the time. Indeed, Tesla's fellow-countrymen claim that his work ranks him on a level with Volta, Watt and Faraday. Approximately half the review is devoted to the section on science and invention. Other sections deal with political, economic, sociological and miscellaneous matters, and among these is an account of recent archaeological discoveries in Yugoslavia. Among the four British or American contributions is one by Mr. C. H. White, who discusses the cultural consequences when a nation's mineral resources are developed. The review is published in Belgrade, price 10s. per annum.

Transmission and Distribution of Electricity

IN a progress report by C. F. Bolton and R. H. Abell on the transmission and distribution of electricity (*J. Inst. Elec. Eng.*, April) there are several points of special interest. The British Grid uses a pressure of 132 kilovolts, but there is a large number of systems operating at 220 kv. in different parts of the world. In Sweden a hydro-electric power station operates over 200 miles at 220 kv. In France there is a line at this pressure which brings hydro-electric power to Paris. Great activity has been shown in electric development in Russia, and the Dnieper system operates at the same pressure. The Boulder Dam project on the Colorado River represents one of the outstanding engineering achievements of recent years. A part of the energy developed, 1.3 million kilowatts, will be transmitted 266 miles to Los Angeles by a 287.5 kv. transmission line. German engineers have constructed several of their 220 kv. lines so that they can be converted ultimately to work at 380 kv. A scheme using a transmission

voltage of 400 kv. has been proposed for the establishment of a large water-power station in Norway for supplying power to Sweden, Denmark and Germany. The main transmission system is to be some 650 miles in length. It terminates at Hamburg, and will have intermediate stations at Göteborg and Copenhagen. The generating plant will have a capacity of nearly a million kilowatts (1.34 million horse-power). The British Grid scheme is now completed, and through it, the considerable water-power sources now available in Scotland are being exploited. The problem of 'system stability' arises when large blocks of power are transmitted over long distances. In Great Britain it is not of special significance.

Care of Old Trees

THE general public probably expresses more sentiment upon the beauty of large trees than upon any other aspect of horticulture. Yew trees may, under good conditions, live to the ripe age of a thousand years, and the oak can boast of very considerable longevity. Whilst the life of a tree must sometime come to an end, the artificial conditions of urban England often shorten its span, unless special care be taken. Mr. A. D. C. Le Sueur has recently shown (*J. Roy. Hort. Soc.*, 61, Pt. 4, 149-159, April 1936) what steps may safely be taken to check decay. Wounds should be cut to healthy wood, treated with a light creosote fungicide, and then rendered waterproof with bitumen. Branches should be cut close to the trunk. Cavity wounds usually contain wood already decayed, and should be cleaned drastically before filling with bitumen or concrete. Artificial support may be given with cables or rods, rather than by bands. Faulty soil conditions, such as lack of nutrients, water or air, or bad drainage, frequently retard good tree growth in public parks. The paper gives many details for the treatment of such backward trees, and provides innumerable instances of scientific practice of the greatest interest.

Earthquake Records at De Bilt, Holland

TWENTY-ONE years ago, the first number of the *Seismische Registreringen in De Bilt* appeared under the editorship of Dr. E. van Everdingen. We have recently received the annual report No. 21 for the year 1933, still issued under the same capable direction. The seismological observatory of De Bilt lies about five miles north-east of Utrecht. In 1904, it contained a pair of Rebeur-Paschwitz pendulums and a Wiechert horizontal seismograph, and, in 1912, a pair of Galitzin horizontal seismographs were installed. In 1933, the same instruments were in action with the addition of a Galitzin vertical seismograph. The bulletin for 1933 contains the records of 450 earthquakes, and it is worthy of notice that, besides the usual details with regard to the times of the principal phases at De Bilt and the estimated positions of the epicentre, the editor should have been able to collect notices of nearly one-third of these earthquakes from the countries in which they were felt.

A Bibliography of Wheat

A BIBLIOGRAPHY of world literature on the genetics and breeding of wheat has been issued by the Institute of Plant Industry, U.S.S.R., and forms the first volume of a new series of publications on wheat (*Bull. App. Bot., Genet. and Plant Breeding*, Series VA, No. 1, pp. 136; 1935). In this work, the titles of articles or books appear in the language of the original contributions, and, where these have been reviewed, reference to the reviewing journal is given. The material is classified under various headings and, within each class, is arranged chronologically. An author index is included.

School Nature Study

THE July number of *School Nature Study* (31, No. 124), the official organ of the School Nature Study Union, contains several articles of interest. An ecological study of the plant life of the salt marshlands of south-west Sussex by A. D. French reveals four important zones, namely, the inner shore banks above high-water mark, beaches and sands above high-water mark, the interzonal region, and the marsh proper. The vegetation of these zones has been carefully examined and recorded. The animal life, too, afforded certain features of interest, and a list of birds is given. The birds of Costa Brava, Spain, have been studied by Margaret M. Hutchinson, and her observations are embodied in a short article (together with a list) in the same number. A. C. Evans, of the Rothamsted Experimental Station, contributes an article on insects and their food. The factors determining an insect's choice of plant food are examined, and the author reveals our great lack of knowledge on this problem, especially from the point of view of plants of economic value. The School Nature Study Union publishes a series of pamphlets dealing with subjects of interest to the biologist, about seventy of which are reprints from *School Nature Study*; five other Special Leaflets are also available. A list of the pamphlets may be obtained from Mr. E. G. Clarke, 7 Stanley Avenue, Wembley, Middlesex.

Library of Conchology

MR. SOHTSU G. KING, the Chinese conchologist and banker, has recently given his valuable collection on conchological literature to the Science Society of China Library, Shanghai. The collection was started some twenty years ago, while he was studying Chinese Mollusca with Prof. A. W. Grabau of the University of Peking. Under their joint authorship, a book entitled "Shells of Peitaiho" was published and is now in its second edition, besides many other scientific papers. The collection consists of many valuable and rare works and several complete sets of journals. It is no exaggeration to say that the collection is unique in the Far East and invaluable to students of zoology in general and conchology in particular. The Council of the Society has passed a resolution that a special room shall be used to house the collection and shall be labelled, "Sohtsu G. King Library of Conchology". The books have already been arranged, and a complete catalogue is in preparation and will be printed

and circulated to research institutions and learned societies interested. In addition to the collection, Mr. King has also given an endowment, the income of which is to be used to provide the collection with the necessary periodical literature.

Records of the American Mercantile Marine

A CO-OPERATIVE project has just been launched by the Smithsonian Institution and the Works Progress Administration of the United States, having the two objects of preserving a set of standard measured drawings of American types of fishing vessels and merchant vessels, to be placed in the Watercraft Collection of the United States National Museum, and of providing work for unemployed naval architects, draughtsmen and boat builders. The work is to be known as the Historic American Merchant Marine Survey, and the information is to be gleaned from builder's models, original drawings and the actual vessels. It is to be hoped these efforts will lead to similar projects elsewhere.

London Health Services

THE Annual Report of the Ministry of Health for the year 1934-35 contains a special detailed review of the public health work carried out in London by the London County Council, the City Corporation and the Metropolitan Borough Councils. In view of the general interest of this review, it has now been issued as a separate publication, with a preface by Sir Kingsley Wood, the Minister of Health ("London Health Services". London: H.M. Stationery Office. 1s. net). The publication gives a useful survey of the division of functions among the various sanitary authorities in London, and describes the public health and poor law medical services, the food protection services, port sanitary administration, and welfare of the blind.

Rubber Latex

A REVISED edition of the book "Rubber Latex" by H. P. and W. H. Stevens has just been published by the Rubber Growers' Association, 19 Fenchurch Street, London, E.C.3, and a copy will be sent to any reader interested, on application. It deals in 224 pages with the properties, composition, coagulation, concentration, manipulation and compounding of latex and latex pastes, the vulcanisation of latex and latex products, and dipping and electro-deposition. The final chapter deals with a selected list of nearly a thousand recent British patents, and indicates the growing importance attached to the direct application of latex.

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(Continued on p. 119.)

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Vol. II, July 1935 to December 1935, Sections A and B bound separately.
Vol. III, Nos. 1 to 6, January 1936 to June 1936.

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All communications to be addressed to The Registrar, the Institute of Chemistry, 30 Russell Square, London, W.C.1.

DEPARTMENT OF SCIENTIFIC RESEARCH AND EXPERIMENT, ADMIRALTY

Applications are invited for a vacant post of Scientific Officer (Civilian) in the Admiralty Scientific Pool, the place of duty in the first instance being the Headquarters Staff of the Department of Scientific Research and Experiment, ADMIRALTY.

Candidates must have a good honours degree in Mathematics or Natural Science and must be of first-rate personality and address. The duties will be mainly in connection with the recording of official and external research work bearing on Naval problems, and a working knowledge of Technical French and German is essential. The successful candidate may also be called upon to take part in the administrative work of the Department.

The salary scale is £400-£18-£454-£25-£580 (efficiency barrier)-£25-£680, but consideration will be given to the payment of an initial salary higher than the minimum of the scale according to age, qualifications and experience of the selected candidate.

The Federated Superannuation System for Universities is applicable to the post under which a contribution equal to 10% of salary is provided by the Admiralty and together with 5% of salary contributed by the holder of the post, is used to effect insurance on his behalf.

The successful candidate will be required to serve for one or two years on probation; he will be eligible for promotion by merit to the higher ranks of the Pool, which contain the following posts:

Senior Scientific Officer	£680-£25-£800.
Principal Scientific Officer	£850-£30-£1,010.
Superintending Scientist	£1,050-£30-£1,250.

Every candidate must be a natural-born British subject, the child of a person who is, or was at the time of death, a British subject.

Applications, together with copies of testimonials, should be forwarded to the Secretary of the Admiralty (C.E. Branch), Whitehall, London, S.W.1, not later than 31st July, 1936, quoting Reference No. C.E. 3709/36.

No application forms are required.

AIR MINISTRY

DIRECTORATE OF SCIENTIFIC RESEARCH

Applications are invited to fill vacancies in the Scientific Research Pool for Junior Scientific Officers. The standard aimed at is a First or Second Class Honours Degree or its equivalent in Engineering, Natural Sciences (if including Physics) or Mathematics. Candidates should have some experience of Experimental Investigation and should preferably be fit for flying duties as observers. Experience of independent research work and, for certain posts, experience in engineering works would be additional qualifications. Ability to read technical French and/or German is desirable.

The salary scale for the post is £275 by £18 to £347 a year. After 2 years' probationary service the appointment will carry superannuation under the Federated Universities Superannuation Scheme, the Government contribution being £32 18s. 0d. a year and the individual contribution £16 9s. 0d. a year.

The Junior Scientific Officer grade is of a probationary character, and during service in this grade an officer's suitability for continued employment and appointment to the grade of Scientific Officer is periodically reviewed. Junior Scientific Officers may normally expect to be promoted to Scientific Officer [£400-£18-£454-£580 (bar)-£25-£680] within six years of the date of their appointment. Promotion to Senior Scientific Officer (£680-£800) and Principal Scientific Officer (£850-£1,010) is governed by merit as and when vacancies arise.

Application should be made on a form to be obtained (quoting Ref. A.950) from the Chief Superintendent, Royal Aircraft Establishment, South Farnborough, Hants, to whom it should be returned not later than 31st July, 1936.

BARBADOS

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Applications are invited from men candidates who possess an Honours Degree in Science of a British University. Should be qualified to teach Botany, Chemistry and Physics to Higher Certificate standard and have had suitable teaching experience of these subjects. Education Diploma desirable. Age limits 25-35 years. Salary £400-£25-£500 per annum. Forms of application can be obtained from The Secretary (SIR/CA), Board of Education, Whitehall, London, S.W.1. Candidates resident in Scotland should apply to The Secretary, Scottish Education Department, Whitehall, London, S.W.1. Closing date 3rd August, 1936.

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Appointment of a University Assistant (Demonstrator) in Chemistry

Salary £250 12s. per annum.

Applications, together with a full statement of qualifications and the name of at least three referees, should be sent, not later than Saturday, 8th August, 1936, to the Secretary to the University, from whom further particulars may be obtained.

H. J. BUTCHART,

Secretary.

The University, Aberdeen.

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Applications are invited for two part-time demonstratorships in the Inorganic section of the Chemistry Department.

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Applications are invited for the post of Assistant Lecturer in Physics. Stipend £300 per annum. Duties to commence on 27th September, 1936. All applications must be sent not later than 29th July to the Registrar, from whom further particulars may be obtained.

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NATURE

SUPPLEMENT

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SATURDAY, JULY 18, 1936

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Direction Finding by Sound*

By Dr. W. S. Tucker, O.B.E., Director of Acoustical Research,
Air Defence Experimental Establishment

IT is a regrettable fact that some of our scientific activities have required the stimulus of war to initiate them and the fear of war to keep them alive. Not the least striking example of this impingement of military necessity on scientific research is afforded by the subject of direction finding by sound. During the Great War, sound provided the only means of locating the submarine that threatened our shipping, mining operations that threatened our entrenchments, the distant and invisible gun and the aeroplane flying behind cloud or in the darkness; and this search by sound provided four widely differing methods all requiring advanced scientific technique. The subject is so large that I am proposing to confine myself to the operation of finding the direction of sound transmitted through the air.

It is curious that, of air-borne sound, the War provided us with ideal sources—the gun and the aeroplane. The gun report is an almost perfect example of an impulsive sound—the anti-aircraft shell burst is even better. The aeroplane, so complex in the nature of its sound, has something so rich in its elements—high frequency, low frequency, impulsive, musical, non-musical—that it gives a fascinating mixture of qualities taxing the provision of many kinds of apparatus for investigating its properties.

The fear engendered by these characteristic sources—gun and aeroplane—has stimulated lines of scientific inquiry almost entirely dominated by military requirements, and such inquiries and the

results of them have fallen into the category of secret investigations with all the handicaps of fettered scientific discussion. I will try, however, to strip my subject as much as possible of its war implications, and endeavour to show how fascinating the study of sound direction finding can become.

All living creatures equipped with listening faculties appear to have a capacity for obtaining the direction of sound, but this sense of direction is only provided by the functioning of two ears. When either a human being or an animal is deprived of hearing in one ear, sense of direction is very seriously impaired. What is called the binaural faculty has to be replaced by that of a single ear, in which reliance must be placed on variations of intensity due to the shadowing of the head. Even so small a creature as the cricket, using two ears, shows good directional perception, as has been shown by the direct flight of the female to the chirping male, and it has been shown that removal of the tympanum of one ear of the female deprives it of this capacity¹. Some interesting experiments of Engelmann², working in the laboratories of Prof. D. Katz, illustrate the performance of a very intelligent sheepdog called "Asti", one of whose ears was bandaged. The dog then lost its remarkable powers of direction finding. Some residual sound in the bandaged ear appeared to give partial help, but, in addition to exhibiting false judgments, the dog's reaction time changed from about $\frac{3}{4}$ second to a mean of nearly 4 seconds.

What, then, is the function of the second ear? The answer appears to be perfectly easy when the

* From the Friday evening discourse at the Royal Institution delivered on May 1. The author wishes to acknowledge with thanks his indebtedness to the Royal Engineer Board of the War Office for permission to refer to matters of military interest.

sounds to be located are impulsive or of short duration. The ears owe their directive capacity to the fact that they are separated, and the distance between them is a determining factor. If the sound is directly in front, the sound arrives at the two ears simultaneously; if from the side, one ear receives the sound a very short time earlier than the other, the measure of that time being determined by the angle that direction makes with the median plane of the head, or with the line perpendicular to that joining the ears. From the known speed of travel of sound and the distance between the two ears, a time interval can be worked out for every direction, so that, if the brain recognises this time interval, a definite direction can be associated with it. A more accurate appreciation of direction can be given by turning the head until we face the sound, and this corresponds to the simultaneous arrival of the sound at the two ears. This time difference theory, enunciated by Hornbostel³, has been supported by most modern exponents, and has been shown to be not inconsistent with the late Lord Rayleigh's theory of location by phase difference.

A very good example of direction finding by measuring time intervals is shown in sound ranging of guns⁴. Here the ears are replaced by microphones. Instead of the base length of only about 6 inches for the two human ears, the microphones were at the ends of a base from half-a-mile to three-quarters-of-a-mile long. The time intervals were therefore long and measurable by suitable timing apparatus, and from these any two microphones gave a direction, three gave two directions and an intersection, and therefore a location. Three more microphones were used in an installation, in the War, making six in all, giving five directions and a mean of locations which improved the accuracy of location very considerably.

The unit of measurable time difference was then about 1/100 sec., and recent advances in sound ranging have made it possible to measure to less than 1/1000 sec.; but the human mechanism of time recording is very much finer than this. Thus, experiments have shown that the pair of human ears with the interpretation of the brain can distinguish time intervals of 30/1,000,000 sec., and interpret them into a perceptible difference in direction. Animals can do even better than this. I am indebted to Prof. Katz for communicating to me some results obtained in his laboratories at the University of Rostock by Engelmann². Engelmann's

method of testing the faculties of animals exhibits great ingenuity. Two similar screens placed side by side served to hide a source of sound, and, on a hook behind the screen hiding the source, was placed a piece of sausage. A dog was trained to associate the correct choice of the screen with the reward of a piece of sausage. By adjustment of the screens both as regards distance from the dog and of their distance apart, the limitations of the dog in the correct identification of the screen gave a measure of the angular separation of the screens, and hence the capacity of the dog to separate directions of sound. The experiments were carried out with three dogs, the dog "Asti" giving the remarkable performance of a separation 2°9', corresponding to a time interval of 14/1,000,000 sec. A smaller dog, "Fritz", gave even better results: a separation of 1°16' and time interval of 7/1,000,000 sec.

Experiments with cats, in which the source of sound was the rustle of two white mice in a cage, gave, in one case, a separation of only 48' and a time interval of 2.8/1,000,000 sec. Experiments with hens and chickens gave other figures showing how very sensitive to sound direction for certain sound these creatures are. Here the source of sound which served as a test for the hen was the 'cheep' of the chick, and the chicken was tested on the cluck of the mother hen.

The following table shows the relative capacities of the various creatures as regards accuracy of direction finding; man is obviously outclassed.

Subject	Base-length between ears	Accuracy of direction finding	Distinguishable time intervals between the ears (10 ⁻⁶ sec.)
Man	14 cm.	4°18'	30
Dog:			
"Asti"	13 cm.	2° 9'	14
"Fritz"	9 cm.	1°26'	7
Cat	7 cm.	48'	2.8
Hen	3 cm.	2° 9'	3.3
Chicken	1.5 cm.	2° 9'	1.6

I have emphasized so far the time difference explanation of this phenomenon of directional listening; but it may be objected that the direction finding of a continuous sound like an aeroplane cannot be so accounted for, since we would appear to have no discrete pulses on which we can observe such time difference. I have already referred to the quality of aircraft sounds and have mentioned its partly impulsive character. However much help may be derived from what is called the phase difference between the waves of incoming sound, our experience with troops has taught us that it is

these flutterings and pulses which appear to be given out irregularly that make direction finding easy. Even when the source of sound is entirely musical, atmospheric irregularities make the sound appear to fluctuate, and it is the time interval between the arrivals of these discrete fluctuations or flutterings which give the binaural sensation so prominently.

Now it must be admitted that this faculty of direction finding by sound grew naturally, both in men and animals, from the necessity of locating sounds nearly in the horizontal plane. With the advent of the aeroplane, we are faced with the necessity of listening to overhead sounds also, and here our listening mechanism shows a lack which it is probable Nature will never contrive to redress. When listening to the overhead sound, rotation of the head does not alter that time difference between the arrivals of the sound at the two ears upon which we depend for acquiring sense of direction, and this disability, although greatest in the overhead position, still persists, though in a gradually lessening degree, as the angle of elevation of the aeroplane is reduced. To get accuracies in the overhead position comparable with that of horizontal listening, the listener must make the axis of his body horizontal, that is, he must lie down with his length parallel to the course of the aeroplane before making use of his ears for direction finding. His head is then placed as well for locating the overhead sound as previously, when the body was erect, it was placed for locating sounds on the ground.

It may be that this uncertainty in placing an aeroplane which is overhead is responsible for the feeling experienced during the War that the bombing aeroplane seemed to spend an undue amount of time exactly over us, an impression, no doubt, which added to the terror of this overhead menace.

In the design of an efficient sound locator there is one obvious improvement to aid directional listening, namely, the artificial separation of the two ears. If we can, so to speak, pull the ears out of the head and separate them, we can increase for any given direction that time difference upon which a sense of direction depends. This pulling out of the ears can be done artificially by means of tubes placed in the ears with their open ends widely separated. If, further, the terminations of these tubes can be some type of sound collector, such as a horn, the improved directional properties can be supplemented by a magnification of the sound.

This was the fundamental principle which led to the design of the first British sound-locator, produced by the Anti-Aircraft Experimental Section of the Munitions Inventions Department under Prof. A. V. Hill. Four wooden horns were used on altazimuth mounting. The operation of direction finding involves two pairs of ears and two pairs of trumpets. The azimuth listener uses the horizontal pair which rotates about a vertical axis, while the altitude pair rotates about a horizontal axis. In operation, all the trumpets in a frame move together so that their mouths always point in the same direction.

It must be noted also that the azimuth listener must be on the correct bearing before the altitude listener can function correctly. This second pair of trumpets takes the place of hypothetical ears mounted on the crown of the head and under the chin, and the corresponding directional listening operation would be analogous to the nodding of the head after it has been swung round to face the sound.

In 1923, the Acoustical Section of the Air Defence Experimental Establishment had the problem of producing a portable sound locator which could be packed in a case after dismantling. The base length of 4 ft. 6 in. was used, but the horns were made smaller than in the early British pattern and, being metal-lined, withstood damage, for a fine crack in a wooden horn of the early type kills its magnifying properties. The performance of this locator after training was adequate for the slow moving and heavy bombing aircraft of ten years ago, but, owing to the high speed of modern aircraft, it is gradually losing its usefulness.

This magnification produced by horns is helpful because it reduces the reaction time of the listener; hence he gets on the correct bearing more quickly than if he were dealing with faint sounds. The horns, however, have another property which helps the listener. As they are rotated into the true direction, the intensity increases, and the listener will naturally turn the horn so that the sound is loudest. High-pitched sounds are more strongly magnified than the low-pitched sounds. The intensity variation as the horn rotates is also greater for the high-pitched sounds. We do not hear the aeroplane through the horns exactly as we hear it with the unaided ear, and, as we rotate them, the quality of sound changes, being richest when the horns face the sound.

We get, then, three factors affecting our correct estimate of direction—the binaural sense which

depends on time difference, giving us the sense of sound straight ahead when facing it, the intensity of the sound which becomes greater, and the quality of the sound which becomes richer and more closely resembles that of the aeroplane as heard by the unaided ear.

Of recent years, several well-known armament firms have produced sound locators in which great diversity of design has been exhibited. Sound collectors have been either of the horn type or have employed concave reflectors with special devices for conveying the sound to the ears. A modern example of the horn type is that produced

give a base length of 7 ft. The listeners are, as it were, clamped to the horns by caps carrying earpads through which sound has access to the ear. They give an impressive magnification, but, unfortunately, are extremely resonant and, in even light winds, provide a disturbing background which hampers listening. This difficulty is overcome by a prolonged period of training. A feature of the trumpet which is liable to be overlooked is the danger to the listener of local gun sounds in which the gun blast is greatly concentrated. These Sperry locators, in the hands of trained troops, give a good performance.

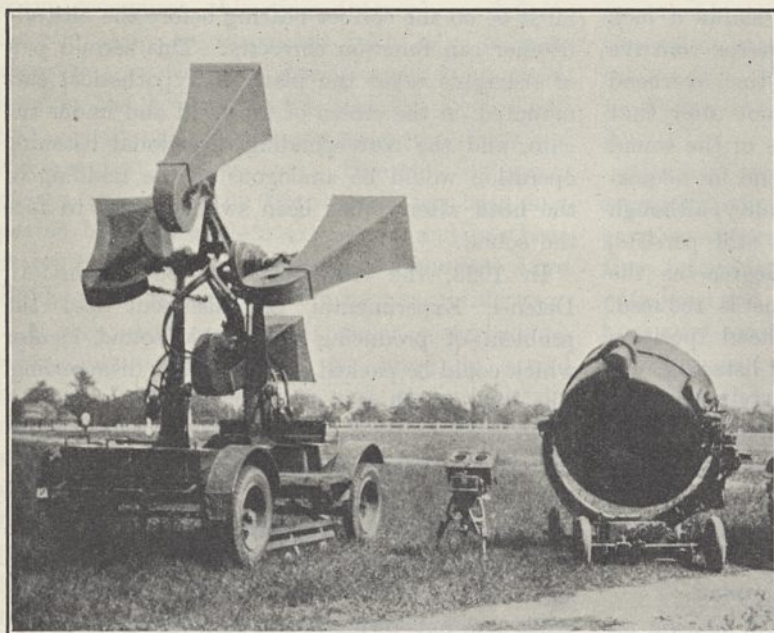


FIG. 1. THE SPERRY SOUND LOCATOR.

by Sperry in the United States. Another type, produced by the firm of Barbier, Benard and Turenne, provides collectors each one of which is composed of a number of horns connected at their narrow ends. The Sautter Harlé locator, also produced in France, is of the reflector type, and so also is one produced by the firm of Goerz of Vienna, in which many striking acoustical features are introduced.

The Sperry sound locator (Fig. 1) consists of large exponential horns, that is horns with curved sides in which the cross-section diminishes in logarithmic relation with distance from the mouth. As such they accord with the latest scientific principles and, in fact, lend themselves to calculation both as regards frequency response and frequency range. They are 16 ft. long and

By the way of comparison, the latest British sound-locator is shown (Fig. 2). Collectors which are paraboloid reflectors have been evolved as the result of researches in which the acoustical properties are accurately known. As in the best of the Continental locators, the instrument is trailer-mounted and the listeners adjust the positions of the locator and themselves by hand-wheel control. The instrument is highly directional, is free from trumpet resonance and can be used in moderately noisy surroundings.

In general, a condition of absolute silence is imposed in the neighbourhood of these locators while they are in operation, but with the new English locator it is quite possible to do effective work when onlookers are talking

near it, so long as they keep away from the direction of listening.

Reviewing all these types of locator, it is interesting to note that, working on independent lines, the mouths of the collectors, which is an important feature of selective directional listening, and the length of the base between collectors, which determines accuracy of location, have achieved about equal dimensions throughout, but it must be confessed that some of the designs do not accord with the simplicity of the functions which they have to carry out.

Efforts of various countries have been concentrated hitherto on the production of sound locators in which the ear is the ultimate criterion. Directive listening is known to require training, and a certain proportion of military and civil

personnel are quite incapable of being trained. The British locator has proved itself to be a very rapid training instrument, but with all possible improvements, some listeners are physically incapable of good performance.

More recently, however, attention has been directed to the production of electrical locators in which it is hoped that difficulties of training will, to some extent, be eliminated.

It is only during the last year that microphones in Great Britain have been produced for all-round listening which can be matched as accurately as the ears are matched. The sensitivity of the microphones themselves is inadequate, and they must have amplifiers similar to wireless amplifiers, but of special design. These again must be matched, or they will, of themselves, introduce time errors or, better expressed, phase changes. Also, the power of discrimination of wanted from unwanted sounds, used automatically by the ears of the listener, must find its analogy in some electrical device, and recently we have been able to produce electrical filters which help to cut out the sounds which form an undesired background.

Finally, we should naturally replace the stethoscopes by telephones, which again must be matched, but that leads us back again to the ear with all its inherent difficulties. There is, however, an alternative to the ear in the cathode ray oscillograph, which may be used in a manner suggested by Dr. E. T. Paris. We have two receptors, so to speak, in the two pairs of parallel plates in the oscillograph, and the two microphone circuits may be connected to these so that each microphone effect can be recorded as a corresponding movement of the spot on the screen. Fig. 3 shows diagrammatically the four plates of the oscillograph, in which plates *aa* correspond to microphone *A* and plates *bb* to microphone *B*. The displacements *aa* and *bb* on the screen shown below correspond to their separate movements. These movements which are, of course, oscillatory, give by persistence of vision a straight line for each microphone, but when the two microphones are connected up, we get the well-known Lissajou

figure, which would be another straight line equally inclined to the first two if these two microphone responses are in phase. When out of phase, the effect depends on the nature of the sound. If the sound is a pure musical tone, represented by a sine wave form, the intervening out-of-phase conditions are represented by ellipses. If, however, the source of sound is as complex as that of an aircraft, and is built up of many frequencies, the pattern only becomes simple, that is, the straight line above referred to, if all the constituents are in phase, namely, when the microphones are equidistant from the source.

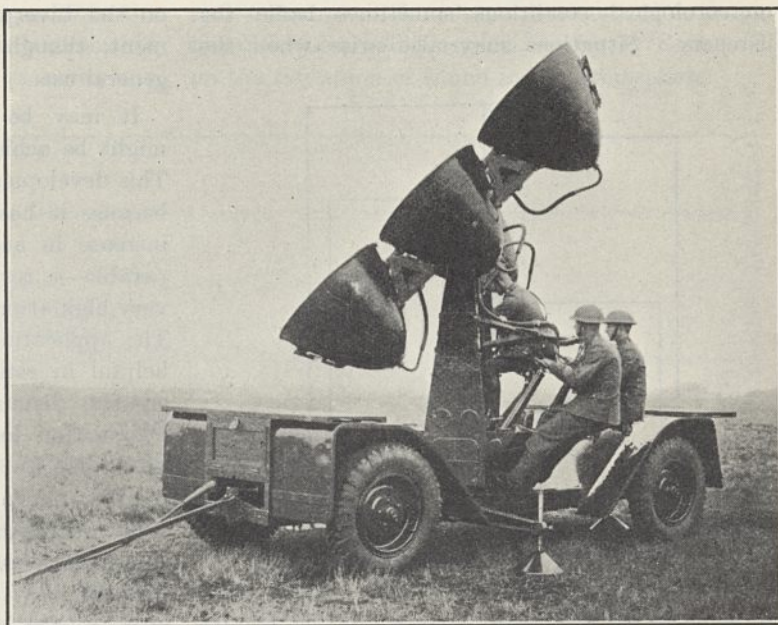


FIG. 2. MODERN BRITISH SOUND LOCATOR.

Gusty winds make directional listening very difficult; for the critical time difference on which direction finding depends becomes variable. The cathode ray oscillograph gives a perfect picture of this disability. The straight line then becomes blurred, and if the sound intensities change, as they do in the two receivers, at unequal rates, the resultant line oscillates. The aural and visual perceptions give an exact parallel. Similarly, other sources of sound, or, it may be reflections of the same source, confuse both aural and visual effects equally. This method of visual indication by the cathode ray oscillograph gives immediate evidence of listening disabilities.

I have so far dealt with sound direction finders in which the two ears or their equivalents in microphones are necessary. There are, however,

direction finders in which use is made of single collectors which can rotate to face the sound and so find a maximum of intensity. Although these direction finders are of considerable interest, they fail to give the accuracy shown by the binaural instruments, and, furthermore, present difficulties in recovering the direction of the sound when it is lost.

I will only give one example of this type, which is of interest in so far as it is entirely devoted to peace operations, and deals with the direction finding of fog horns and ships' sirens at sea. The need of supplementing the human ear has been recognized by many navigators, especially as meteorological conditions sometimes baffle the listeners. Situations may also arise when the

could light a lamp through the agency of a relay. Sixteen of these lamps were arranged in a dial to give the points of the compass against which any sound disturbance could be anticipated. For near foghorns, a group of lights might be shown on a definite arc, the centre of which would give the bearing. This instrument was used for a period on the Mersey pilot-service and on the Holyhead-Dublin mail service. A later pattern, where a much larger drum was used, avoided the operation of rotating the drum, the same effect being achieved by using a number of radial paraboloid receivers, each with its own light indicator. This was installed on S.S. *Victorian* of the Allan Line on the Liverpool-Montreal service. The instrument, though successful, was not brought into general use.

It may be suggested that considerable gain might be achieved by using very large receivers. This development, however, has not been pursued because it has been discovered that appreciable increase in acoustical range has not been comparable—a result which can be attributed to the very high attenuation of sound in the atmosphere. The application of the inverse square law is not helpful in estimating range extension, since, at greater distances than normal listening, the attenuation losses are high in comparison with those due to spherical divergence. Very large receivers have been tried and have resulted in very disappointing performance at long ranges. Thus, large exponential horns which admittedly magnify very impressively, will add only a few miles to the audible range. A gain in accuracy of direction finding may be achieved, but, even so, the accuracy obtained by a single large receiver working on a maximum of intensity cannot compete with that derived by employing the binaural effect, using pairs of receivers of more modest dimensions.

It is obvious that no description of sound direction finding would be adequate without reference to two sources of error. The first one, which applies to the location of all sources of sound, whether fixed or moving, is due to the physical nature of the atmosphere. The effect of wind in creating difficulties of listening range is, of course, familiar, and I do not wish to dwell on this. Meteorological acoustics is a science of itself and might easily occupy the whole of this discourse. It is my purpose rather to indicate in a few words how wind and temperature may affect the direction of listening. We may regard the velocity of sound

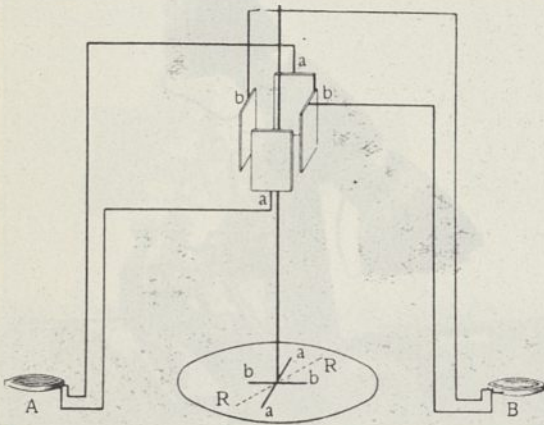


FIG. 3. DIAGRAM OF CATHODE RAY OSCILLOGRAPH.

nearness of the foghorn involves hasty and definite action. The invention of Messrs. W. and T. G. Hodgkinson is directed to the supply of accurate bearings (to half a point of the compass).

The devices tried out were of two types. The first and simpler form of direction finder consisted of a paraboloidal receiver mounted in a drum rotatable about a vertical axis. The axis of the paraboloid was horizontal and coincided with a diameter of the drum. At the focus of the paraboloid a contact microphone was mounted, and the mouth of the paraboloid was protected from wind by a perforated screen. Microphone adjustments were such that the noises of the ship on which it was erected and disturbances from wind produced little effect, but it would respond to horns and sirens up to ranges of three miles. The axis of the drum carried a commutator, and brushes were arranged so that, for sixteen positions of the drum, currents generated by sound in the microphone

in still air at uniform temperature as a physical constant, but air is very rarely still and never at a fixed temperature as we ascend. We must increase or decrease the velocity of sound according as the wind is with or against the direction of travel, and according as the temperature increases or decreases. The effect of the variation is to produce refraction, to a greater or less degree, and the effects of these variations have been worked out precisely from mathematical considerations⁵. The following simple illustrations indicate in what manner meteorological conditions affect directional listening. If we consider the wind to increase with height in the direction of listening, the sound ray comes down more steeply. If opposite to the direction of listening, the sound ray is bent so that it comes in at a smaller angle. For example, in a

illustration is shown in Fig. 4, where the directions of sound rays given out by an aeroplane at 7,000 ft. are mapped out. This acoustical distribution of rays can be worked out if we know how wind and temperature change as we ascend. Here, the sound rays spread in such a way as to give a region in which no sound is heard, hence no direction can be defined; but above and below it there are errors in direction as shown. Provision for such corrections will eventually be made, for, if sound is to be employed for controlling gun fire, great accuracy will be essential in obtaining direction.

The survey of the atmosphere as regards wind and temperature has been accessory to a large research (now being carried out by P. Rothwell) on the refraction of sound in the atmosphere.

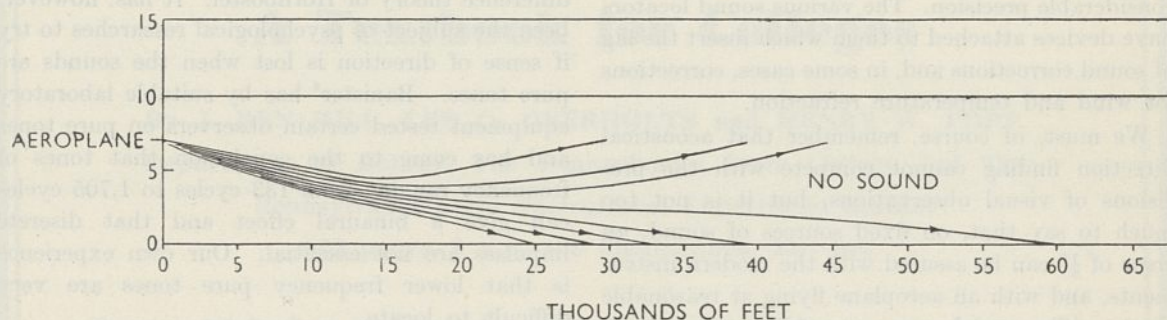


FIG. 4. DIRECTIONS OF SOUND RAYS FROM AN AEROPLANE AT 7,000 FT.

south-west wind so prevalent in England, an aeroplane would be heard in a south-west direction at a higher angle than the true, or, if with the same wind we listen to an aeroplane in the north-east, we should be hearing it at a lower angle. The reason is that wind from the south-west increases as we ascend in nearly all cases.

The effect of the temperature is such that, if no wind had to be allowed for, the aeroplane would always be heard at a lower angle of elevation than it actually is. The reason is that the temperature during the day is nearly always lower as we ascend, and, in consequence, the velocity decreases. The effect is the same as if we were listening against the wind, as described above. At night, however, the reverse effect frequently occurs, because the ground cools by radiation and the temperature of the air above it is higher. At night therefore it frequently happens that we hear an aeroplane at a greater angle of elevation. These effects are quite large, as much as 10° for very low angles of elevation, but when the aeroplane approaches the overhead position, these errors become negligible. An

A more serious error in sound direction finding occurs if the source of sound is moving. The small velocity of sound relative to that of light is responsible for an error called the 'lag of sound', and it can be defined as the angle between the line of sight and the direction of listening. Taking an aeroplane as the moving source, while the sound which it gives out is approaching the listener, the aeroplane has travelled on its course, so that the listening direction will always be behind the visual one. The lag of sound varies according to the direction in which we are listening. If the aeroplane is coming straight towards us or receding from us, there is no correction; but if it is flying across our field of vision, such as it would be if vertically overhead, the lag of sound is a maximum. The angle thus becomes approximately $\phi = v/V$ where V is the speed of sound and v the air-speed of the target, but a wind correction must be incorporated with this if the wind varies between the aeroplane and the ground. No correction is necessary if there is no wind. How large the correction may be is indicated in the accompanying

table, which gives the angular lag of listening direction for an aircraft flying overhead. Against this correction, a year is quoted, corresponding roughly to the speeds of aircraft prevalent at that time.

	Air speed : miles per hour	Angular error overhead position
1918	60	4.6°
1926	120	9.1°
1934	180	13.8°
1936	240	18.4°
1940?	300	23.0°

The corrections would suggest a very serious disability in sound locating, but this disability may easily be exaggerated, for, if we know the airspeed of the aircraft and the direction in which it is travelling, corrections may be applied with considerable precision. The various sound locators have devices attached to them which insert the lag of sound corrections and, in some cases, corrections for wind and temperature refraction.

We must, of course, remember that acoustical direction finding cannot compete with the precisions of visual observations, but it is not too much to say that, on fixed sources of sound, an error of $\frac{1}{4}^\circ$ can be assured with the modern instruments, and with an aeroplane flying at reasonable heights, all sound locator manufacturers quote 2° accuracy. The distance away of the target is, of course, a determining factor, as with low-flying targets having a high angular velocity, difficulties of following, both physical and psychological, make the operation of direction finding difficult. By careful training, a listening team of two listeners per locator can achieve an accuracy of 1° for a reasonable proportion of the time during which the aircraft is within hearing and at heights above 5,000 ft.

Is sound as an aid to defence likely to be completely outclassed because of its low velocity? We are apt, with the sensational reports of greater and greater speeds of aircraft, to exaggerate the heavy handicaps from which sound suffers. In direction finding, it is true that a large correction may be involved, but, if it is an accurate one, the result may still be adequate for the purpose for which sound locators were designed. We are by no means approaching yet the stage described in the well-known petrol advertisement, and we have

one consolation in the fact that very high-speed aircraft produce much stronger sounds than those flying at lower speeds, so that what we lose in time through high speed we gain in range of audibility.

It is not desired, however, to close on the note of war. We are endowed with a directional listening faculty, the study of which has been seriously neglected. We scarcely appreciated that we had this faculty until sound locators were designed and time differences exaggerated, so that an almost uncanny throwing of our perception of sound from one ear to the other was observed only by a slight rotation of such instruments.

We have claimed the impulsive character of the aircraft sound as a valuable asset in sound direction finding, and we have been able to explain the phenomenon of direction listening on the time difference theory of Hornbostel. It has, however, been the subject of psychological researches to try if sense of direction is lost when the sounds are pure tones. Banister⁶ has by suitable laboratory equipment tested certain observers on pure tones and has come to the conclusion that tones of frequency ranging from 133 cycles to 1,705 cycles can give a binaural effect and that discrete impulses are not essential. Our own experience is that lower frequency pure tones are very difficult to locate.

Banister has attempted to reconcile these results with Hornbostel's theory of time differences and has produced a theory which may explain why such an operation is possible. The crests of the sound wave, so to speak, can fulfil the function of discrete pulses, if certain assumptions are made on the mechanism of the ear.

These and other experiments on the theories of hearing should benefit by the attention now being devoted to sound direction finding, and it is hoped that instruments devised specifically to defend us against war dangers will thus give an impetus to work of purely scientific value.

¹ J. Regen, *Sitz. Akad. Wiss. Wien, Math.-Naturwiss. Kl.*, (1), 132, 81 (1924).

² Engelmann, "Untersuchungen über die Schall-lokalisierung bei Thieren". (J. A. Barth, Leipzig.)

³ E. M. von Hornbostel. "The Time Theory of Sound-Localization". Physical Society Discussion on Audition, June 19, 1931.

⁴ "Dictionary of Applied Physics", vol. 4, p. 733.

⁵ E. A. Milne. "Sound Waves in the Atmosphere". *Phil. Mag.*, 42, 100 (1921). Tucker. "Some Problems of Modern Meteorology. No. 11 Meteorological Acoustics". *Quart. J. Roy. Met. Soc.*, 59, No. 250, July, 1933.

⁶ H. Banister. "The Basis of Sound-Localization". Physical Society Discussion on Audition, June 19, 1931.



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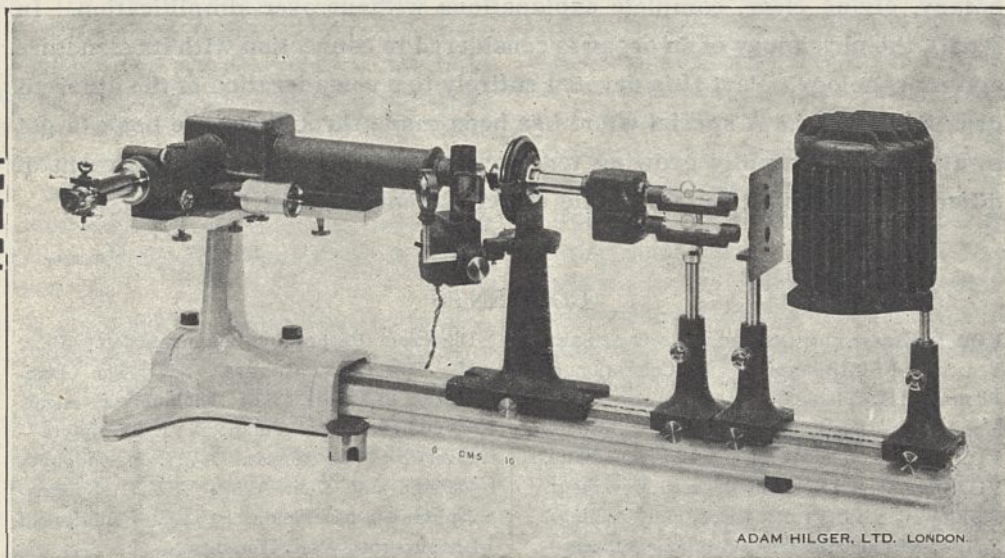
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Civil List Pensions

AMONG the Civil List pensions granted on March 12 and recently announced in a White Paper (H.M. Stationery Office, 139, price 1d.) are the following pensions for services to science: Miss A. M. Buckton, in recognition of her services to literature and of the services rendered by her father, the late Mr. George B. Buckton, to entomology, £60; Mrs. S. I. Cunningham, in recognition of the services rendered by her husband, the late Mr. J. T. Cunningham, to zoology, £90; Miss R. M. Fleming, in recognition of her services to anthropology and geography, £80; Mrs. C. D. Hodgkinson, in recognition of the services rendered by her husband, the late Prof. W. R. Hodgkinson, to chemistry, £90; Mrs. B. Kaye, in recognition of the services rendered by her husband, the late Mr. W. J. Kaye, to the study of archaeology, £60.

Grants for Cancer Research

At the recent quarterly meeting of the Grand Council of the British Empire Cancer Campaign, grants totalling £5,296 were approved; £1,187 to Dr. A. Pollard, working at the Courtauld Institute of Biochemistry at the Middlesex Hospital, on a special scheme of biochemical research inaugurated by the Scientific Advisory Committee; £150 to Dr. F. G. Spear, working at the Strangeways Research Laboratory, Cambridge, for the purchase of a low-voltage equipment apparatus, and £700 for the purchase of a 200 k.v. 10 m.a. Greinacher set; £300 for six months for work being carried out under the direction of Mr. F. C. Pybus through the North of England Council of the Campaign; £1,256 for fifteen months to Dr. Alexander Haddow, who is transferring from his research appointment in Edinburgh to continue special research work at The Royal Cancer Hospital (Free); £320 to Mr. Nevill Willmer, working at the Physiological Laboratory, Cambridge, for technical assistance and purchase of apparatus; and £150 for six months to Dr. Alice Leigh-Smith, working under the direction of Dr. Thomas Lumsden at the London Hospital.

The Structure of Aneurin and Thiochrome

MESSRS. F. BERGEL and A. R. Todd point out that in their letter under this title in NATURE of July 11 (p. 76), formulæ I and II are printed with HCl apparently attached to carbon atom 5' of the thiazole nucleus; actually the HCl should be represented merely as attached to the molecule as a whole, since it cannot be allocated with certainty to any particular nitrogen atom; it cannot, of course, be attached to a carbon atom. In formula III a single bond should be inserted between C₅ of the pyrimidine ring and the thiazole nitrogen.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

A lecturer in biology in The Polytechnic, Regent Street, London, W.1—The Director of Education (July 20).

A lecturer in mechanical engineering in the Burnley Municipal College—The Director of Education, Education Offices, Burnley (July 20).

An assistant in the Mechanical Engineering Department and an assistant in the Electrical Engineering and Physics Department of the Coventry Technical College—The Director of Education, Council House, Coventry (July 22).

Mechanical engineers for the Supply Board Technical Establishment under the Director of Ordnance Factories—The Under-Secretary of State (C.5), War Office, London, S.W.1 (July 24).

Four instructors in motor engineering in the South-East Essex Technical College—The Clerk to the Governors, Five Elms Council School, Wood Lane, Dagenham (July 24).

A lecturer in mathematics, and three lecturers in engineering, in the Acton Technical College, High Street, Acton, 3—The Principal (July 24).

A lecturer and deputy director of the Department of Anatomy in the St. Thomas's Hospital Medical School, London, S.E.1—The Dean (July 24).

An assistant lecturer in physics in the University of Manchester—The Registrar (July 29).

A lecturer (Grade IIB) in electrical engineering in the University of Birmingham—The Secretary (July 29).

Junior scientific officers in the Directorate of Scientific Research of the Air Ministry—The Chief Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (July 31).

A head of the Department of Mechanical Engineering in the Bradford Technical College—The Principal (July 31).

A civilian scientific officer in the Admiralty Scientific Pool—The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (July 31) (quote C.E. 3709/36).

A demonstrator in chemistry in the University of Aberdeen—The Secretary (August 8).

A temporary assistant lecturer in chemistry in the University of Manchester—The Registrar (August 8).

Two part-time demonstrators in inorganic chemistry in the University of Leeds—The Registrar (August 15).

A lecturer in fuel technology in the University of Sheffield—The Registrar (August 15).

A lecturer in metal mining in the University of Birmingham—The Secretary (August 15).

A University reader in physiology in the London Hospital Medical College—The Academic Registrar, University of London, S.W.7 (September 11).

A part-time lecturer in science in St. Paul's Training College, Selly Park, Birmingham—The Principal.

A part-time demonstrator in mathematics in University College, Southampton—The Registrar.

An assistant lecturer in geography in University College, Hull—The Registrar.

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 128.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Atomic Masses of Uranium and Thorium

WITH ions from a spark between a thorium or uranium electrode and a tin electrode, it was found that easily resolved doublets are given by the mass-spectrograph, formed by the doubly charged thorium ions with the tin isotope at 116 in one case, and in the case of uranium with the isotope at 119 (Fig. 1). The mass difference is found to be 0.120 ± 0.003 for thorium (the average of six doublets of nearly equal intensity), and 0.131 ± 0.003 in the case of uranium (average of the values for the five best doublets). The packing fraction for the tin isotopes has been determined by Dr. Aston¹ as 7.3 ± 1 . Using this value, the atomic mass of thorium (oxygen = 16.000) is 232.070 and that of uranium 238.088.

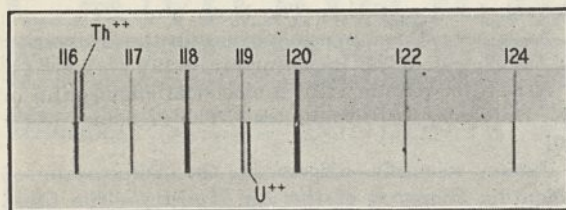


FIG. 1. Ions from electrons of tin and thorium (above) and tin and uranium (below).

Doubly charged ions of the faint isotope of uranium² at 235 appeared on four photographs, unsymmetrically spaced between the tin lines at 117 and 118. Its mass was found to be 235.084 ± 0.01 . The proportion of this isotope is 0.4 per cent, according to the actino-uranium theory. Reduced to the chemical scale, the atomic weights become 232.024 for thorium and 238.028 for the mean of the two uranium isotopes, as compared with the usually accepted values 232.12 and 238.14. The discrepancy of approximately one tenth of a unit is too large to be ascribed to an error in the masses of the tin isotopes.

From their analysis of the transformations induced by neutron bombardment of uranium, O. Hahn, L. Meitner and F. Strassmann³ have recently concluded that a uranium isotope of mass 235 exists with a half-life of only 24 minutes. It is transformed by β -ray emission into eka-rhenium ($N = 93$) of the same mass, which is probably a long-lived product. As the uranium and pitch-blende samples used in the present experiments were of unknown origin, analyses of the uranium ions from purified samples of uranium salts were made to make sure that the faint component is an isotope of uranium and not by any chance eka-rhenium. Pure uranyl nitrate crystals were heated and packed in a nickel tube. With this electrode the isotope at 235 was observed apparently in the same ratio as with the other electrodes. No precipitate was obtained by hydrogen

sulphide, showing the absence of an appreciable amount of eka-rhenium. The uranium was next freed from other elements by precipitating it as sodium uranyl acetate. This salt when heated and used as the electrode also gave the isotope at 235 just as before. Since this long-lived isotope at 235 thus belongs to uranium, the short-lived isotope formed by neutron bombardment must be isomeric with it, the two having the same mass and charge but differing in nuclear properties.

A. J. DEMPSTER.

University of Chicago.

June 12.

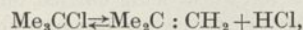
¹ F. W. Aston, *Proc. Roy. Soc., A*, **115**, 506 (1927).

² A. J. Dempster, *NATURE*, **136**, 180 (1935).

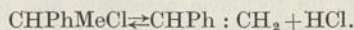
³ O. Hahn, L. Meitner, F. Strassmann, *Ber. deut. chem. Gesell.*, **69**, 913 (1936).

Unimolecular Elimination and the Significance of the Electrical Conduction, Racemization and Halogen Replacement of Organic Halides in Solution

THERE are a number of cases in which the development of electrical conductivity in sulphur dioxide solution has been held to indicate the electrolytic dissociation of an alkyl halide. One of the best known examples is that of *tert.*-butyl iodide¹. We find, however, that *tert.*-butyl chloride absorbs bromine quantitatively in sulphur dioxide, the products being *isobutylene* dibromide and hydrogen chloride. This suggests a rather rapidly established equilibrium,



in which, however, the left-hand components have the smaller free energy. α -Phenylethyl chloride also is said to give a conducting solution in sulphur dioxide: we find that the pure chloride in the pure solvent does not conduct, but that when there is conduction, styrene and hydrogen chloride are present:

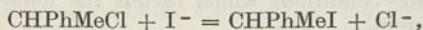


Under conditions of purity in which the chloride does not conduct, hydrogen chloride itself has negligible conductivity in small concentration, but even in these circumstances the addition of bromine leads to a quantitative yield of styrene dibromide.

Observations of the unimolecular racemization of optically active alkyl halides have also been held to measure their rates of electrolytic dissociation or at least their ionization. α -Phenylethyl chloride has been shown to racemize in sulphur dioxide at a rate which is unaffected by added chloride ions². A similar but more rapid racemization has been observed with formic acid as solvent³. In formic acid also styrene and hydrogen chloride are formed; we find, moreover, that the rate of racemization is substantially accounted for by the rate of formation of

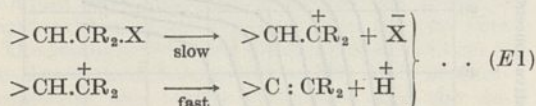
hydrogen chloride. In sulphur dioxide a direct comparison of rates is scarcely possible owing to the one-sidedness of the equilibrium.

The unimolecular replacement in sulphur dioxide⁴,



is open to the same explanation, since styrene adds hydrogen iodide, which would be formed from the added iodide ions and the liberated hydrogen chloride. Several supposed rearrangements can be similarly re-interpreted.

We are thus able to group all these conductometric, polarimetric, kinetic and other observations under our general mechanism (customarily labelled *E1*) for unimolecular elimination reactions:



This mechanism assumes that the rate-determining stage is the ionization of the halide, and to this extent we support the inference drawn by previous investigators^{2,3} to the effect that ionization is fundamentally involved. In our mechanism the instability of an alkyl cation containing a potential proton is made responsible for the production of olefin.

Experimental particulars and more extended applications of the *E1* mechanism will be published in the *Journal of the Chemical Society*.

University College,
London.
July 1.

E. D. HUGHES.
C. K. INGOLD.
A. D. SCOTT.

¹ Walden, *Ber.*, **35**, 2029 (1902).
² Bergmann und Polanyi, *Naturwiss.*, **21**, 378 (1933).
³ Bodendorf und Böhme, *Annalen*, **516**, 1 (1935).
⁴ Ogg and Polanyi, *Trans. Faraday Soc.*, **31**, 617 (1935).

Equilibria in Salt Systems with Deuterium Water

IN connexion with the letters of Bell¹, of Partington and Stratton² and with editorial notes³, it is of interest to note the degree of activity in this field. As is justly stated in the second letter cited above, "measurements of dissociation pressures of salt hydrates are somewhat difficult". By way of illustration, whereas Perpérot and Schacherl⁴ report a value for the dissociation pressure equilibrium at 25° of cupric sulphate penta- and tri-deuterates which is 36 per cent lower than the corresponding value for the ordinary hydrates, two of us in 1934 had found this pressure difference to be only 8 per cent. We shall therefore welcome the promised results of Partington and Stratton. We have studied pressure equilibria in this and other univariant salt deuterate systems with and without the liquid phase (saturated solution) present, over a range of temperature.

The solubility relations of salts in deuterium water seem to have received less attention⁵. A few results may perhaps be of interest. If, following "International Critical Tables", concentration is stated in terms of moles of anhydrous solute per 1,000 gm. (55.51 moles H₂O) in the case of ordinary water, for purposes of comparison we may state the number of moles of solute per 1111.7 gm. (55.51 moles D₂O) in the case of deuterium water. For potassium chloride on this basis, we find the solubility in deuterium water lower than that in ordinary water

by about 7 per cent at 30°, 3.6 per cent at 100°, and 1.5 per cent at 180°.

In speaking of the solubility of deuterates and hydrates, we refer to solubilities in deuterium water and in ordinary water respectively. Cupric sulphate pentadeuterate is, at 10°, nearly 12 per cent less soluble than pentahydrate; but the difference in solubility falls to about 1.5 per cent near 96°, which is close to the transition temperatures of both salts to their tri-aquo forms. Strontium chloride hexahydrate passes to dihydrate at 61.3°, and the hexadeuterate to dideuterate about 56.5°. The graph of solubility of hexadeuterate against temperature lies lower in concentration than that of the hexahydrate at lower temperatures but crosses the hexahydrate curve about 10°; the dideuterate solubility curve crosses the hexahydrate curve about 60° and the dihydrate curve about 115°, both deuterate curves showing a faster change of solubility with temperature than the corresponding hydrate curves.

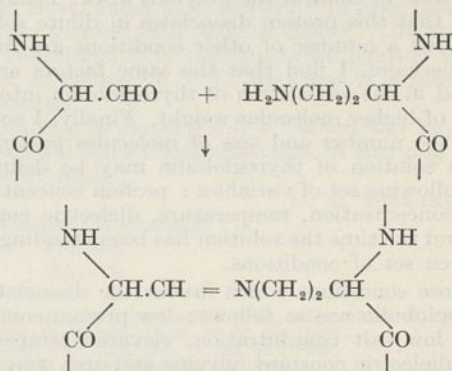
F. T. MILES.
Princeton University,
June 5.
R. W. SHEARMAN.
ALAN W. C. MENZIES.

¹ NATURE, **137**, 534 (1936).
² NATURE, **137**, 707 (1936).
³ NATURE, **137**, 698 (1936).
⁴ *J. Phys. et le Rad.*, vii, **6**, 439 (1935).
⁵ But cf. Taylor, Caley and Eyring, *J. Amer. Chem. Soc.*, **55**, 4334 (1933).

Cross-Linkage Formation in Keratins

THE depilation of hides and skins prior to tannage¹, and the permanent setting of stretched hair and wool² are both important industrial processes considered to be governed by the development of resistant cross-linkages between the peptide chains of keratins. Speakman² has suggested that when stretched wool fibres are set in steam, the cross-linkages developed consist of -S-NH- groupings formed subsequent to the hydrolysis (R.S.S.R. ⇌ R.SH + HOS.R) of the cystine disulphide cross-linkages; but it is admitted that other resistant linkages must be formed when cross-linking is attended by loss of sulphur.

A possible chemical mechanism, hitherto overlooked, for the production of such resistant linkages may arise by the auto-oxidation-reduction of the sulphenic acid side-chains produced by the hydrolysis of the cystine disulphide cross-linkages. Such decomposition of the sulphenic acid side-chains would yield hydrogen sulphide, and aldehyde groups (>CH.CH₂.SOH → >CH.CHO + H₂S) capable of linking-up with the amino-groups of adjacent peptide chains, for example, those of lysine.



That the sulphenic acid radical can decompose in this manner is indicated by the production, with the liberation of hydrogen sulphide, of glyoxylic acid from dithiodiglycolic acid, and of phenylglyoxylic acid from dithiodiphenylglyoxylic acid³. Keratin is also known to evolve hydrogen sulphide under the action of steam, and to lose 50 per cent of its sulphur when treated with sodium hydroxide⁴.

On the assumption that the cystine disulphide cross-linkages must be severed before hair can be removed rapidly from hides, the above hypothesis explains why fresh lime liquors are not efficient depilators, unless they contain reducing agents, for example, sodium sulphide. These substances reduce the sulphenic acid side-chains to cysteine side-chains and thus prevent the generation of aldehyde groups. The unexpected ability of aliphatic primary amines⁵ (especially methylamine) to facilitate depilation by fresh lime liquors (free from reducing agents) may also be due to the prevention of cross-linking, since these amines could condense with, and mask, the aldehyde groups arising by the sulphenic acid decomposition.

H. PHILLIPS.

Wool Industries
Research Association,
Torridon,
Leeds, 6.

¹ Marriott, *J. Int. Soc. Leather Trades Chemists*, **12**, 216 (1928).

² Speakman, *NATURE*, **132**, 930 (1933).

³ Schöberl, *Annalen*, **507**, 111 (1934); *Ber.*, **67B**, 1545 (1934).

⁴ Harris, *Bur. Stand. J. Res.*, **15**, 63 (1935).

⁵ McLaughlin, Highberger and Moore, *J. Amer. Leather Chem. Assoc.*, **22**, 345 (1927).

Association and Dissociation Reactions of Thyroglobulin

FROM their ultracentrifugal studies on thyroglobulin, Heidelberg and Pedersen¹ found that solutions of this protein within its pH stability region² are fairly homogeneous (Fig. 1). The sedimentation picture shows, in addition to a predominating component consisting of molecules having a molecular weight of about 700,000, a small amount of heavier and lighter molecules with poorly defined sedimentation boundaries. These molecules were assumed to have been formed respectively by the dissociation and association of the molecules comprising the predominating component. It was noticed that on dilution the number of lower molecular weight molecules increased.

In the study of the stability of thyroglobulin being carried out by means of the ultracentrifuge, I have been able to confirm the previous work. I find, however, that this protein dissociates in dilute solutions provided a number of other conditions are fulfilled. Furthermore, I find that the same factors are concerned in the association of thyroglobulin into molecules of higher molecular weight. Finally, I conclude that the number and size of molecules present in a given solution of thyroglobulin may be defined by the following set of variables: protein concentration, salt concentration, temperature, dielectric constant, pH and the time the solution has been standing under a given set of conditions.

Those conditions which favour the dissociation of thyroglobulin are as follows: low protein concentration, low salt concentration, elevated temperature, high dielectric constant (glycine and urea were added

to the thyroglobulin solutions in this set of experiments), a pH displaced from the isoelectric point (only values on the alkaline side, but still within its pH stability region, have been studied). These are the same conditions which favour the ionization of the protein.

On the other hand, those conditions which favour the association of thyroglobulin are the opposite or the same as those which minimize the ionization of the protein.

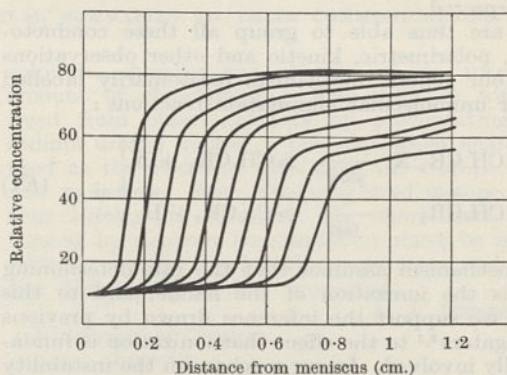


FIG. 1. Sedimentation diagram of thyroglobulin prepared essentially to reference 3.

When placed under the proper combination of conditions, thyroglobulin dissociates with a slow and measurable rate into a series of components of lower molecular weight having well-defined sedimentation boundaries (Fig. 2). I have been able to reverse the reaction, resynthesizing the original molecule from the dissociated fragments. Moreover, under the proper conditions, thyroglobulin will associate in due course into higher molecular weight components having definite sedimentation boundaries.

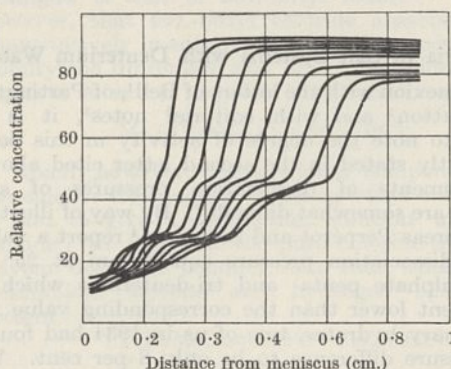


FIG. 2. Sedimentation diagram of dissociated thyroglobulin.

These factors alone cannot account for the mechanism of thyroglobulin economy within the body, for under the conditions existing in the living cell the rates of dissociation and association would be very slow.

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May 13.

¹ M. Heidelberg and K. O. Pedersen, *J. Gen. Physiol.*, **19**, 95 (1935).

² M. Heidelberg and T. Svedberg, *Science*, **80**, 414 (1934).

³ M. Heidelberg and W. Palmer, *J. Biol. Chem.*, **101**, 433 (1933).

Raman Spectrum of Cyclopropane

THE Raman spectrum of cyclopropane is of great interest in view of the fact that it is the simplest of the cyclic hydrocarbons, and also from the point of view of the structure of the cyclopropane molecule. I have investigated this substance both in the liquid and vapour states and have obtained the following results :

Liquid	{	$\Delta \nu$ (cm. ⁻¹)	736*	863	1185	1434	1503*	2852*	2952*	3010	3028	3080
		Int.	Obd	8b	15	2b	0s	$\frac{1}{2}$	1	10	10	10
		<i>e</i>	D	D	P	D	P	P	P	P	P	D
Vapour	{	$\Delta \nu$ (cm. ⁻¹)		863	1185					3010	3028	
		Int.		0b	2s					1s	2s	
		<i>b</i>	b = broad ; d = diffuse ; s = sharp ; P = polarised (<i>e</i> << 6/7)									
			D = depolarised (<i>e</i> ≈ 6/7).									

The frequencies marked with an asterisk in the case of the liquid have not been noticed by the previous investigators^{1,2} and are reported here for the first time. The strongly polarised Raman line at 1185 cm.⁻¹ and the depolarised Raman line at 863 cm.⁻¹ presumably represent the totally symmetric and the deformation vibrations respectively of the triangular carbon ring which forms the nucleus of the cyclopropane molecule. However, for an equilateral

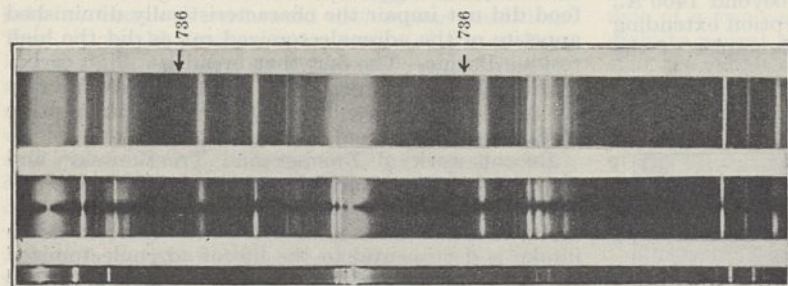


FIG. 1. Raman spectrum of cyclopropane; a, liquid; b, liquid (polarisation); c, vapour.

triangular model, the doubly degenerate deformation frequency is forbidden in the Raman effect according to Placzek's selection rules. The fact that the Raman line at 863 cm.⁻¹ persists even in the vapour state clearly shows that its appearance in the liquid spectrum cannot be due to the influence of the neighbouring molecules. The influence of the hydrogen atoms on the vibrations of the carbon ring might be a possible explanation for the appearance of this line. The matter, however, requires mathematical investigation.

A striking difference between the liquid and the vapour spectra is noticed when we compare the Raman lines at 3010 cm.⁻¹ and 3028 cm.⁻¹. In the liquid picture, these two lines are of equal intensity or perhaps $\Delta \nu = 3010$ cm.⁻¹ is slightly more intense than $\Delta \nu = 3028$ cm.⁻¹. The intensity of either of these is less than that of the Raman line at 1185 cm.⁻¹. In the vapour picture $\Delta \nu = 3010$ cm.⁻¹ is found to have become considerably weaker, while $\Delta \nu = 3028$ cm.⁻¹ has gained in intensity and is almost as strong as Raman line 1185 cm.⁻¹ Such a strong difference between the relative intensities of the Raman lines between vapour and liquid in the case of a non-polar molecule is remarkable, and evidently requires further elucidation.

R. ANANTHAKRISHNAN.

Department of Physics,
Indian Institute of Science,
Bangalore. May 6.

Electronic Specific Heat in Palladium

KEESOM and Clark¹ have shown that the atomic heat of nickel at low temperatures contains a linear term $0.0019 T$, which is many times bigger than the contribution from the free electrons to be expected from the Sommerfeld theory. Mott² has suggested that this term is due to the unfilled quantum states (positive holes) in the *d*-shell of nickel, and that a similar term should occur for the other transition metals, whether ferromagnetic or paramagnetic.

In order to test this theory and to make more quantitative data available on the subject, the specific heat of palladium was determined, palladium being chosen on account of its similarity to nickel and its high paramagnetism, which according to Mott should imply a large electronic specific heat. Though the electronic component in these transition metals is larger than usual, it is nevertheless small in absolute magnitude. But since it varies proportionally with the temperature, whereas the specific heat due to the lattice vibrations varies near the absolute zero with the cube of the temperature, the two become comparable in magnitude at sufficiently low temperatures³. Experiments were therefore carried out in the liquid helium region.

The specific heat of a block of metallic palladium (weighing 25 gm.) kindly put at our disposal by Prof. Mott was measured between 2.5° K. and 22° K. in a vacuum calorimeter enclosed in a helium liquefier using the Simon expansion method.

The sample was contained in a small copper calorimeter on which were wound heating and thermometer coils of eureka wire, thermal contact between the calorimeter and the palladium being effected by the use of helium gas at a low pressure.

The results showed that the atomic heat of palladium in the region 2.5°–22° K. could be expressed in the form

$$C = 0.0000224 T^3 + 0.0031 T \text{ cal./degree.}$$

The first term represents the component due to the lattice vibrations and corresponds to a Debye characteristic temperature of $\theta = 275^\circ$, while the second term represents the specific heat of the free electrons or positive holes. At 2.5° K. the linear term is about twenty times as great as the T^3 term, while the two terms become of equal magnitude at about 12° K. The value of the electronic specific heat is, as predicted by Mott, much higher than for normal metals, and is even greater than that of nickel. The above result is considered from the theoretical point of view in a book on metals by N. F. Mott and H. Jones, to appear shortly.

I should like to thank Prof. F. Simon and Dr. N. Kúrti for their advice and assistance in carrying out this determination.

G. L. PICKARD.

Clarendon Laboratory,
Oxford.
June 8.

¹ R. Lespleau, M. Bourguel and R. Wakeman, *Bull. Soc. Chim. France*, (4), 51, 400 (1932).

² K. W. F. Kohlrausch and F. Koppl, *Z. phys. Chem.*, B, 26, 209 (1934).

¹ W. H. Keesom and C. W. Clark, *Physica*, 2, 513 (1935). K. Clusius and J. Goldmann, *Z. phys. Chem.*, B, 31, 256 (1936).

² N. F. Mott, *Proc. Roy. Soc., A*, 152, 42 (1936).

³ F. Simon, *Z. Elektrochemie*, 34, 530 (1928).

Transparency of Sodium and Potassium Films in the Schumann Region

THE remarkable transparency of alkali metal films reported by R. W. Wood¹ is of considerable interest, on one hand in relation to the theory of electrons in metals and on the other in relation to spectroscopic technique, for these films are unique as filters².

We have recently succeeded in depositing transparent films of sodium and potassium on fluorite cooled to liquid air temperature before the slit of a vacuum spectrograph. Photographs of the spectrum of the transmitted light establish that not only does sodium transmit from 2100 Å. to 1860 Å., as observed by Wood, but also that it transmits through the entire Schumann region to 1250 Å. (limit of fluorite). Experiments made with different film thicknesses indicate that there is some absorption in the neighbourhood of 1250–1400 Å., and it seems reasonable to anticipate that the transparency of sodium does not extend very far beyond 10 volts. For potassium films (which transmit wave-lengths less than 3150 Å.) there is no observable transmission beyond 1400 Å., while there is evidence of weak absorption extending to between 1700 Å. and 1800 Å. Examples of the spectra are shown in Fig. 1.

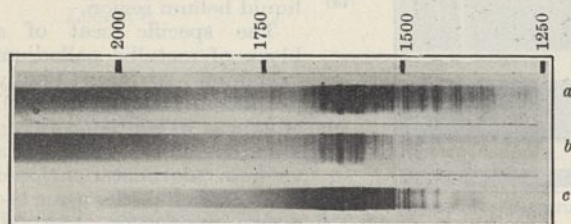


FIG. 1. Transmission of fluorite (a) without metal film, (b) with potassium film, (c) with sodium film.

A sodium film on fluorite is therefore an ideal filter to remove all visible and ultra-violet light of wave-length greater than 2100 Å. and to pass the entire Schumann region. A full account of our experiments will be published later, but it is appropriate now to indicate the conflict of the experimental results with the existing theory of the optical properties of metals³. According to Wilson's formulæ,

(i) for body-centred cubic lattices the absorption bands overlap and there is no transparency;

(ii) there is a sharp rise in the absorption at the low frequency end of an absorption band and slow decrease at the high frequency end.

Both of these conclusions are at variance with the experiments, so the theory cannot be applied in its present form to describe the optical properties of the alkali metals, which ought to afford the most favourable case for the quasi-free-electron model.

One of us (D. G. H.) is indebted to the National Research Council of Canada for scholarships to carry out this work.

W. H. WATSON.
D. G. HURST.

McGill University,
Montreal.
May 5.

¹ R. W. Wood, *Phys. Rev.*, **44**, 353 (1933).

² H. M. O'Bryan, *Rev. Sci. Inst.*, **6**, 328 (1935).

³ See, for example, A. H. Wilson, *Proc. Roy. Soc.*, **A**, **151**, 280 (1935).

High Potassium Diet and the Survival of Adrenalectomized Rats

WHILE investigating the factors influencing the length of survival of rats after adrenalectomy, we found¹ that rats receiving liberal quantities of bread as a supplement to their usual diet lived many times longer than the controls fed on the stock ration alone. That this was only partly due to the high sodium chloride content of the bread (8 per cent by dry weight) seemed evident from the still markedly prolonged survival of rats receiving bread with a sodium chloride content as low as the stock diet, namely, 1 per cent. This diet, containing cereals, meat, molasses and vitamins (Purina Dog Chow), was taken well by unoperated animals. After adrenalectomy, however, the rats soon manifested an almost complete anorexia for the Purina, but those with access to bread in addition ate this well almost until the time of death. Consequently, these animals ingested more sodium chloride and a greater number of calories than the rats on Purina alone—facts favouring survival.

In explanation of the preference shown by the rats for bread, we suggested that this being a low residue food did not impair the characteristically diminished appetite of the adrenalectomized rat as did the high residue Purina. The fact that bread is a high carbohydrate food we emphasized as important in view of the well-known breakdown in carbohydrate metabolism in adrenal insufficiency.

Recent work of Zwemer and Truszkowski² and also Allers, Nilson and Kendall³ appears to be of importance in the interpretation of our results. These workers have shown that a high potassium intake is detrimental to the life of adrenalectomized animals. In view of this finding, we have analyzed our diet and found the potassium content of the Purina to be 0.46 grams per cent, while that of the make of bread chiefly used was but 0.135 grams per cent. This result indicates that the low potassium content of the bread may have been a factor favouring survival in our rats so fed. Experiments are in progress to determine the relative importance of these factors.

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G. A. McVICAR.

Department of Medicine,
University of Toronto,
Toronto.

¹ R. A. Cleghorn, S. M. M. Cleghorn, M. G. Forster and G. A. McVicar, *J. Physiol.*, **88**, 229 (1936).

² R. L. Zwemer and R. Truszkowski, *Science*. In the press, 1936.

³ W. D. Allers, H. W. Nilson and E. C. Kendall, *Proc. Staff Meet. Mayo Clinic*, **11**, 283 (1936).

Humidity and Insect Metabolism

ENTOMOLOGISTS have suggested that certain insects may show a greater rate of metabolism in dry air than in moist at the same temperature. They believe that such increased metabolism should cause a greater production of metabolic water, to compensate for evaporation from the insect's body, and maintain a constant ratio of water to dry matter at different atmospheric humidities. This increase in metabolic rate is assumed to occur in resting insects which are not moving actively. Buxton¹ obtained results which indicated that, at 23° C., the mealworm used up its reserves more rapidly in dry air than in moist, and kept the ratio of water to dry matter constant. As the body composition of mealworms is so variable, and as these results were obtained from rather small

numbers, it appeared advisable to make further experiments before finally accepting a conclusion of such general physiological importance.

Numerous experiments were made, in which large numbers of individual mealworms were subjected to various humidities at temperatures ranging from 8° to 37° C.³ Analyses after intervals of from 14 to 35 days showed that the rate at which the reserves were utilized was governed by temperature alone. For example, batches of these insects consumed reserves equal to 19 per cent of their dry weight in 35 days, when exposed to humidities of either 0 or 60 per cent at 24° C. I also made daily estimations of the amount of carbon dioxide produced by mealworms at different temperatures and humidities, and found that the rate of respiration appeared to be governed by temperature alone, and unaffected by changing humidity.

Experiments with other insects, including bed-bugs⁴, clothes-moths⁵ and adult⁶ and pupal⁷ tsetse flies all show that with them the rate of metabolism is governed by temperature, and unaffected by changes in humidity.

In the light of present knowledge, it is difficult to see how an increase in the rate of metabolism could help an insect to withstand desiccating conditions. True, it would produce more water of metabolism, but this would mean an increase in the rate of respiration (to obtain the extra oxygen) and consequently the spiracles would be opened more frequently. This would allow more water to be evaporated⁷. For every molecule of metabolic water produced, at least one molecule of oxygen must be taken in, and under dry conditions more water is lost by the evaporation which accompanies respiration than is gained by metabolism. This has been shown by analyzing insects which have been subjected to low humidities, and by the fact that many insects are more susceptible to desiccation at high temperatures (where metabolism is actually increased) than at low temperatures.

With an actively moving insect, an unfavourably low humidity may perhaps cause great activity, and a consequent increase in the metabolic rate; but this will hinder, rather than help in withstanding desiccation. With resting insects such as fasting mealworms, a lowering of the humidity does not increase the rate of metabolism; if the metabolic rate were increased, it would not be of any advantage.

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London School of Hygiene and
Tropical Medicine.

¹ Buxton, P. A., *Proc. Roy. Soc.*, B, **106**, 560-577 (1930).
² Buxton, P. A. and Lewis, D. J., *Phil. Trans. Roy. Soc. Lond.*, B, **224**, 175-240 (1934).
³ Mellanby, K., *Proc. Roy. Soc.*, B, **111**, 376-390 (1932).
⁴ *Parasitology*, **27**, 111-22 (1935).
⁵ *Ann. App. Biol.*, **21**, 476-482 (1934).
⁶ *Bull. Ent. Res.* (in press) (1936).
⁷ *Biol. Rev.*, **10**, 317-333 (1935).

Organizers in Mammalian Development

EMBRYONIC organizers, discovered in the Amphibia by Spemann¹, have since been found also in birds (Waddington²) and fish (Luther, Oppenheimer³). It seems probable that embryonic determination is brought about in the same way in all groups of vertebrates, and rather similar conditions have been found in some invertebrates. Previous work on mammalian embryos has, however, produced very little definite evidence in support of this suggestion. The occurrence of identical twins shows that regula-

tion is possible in very early stages (see Nicholas⁴), while several authors have described apparently mosaic development of parts isolated from early somite, or later, stages.

The only available fact concerning the actual process of determination in mammalian embryos is that the ectoderm of the rabbit embryo in the primitive streak stage can be induced, by a chick organizer, to form neural tissue (Waddington⁵, working with the tissue culture technique⁶). Attempts to obtain inductions by transplanting pieces of the rabbit primitive streak into other rabbit embryos have so far been unsuccessful, although the grafts differentiate into neural tissue and (probably somitic) mesoderm; small amounts of neural tissue have been found in grafts which did not include the anterior end of the primitive streak, the rabbit behaving in this respect exactly as does the chick.

Grafts may also be made from the rabbit into the chick, and the grafted tissues differentiate (Waddington and Waterman⁶). Until recently, no inductions were observed in these grafts, but this long-expected result has now occurred; in a specimen, No. 36-9ORC, the anterior part of the embryonic axis of a two somite rabbit has induced a small but definite neural plate in the host chick. This shows that the rabbit contains an organization centre, and, taken with the fact mentioned above that the rabbit ectoderm is competent to react to a chick organizer, scarcely leaves room for doubt that the determination of the mammalian embryo during normal development is in fact produced by an organization centre.

C. H. WADDINGTON.

Strangeways Research Laboratory
and Department of
Experimental Zoology,
Cambridge. June 30.

¹ H. Spemann, *Arch. Entw-mech.*, **43**, 448 (1918).
² C. H. Waddington, *NATURE*, **125**, 924 (1930); *Phil. Trans. Roy. Soc.*, B, **221**, 179 (1932).
³ W. Luther, *Biol. Centralbl.*, **55**, 114 (1935). Oppenheimer, *Proc. Nat. Acad. Sci.*, **20**, 536 (1934); *Proc. Soc. Exp. Biol. and Med.*, **31**, 1123 (1934).
⁴ J. S. Nicholas, *Anat. Rec.*, **55**, 31 (1933).
⁵ C. H. Waddington, *J. Exp. Biol.*, **11**, 224 (1934).
⁶ C. H. Waddington and A. J. Waterman, *J. Anat.*, **67**, 356 (1933).

Metabolism of Cartilage

THE recent letter of Bywaters¹ on this subject prompts us to describe some observations made independently in the course of a study of normal mammalian tissues showing an anaerobic type of metabolism. Following our investigation of the metabolism of the medulla of kidney², a tissue recognized as having a poor capillary supply, we were led to study cartilage because this is an entirely non-vascularized tissue, and here we found the same association of anaerobic type of metabolism and poor oxygen supply as in medulla of kidney.

Our experiments were done with thinly sliced rib cartilage of the rat, suspended in a bicarbonate-saline medium. Concentration of glucose: 0.2 per cent.

Material	Respiration	Aerobic glycolysis	Anaerobic glycolysis
	Q _{O₂}	Q _G ^{O₂}	Q _G ^{N₂}
Costal cartilage			
Specimen I	- 0.68	+ 1.22	+ 1.36
Specimen II	- 0.22	+ 1.27	+ 1.85
Xiphisternum	—	—	+ 0.90

These figures are much higher than those obtained by Bywaters for the rabbit; in particular, the

respiration though small is easily measurable. Comparing the ratios of respiration, aerobic and anaerobic glycolysis, we find roughly the same relationship for medulla of kidney, cartilage and tumours.

Approximate ratio	$Q_{O_2} : Q_{G^O}^O : Q_{G^N}^N$
Medulla of kidney	1 : 2 : 4
Cartilage	1 : 3 : 4
Tumours	1 : 2 : 4

Thus cartilage gives further support to the view previously expressed² that the metabolic type depends on the relationship between oxygen supply and energy requirements of the tissue.

F. DICKENS.

H. WEIL-MALHERBE.

Cancer Research Institute,
North of England Council of the
British Empire Cancer Campaign,
Royal Victoria Infirmary,
Newcastle on Tyne. July 3.

¹ Bywaters, *NATURE*, **133**, 30 (1936).

² Dickens and Weil-Malherbe, *Biochem. J.*, **30**, 659 (1936).

Optical Polarization Ellipsoids of the Hydrogen Halide Gases

ESTIMATES of polarization and related constants of the four hydrogen halides¹ appear to reveal certain peculiar, though simple relations. If α is the mean optical polarizability of a halide HX, b_1, b_2 respectively that along and perpendicular to the internuclear axis of symmetry S , r_e the equilibrium internuclear distance of HX, and $\alpha(X)$ the polarisability of the negative ion X^- , I find that (1) $\alpha = 1.242r_e^3$,^{2,3} and, further, if (2) $b_1 \propto r_e^3$, then since $3\alpha = b_1 + 2b_2$, (2a) $b_2 \propto r_e^3$, (2b) $b_1 \propto b_2$, and (2c) $b_1 = \alpha(X)$ (Born and Heisenberg⁴).

Stuart⁵, arguing from the positive sign of the constant occurring in the electro-optical Kerr effect of hydrogen chloride, found that the direction of greatest polarisability b_1 coincided with the axis S , along which the permanent dipole also lies. If we take¹ $\alpha(\text{HCl}) = 2.56$, and⁵ $(b_1 - b_2)_{\text{HCl}} = 0.77 \times 10^{-24}$ c.c., it follows that b_1, b_2 are 3.07 and 2.30×10^{-24} c.c. respectively. Using the above assumption (2), the corresponding values for the other halides may be calculated, as in the following scheme.

HX	$b_1, b_2, \frac{1}{2}(b_1 + 2b_2)$ (in c.c. $\times 10^{24}$)		$\alpha(\text{HX})$ (expt. ¹)	$\alpha(X)$ ⁴	r_e
HF	0.96	0.72	0.82	0.99	0.864A.
HCl	3.07	2.30	2.56	3.05	1.272
HBr	4.19	3.14	3.49	4.17	1.411
HI	6.24	4.68	5.20	6.28	1.612

The anisotropy δ is connected with the depolarization factor Δ (ratio of light intensity scattered parallel and at right angles to direction of incident beam) for gas molecules having an axis of symmetry, as follows:

$$\delta^2 = \frac{5}{6-7} \frac{\Delta}{\Delta} = \frac{(b_1 - b_2)^2}{b_1 + 2b_2} = \frac{1}{9} \left(\frac{b_1 - b_2}{\alpha} \right)^2,$$

so that we have $\delta^2 = 0.01007$, $\delta = 0.1004$ and $\Delta = 0.0119$ for each of the four cases. (Stuart⁵ found $\Delta(\text{HCl}) = 0.0125$, giving $b_1 = 3.01$, $b_2 = 2.24 \times 10^{-24}$ c.c.)

If we may take $\delta = 0.1$, we have $10(b_1 - b_2) = b_1 + 2b_2$, whence $b_2/b_1 = 0.75$, $b_1 = 1.2\alpha = 1.490r_e^3$, $b_2 = 0.9\alpha = 1.117r_e^3$, and $b_1 - b_2 = 0.3\alpha$.

On the present basis of argument, therefore, I conclude that (1) the four hydrogen halides have equal optical anisotropies, (2) the optical polarization ellipsoids constitute similar solid figures, (3) b_2 is approximately equal to 75 per cent of b_1 , and (4) b_1 of HX is equal to the polarizability of the halogen ion X^- , a somewhat surprising result. Dispersion of refractive index is neglected in making the estimates.

Further work on the depolarization and Kerr effects of the hydrogen halides other than hydrogen chloride is desirable to confirm these predictions.

C. H. DOUGLAS CLARK.

Department of Inorganic Chemistry,

University, Leeds.

June 3.

¹ C. H. Douglas Clark, *Trans. Faraday Soc.*, **31**, 585 (1935) (where α^* = present α).

² Clark, *Phil. Mag.*, (vii.), **19**, 476 (1935).

³ Clark, *Proc. Leeds Phil. Soc.*, **3**, 208 (1935).

⁴ M. Born and W. Heisenberg, *Z. Phys.*, **23**, 388 (1924).

⁵ H. A. Stuart, *Z. Phys.*, **55**, 358 (1929).

Focal Depth of the Hawke's Bay Earthquake of February 2-3, 1931

In the seismological report of the Hawke's Bay earthquake of February 2-3, 1931¹, an attempt was made to arrive at a value for the focal depth of the shock. The method used was similar to that developed by Jeffreys² for near earthquakes in western Europe, depending on the apparent delay of the surface wave Pg . In the Hawke's Bay earthquake, a phase agreeing reasonably well in velocity with Pg was observed on the seismograms at Arapuni, Takaka and Wellington, and the mean apparent delay led to a focal depth of 13 miles (21 km.). On account of the confused nature of the Wellington and Arapuni records, and the lack of precise time on most of the records, it was considered that a definite value for the depth could not be obtained, but that it probably lay between 10 miles and 15 miles (16-24 km.). In the original interpretation of the Takaka record, the first phase recorded after Pn was considered to be P^* , and the interval between Pn and Pg was 28 seconds.

In a recent paper³, C. G. Dahm, of Saint Louis, U.S.A., had occasion to discuss the focal depth of the Hawke's Bay earthquake, using data from the Takaka seismogram. He found an interval of 7.5 sec. between what he considered to be the phases Pn and \bar{P} , and states that this agrees with a focal depth of 10 km. (6 miles). Dahm points out that the Takaka data are not conclusive, and after some further considerations, finally arrives at a focal depth of the order of 10-12 km. (6-8 miles).

Having rightly directed attention to the difference between his own value for the depth and that given in the Hawke's Bay earthquake report, Dahm criticises this report, considering that the methods used appear to be based on doubtful assumptions. In view of this criticism, I re-examined the original Takaka seismogram. On both horizontal components the first movement (presumably Pn) is very small and emergent, and the interval before the arrival of the second phase was found to be 8 sec. on the E-W component, and 11 sec. on the N-S component. This discrepancy of 3 sec. may be due to the arrival of Pn not having been recorded on the E-W component. On the vertical component, Pn is very small, but the interval to the next phase was observed to be about 10 sec. The mean interval between Pn and the next phase at Takaka therefore appears to

have been of the order of 10 sec. No phase could be found to correspond with an interval of 7.5 sec., as read by Dahm, and if it is assumed that the second phase is \bar{P} , then a focal depth somewhat greater than 10 km. is indicated. This would tend to diminish the discrepancy between Dahm's determination of the focal depth, and that given in the Hawke's Bay earthquake report.

It should be mentioned that the re-examination of the Takaka seismogram did not appear to warrant any serious alterations to the original interpretation from which the focal depth of 10-15 miles (16-24 km.) was determined. Further, although Jeffreys' theory regarding the waves in near earthquakes has been somewhat modified in a more recent paper⁴, the apparent delay of the P_g wave would still lead to a determination of focal depth.

From the foregoing statements, it is considered that Dahm's interpretation of the Takaka seismogram is open to question, and that his criticism of the Hawke's Bay earthquake report is not justified.

R. C. HAYES.

Dominion Observatory,
Wellington, N.Z.
April 24.

¹ C. E. Adams, M. A. F. Barnett and R. C. Hayes, Seismological Report of the Hawke's Bay Earthquake of 1931, February 2-3. Dominion Observatory Bulletin 85.

² H. Jeffreys, "The Earth", 2nd Edition.

³ Cornelius G. Dahm, "The Velocity of P waves in the Earth Calculated from the Macclwane P curve, 1933", *Bull. Seis. Soc. America*, 26, 1 (1936).

⁴ H. Jeffreys, "A Rediscussion of Some Near Earthquakes", *Geophys. Supp., Mon. Not. Roy. Ast. Soc.*, 3, No. 3, March 1933.

Continuous Spectra of Certain Types of Stars and Nebulae

MR. W. M. H. GREAVES¹ has made certain objections to my tentative explanation of secondary maxima in the continuous spectra of novae, etc.², because the observations of Nova Herculis 1934 made by various observers do not fully agree.

I should like to point out that a close inspection of the curves given by Beileke and Hachenberg³ discloses, however, the presence of a secondary maximum in most curves at practically the same wave-length as observed by Barbier, Chalonge and Vasy⁴ and reproduced in my note. The results of the unpublished Greenwich observations are, of course, unknown here.

However, leaving aside the Nova Herculis 1934 spectrum, we find, in the spectra of several former novae, the presence of secondary maxima upon which I based my theory of two different types of continuous emission spectra in novae, etc., superimposed on each other. Whether or not one of these emissions is continuous electron radiation is an open question. I only wish to direct attention to this type of emission, the existence of which does not seem to be generally realized. This type of spectra is quite different from the Planck black body radiation on which most astrophysical theories are based. I believe that the continuous electron emission will help in explaining several phenomena observed which have not been accounted for so far.

WILLI M. COHN.

Berkeley, California.
May 26.

¹ W. M. H. Greaves, *NATURE*, 137, 405 (1936).

² W. M. Cohn, *NATURE*, 137, 150 (1936).

³ F. Beileke and O. Hachenberg, *Z. Astrophys.*, 10, 366 (1935).

⁴ D. Barbier, D. Chalonge, E. Vasy, *C.R.*, 201, 128 (1935).

The Teaching of Science in Schools

AN account of a conference on general science opened by the president of the Royal Society appeared in *NATURE* of April 11, p. 626. This association of prominent men of science with secondary education is very desirable. I write to suggest that the present is a very critical time for science teaching in schools, and that men of science may now be able to give help in a more effective way than by presiding at meetings and conferences.

Such help has been given in the past. In 1918 a committee of which Sir J. J. Thomson was chairman issued a report on the teaching of science and made many valuable suggestions. A few of these have been carried out, but only a few; in the meantime, conditions have altered, and the whole question needs reconsideration. The recent conference represents a belated attempt to implement recommendation No. 17 of that report:

"That the science work for pupils under 16 should include, besides physics and chemistry, some study of plant and animal life."

To do this in the limited time at the teacher's disposal presents difficulties, but this recommendation must necessarily be read in conjunction with recommendation No. 8:

"That in all secondary schools for boys the time given to science should not be less than 4 periods in the first year of the course from 12 to 16, and not less than 6 periods in the three ensuing years."

This was published nearly twenty years ago, when the great necessity was to obtain for science some sort of recognition in our educational system. It would be expected that what was recommended then would be axiomatic now. Surprising as it may appear, the very body which was partly responsible for this recent conference expressed the intention of trying to formulate a generalized course in chemistry, physics and biology to occupy only 4 periods a week; that is, 3 hours or a little less.

If this proposal comes into being, we shall be back again in pre-scientific times. If I read the recommendation of the Thomson committee aright, it did not maintain that the 6 periods a week was an adequate time, but merely that it was as much as many schools under present conditions could be expected to give. A considerable number of schools have now approximately that time. There is a danger that the publicity which has been given to a particular sub-committee may lead to reduction of this inadequate minimum of time which many science teachers already have.

The whole problem of the school time-table is now in hopeless confusion. No attempt is being made, for example, to correlate the mathematics and the science in the manner suggested by the Thomson committee. Teachers of mathematics and science scrupulously respect each others' territory. The dominant influence is that of a group of headmasters who wish to keep the classical bias of the time-table, and this is probably the origin of the proposal to formulate a scheme for 4 periods a week, a proposal which was originally suggested by the Secondary Schools Examination Council. The time is ripe for another committee, similar to the old Thomson committee, to reconsider the whole question in the light of the conditions of the present day.

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Teddington.

Estimation of Vitamin A

WITH further reference to our letter under this title in *NATURE* of March 7, p. 402, we have been in touch with Dr. E. M. Nelson, chief of the Vitamin Division, United States Department of Agriculture, Food and Drug Administration, Washington, concerning the ambiguous position of the U.S. Pharmacopœia Reference Cod Liver Oil. Our query was, Are we sure that the "Reference Oil" now in use is identical with the original product? In reply to our question he has given us permission to publish the following facts, which undoubtedly throw some light on a rather difficult situation:

"There has been only one lot of this reference oil prepared and the samples that have been issued were all bottled at the same time from this lot. Since the potency of 3000 units of vitamin A and 95 units of

vitamin D were assigned to this oil, assays have been made at intervals by six laboratories for both its vitamin A and vitamin D content. There has been no indication that the oil has changed in vitamin potency. As soon as the oil was obtained samples were sent to Dr. Charles E. Bills of Mead Johnson and Co., for spectrophotometric determination of vitamin A. He has made several such examinations since that time. His last report was made to the U.S. Pharmacopœia Vitamin Committee on March 24, at which time he stated that as far as can be determined spectrophotometrically the oil has not changed in vitamin A potency."

JOHN F. WARD.

Crookes Laboratories,
London, N.W.10.

R. T. M. HAINES.

June 12.

Points from Foregoing Letters

THE atomic masses of doubly charged thorium 232, and of uranium 238, have been determined by Prof. A. J. Dempster with the mass-spectrograph, by comparison with the isotopes 116 and 119 of tin (having the same mass-charge ratio). The presence of 0.4 per cent of a stable uranium isotope of mass 235 was also found, and since a radioactive uranium isotope of mass 235 and of half-life 24 hours is already known, Prof. Dempster concludes that the two isotopes, having the same mass and charge, are isomers differing in nuclear properties.

Some previous observations of the conductivity, unimolecular racemization and halogen replacements of alkyl halides in sulphur dioxide and formic acid solution are interpreted by Dr. E. D. Hughes, Prof. C. K. Ingold and A. D. Scott as arising from the slow liberation of a negative halogen ion (Cl^-) followed by the rapid elimination of a positive hydrogen ion (H^+). The original saturated compound thus becomes unsaturated, as is shown by its subsequent ability to absorb bromine.

A possible chemical mechanism to explain how the addition of sodium sulphide or of certain primary amines helps the removal of hair from hides by fresh lime liquors is suggested by Dr. H. Phillips. These substances reduce the sulphenic acid side-chains to cysteine, and thus prevent the generation of aldehyde groups; this facilitates the severing of the cystine disulphide cross-linkages of the keratin substance.

From the rate of sedimentation of solutions of thyroglobulin (the active constituent of the thyroid gland) under the influence of strong centrifugal forces, Dr. H. P. Lundgren concludes that it consists mainly of particles of 'molecular' weight 700,000. Low concentration of thyroglobulin or of salts, high temperature, high dielectric constant and $p\text{H}$ above the isoelectric point have been found to favour the dissociation of thyroglobulin into components of lower particle weight.

The atomic heat of palladium between 2.5° and 22° K. has been determined by G. L. Pickard. He finds, in agreement with Mott's views, that it can be expressed as the sum of two factors, one due to lattice vibrations, which varies with the cube of the temperature, and another, the electronic specific heat, varying directly with the temperature and due to unfilled quantum states (positive holes).

The transparency of thin films of sodium and potassium in the far ultra-violet (Schumann region) has been determined by Prof. W. H. Watson and D. G. Hurst. They point out the value of sodium films as filters to remove the visible and ultra-violet light above 2100 Å., and direct attention to the conflict between experimental results and the existing theory of the optical properties of metals.

Rats from which the adrenal body has been removed live longer if fed on bread than when fed on Purina Dog Chow. Dr. R. A. Cleghorn and G. A. McVicar suggest that this is due to the lower potassium content of the bread, since it has been shown that potassium is detrimental to adrenalectomized animals.

By grafting on to chick embryo the anterior part of the embryonic axis of a two somite rabbit, a small but definite neural plate was induced in the host. This, C. H. Waddington states, shows that the rabbit contains an organization centre, and is additional proof that determination of the mammalian embryo is in fact produced by an organization centre.

Dr. C. H. Douglas Clark finds that the optical polarization ellipsoids of the four hydrogen halide gases constitute similar figures having equal anisotropies and depolarization factors. He calculates the polarizabilities for the four cases, and finds that the polarizability at right angles to the internuclear line is about 75 per cent of that along this line, and is equal to the polarizability of the corresponding negative ion.

In view of the divergence in the interpretation of the seismograms of the Hawke's Bay earthquake of 1931 and the calculations of the focal depth therefrom, R. C. Hayes has re-examined the original Takaka seismogram. Its record, he states, confirms in the main the original interpretation, from which a focal depth of 16-24 km. was inferred.

Referring to the note in this column (July 11, p. 81) on "Inactivation of Crystalline Pepsin", Dr. J. Steinhardt states that the fifth-power relation reported in his communication does not extend over the small interval $p\text{H}$ 6.2-6.45, but from the most acid solutions measured to $p\text{H}$ 6.45. The velocity interval was over 1 to 5,000, while the smaller interval given in the synopsis is equivalent only to a range of about 1 to 15.

Research Items

Actions of Acetylcholine on the Brain

THE pharmacological actions of acetylcholine are of particular interest because, in almost every case in which this substance has been shown to have an action in the body, evidence has been obtained of the presence of a nerve which liberates acetylcholine locally in such a way as to produce this action. Henderson and Wilson have recently filled an important gap in our knowledge of the actions of this substance (*Quart. J. Exp. Physiol.*, 26, 83; 1936). They have injected acetylcholine into the ventricles of the brain in man. This causes vomiting, intestinal peristalsis and sweating. Its effects on the heart rate, blood pressure, respiration, the pupil, etc., were small and inconstant. The injection of eserine caused similar effects, and potentiated the effect of a later injection of acetylcholine. These effects were produced by comparatively small doses, and it is clear that they were due to a local action on the brain and not to a general action after absorption into the general circulation. Atropine, injected into the ventricles, prevented or abolished the effect. Apart from the interest of the observations themselves, these results are important because they suggest that certain impulses may be transmitted chemically by acetylcholine across synapses in the central nervous system.

Flour Beetles of the Genus *Tribolium*

THE small beetles of this genus are of great economic importance since they are able to subsist on a wide variety of food materials, and have become widely distributed through commerce. The ease with which they can be reared under controlled environmental conditions has also marked them out as very suitable material for population studies and other kinds of laboratory investigation. In Technical Bulletin No. 498 (March 1936) of the United States Department of Agriculture, Mr. Newell E. Good has brought together a mass of useful information respecting the biology, habits and control of the species of *Tribolium*, together with a selected bibliography of the genus. Keys are given as an aid to the identification of the economically important species, which are also admirably figured. Although primarily written from the economic point of view, the Bulletin will prove useful to laboratory workers also. In the latter connexion, the tabular data respecting development at specified temperatures and on oviposition and longevity may be specially mentioned.

Spotted Wilt Virus and the Hormone Heteroauxin

WE have received a communication from Dr. B. J. Grieve, of the Department of Botany, University of Melbourne, in which he describes the results of his investigations into the action of the spotted wilt virus upon the growth regulator heteroauxin. It is well known that spotted wilt arrests the growth of infected tomatoes, and it seemed likely that the virus inactivated the growth hormones in these plants. The technique of Went was first used to compare the effects of diseased and healthy juice upon the inward curvature induced by heteroauxin on split pea stems. In four experiments, such curvatures were observed upon the stems placed in healthy juice

with heteroauxin, but were absent from those treated with virus juice and the hormone. This seemed to show an inactivation of the growth regulator by the virus, but a further number of similar experiments did not indicate any difference between the two kinds of treatment. Another and more conclusive method of study involved the injection of various amounts of heteroauxin into healthy, and into diseased, tomato plants. Adventitious roots appeared upon the stem in the majority of healthy plants, but did not form upon diseased tomatoes, unless the plant appeared to have thrown off the disease. The inhibitory action of spotted wilt virus on heteroauxin is not shared by two other viruses which were used, namely, tobacco viruses 1 and 6.

X-Chromosome of *Drosophila*

THE X-chromosome of *Drosophila melanogaster* and *D. simulans* contains near the end an enlargement or 'bulb' in the salivary gland chromosome, the nature of which has been investigated by Dr. C. A. Offermann (*J. Genetics*, 32, 103). He finds that the bands run obliquely in two series in the 'bulb', and that it represents a symmetrical duplication or 'branch' of a short chromosome segment. This might arise through three breaks and two re-attachments in a pair of chromosomes, or by five breaks and three re-attachments. In either case, one of the breaks must occur at the same level in both chromatid strands. As the 'bulb' occurs in two closely related species, it must have arisen in their common ancestor and must therefore be a stable feature of the chromosome. This is accounted for by the fact that crossing-over can occur between the two arms of the duplication, the bands of which are in reverse order. The less condensed appearance of the 'bulb' in salivary chromosomes of the male than in the female is attributed to a lesser synaptic attraction between the chromonemata in the male nuclei.

Strength Tests of Structural Timbers

UNDER this title in *Forest Products Research Records*, No. 8, Part I dealt with general principles, with data on redwood from Gefle and Archangel. Part 2 of the same series (April 1936) deals with general procedure of selecting and testing joists, with data on British Columbian Douglas fir (*Pseudotsuga Douglasii*) by C. J. Chaplin and E. H. Nevard. The tests were carried out with small clear specimens and also on a full scale: the results are of considerable interest. In summarizing them, the Director of the Princes Risborough Laboratory says that "A comparison between the results given in this report and those published by the Forest Products Laboratories of Canada may show an apparent discrepancy in the strength values. This is due to difference in the relation between width and depth of cross-section of the pieces tested and to differences in character which may occur between samples of the timber. Such differences in character must be expected where a wide range of the timber is dealt with in the country of origin. The Forest Products Research Laboratory at Princes Risborough accepts completely the validity of the Canadian figures, and urges their use in all circumstances concerning the

strength of Canadian Douglas fir. The same applies to results published by the Forest Products Laboratory at Madison, U.S.A., for Douglas fir grown in that country."

Experiments with 'Electrets'

A COMMUNICATION entitled "The Disengagement of Energy in Melting Electrets" has been received from Drs. G. Grotzinger and H. Frei, of the University of Vienna. An 'electret' is produced by solidifying certain types of wax, for example, carnauba wax, in a strong electric field. The wax thereby acquires a polarization, in the direction of this applied field, which may be retained unimpaired over very long periods of time. It may be said to be the electrical equivalent of the permanent magnet. A paper by A. Gemant, published in the *Phil. Mag.* (20, 929; 1935) describes much research work on the subject, with a bibliography of earlier papers. Drs. Grotzinger and Frei state that, when an electret is melted, the stored charge is released as an electric current, and that this charge is the same whether the electret is melted immediately or several days after its preparation. This, however, is to be expected, since it is known that electrets can retain their original charge for a considerable period. The authors also record that, when the electric field is applied to an already solid sample of the electret material, the stored charge is much less than before, and instead of being retained, as in the normally produced electret, it disappears fairly rapidly. This is quite a normal procedure, and the experimental result is what would naturally be expected.

Transmutation of Platinum by Deuterons]

TRANSMUTATION by bombardment with artificially accelerated deuterons, which is nearly general among the light elements, has now been observed with very heavy elements. J. M. Cork and E. O. Lawrence (*Phys. Rev.*, 49, 788, June 1) have bombarded platinum foils with deuterons of maximum energy 5×10^6 volts. The induced radioactivity was composite in character; periods of 28 min., 8.5 hr., 49 min., 14.5 hr. were detected, and a chemical investigation showed that the first two periods were associated with iridium and the second two with platinum. Both positrons and electrons were emitted. The transmutation of such heavy elements is not to be explained on the Gurney-Condon-Gamow theory of the penetration of potential barriers, and the formation of iridium isotopes is not explained by the theory of Oppenheimer and Phillips, in which only the neutron part of the deuteron enters the nucleus. The direct action of secondary neutrons was excluded by a special experiment. The production of iridium isotopes probably follows the entry of deuterons of special velocities into the nucleus by a 'resonance' process, and the dependence of transmutation efficiency on deuteron velocity is in accordance with this view.

Velocity of Rapid Reactions

SOME years ago, Hartridge and Roughton devised a method for the study of rapid reactions in which two solutions were mixed and then made to flow down a tube. The progress of the reaction at points along this tube was measured by optical methods. The method has now been improved by the use of photo-electric cells and by reducing the scale of the apparatus (F. J. W. Roughton and G. A. Millikan, *Proc. Roy. Soc.*, A, 155, 885, June 2). The mixing arrangements and the character of the flow down

the tube have been specially studied. The smallest apparatus may be used with 20-30 c.c. of fluid to study reactions with half-periods of 0.0005 sec. Some experiments on reactions which have been studied by other methods confirm the validity of the method.

Low Temperature Carbonization of Coal

THE Department of Scientific and Industrial Research has published the results of tests made in accordance with a standing arrangement by the Director of Fuel Research on a plant erected by the Coal Research Syndicate, Ltd., at Mansfield, for the carbonization of coal at low temperatures (London: H.M. Stationery Office. 9d. net). The process has interesting features. A charge of lump coal (35 tons), almost devoid of caking properties, is carbonized in a chamber 10 ft. in diameter and 25 ft. high by the combustion at the top of the column of part of the gas made. The products of combustion and distillation are drawn downwards through the charge, and leave the bottom for the gas treatment plant. A portion of the gas is returned to the top of the carbonization chamber when, as mentioned above, it is burnt after the addition of air. At the end of the carbonization, the bottom of the retort is withdrawn by hydraulic gear, and the whole charge is dropped for quenching. The coke product was found, on test, to be a satisfactory fuel for the open grate. This process is interesting because, unlike most low temperature processes, it handles the material in bulk comparable and exceeding that in modern coke ovens.

Development of the Coiled-Coil Lamp

In the *Technical Review* of April published by the Philips Laboratory, Eindhoven, Holland, there is an instructive paper by W. Geiss on the development of the coiled-coil lamp. The first material used for lamp filaments was carbon and later graphite. A further increase in temperature was made possible by the adoption of metals with high fusion points like osmium, tantalum and tungsten. At present, tungsten is considered the best material for lamp filaments. To obtain a high efficiency, it is essential to keep the rate of volatilization as low as possible. A 'filling' of argon or nitrogen at 50-100 cm. pressure greatly diminishes the rate of volatilization. Unfortunately, the gas filling increases the losses by thermal conduction and convection. In this respect thick filaments give much more satisfactory results than thin ones. If a long thin filament is wound in the form of a spiral, its total heat losses are of the same order as for a filament of the same length and cross-section as the spiral. It has been found possible to reduce the effective length of the coil still farther by winding the coil itself round a core, and this gives the 'coiled-coil' arrangement. The first attempts to use coiled coils were made twenty years ago, and failed mainly because the filaments expanded during service. By suitable pre-treatment, this difficulty was overcome. A mixture of argon and nitrogen has been used for filling these lamps. If krypton or xenon were used as a filling, the heat losses would be greatly diminished. Whether they will ever be used depends on the progress that is made in isolating these rare gases. If the flux from a single-coiled and a coiled-coil lamp is the same, the saving in power in the latter lamp is 7-10 watts; in addition, it maintains its efficiency better during life. The increase in the efficiency obtained by coiling the filaments is more marked for lamps of small candle-power.

Tercentenary of the University of Utrecht

ON June 22-24, a brilliant sun shone on the ancient and famous city of Utrecht, thronged with students and visitors from many lands and gaily decorated with the national flag of Holland and the colours of all the Faculties. The occasion was the celebration of three hundred years of the University's existence. To Utrecht had come the representatives of most of the universities and learned academies of the world, to pay homage and do honour to her ancient and distinguished university. Amidst the scarlet gowns and many coloured hoods of the professors and academicians flashed the white plumes of the horses and the gay cockades of the splendid coachmen of the students' carriages, for to Utrecht had also come the representatives of the students' "senates" from all the universities of Holland, and the associations and clubs of old University of Utrecht men from every part of the country. In this land won by brave men from the sea, where freedom dwells and learning flourishes, all had met to place another milestone on the long road of civilization, wherewith to mark the completion of the third century of a great university's beneficent life.

During the forenoon of Monday, June 22, the associations and clubs of former members of the University came with their banners in a procession from the station, whilst a great carillon pealed and thundered from the thirteenth century tower of the Cathedral Church. In the afternoon, gifts were presented to the University. At eight o'clock in the evening, the foreign delegates, representing universities and learned academies and societies, were received by the Council and Senate in the great Hall of the University, while at nine o'clock the municipality of Utrecht held a reception in the rooms and beautiful garden of the Municipal Art Gallery.

Serious business began on Tuesday, June 23. In the morning the delegates, in academic robes and decorations, were received by the University in the Church of St. Peter. Addresses of welcome were delivered by Dr. S. Jacob, the President of the Council, and Prof. C. H. Vollgraff, the Rector Magnificus. Speeches of congratulation and thanks were then made by Prof. J. Huizinga, of the University of Leyden, and by several foreign delegates, including Dr. Clarke, of the University of Oxford. The University hymn, "In Babylonia", was played on the viola, with organ accompaniment, by Mrs. Vogelsang. As the name of each delegate was called, he came forward and presented an address of congratulation to the President and the Rector. Then the members of Council, the professors of the University of Utrecht and the foreign delegates walked in procession from the Church of St. Peter to the Cathedral Church, where lunch was provided in the cloisters and the beautiful old cloister garden. Among the other English delegates present may be mentioned Prof. G. Barger (representing the University of Edinburgh), Prof. F. G. Donnan (representing the Royal Society and the University of London), and Prof. D'Arcy Thompson (representing the Royal Society of Edinburgh and the University of St. Andrews).

After lunch, the great procession of professors and delegates walked through the streets of Utrecht, which were thronged by enormous crowds of citizens and guarded by cordons of police. This brilliant and most impressive scene was watched by the Queen of Holland and the Princess Juliana. The procession returned by a different route to the Cathedral Church, where a solemn service of commemoration was held in the presence of the Queen and the Princess, and a great gathering of invited guests, including many high officers of the army and navy and high officials of the State. After some of the beautiful organ music of Bach, addresses were delivered by the President of the Council and the Rector Magnificus, the latter giving a long account of the struggle of Western civilization for freedom of learning and liberal government. Then came a very interesting ceremony, the presentation of the first gold medal of honour of the University to the Queen, to which Her Majesty made a suitable reply of thanks. After some more organ music, a short and eloquent address was delivered by His Excellency the Minister of Education, Art and Science. The proceedings were concluded by the ceremony of attaching the third centenary ring to the pole of the great banner of the University.

After the commemoration service, a number of foreign delegates were presented to the Queen, and as the great procession again filed out of the Cathedral Church, a carillon was played by J. A. H. Wagenaar.

In the evening, a banquet was given by the Senate of the University, at which many delegates made speeches of congratulation and thanks. After the banquet the guests were taken by bus to a wonderful open-air performance by members of the Students' Associations. This was a dramatic pageant entitled "De Groote Geus" (The Great Vagabond). The façade of a great castle had been erected in a large meadow, representing the stronghold of a Spanish noble. In front of this the peasants and citizens held a market fair. Then came the "Groote Geus"—the Dutch Tilleulenspiegel—with his jesters and his jests, to amuse the people and by sarcastic innuendo to arouse them from their bondage. Their anger grew, but Spanish horsemen and men-at-arms poured from the castle gates to quell them. Finally, the Hidalgo with his chatelaine and retinue came out to witness a masque prepared by Tilleulenspiegel. But the people saw what he meant—it was a masquerade of the "Fat- and swollen-headed overlords". In a burst of rage and anger, they stormed and burnt the castle. The drama thus represented the struggle of the Netherlands for freedom from the Spanish yoke. It was a fine performance, played by something like three hundred students, with elegant costumes and elaborate flood-lighting effects. High praise must be accorded, not only to the author, producer and director, but also to the excellent acting and speaking of Tilleulenspiegel, who had a very heavy part. A special and very enjoyable feature of the pageant was the dramatic music, which was played from behind the façade by the municipal orchestra. This music was specially composed for the occasion by Dr. H. E. Enthoven.

The forenoon of Wednesday, June 24, was taken up by the conferring of honorary degrees on a number of delegates in the Great Hall of the University. Among those who were thus honoured may be mentioned Sir Henry Dale, Prof. Herbert Freundlich (University College, London), and Dr. Clarke (University of Oxford). At midday the delegates and their ladies were entertained to lunch in the cloisters and cloister garden of the Cathedral Church, after which they witnessed the march past the University of the students' "Masquerade". This was a dramatic procession of pikemen, mounted knights, etc., of which the special feature was the "Prince of Orange" and his retinue.

In the afternoon, there was a very enjoyable excursion (by autobus) into the province of Utrecht, including a visit to Hilversum and its new town hall (a fine building in the modern unadorned style) and tea in the park of the Chateau Deynselburg, given by Madame and Dr. S. Jacob. On returning to Utrecht, the guests paid homage to the "Prince of Orange", who held a Court.

The day concluded with a gala concert in the Tivoli Concert Hall, conducted by the famous Willem Mengelberg. The programme was: *Sol Justitiae*: a hymn dedicated to the University of Utrecht on the occasion of the third centenary (composed by Dr. H. E. Enthoven); *Piet Hein*: a Dutch rhapsody

(composed by Dr. P. G. van Anrooy); Overture to the "Taming of the Shrew" (composed by Dr. Joh. Wagenaar); Beethoven's Fifth Symphony.

The music was well played by the municipal orchestra under the spirited leadership of Mengelberg. An amusing incident was the arrival of the "Prince of Orange" and his retinue. Even the great Mengelberg had to come down from his rostrum and pay homage!

Thus ended three wonderful days of lavish Dutch hospitality, academic ceremony and students' pageantry. As if in remembrance of the University motto, *Sol Justitiae, illustra nos*, the sun shone brightly on the gay scene of scarlet gowns, white-plumed horses, knights on horseback and the great Prince of Orange. The professors of the University amply sustained the honour of their city and their country in offering very kind private hospitality to many of the invited guests.

It was a great demonstration of the universality of learning, of the brotherhood of truth and freedom. As one stood in the peaceful cloister garden and listened to the carillons from the ancient tower, the message of a noble civilization resounded in one's ears. One was glad to feel that Holland had kept the sweet music of her old carillons and in the benign tolerance of a greater humanity had won the freedom of her soul.

F. G. DONNAN.

Fractures in Metals and Brittle Materials

A DISCUSSION on "Fractures in Metals and Brittle Materials" was held at the Royal Society on Thursday, June 11. Many points of importance were brought out in this interesting discussion, and it is perhaps difficult in the small space of a general article to do justice to them.

In introducing the subject, Dr. H. J. Gough presented a review of the present position of knowledge in regard to the understanding of the mechanism of failure. As regards metals, he holds that in view of their essentially crystalline structure the required physical explanation must be in terms of atomic structure before any real progress in ideas can be achieved. Stripped of non-essentials, the problem is that of obtaining an understanding of plastic deformation and a realization of the exact conditions under which a crack is formed. He emphasized the disability of not having available a satisfactory conception of the laws of cohesion in the metallic state, and the extreme value of any new contribution in this direction. Elasticity is an expected property in a metallic crystalline aggregate, but plasticity is a property which is extremely difficult, at the present time, to understand.

The study of single crystals is very helpful since the processes of deformation and fracture are characteristics associated with the crystal structure, and effects in crystal aggregates are modifications of the effects occurring in single crystals. The geometrical aspects of deformation are established, but give no information on the mechanism of fracture. While stressing the fact that the characteristics of deformation and fracture are probably capable of explanation in terms of single crystals, it must be remembered that the strength of polycrystalline aggregates depends to some extent on crystal size,

so that an understanding of the part played by the crystal boundaries is a very important factor in the solution of the whole problem. No established explanation has yet been provided in regard to work-hardening, strain hysteresis, twinning and the process of conversion of strain energy indefinitely into heat energy.

Assuming that the mechanism of fracture is essentially a property of the individual crystals, Gough and Wood have described, in a recent paper, an investigation by X-ray methods into the physical system prevailing after different numbers of cycles in fatigue tests. It would appear that at fracture the physical system is the same under all conditions. Under a safe range of stress the damage to the crystal structure is not progressive, but a stable state is reached, whereas under an unsafe range of stress progressive change takes place. The changes in the neighbourhood of the ultimate fatigue crack are characteristic and exactly similar under all unsafe ranges of stress, and in this area the original structure is destroyed and new crystallites formed. This appears to be a definite advance in knowledge.

Prof. G. I. Taylor confined his remarks chiefly to the more precise mathematical theory of internal flaws. If one crystal is deformed, and hardening is produced in the crystal, additional stresses are imposed on the surrounding crystals, which therefore tend to become deformed. In steel at the yield point the stress is reduced on deformation. In this case the deformation tends to proceed in the same crystal and an irregular deformation results.

If the material has internal flaws—such as might be represented by small spherical and ellipsoidal cavities—the stresses acting locally are increased. Failure under these local stresses would be expected

to occur when certain critical combinations of shear and direct stress are reached. (The exact relationships between shear and direct stress which follows from Mohr's hypothesis and from that of von Mises differ somewhat.) A special case is that where the cavity is filled with a material. For simple shapes of cavity, the stresses can be calculated, and one result is that if a flaw is assumed to be ellipsoidal, then the greatest concentration of stress may occur with the direction of the flaw at 45° or at right angles to the direction of principal stresses, according to the relative compressibility of the 'inclusion'.

Prof. L. N. G. Filon dealt chiefly with the different types of fracture which occur in solids, and illustrated his remarks with a large number of fractures in cast iron and glass. In ductile materials, slip does not always occur at 45° to the principal stresses. A fracture in a strip of mild steel broken in tension showed a fracture at approximately 60° to the line of the principal stresses. This was not due to any asymmetrical properties of the steel, since a second slip line clearly shown by the material was exactly symmetrical with the first. In cast iron, brittle fractures can be obtained by a bending operation in which pure tension is applied to some parts of the material, and pure longitudinal compression in other parts. In this case fracture occurs at right angles to the stress lines. A curious 'staircase' fracture has been observed in these brittle materials in which the fracture began at right angles to the tension, but after passing through the material for some distance, branched along the line of tension, and branched back into the original direction and gave a step. In some cases several steps were observed. The conclusion reached was that in the same material the type of fracture obtained depends on the method of application of stress.

The possible effects of sub-microscopic cracks was the chief point discussed by Prof. E. N. da C. Andrade. He considers that the existence of surface cracks has been well established in three series of experiments. A strip of mica loaded so that the edges are stress free has a strength of about ten times the normal value. Andrade and Martindale in experiments on thin metal films on glass, diamond or other substance, have found that recrystallization proceeds on definite lines on the surface. These lines do not appear when the film is produced on the very perfect cleavage faces of mica. Indirect evidence of these surface cracks is afforded by experiments of Roscoe on cadmium wire, which had its critical shear stress increased to double the normal value when coated with a thin film of oxide a few molecules thick. It is well known that freshly drawn threads of quartz and glass are stronger than old threads. Griffiths believes this to be due to the absence of cracks in the freshly formed threads. In concluding, Prof. Andrade indicated briefly some of the difficulties of forming a theory of plastic deformation. In plastic materials, twinning and gliding take place on the twinned material in a way which is very complicated even in single crystals.

Dr. W. H. Hatfield said that the stress which may be safely applied is far removed from the stress which produces fracture, and that from the point of view of the engineer and metallurgist, the actual mechanism of fracture is less important than a satisfactory explanation of the means which are effective in increasing the safe range of stress. In iron, the fatigue range of the crystalline aggregate is increased and the stress to produce initial plastic deformation

is also increased by 'sprinkling' particles of a hard, brittle substance, carbide of iron, through the mass of the ductile metal. It requires to be explained how the presence of such carbide particles raises the stress required to produce initial deformation in the continuous matrix of ductile ferrite. An increase in the value for the stress up to which strain is proportional to stress is difficult to understand. Particles of other hard brittle materials such as slags, sulphides, etc., do not have the same effect, in that they leave the yield point and maximum stress unaltered, but the ductility is very much decreased. It seems, therefore, that the adhesion and cohesion between the ductile matter and the particular inclusions is an important factor. An interesting fact which requires explanation is the influence of cold work on the fatigue values. It seems peculiar that a process of plastic deformation should increase the resistance to fracture. Much has been written on the effect of grain size, but it is easy to overlook the fact that to modify grain size as the only variable is extremely difficult, if not impossible. The causes of the modification of grain size may well be the real cause of the apparent effect of grain size.

Prof. P. B. Haigh's contribution was of particular interest in that it could be considered that his observations postulated a resuscitation of the idea of stress in metals translating the crystalline to the amorphous phase. When a slip band is formed in a crystalline ductile metal, the increase in the volume from the crystalline to the amorphous state tends to produce fluid pressure in a core surrounded by increased shear stress, and the band tends to spread across planes of easy cleavage in the grain.

Mr. S. A. Main suggested that more work on the speed of testing and the influence of temperature might lead to further information on the main problem. He also referred to the characteristic appearance of slip bands which are visible under the microscope and are therefore of a different size from Gough's 'crystallites'. There can be little doubt that the characteristic separation of the bands has a fundamental bearing on the problem.

Sir Robert Hadfield, in a written contribution, said that when attending trials of projectiles against modern armour, he had often observed that there seemed to be little difference in the appearance of a fracture, as compared with the fractures met with under ordinary static or dynamic conditions at comparatively low velocities of impact. Nevertheless, there were instances of remarkable differences in behaviour of various steels according to the manner in which they were tested, that is, whether comparatively slowly or rapidly. Some materials like over-heated mild steel, tough under slow stressing, are quite brittle at moderate speeds of testing. Mild steel of ordinary good quality is tough at all normal speeds used in impact testing, but tends to break with a brittle fracture when attacked at high speeds with rifle bullets. With regard to the effect of low temperature, there seems to be no simple explanation of the different responses made by different metals. Thus the retention by nickel of its toughness at very low temperature is not simply explained by its particular type of cubic structure, namely, the face centred cubic, in contrast with that of iron, which is body centred cubic.

The discussion was an extremely valuable one, and has served to indicate many directions in which intensive investigation can usefully proceed.

Research Fellowships and Grants

ROYAL SOCIETY AWARDS

THE Council of the Royal Society decided in the spring of this year to found an E. Alan Johnston and Lawrence research fellowship in medicine by means of funds available to the Society by bequests under these two names. The value of the stipend is £700 per annum, plus superannuation allowance. Seventeen candidates applied for the fellowship and of these, four were selected for special consideration. Council would gladly have appointed any one of them to a fellowship had four fellowships been available. The reception of the fellowship is a strong indication that candidates of high merit are available for full-time research posts in medicine. Council finally selected Dr. John McMichael, of Edinburgh, to work at the Edinburgh Royal Infirmary on the pathology of heart failure. From 1934 to 1936 he has been a lecturer in human physiology at Edinburgh. He has been offered special facilities for his work at the Edinburgh Royal Infirmary.

The Council of the Royal Society has also approved plans for medical research on malaria and on nutrition in India, involving a total expenditure of more than £8,000 in the next five years. Colonel Sinton has been appointed to investigate certain aspects of malaria at the Horton Centre. Another series of investigations on malaria, in conjunction with the London School of Hygiene and Tropical Medicine, provides for a study of mosquitos in the tropics, and Dr. C. Wilson has been offered a research appointment to enable a survey of nutritional conditions in India to be undertaken.

LEVERHULME FELLOWSHIPS AND GRANTS

Awards of Leverhulme fellowships and grants in aid for research for 1936 have been made to the following, among others, the subject of research being indicated in brackets: Dr. Agnes Arber (studies in the principles of angiospermous morphology and in the history of botany); S. J. Duly, head of the Department for the Scientific Study of Commercial Products, City of London College (carriage of goods by sea); Dr. F. Fairbrother, senior lecturer in chemistry, University of Manchester (the study of electrolytic dissociation processes and the mechanisms of chemical reactions by the use of induced radioactivity); C. P. Fitzgerald (sociology of the non-Chinese tribes of Yunnan, S.W. China); S. D. Garrett, formerly assistant plant pathologist, Waite Agricultural Research Institute, University of Adelaide, South Australia (biological antagonism of the soil microflora towards root disease fungi or crop plants—renewal of present fellowship); Dr. J. de Graaff Hunter, lately director of the Survey of India (planning and execution of geodetic triangulation of great extent); Mrs. K. Lonsdale, research worker, Royal Institution (relation between structure and physical properties of organic molecules—renewal of present fellowship); E. P. Mumford, lately director of the Pacific Entomological Survey, Honolulu (terrestrial and freshwater biota of the Marquesas Islands—renewal of present fellowship); F. R. Perry, member of Research Department, Metropolitan-Vickers Electrical Co., Ltd.,

Manchester (the study of overvoltages due to lightning on transmission lines—renewal of present fellowship); Dr. A. L. Reimann, research physicist, General Electric Company, Limited, Wembley, Middlesex (electronic conduction phenomena in solid insulators and semi-conductors); Dr. R. H. Thouless, head of the Department of Psychology, University of Glasgow (research in visual perception); Dr. W. E. Williams, lecturer in physics, King's College, London (determination of the vacuum wave-lengths and the structures of spectral lines by means of his reflection échelon).

Grants in aid of research have been made to the following: Prof. A. E. Boycott, late Graham professor of pathology, University of London (ecology and genetics of British non-marine Mollusca); Prof. H. J. Fleure, professor of geography, University of Manchester (physical (racial) characteristics of the peoples of Wales); Prof. J. W. Heslop Harrison, professor of botany, Armstrong College, Newcastle-on-Tyne (researches on evolution and heredity—renewal of present grant); T. N. Hoblyn, statistician, East Malling Research Station, Kent (technical problems in the layout and conduct of horticultural field experiments under tropical and sub-tropical conditions); Dr. W. H. Pearsall, reader in botany, University of Leeds (growth of Algæ); Dr. O. W. Richards, lecturer in entomology, Imperial College of Science and Technology, London (habits of South American bees and wasps); Prof. C. W. Valentine, professor of education, University of Birmingham (psychology of early childhood). A Leverhulme travelling fellowship has been awarded to Mr. A. Ruscoe Clarke on the nomination of the Medical Research Council.

Particulars of these awards can be obtained from the Secretary, Leverhulme Research Fellowships, Union House, St. Martins-le-Grand, London, E.C.1.

BEIT MEMORIAL FELLOWSHIPS

The trustees of the Beit Memorial fellowships for medical research have made the following awards, the subject and place of research being given after the name of each new fellow: *Fourth Year Fellowships* (£500 a year): Dr. E. S. Horning, to continue his research on the cancer-producing effects of oestrogenic compounds, and on the possibility of producing tumours *in vitro* (Imperial Cancer Research Fund, Queen Square, London); Dr. W. J. Dann, to continue his work on the vitamin B₂ complex in reference to the treatment of pellagra (Duke University School of Medicine, North Carolina, U.S.A.). *Junior Fellowships* (£400 a year): Dr. I. Berenblum, to study the mechanism of skin irritation by chemical substances in reference to their action as exciting or preventing the development of cancer (Dunn School of Pathology, University of Oxford); D. D. Woods, to study the metabolism of the anaerobic bacteria, and the phenomenon of adaptation in bacteria (Dunn Institute of Biochemistry, University of Cambridge); Dr. A. Neuberger, to study the carbohydrate group in proteins and its possible relationship to their antigenic properties in bacterial immunity (Department

of Pathological Chemistry, University College Hospital Medical School, London); C. W. Bellerby, to investigate the control of the reproductive cycle by the anterior lobe of the pituitary (Department of Social Biology, University of London); Dr. T. W. Birch, to attempt to identify the component parts of the vitamin B₂ complex (Nutritional Laboratory, Cambridge); Lilian M. Pickford, to study the part played by the posterior pituitary gland in the control of water excretion by the kidneys (Pharmacological Laboratory, University of Cambridge); Dr. R. J. Pumphrey, to investigate the sensory physiology of insects, and the electrical response in the central nervous system to peripheral stimulation of afferent nerves (Zoological Laboratory, University of Cambridge); T. A. H. Munro, to study the role of inheritance in mental disorder (Research Department, Royal Eastern Counties Institution, Colchester).

AWARDS OF ROYAL COMMISSION FOR THE EXHIBITION OF 1851

The Science Scholarships Committee of the Royal Commission for the Exhibition of 1851 announces the following appointments for 1936: *Senior Studentships*: Dr. R. C. L. Bosworth, for research in chemical physics at Cambridge; N. A. Burges, for research in mycology at Cambridge and the Strangeways Research Laboratory, Cambridge; T. T. Paterson, for research in geology and prehistory at Cambridge; A. F. Rawdon-Smith, for research in physiology and psychology at Cambridge; Dr. D. Shoenberg, for research in physics at Cambridge. All the above awards were made on the recommendation of the University of Cambridge. *Overseas Scholarships*: D. G. Hurst, for research in physics at the Universities of California and Cambridge; J. Marsden, for research in physical chemistry at the University of Cambridge; on the recommendation of McGill University, Montreal. A. D. Misener, for research in physics at the University of Oxford or Cambridge; S. L. Cohen, for research in biochemistry at the

Technische Hochschule, Zurich; on the recommendation of the University of Toronto. H. C. Corben, for research in theoretical physics at the University of Cambridge; on the recommendation of the University of Melbourne. R. N. Robertson, for research in botany at the University of Cambridge; on the recommendation of the University of Sydney. I. E. Coop, for research in physical chemistry at the University of Oxford; on the recommendation of the University of New Zealand. Dr. B. G. Shapiro, for research in biochemistry at King's College Hospital, London; on the recommendation of the University of Cape Town. C. O'Kelly, for research in experimental physics at the University of Cambridge; on the recommendation of the National University of Ireland.

SALTERS' INSTITUTE AWARDS

The following awards for 1936-37 have been made by the Salters' Institute of Industrial Chemistry and approved by the Court of the Salters' Company: Fellowships renewed to: E. I. Akeröyd, Emmanuel College, Cambridge; L. R. Barrett, Lincoln College, Oxford; T. K. Hanson, Oriol College, Oxford; and C. S. Windebank, University of London. Fellowships awarded to: L. M. Baxt, King's College, London; and T. A. Dent, St. Catharine's College, Cambridge. The Institute has also awarded 150 grants-in-aid to young men and women employed in chemical works to facilitate their further studies.

MEDICAL RESEARCH COUNCIL AWARDS

The Medical Research Council announces the following awards of travelling fellowships for the academic year 1936-37: Medical Research Council fellowships in medical science: J. T. Chesterman, H. E. Holling. Dorothy Temple Cross Research fellowships in tuberculosis: A. L. Jacobs, J. Smart, Dr. B. C. Thompson, V. C. Thompson. Rockefeller fellowship in psychiatry: Dr. J. H. Quastel.

Excavations at Tell Duweir, Palestine, 1935-36

AN exhibition of antiquities from Tell Duweir, the ancient Lachish, which have been obtained by the fourth expedition of the Wellcome Archaeological Research Expedition to the Near East in 1935-36, opened at the Wellcome Research Institute, Euston Road, London, N.W.1, on July 9 and will remain open until the end of the month.

The excavations, which again were under the field direction of Mr. J. L. Starkey, were mainly directed to completing the clearance of a number of areas attacked in the course of previous seasons' work; but nevertheless, material of considerable archaeological interest and importance was obtained. An interesting group of bronze objects, much crushed, came from a quarry on the saddle, which had partially collapsed in ancient times. These objects date from the early Middle Bronze Age of pre-Hyksos times, and among them were a kohl stick and mirror, of which the latter is the first example to be found at Tell Duweir.

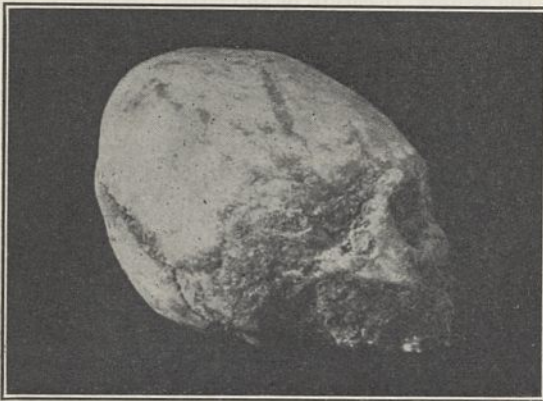
A further clearance of the temple and its super-

imposed reconstructions made it clear that the essential plan of all three structures was identical, but that there had been a great expansion in the second temple. Further evidence was obtained pointing to the temple having been the seat of the cult of a triad of deities, of which one was female, and of affinities with the north. Below the floor of the second temple, a mass of pottery was found under the altar bench, which included a Late Helladic II goblet, dating at about 1450-1400 B.C. It is of buff paste with cream slip and has a painted band decoration showing an ivy leaf motif. This, from the point of view of the archaeologist, is one of the most important finds of the season, as it dates more or less accurately, and links up a number of Palestinian finds.

Two sides, measuring eighty-five and seventy-five feet respectively, of a remarkable opening, apparently the entrance to a subterranean tunnel, have been cleared; and a clearance within the gate has revealed under the Persian level what was apparently the

commercial quarter, with shops of a wine or oil seller, corn chandler and a weaver containing many of the appurtenances of their trades.

What proved, however, to be the most extensive and, in some ways, the most important discovery of the season, was made in the western valley in continuation of work begun two years ago. Here in a little-disturbed, small circular tomb lined with plaster was a collection of objects in number such as is rarely found in so small a space. From this were taken two hundred pots, of which fifty-three were types new to Tell Duweir. The most interesting was a censer, which in paste and finish recalls the famous Tell Duweir ewer on which was the inscription in the early Palestinian alphabetic script. This censer has lugs and a flat cover, on the upper side of which is an incised decoration with tree or plant motif in a hatched border, and on the under side a further example of the early script.



Photo

Ralph Richmond Brown

FIG. 1. Artificially deformed skull from Tell Duweir. By courtesy of the Wellcome Archaeological Research Expedition to the Near East.

The tomb itself, as is shown by a number of scarabs, dates from 1400 to 1300 B.C. or even 1275 B.C. Among the objects found are a long-tanged bronze dagger of Eighteenth Dynasty type, bronze lance and sporting arrow heads, and faience draughtsmen with plaques from the gaming board. In an adjacent larger sepulchral chamber the upper levels were a mass of rubbish, possibly from the Assyrian occupation, but the lower levels were composed of a conglomerate of human skeletal remains, of which the condition suggests that they may have been thrown through a hole in the roof—the door on the west side was found still blocked—as salvage from the buildings, when the city was sacked by Sennacherib in 701 B.C.

This skeletal material will afford valuable evidence of the physical characters of the early inhabitants of Palestine, especially as a remnant of the Canaanitish population may have lingered on at Lachish. Even more interesting is the fact that, in addition to head wounds, several of the skulls show a number of pathological conditions. Some have been artificially deformed (Fig. 1) and show such elongation in the occipital region that they resemble in shape the form of head familiar in the representations of Akhenaton; others have been trephined. Of these latter, two examples, instead of the more usual circular operation, have had a square section of bone, about an inch across, removed by sawing cuts, which intersect. This method, known in the Inca skulls from South America, is new to the ancient civilization of the Old World.

Educational Topics and Events

BELFAST.—Dr. W. H. McCrea, at present reader in mathematics in the University of London, has been appointed to the chair of mathematics in the Queen's University.

READING.—Under the will of the late Dr. Alfred Palmer, who died on May 20 last, the University has benefited by a valuable bequest of freehold property. It includes the main buildings of St. Andrew's Hall, the largest of the University's halls of residence for women students; a house known as "Summerbrook", near the main University site, which serves as the headquarters for the advisory officers of the Southern Agricultural Province; two houses used by Wessèx Hall, another of the University's halls of residence for women students; four houses adjoining the main University site and used for general University purposes. The properties, which have hitherto been held on lease by the University, have been bequeathed free of duty.

Mr. Gerald E. H. Palmer has been elected a member of the University Council to fill the vacancy caused by the death of Dr. Alfred Palmer.

Mr. G. T. H. Kimble has been appointed lecturer in geography.

SHEFFIELD.—The following appointments have recently been made: Mr. N. S. Boulton, as lecturer in civil engineering; Mr. W. S. Milner (at present assistant lecturer), to be lecturer in electrical engineering; Mr. W. Skyrme Rees, as demonstrator in anatomy.

"ACADEMIC FREEDOM" continues to form the subject of much anxious discussion in America. The president of the University of California in a recent speech on "Problems of an American University" (*School and Society*, May 30) declared that more and more in the last year or two his university has felt, in common with others, the pressure of special groups, and he drew a lamentable picture of what the loss of freedom has meant to the universities of Germany, Italy and Russia. In these countries, "to-day there are no universities—only names and shells from which the spirit has departed. In each of these totalitarian States, universities have become the agents, the adjuncts, the subordinates of the State". In the same journal in which this speech is reported appears a letter from the president of the University of Minnesota referring to the increasing amount of control the Federal Government is exercising over the schools of the country, and to the necessity of keeping the schools and universities free from dictation by pressure groups and from regimentation by Government agencies. In the preceding issue, Prof. Thomas Woody, of the University of Pennsylvania, writes of the "hysterical efforts to create loyal citizens by legislative fiat" in recent attempts to pass laws to keep history "pure", and to regulate and restrict the teaching of science. "Even more serious in its ultimate possibilities for the suppression of freedom of the schools and colleges of the nation is the present obsession with respect to loyalty oaths for teachers". He proceeds to examine at length the grounds on which the requirement of such oaths (now prescribed in nineteen States) has been defended.

Science News a Century Ago

Sir Goldsworthy Gurney and his Steam Carriages

AMONG the successful pioneers of steam locomotion on roads was Sir Goldsworthy Gurney (1793-1875), the Cornish surgeon and inventor, known also for his invention of the oxy-hydrogen blowpipe and the limelight. It was while living in London that he turned his attention to steam-carriages, and in 1829 he went from London to Bath and back at a rate of fifteen miles an hour. On July 18, 1836, in the House of Lords, reference was made to the Steam-carriages Tolls Bill which had then passed through the committee stage. The Marquess of Salisbury, however, proposed it should be referred to a select committee for further consideration. In the course of his reply to this suggestion, the Earl of Radnor said: "Mr. Gurney, a gentleman of considerable talent, had directed all his attention to the construction of steam-carriages applicable to the road. He had given up a lucrative business, and applied himself wholly to that point. He had brought his invention to a state of great perfection; when all at once, a bill was introduced, not directly affecting his invention, but by a side-wind, entirely obstructing it, and laying such a tax on steam carriages as would completely defeat his object. His invention had been used without any accident whatever occurring; and this bill was intended merely to take off that burden which indirectly would operate greatly to the prejudice of Mr. Gurney".

Geology of the Island of Ascension

ON July 19, 1836, H.M.S. *Beagle* reached the island of Ascension, which Darwin compared to "a huge ship kept in first-rate order". Speaking of the geology of the island, he said: "The lava streams are covered with hummocks, and are rugged to a degree which, geologically speaking, is not of easy explanation. The intervening spaces are concealed with layers of pumice, ashes and volcanic tuff. . . . In several places I noticed volcanic bombs, that is, masses of lava which have been shot through the air whilst fluid, and have consequently assumed a spherical or pear-shape. Not only their external form, but, in several cases, their internal structure shows in a very curious manner that they have revolved in their aerial course". Describing more particularly one of these objects, he said: "The central part is coarsely cellular, the cells decreasing in size towards the exterior; where there is a shell-like case about the third of an inch in thickness, of compact stone, which again is overlaid by the outside crust of finely cellular lava. I think there can be little doubt, first, that the external crust cooled rapidly in the state in which we now see it; secondly, that the still fluid lava within, was packed by the centrifugal force, generated by the revolving of the bomb, against the external cooled crust, and so produced the solid shell of stone; and lastly, that the centrifugal force, by relieving the pressure in the more central parts of the bomb, allowed the heated vapours to expand their cells, thus forming the coarsely cellular mass of the centre".

The Herbarizing Dinner of the Society of Apothecaries

ON July 20, 1836, "the annual herbarizing dinner of the Society of Apothecaries took place . . . pre-

ceded by a lecture given at their hall by John Lindley, Ph.D., Professor of Botany to the Society. The noble President of the Medico-Botanical Society (Earl Stanhope), the Vice Presidents of the Linnean and Horticultural Societies, the President of the Royal College of Surgeons (Sir Astley Cooper), the ex-censors of the Royal College of Physicians, the Professors of Botany at the Metropolitan Schools of Medicine, and about 150 other gentlemen, attended on the occasion" (*The Times*).

Death of Jean-Félix-Adolphe Gambart

ON July 23, 1836, the French astronomer Jean-Félix-Adolphe Gambart, died at the early age of thirty-six years. He was born at Cette, in the Department of Hérault in May 1800. While quite a young boy he went to sea and then lived with his father, a teacher of navigation at Havre. His talents having attracted the attention of Alexis Bouvard (1767-1843), "the computing partner" of Laplace, he went to Paris, and in 1819 through Bouvard was made an assistant at the observatory at Marseilles of which Jean Louis Pons (1761-1831) was then the director. Pons having removed to Italy, Gambart in 1822 was made director of the Observatory, and though supplied with somewhat inferior instruments, in the course of eleven or twelve years discovered thirteen comets, including Biela's comet, first seen on February 17, 1836. In recognition of his work he was made a member of the Paris Academy of Sciences. Recalled to Paris in 1834 for work at the Bureau des Longitudes, his promising career was cut short by consumption.

Medical Statistics

IN his retrospective address delivered at the third anniversary meeting on July 23, 1835, of the Provincial Medical and Surgical Association held at Oxford, Dr. J. C. Prichard, F.R.S., senior physician to the Bristol Infirmary, said that there could be no method of research more in harmony with the philosophical character of the present age than inquiries which were termed statistical. There was no investigation more calculated to extend our knowledge, on a great scale, both of the physical and moral condition of mankind without opening the door to anything discursive or imaginary. Statistical researches were likely to afford the most satisfactory solution of difficult problems which had hitherto been thought to lie within the realm of speculation; and our mistrust of the speculative way of treating such questions was increased by the remark that in almost every inquiry submitted to the test of accurate numerical calculations, the result had turned out in direct opposition to what appeared to be the most probable conjecture. Who, for example, would ever have imagined that human life would not exhibit a larger average duration in the genial climate of Greece, Italy and other countries on the northern coast of the Mediterranean . . . than on the inclement shores of the Baltic and Frozen Ocean? It had been demonstrated, however, in a memoir drawn up with great accuracy of research and presented to the Academy of Sciences that human life had double the duration, or that men lived on the average twice as many years in the *Ultima Thule*—the bleak Iceland and on the Norwegian coast—as in the delightful plains of Campania and in the valleys of Andalusia.—(*Trans. Prov. Med. and Surg. Assoc.*, 1836.)

Societies and Academies

Paris

Academy of Sciences, June 8 (*C.R.*, 202, 1881-1952).

ANDRÉ BLONDEL: A radioelectric method for the calculation of transient régimes.

GEORGES CLAUDE: The presence of gold in sea-water. An application of the method suggested by Glazunov to 168 cubic metres of sea-water taken off the coast of California. The gold was too small to be determined, and was less than 0.1 mgm. per cubic metre.

DMITRI RIABOUCHINSKY: The paradox of d'Alembert at supersonic velocities.

EDGAR BATICLE: The problem of collisions.

SALVATORE CHERUBINO: Holomorph functions of a matrix.

LÉON POMEY: The general harmonic properties of unicyclic involutions of order n .

RENÉ LAGRANGE: An inequality of Hobson.

ALEXANDRE WEINSTEIN: The equations of the vibrations of a fixed-in plate.

MLLE. NINA BARY: The Diophantic nature of the unicity problem of the trigonometrical development.

JEAN HELY: The application of a synthetic theory of relativity to the orbits of the planets.

CHARLES PLATRIER: The problem of Barré de Saint-Venant in perfectly flexible homogeneous media.

IMAI-ISAO: The stability of the double row of vortices in a rectilinear canal.

A. TOUSSAINT and S. PIVKO: The influence of the limitations of the fluid sheet on the aerodynamic characteristics of supporting wings. Experimental verifications.

BERNARD KWAL: Dirac's equation and the theory of the electromagnetic field.

MARCEL PAUTHENIER and MME. MARGUERITE MOREAU-HANOT: An ionic generator giving a million volts. Details of the practical realization of an apparatus based on a theory previously described.

JEAN GRANIER: An important cause of error in the measurement of capacities by the ballistic method. In measuring condensers of high capacity, either the variations of period must be taken into account or less sensitive galvanometers, heavily shunted and with a high moment of inertia, must be used.

JEAN LECOMTE: Infra-red absorption spectra and the modes of vibration of organic compounds. From the study of compounds of the types $X.CH_2CH_2.Y$ and $X.CH_2.CH_2.CH_2.Y$, the numerous absorption bands found in nearly all the spectra for frequencies lower than $1,100\text{ cm.}^{-1}$, can be explained only if the existence of several molecular forms is admitted.

JEAN REBOUL: The action exerted by ordinary metals on the photographic plate and on the electrometer. The study of the ionization of the atmosphere surrounding ordinary metals, suggests that there is an emission by these metals of an X-radiation of small quantum. The action on the photographic plate is not parallel to the ionization, and Russell's suggestion of the formation of hydrogen peroxide may apply in some cases.

PIERRE AUGER and ALBERT ROSENBERG: The properties of the cosmic corpuscles of the penetrating group.

HORMISDAS: A new colorimeter for determinations in series.

HORIA HULUBEI: Researches relating to element No. 87. The results of experiments given are consistent with the presence of element 87 in extremely small quantity in pollucite.

CLÉMENT COURTY: The diamagnetism of thio-cyanates and of the ion Cu^+ .

MARC TIFENEAU and MLLE. B. TCHOUBAR: The differences of behaviour of the *cis* and *trans* cyclohexanediols during their dehydration.

ALBERT KIRRMANN and PIERRE RENN: The mechanism of the allyl transposition.

FRANÇOIS DUPRÉ LA TOUR: Inversion of polymorphism in the series of normal saturated diacids.

GEORGES REMPP: A differential frigorimeter. A simple instrument for measuring the mean velocity of the air, possessing a greater thermal inertia than the hot wire anemometer.

ETIENNE FGEX and MAURICE LANSADÉ: The pathogenic action of a bacterium isolated from potato tubers. The characters of this organism agree with those of *Bacterium xanthochlorum*. Studies have been made of its pathogenic action on potato tubers and buds, leaves of Solanaceæ and Leguminosæ and on seeds of Solanaceæ.

PAUL RIOU and JOACHIM DELORME: The lead values in maple and cane sugars. From a determination of the lead values of cane sugars from various sources, it is concluded that this value can give no indication of the adulteration of maple sugar with raw cane sugar.

ALBERT RAYNAUD: The heterochromosomes of mulot.

ROBERT BRUNET and ANTOINE JULLIEN: The architectural characteristics of the heart in two marine lamellibranchs, *Ostrea edulis* and *Venus gallina*.

MLLE. MARIE LOUISE ROCCO: The presence of allantoinase in insects. The aerial arthropods, like the aquatic arthropods, contain the enzyme allantoinase.

FRANCIS RATHERY, ANDRÉ CHOAY and PIERRE DE TRAVERSE: Isolation from the mucous membrane of the jejunum of a principle reducing glycaemia.

MAURICE DOLADILHE and MLLE. MARGUERITE MICHEL: Contribution to the study of the alexic properties of protein C.

Official Publications Received

Great Britain and Ireland

Fifty Years a Borough, 1886-1936: The Story of West Ham. Edited and compiled by Donald McDougall. Pp. 298. (West Ham: Central Library.) 3s. 6d. [296]

The North of Scotland College of Agriculture. Guide to Experiments and Demonstration Plots at Craibstone, 1936. Pp. xii+72. (Aberdeen: North of Scotland College of Agriculture.) [37]

Other Countries

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 97: Studies on Contagious Pleuro-Pneumonia of Cattle. By A. D. Campbell, Dr. A. W. Turner, Dr. H. R. Seddon and Dr. H. E. Albiston. Pp. 88. Bulletin No. 98: Cercospora Leaf-Spot (Frogeye) of Tobacco in Queensland. By A. V. Hill. Pp. 46+7 plates. Pamphlet No. 62: The Chemistry of Australian Timbers. Part 5: A Study of the Lignin Determination, 3. By Dr. W. E. Cohen. (Division of Forest Products: Technical Paper No. 20.) Pp. 30. Pamphlet No. 63: Studies of Five Introduced Grasses. By Dr. A. McTaggart, W. Hartley, T. B. Paltridge and H. K. C. Mair. Pp. 32+2 plates. (Melbourne: Government Printer.) [226]

Peabody Museum of Natural History. Bulletin 4: Miocene Marine Mammals from the Bakersfield Region, California. By Leslie E. Wilson. Pp. 143. (New Haven, Conn.: Yale University.) 1.25 dollars. [246]

Proceedings of the United States National Museum. Vol. 83, No. 2986: A New Genus and Species of Trematode from the Little Brown Rat and a Key to the Genera of Pleurogenetinae. By Ralph W. Macy. Pp. 321-324. (Washington, D.C.: Government Printing Office.) [246]