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International Control of Aviation

THE prominence which the question of air raids and air defence is receiving affords a timely reminder both of the extent to which aviation is rather an international than a national problem, and of the way in which this new power of flight has become rather a menace than an aid to civilisation. A memorandum*, and also one of the six projected handbooks dealing with air raid precautions, have recently been issued by the Air Raid Precautions Department of the Home Office†. In a general preface to the handbook it is explained that measures for safeguarding the civil population against the effects of air attack have become a necessary part of the defensive organisation of any country which is open to air attack, and that the need for them does not arise from any belief that war is imminent. The risk of attack from the air, however remote it may be, is a risk which cannot be ignored, and preparations to minimise the consequences of such attack cannot be improvised on the spur of the moment, but must be made, if they are to be effective, in time of peace.

The handbooks are designed to describe a scheme of precautions which it is hoped would prove effective in preventing avoidable injury and loss of life or widespread dislocation of national activities, and endeavour to give the best available information on methods of passive defence against air attack. The handbook before us is intended primarily for the use of those who in a war emergency would be engaged on first-aid services for the civil population, especially members of the St. John Ambulance Brigade, the St. Andrew's Ambulance Association and the British Red Cross Society. It contains a sufficient account of the chemical agents likely to be used and the methods by which they might be distributed to enable such persons to appreciate the dangers to which they would be exposed, as well as adequate information on general principles with regard to protection against gas. Steps to be taken for the protection of rooms, etc., against gas, the use of respirators and protective clothing and the treatment of various types of casualties are detailed, as well as measures for the decontamination of personnel and material.

Both the matter and the general principle underlying the publication of these handbooks have already received severe criticism. In the first place, it has been pointed out that the precautions described in the handbook are quite inadequate to confer any real protection. At a recent conference in London it was strongly maintained that it would be impossible adequately to protect a large civil population during a gas attack, or prevent them receiving injuries afterwards from, for example, mustard gas lingering in different places.

It is true that the handbook only professes to deal with avoidable injury, but any attempt in this way to minimise risk may easily create a feeling of false security and encourage the belief that the danger can be entirely avoided. This risk has probably been responsible for opposition from those who emphasise the impossibility of affording civilians the same protection as the services because of the enormous cost. A statement signed by Sir F. G. Hopkins and a number of

* Air Raid Precautions. Memorandum No. 1: Treatment of Casualties and Decontamination of Personnel. (Issued by the Home Office, Air Raid Precautions Department.) Pp. 15. (London: H.M. Stationery Office, 1935.) 4*d*. net.

† Air Raid Precautions. Handbook No. 2: Anti-Gas Precautions and First Aid for Air Raid Casualties. (Issued by the Home Office, Air Raid Precautions Department.) Pp. 110. (London: H.M. Stationery Office, 1935.) 6*d*. net.

other men of science, and issued by the National Peace Council, takes this view. Adequate defence must provide security against the simultaneous, and not merely the independent, use of high explosive bombs, incendiary bombs and gas attacks. It is necessary to insist that, however wise the proposed measures may be in themselves, the only adequate defence against air warfare is the abolition of war itself, and to point out the danger of allowing precautions or palliatives to divert attention from the main objective.

It is very generally accepted that abolition of national military and naval forces could not be achieved without the international control of civil aircraft, and the more reasonable it is for the British Government or any other Government to consider the means of protecting the civil population from air attack, the more imperative it is that the means of introducing international control should be explored. Equally desirable is the careful examination of the practicability of establishing an international air police force such as has received forceful advocacy of late.

The many questions which arise out of these proposals, such as the relation of an international force to the League of Nations, the technical difficulties to be overcome or the methods of preventing misuse of civil aviation, merit close and scientific study; it may well prove that along these lines will be found the only adequate safeguard and security for all nations. Scientific workers have a special responsibility for assisting in bringing to bear on all such questions an unprejudiced mind and the careful and impartial scrutiny of every factor involved which should be characteristic of the scientific mind.

Inevitably the study of the problem of the air from this point of view leads to the consideration of the whole problem of the future peaceful development of civil aviation. It would be difficult indeed to find a more signal example of the frustration of science than is afforded by aviation, and it is inconceivable that the development either of an international air police force or of international control of civil aircraft could be more inimical to development than the national jealousies and obstructions hitherto in vogue. The effect of these was strikingly demonstrated in the able report on the economics of air transport in Europe recently submitted by M. Henri Bouchée to the special sub-committee of the Air Transport Co-operation Committee of the League of Nations.

The substitution of a single International Air Board of Control under the League of Nations for the twenty-six different controls now exercised by the separate States of Europe alone would remove many hindrances to the development of civil aviation, including restrictions on design, flying lanes and prohibitions to engage in entrepôt trade, and would provide far greater stimulus than is possible under the present conditions of national sovereignty. The powerful plea advanced by M. Bouchée for collective action, calculated on a European scale to meet European needs and based on strictly economic lines, utilising subsidies in a manner enabling air transport to establish itself once and for all, and affording aviation the freedom which is natural to it but which as yet it has neither demanded nor received is, however, only one aspect of the question.

The technical problem in civil aviation is equally important, and here the whole development of civil aviation has been warped from the start through the influence of the War. But for that factor, as Colonel Moore-Brabazon has pointed out, aviation might have developed along different lines, quietly and efficiently, and civil aviation might have played the important part it is meant to do in intercommunication, the military side lagging behind. As a result of wartime development, civil aviation has become no more than an off-shoot of the great military organisations in various countries, and only in Great Britain and the United States can it be said that aviation has been allowed to develop free from direct military influence.

The Diesel engine provides a conspicuous example of the ulterior effect of military influence on civil aviation. From the civil point of view, the Diesel engine has many advantages, notably in burning a fuel of high flash-point and the price of which in Great Britain is less than half that of petrol. This engine, however, is of little interest for military purposes because its performance is not so good as that of the petrol engine and it is also heavier. Since the major outlook for a new type of machine depends on its possibilities for military uses, there is little inducement for the manufacturer to develop the Diesel engine, although there is no type of transport for which the petrol engine is more fundamentally unsuitable than for the aeroplane with its load of inflammable fuel.

If civil aviation is to develop to the full and render its due service to mankind, it must be

freed completely from military influence, whether technical or economic. The root of the problem lies in the conflict between the conceptions of sovereignty of the air and freedom of the air. Only as the latter conception triumphs can humanity hope that aviation will progress as an instrument not of war but of peace. Scientific workers can never rest content with the mere precautionary methods outlined in the handbooks and policy of the Air Raid Precautions Department. They can indeed contribute something to see that the precautions, so far as they go, are technically sound and are fairly and not unfairly criticised. They fail in their duty, however, if they do not also continue to point out that the only adequate defence or security against air attack lies in the abolition of war itself and in liberating aviation from the bonds imposed on it by the narrow nationalism expressed in the Air Convention of 1919, and clothing it with the freedom of service in which were conducted those technical and scientific investigations which first gave it birth.

The Changing World of the Ice Age

The Changing World of the Ice Age
By Prof. Reginald Aldworth Daly. (Yale University: Mrs. Hepsa Ely Silliman Memorial Lectures.) Pp. xx+271+8 plates. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1934.) 22*s*. 6*d*. net.

IN this book Prof. Daly has reprinted the Silliman Lectures for 1934 which he delivered at Yale University to "an audience with a varying knowledge of the facts and principles of geology". But to make the book of greater value to more serious students, the lectures have been somewhat expanded. The author had a threefold aim: (1) to picture the remarkable effects of the Pleistocene glaciations and deglaciations upon the sea-level all over the world; (2) to illustrate some of the no less extraordinary changes in the geography of the regions that were heavily glaciated during the Ice Age; (3) to discuss the behaviour of the solid earth when it was loaded with the ice-caps and then relieved of those loads by melting and evaporation.

The book is divided into seven sections. A very large amount of material has been used, and many of the facts and instances cited are not easily found elsewhere because of the difficulty of access to many of the publications and the difficulty of reading some of the less-familiar languages in which they are written. At the outset, it may be said that the author accepts a number of hypotheses which some observers are not prepared to adopt, but he never misleads his readers into the supposition that these views are of unanimous acceptance.

In the first section, past and present ice-caps, their measurement and weights are described. Then the sequence of glaciations is considered and the author, while accepting the four glaciations of Penck and others, in Europe and America, lays stress upon the long duration of the second interglacial phase and its separation of the first twin glaciation from the second twin glaciation. These two peaks of climatic change in the glaciated tracts corresponded with two major pluvial stages in regions now relatively desert, and also with two major periods of deposition of loess in different continents. These climatic rhythms affected simultaneously the whole surface of the earth. An estimate of the duration of the Ice Age is given as nearly one million years. These considerations lead up to the urgent question of what caused the Ice Age; the author is frankly in doubt and confesses that the subject is still in the state of speculation and remains to him a baffling mystery.

The second section of the book will probably be of greater interest to European readers than are the remaining sections, for it deals with the recession of the Fennoscandian ice sheets; and especially to students of prehistory, for post-palæolithic man has left determinable evidences of sequences of culture in relation to geological changes all round the Baltic shores.

Pleistocene changes in the geography of northern Europe are registered largely by the marks left by the waves of the ocean that kept shifting its level, both up and down, all over the earth. It is not, perhaps, generally realised to what an extent the robbery of water from the oceans during the maximum glaciation depressed the general level of the sea; the author shows that the amount was probably as much as 90 metres all over the earth; and even during the last glaciation, a sinking of some 75 metres was attained. But he warns his readers against supposing that in the warmest interglacial stage the sea-level was higher than it is at present by more than a few tens of metres; and further, that the

strand-lines on the lands cannot be in uniform relation to the surface of the existing ocean because of the earth's elastic and plastic response to the loading and the unloading with ice and water.

The recession of the North American ice is discussed in the third section, and comparison is made with the European phenomena. This chapter may be described as indispensable to students of the Ice Age, and moreover it summarises in some fifty pages the great volume of matter not easily accessible to the student, that has been published in monographs, reports and the like in recent years, while its clearness is increased by an adequate number of good maps and pictures.

The mechanism of the earth's deformation and recoil, especially as regards the effects of the crust's yield to the ice-loads, is dealt with in the fourth section. The author directs attention to the need of distinguishing between the immediate, elastic and the prolonged plastic response to load and release, and prefers the hypothesis of 'punching' to explain the plastic upwarping around ice caps to the 'wave' or 'viscous bulge' theory.

The remaining sections are devoted to the consideration of the high and the low sea-levels of the Pleistocene in areas removed from the glaciated tracts. Special emphasis is placed upon the want of uniformity in heights above sea-level of the abandoned sea-beaches; it is pointed out that there can be no simple criterion of the eustatic emergence "based upon the naïve idea that this process gives strandmarks at constant heights all over the world". But the more recent the eustatic emergence, the fewer are the dangers of mistaking the traces of the corresponding strand-lines on the rocks of continents and islands.

Finally, the effects are discussed of the changes of sea-level upon coral reefs in Pleistocene times, and the 'glacial control' theory of atoll and barrier reefs finds preference to the hypotheses of Darwin and Dana respectively.

The book is thoroughly illustrated with maps and views, and the author is to be congratulated not only on them but also for departing from the too usual practice of giving insufficient references in the text to the illustrations. It is a book of first-class importance and of equal interest, and is written in such concise and clear language that any well-educated boy could understand it.

H. D.

Everyday Life of Extinct Animals

Vorzeitliche Lebensspuren

Von Othenio Abel. Pp. xv+644. (Jena: Gustav Fischer, 1935.) 24 gold marks.

EXTINCT animals are known chiefly by their fossilised bones, teeth or shells, which afford many clues to their mode of life and reproduction. There are, however, several other kinds of fossils which add to our knowledge of extinct animals as living organisms. Footprints, remains of food, coprolites, traces of disease and accident, and even remains of dwellings, are all most instructive when they are satisfactorily interpreted. These are described by Prof. O. Abel as "Vorzeitliche Lebensspuren" in the handsome volume before us. Here they are discussed critically, with many original observations, and they are illustrated by an unrivalled series of photographs besides drawings and diagrams.

In the first chapter, on reproduction, the most interesting section is that on the young often found within the skeleton of Ichthyosaurians. Prof. Abel concludes that although the majority must be unborn embryos, a few may perhaps have been swallowed as food. The marked discrepancy in size sometimes observed among the contained young seems to justify this conclusion.

The second chapter, which is by far the longest, discusses tracks and footprints and the modes of locomotion which they imply. The interpretation of these fossils is difficult, because so little is known of the tracks of most animals which live now. The conclusions to be drawn from the hand-shaped footprints of *Cheirotherium* from the Trias, which have already been studied by Soergel, and the classification of reptilian footprints by Nopcsa, however, are valuable, and Prof. Abel reviews them in detail. He is of opinion that no undoubted footprints of vertebrates have hitherto been found in Devonian rocks, and he thinks that the *Thinopus* of Marsh is probably a coprolite of a fish. He also points out that some of the Carboniferous footprints have been wrongly interpreted: he would explain the so-called claws of *Onychopus*, for example, as being the marks of runnels of water into the print. It is curious to note that some imprints of the fins of fishes in motion have been preserved in the Jurassic lithographic stone of Bavaria. The tracks of crustaceans and worms are familiar.

The chapter on food and feeding is remarkably exhaustive, beginning with an account of the stomach-contents of the Siberian mammoth and the North American mastodon, and ending with a discussion of the feeding tracks of certain worms. Referring to the remains of land plants found inside the fossil 'mummified' bodies of the aquatic dinosaur *Trachodon*, and sometimes described as the food of this reptile, Prof. Abel advises caution in identifying the stomach-contents within skeletons. *Trachodon* must have fed in the water, and the fragments of land plants were evidently introduced into the fossil with the rock sediment. He also agrees with those who assert that coprolites marked by a spiral valve have never been found in Stegocephalian Amphibia or in Ichthyosauria: he refers all such coprolites to fishes, in which they have often been found.

Among borings and other traces of dwelling places which are described, the most interesting perhaps is the fossil nest of a termite from an Upper Pliocene deposit near Vienna. Among fossil examples of commensal and symbiotic animals, the most curious is *Kerunia*, from the Upper Eocene of Egypt, which seems to be a hydractinian associated with a crustacean. Among indications of injury and disease, the irregular rugosities on the snout of many crocodile-like Triassic reptiles are remarkable. The prevalence of disease among the bears which inhabited the European caves during the Pleistocene period is also interesting.

A brief account of fossil records of death struggles is followed by a final chapter on insects and spiders in amber, which is contributed by Dr. Adolf Bachofen-Echt. Like the rest of the volume, it is illustrated by photographs which are as remarkable as they are beautiful.

From this brief summary it will be seen that Prof. Abel's volume is not only a valuable work of reference in an unusual subject, but is also a stimulating contribution to palæontological research.

A. S. W.

Mathematics and Materialism

The Search for Truth

By Prof. Eric Temple Bell. Pp. x+279. (London: George Allen and Unwin, Ltd., 1935.) 7*s*. 6*d*. net.

PHILOSOPHY is a subject of study as earnest and important as any individual science. Prof. Bell apparently does not share this view, however, for in his book, which has the characteristics of a brilliant joke, he simply uses some aspects of the history of science as an occasion to poke fun at philosophy and to launch an attack on philosophers. Thus, he tells us that a considerable part of the efforts of the Greek thinkers "seems to have centred round the verb 'to be' ". And again, that "Aristotle and Plato were presently to prepare the ingenious noose with which the Middle Ages were later to hang themselves; and Euclid was to tie knots around the vital parts of geometry which were to paralyse its creative function for two-thousand years" (pp. 97–98). Or again, that "the theologians of the Middle Ages before the Twelfth Century had built their cathedral of learning and reason" on the first half of Aristotle's logical treatise (p. 143). For him, St. Anselm, Abelard and William of Occam were "incurably logic-mad"; and Duns Scotus deserves immortality on the only count that "his name has passed into the English language in the word *dunce*".

Prof. Bell may dislike speculations that cannot be tested at this moment by experiment; he may even be praised for exposing fourth dimension charlatans; but he certainly does no service to real scholarship by carrying to extremes the process of "debunking", which seems to become a source of inspiration in many quarters, across the Atlantic especially. In any event, he has no right to be misleading as when he endeavours to draw a parallel between the invention of non-Euclidian geometries and the exposition of many-valued logics given by Prof. Lukasiewicz—two branches of knowledge which have neither the same origin nor the same implications.

It would serve no useful purpose to initiate a general argument about a book full of pointless remarks and stripped of all references, until its author takes the trouble of recasting his pronouncements in the habitual forms of a tolerant and well-founded controversy. We should also like him to tell us more about truth, for though he concerns himself, lightly we believe, with the "Search of Truth", all we hear about this important idea is that, for Prof. Bell, an "Eternal Absolute Truth", which has no reference to experience, is of no importance whatever.

With this mere confession of faith, however, materialism will fare no better. Without sharing this particular creed, we can say, nevertheless, that a skilful use of the history of science and the sociological interpretation of mathematics could

have prepared a serious case for materialist science, in spite of the difficulties of experimenting with transfinite numbers, non-Archimedian geometries and many-valued logics. Prof. H. Levy has hinted at such an interpretation in a chapter of "The Universe of Science". A parallel method was also suggested in an article on "Numbers and Numerology" in NATURE of January 20, 1934, p. 80, in which the attempt was made to raise to a higher level the whole problem of the relations of thought and number. Until we are given such an interpretation, it is difficult to acknowledge, as we are invited to do by the publishers of this work, that "materialist science at last has its Jeans". T. G.

Prof. Hans Molisch's Recollections

Erinnerungen und Welteindrücke eines Naturforschers

Von Hans Molisch. Pp. xii+232. (Wien und Leipzig: Emil Haim und Co., 1934.) 10.80 gold marks.

IN this autobiography, written at the instigation of his friends and pupils, Hans Molisch gives us his recollections of a busy and not uneventful life devoted to the pursuit of science. His researches, particularly those into the microchemistry of plants, are well known in Great Britain, but with his personality we are less familiar. His biographical recollections will therefore do something towards our enlightenment.

Born in 1856 at Brünn, now famous as the seat of Gregor Mendel's epoch-making experiments, Molisch learnt, as a boy, in his father's nursery gardens, the methods of cultivating plants, which stood him in good stead when he became a plant physiologist. His training for this career he acquired at the University of Vienna under Julius Wiesner, whose assistant he afterwards became. His first professorial appointment was at the Technical College in Graz, and later he was promoted to the botanical chair in the German University of that town. He has a good deal of interest to tell us of the staff and the students of this university and something too of the ill-feeling which existed between the Czechs and the German students.

In 1897, aided by funds from the Academy of Sciences in Vienna, Molisch undertook a journey round the world, working for some time at the botanical gardens at Buitenzorg. Of his travels, as well as his work, he gives us an interesting account.

On the retirement of Wiesner in 1909, Molisch was appointed professor of plant physiology in Vienna, where he remained until his own retirement in 1928. Here he continued his microchemical investigations, but found his activities somewhat cramped by the absence of experimental grounds. In 1914 he visited England and only just escaped being interned on his return through France. While still holding his professorial chair in Vienna, he was invited to become for two years the director of the New Botanical Department of the Tôhoku Imperial University at Sendai, and on this occasion made his second journey round the world. He tells us a good deal about his stay and his work in Japan, though of course less fully than in the book he published in 1926.

After his retirement from the professorship at Vienna, he was invited to lecture and work at the Bose Institute in Calcutta, and the account of his work there will be read with interest. Molisch's account of the conditions in India and its people is worth perusal.

The author concludes his book, which contains his portrait and a number of other illustrations, with some reflections on 'life', stating his opinion that living matter has never arisen from lifeless inorganic matter, and his belief that the origin of life is at the present moment and perhaps will always remain insoluble—a riddle of the universe.

The Biology of Flowers

By W. O. James and A. R. Clapham. Pp. viii+116+41 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1935.) 8*s*. 6*d*. net.

THIS unusual book should prove valuable in inspiring enthusiasm for what is so often made a very dull branch of botany to the average student. Each flower is carefully described in readable language, so that, once having worked through the book, the student can turn to his more compact Flora well armed and ready to follow floral taxonomy with interest. The diagrams are singularly attractive, but there seems no excuse for their being reproduced on such a large scale, since most of them are either floral diagrams or halves of flowers. Nearly all could have been reduced to a quarter of their present size, without detracting from their usefulness; thus reducing considerably the size and possibly the price of the book.

(1) Theoretical Physics
By Prof. Georg Joos. Translated from the first German edition by Dr. Ira M. Freeman. Pp. xxiii+748. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1934.) 25*s.* net.

(2) Lehrbuch der theoretischen Physik
Von Prof. Dr. Georg Joos. Zweite Auflage. Pp. xvi+676. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1934.) 24 gold marks.

(1) THE first edition of the book by Dr. Joos appeared in 1932 and was favourably noticed in NATURE, 131, 221; 1933. The English edition now before us shows every sign of having been prepared with great care, and is written in clear and straightforward language, which is unfortunately more than can be said for many translations from the German. Only minor alterations and corrections have, apparently, been made in preparing the English version. We can congratulate Dr. Freeman on his very satisfactory performance of a task which we are glad to see accomplished.

(2) The second German edition contains a new chapter on nuclear physics, which consists mainly of a non-mathematical description of the new work on artificial transmutation and the newly-discovered elementary particles. There is also a brief addition concerning the method of magnetic cooling which has been applied with such success by de Haas, Simon and others to obtain exceedingly low temperatures. Otherwise there is little change in this admirable textbook.

It seems a little strange to an English reader that a German cannot bring out even a new edition of a work on theoretical physics to-day without a prefatory reference to the *neues Reich* and the *harter Daseinskampf des deutschen Volkes*, but we suppose that it has its reason. We further note the addition of a glossary explaining 'foreign' terms, in which *Absorption* (*Verschluchung*), *Elastizität* (*Dehnbarkeit*), *Kapillarität* (*Haarröhrchenkraft*) and such-like non-Prussian words, are translated into the new German, although these 'foreign' words appear in the articles in Gehler's "Physikalisches Wörterbuch" of more than a hundred years ago. Merkwürdig!

E. N. da C. A.

(1) Grundriss der Cytologie
Von Dr. Lothar Geitler. Pp. viii+296. (Berlin: Gebrüder Borntraeger, 1934.) 19.20 gold marks.

(2) Handbuch der Pflanzenanatomie
Herausgegeben von Prof. K. Linsbauer. Allgemeiner Teil: Cytologie (Die Organe der Zelle). Band 2: Allgemeine Pflanzenkaryologie. Hälfte 1: Der "Ruhekern". Von Prof. Dr. Georg Tischler. Zweite Auflage. Pp. xx+630. (Berlin: Gebrüder Borntraeger, 1934.) 64 gold marks.

(1) THE number of cytological books is rapidly increasing. The two before us, while both morphological, are almost entirely different in their contents. The work by Geitler aims, on the whole successfully, at giving a statement of the fundamental facts of general cytology, and cites results from plant and animal cells with equal frequency. Its six sections deal respectively with cell morphology, cell division, nuclear division, fertilisation, meiosis, and cytology in relation to heredity. The work is illustrated with 209 figures, some of which are original, a number being photomicrographs. Some of the recent studies of chromosome structures are given, including photographs of the salivary gland chromosomes in the *Simulium* larva. Selected studies are given from the Protozoa, Algæ and other groups of plants as well as the higher plants and animals. This book will serve a useful function as an introduction to the modern problems connected with cytology.

(2) Prof. Tischler's work is a second edition, the first having appeared in 1922. It deals exclusively with the resting plant nucleus, being an exhaustive review with citations of all the relevant literature. The present edition is largely increased in size, the number of publications cited having risen from 1,909 to 3,883, a striking index of the rapid increase in cytological literature. The topics considered are arranged under such headings as the general morphology and chemical organisation of the resting nucleus, the morphology of network, karyolymph, nucleoli, protein crystalloids, the nuclear membrane and exchanges through it, multinucleate cells, and the relation of the resting nucleus to cell division. This volume will be of permanent value as a work of reference.

Experimental Physical Chemistry
By Prof. Farrington Daniels, Prof. J. Howard Mathews and Prof. John Warren Williams. (International Chemical Series.) Second edition. Pp. xix+499. (New York and London: McGraw-Hill Book Co., Inc., 1934.) 21*s.* net.

FOR this second edition the authors have largely rewritten their book; alterations in experimental procedure to give higher accuracy, replacement of less satisfactory methods by new ones, and a different treatment of electromotive force and capacity constitute the principal changes.

In Part I, "Laboratory Experiments", each of the fifteen chapters deals with a particular field of physico-chemical work. The experiments are systematically described, each method being preceded by an adequate explanation of the theoretical principles involved, and followed by a summary of the practical applications of the method and suggestions for further work. Under the heading of Apparatus, Part II deals with means and technique necessary for work of a more advanced nature. These operations are grouped under chapter headings of the subjects to which they are most applicable, the order adopted for Part I being repeated in Part II; this, together with adequate cross-references, gives the book added coherence. Part III is concerned with miscellaneous operations, such as calibration, thermostatic control, the determination and influence of errors, which are of value in the conducting of any detailed systematic investigation.

Though the authors make no claim for completeness, this is a well-proportioned and comprehensive guide for both the student and the research worker.

H. K. W.

Speed*

By Prof. B. Melvill Jones

THE reason why a real fluid can leave the surface is now well understood, but the calculation of the precise point at which it will do so is still a matter of great difficulty, over which we are only just beginning to obtain the mastery. It is still true, in the main, to say that the question whether or not a given body will give a good streamline flow can be determined only by experiment, and it is entirely for this reason that it has been found worth while, in the countries interested in aeronautical development, to spend large sums of money on the construction of huge wind tunnels, within which the necessary experiments can be made. Even in these tunnels the question cannot be settled with absolute certainty, and research workers are turning more and more to face the difficult technique of experimenting in actual flight, to determine how nearly the flow about actual aeroplanes approaches the ideal streamline form.

It is, of course, no easy matter to design and make what may be described as streamline aeroplanes. It is necessary first to eliminate such an obvious obstruction to the air as the undercarriage, by pulling it up into the body or wings when in flight. This involves designing a light and strong mechanism which will return the wheels to the landing position and lock them there with wellnigh absolute certainty. The importance of this point strikes one with added force when landing for the first time upon a collapsible undercarriage which cannot be seen from inside the aeroplane. Next, there is the still more difficult problem of cooling the engines without exposing unstreamline objects to the air stream. The problem is especially difficult with the air-cooled engine which is so convenient in other respects: it has been partly overcome by devices known as the N.A.C.A. cowling and the Townend ring, which are placed around the engine to prevent it from deflecting the air stream away from the surface of the body behind it. Then again the pilot must be able to see forward comfortably through a window which does not spoil the streamline form of the body. This is rather easier when there is no engine in the nose of the body, for the pilot can then be placed well forward in a position where there is less danger of his window causing the stream to separate from the body. Finally, it is necessary to ensure that the junctions between the body and the wings and tail are not such as to lead to unstreamline flow, even though these parts separately would behave in a perfectly streamline manner. It is only recently that reliable information on this point has become available and led to designs in which the wings are carefully moulded into the body.

* *Continued from page* 466.

Until two or three years ago, these difficulties were altogether too much for designers and constructors, with the result that the resistance of the average aeroplane at high speeds was many times greater than it would have been with correct streamlining, and speeds of 100 miles per hour or slightly more were all that could be obtained from the power—one horse-power to about 12–15 lb. weight—usually supplied for transport purposes. During the past few years, the speed of the most advanced forms of civil aerial transport has risen from something less than 100 miles per hour to the neighbourhood of 170 miles per hour—the top speeds of the best aeroplanes have, as everyone knows, risen to more than 200 miles per hour, but I am referring to the actual travelling speed. This increase has been primarily due to improvements in streamlining. Secondary developments, such as that of the variable pitch screw and the split-flap wing, have been necessary to enable advantage to be taken of the reduced head resistance without adversely affecting the problem of landing and taking off, but these of themselves could have achieved but little upon the older unstreamline aeroplane.

In the epoch of the imperfectly streamline aeroplane, from which we are only now beginning to emerge, the skin friction on the exposed surfaces contributed so small a fraction to the whole resistance that, even if it could have been eliminated altogether, the speeds would not have increased to any important extent, but, now that it is becoming possible to approach the perfect streamline shape, skin friction provides the dominating contribution to the resistance, and its study with the view of possible reduction of head resistance is transformed from a matter of mainly academic interest to one of supreme practical importance. Here again that curious and insistent urge, which causes the unpractical man of science to study problems for their own sake, without reference to their immediate practical application, has stood us in good stead; for now that skin friction has suddenly taken the foremost place in the

search for still greater speed, we find ourselves already in possession of much useful information about it, although there is still a long way to go before we shall understand its action completely. It is to the consideration of what we already know about skin friction that we must now turn.

A real fluid, such as air, cannot slip over a solid surface ; the layers in immediate contact with the surface having no appreciable motion over it. This, of course, is in direct contrast to the ideal fluid of the mathematicians, which is assumed to slip with perfect ease. When one examines the flow of air close to a solid surface, one finds that the velocity parallel to the surface increases very rapidly from zero at the surface to the full velocity of the main stream at a point not far from the surface. The thin sheet of fluid in which this rapid change occurs is called the *boundary layer*. When the flow within this boundary layer is smooth, in the sense that sheets of fluid slip over one another without mixing—like the cards of a pack which is thrown down on a table—we say that the boundary layer is *laminar*, and it is found that when a body, such as a wing, has a smooth surface and a rounded leading edge the boundary layer is smooth—or laminar—for some distance along the surface back from the leading edge. Sooner or later, however, at some point behind the leading edge, this laminar condition breaks down and the flow within the boundary layer becomes *turbulent*, so that the separate sheets of air no longer slip as a whole over one another, but are thoroughly mixed together by the formation of little eddies and erratic movements of small portions of air to and from the surface. Anyone who has looked down over the side of a ship in motion will have seen the effect of this turbulence extending, on a large ship, for a foot or more from the side.

The distance from the leading edge of the wing or the bow of a ship at which the flow within the boundary layer passes from the smooth to the turbulent form is controlled by a number of factors such as the speed of the main flow, the shape and roughness of the solid surface and the turbulence, if any, already in the fluid before it reaches the wing. Speaking roughly, the greater the speed, the greater the roughness, or the greater the initial turbulence of the fluid, the sooner does the transition take place, and although we have a great deal of experimental evidence on the matter, we have, as yet, no means of calculating the distance from the leading edge at which the transition will occur, or even of placing any theoretical limit upon this distance if the surface were perfectly smooth and the main stream perfectly steady.

Experiments made in wind tunnels suggest that at speeds now in contemplation for civil aircraft—say 200 miles per hour—the transition to turbulent flow would be expected to occur within a few inches from the leading edge of the wings and front of the body, so that almost the whole of the surface of the wings and body would be covered by a turbulent boundary layer. But unfortunately there are no large high-speed tunnels yet in existence in which the air stream is as free from turbulence as the open air through which aeroplanes fly ; consequently it is to experiments on actual aeroplanes in flight that we must look for a final reliable estimate on this matter. There is as yet very little evidence of this kind available, but the necessary work is in hand.

The practical importance of discovering how far back it is possible to coax the boundary layer to remain smooth will be appreciated from the fact that the skin-friction force exerted by the smooth layer on a high-speed aeroplane would be about one-eighth that of the turbulent layer, so that anything which would increase the area covered by the smooth layer would have a powerful effect in raising the ultimate limit of speed. Assuming, however, for the moment, that it will not be feasible in the near future to retain the smooth form of the boundary layer over more than a small portion of the total exposed surface of an aeroplane, we have to consider the magnitude of skin-friction applied by the turbulent layer.

We have already a considerable knowledge of the skin-friction forces on thin smooth flat plates advancing edgewise into air or water, and we know that on such a plate, as large as the wings of a large aeroplane, the mean skin-friction resistance applied by the turbulent boundary at a speed of 200 miles per hour would be about one-third of a pound per square foot of exposed surface. But, in order to obtain this low figure the exposed surfaces would have to be very smooth. Recent work by Profs. Prandtl and von Kármán has suggested that roughness corresponding to small grains of sand larger than one-thousandth of an inch in diameter, thickly spread over the surface, would appreciably influence the results. Grains, for example, of the order one-hundredth of an inch in diameter would, it is estimated, raise the friction by as much as sixty per cent.

These estimates, it is true, were based only upon experiments made in long pipes with roughened surfaces, and the results were applied to flat pieces of finite length, after elaborate calculations based on unverified assumptions, but, for my part, I believe that the estimates will be found to be substantially correct when checked by direct

measurement on wings of various roughnesses. Such experimental checks should shortly become available from experiments in the compressed air tunnel at the National Physical Laboratory, and from some experiments which we are making at Cambridge to find the resistance of parts of the wings of actual aeroplanes in flight.

As to how far the skin friction on the curved surfaces of a wing or an aeroplane will be the same as that on a flat surface, we are still very much in the dark. The curvature of the wing causes the pressure to change from point to point on its surface, and these pressure changes, or gradients as they are called, influence the flow in the boundary layer and the intensity of the friction applied by it. They also appear to influence the point of transition from smooth to turbulent flow, in the sense that the flow seems more likely to become turbulent when pressure is increasing in the direction of flow. It has long been known that a too rapid pressure rise in the direction of flow reverses the flow in the boundary layer, and is the cause of the separation of flow from the surface of unstreamline bodies ; and it now seems that pressure gradients, much smaller than are necessary to cause separation, may still adversely affect speed by encouraging the boundary layer to take on the turbulent form with its inevitably increased resistance. It may be that the impossibility of avoiding such rising pressure gradients over some parts of the surface of an aeroplane will place a final bar upon efforts to extend the laminar boundary layer over the whole exposed surface, but it is as yet too early to make any definite prediction on this question.

We are now in a position to take stock of the situation in respect of the attainment of high speeds by the civil transport aeroplanes of the near future. The most efficient aeroplanes of the present day have travelled a long way towards perfect streamlining, and achieve cruising speeds of a little less than two hundred miles per hour. It has been estimated that if perfect streamlining were to reduce their head resistance to that of a smooth flat plate of the same exposed area with turbulent boundary layer, they would travel some 20 per cent faster than at present on the same power. Hence there is some improvement, though not much, still to be achieved by perfect streamlining.

Now, however, that skin friction has been promoted from the minor role which it played in the pre-streamline epoch to the principal part which it will henceforth play amongst the factors which limit speed, it is no longer accurate enough to assume that it can be represented by the turbulent layer skin friction on a flat plate, and a great vista of research is opened up, of which the object will be to determine accurately the skin friction on the actual curved surfaces of the aeroplane, and to reduce it so far as possible towards the figure appropriate to the laminar boundary layer. Complete success along these lines might result in a further eightfold reduction of direct head resistance, which might correspond to a nearly twofold increase of speed with the same power. One cannot say yet what part, if any, of this great reduction will ever be achieved, for the difficulties in the way of extending the laminar layer appreciably may be very great, and they may prove to be insurmountable. One can only note the reward to be gained if success were complete, and observe that to achieve a relatively small fraction of this reward would be worth a very great effort.

An alternative to the reduction of head resistance would be an increase of power for weight, and no one can predict what new developments of the power units may occur. But to increase speed greatly by this method alone is a difficult matter, for even if the power were to be doubled, by giving to civil aeroplanes powers comparable to those given to-day to war aeroplanes, speed would be increased only by some 25–30 per cent. Personally, I do not look for much increase along these lines in the near future.

There is one other foreseeable way of evading the restrictions on speed, which is much discussed at present, but which has not yet been exploited. This is to fly very high, using totally enclosed aeroplanes within which pressure and temperature can be maintained at a comfortable level for the occupants. By this means, the direct resistance to motion might be decreased almost indefinitely, at the expense of some increase in what I have called the track-laying power, which, as I have shown, places no final limit on speed. Many very difficult practical problems must be overcome before much can be made of this method, and it is too early to give any estimate of the increases in economical speed which might result from this line of attack. Possibly the ultimate limiting factor here will be the difficulty of cooling the engine at these high altitudes.

For my own part, I feel reasonably confident that stratospheric flying, as this high flying is called, with its as yet unpredictable limits to speed, will eventually provide the principal means of long-distance transport over the earth. For I cannot believe that man will fail to take advantage of the arrangement, so conveniently provided by Nature, whereby the air is thick where he has to land and take off, and thin a little way above, where he can travel at high speed with small resistance and without inconveniencing those who remain on the ground.

Surface Chemistry

THE immense progress that has been made in unravelling the details of surface phenomena, since the fifty years old generalisation of J. J. Thomson and Willard Gibbs that the energy conditions at surfaces may profoundly modify not only the concentrations, but also the chemical equilibria at surfaces, were well surveyed on September 6 in a vigorous and crowded discussion held by Section B (Chemistry) at the Norwich meeting of the British Association. The principal speakers were Profs. H. Freundlich, E. Waldschmidt-Leitz, E. C. C. Baly and E. K. Rideal, and Drs. N. K. Adam, A. H. Hughes and J. H. Schulman. Many of the outstanding points in the behaviour of molecules at the principal types of surfaces which occur in systems of actual or potential biological importance were touched upon in more or less detail.

With the simplest kinds of surface film, the unimolecular films at water-air surfaces, the structure is now so fully known that the size, shape, mechanical properties, orientation and motion of the molecules can be discerned in much detail. The links, also, with structural organic chemistry have been made secure by establishing the truth of Langmuir's generalisations that the surface films behave just as would be expected of a layer of floating objects having all the properties of the molecular models of the organic chemist, and that the field of force of the surface is simply the aggregate of the chemical forces round the surfaces of the individual molecules. Fatty compounds and sterols may have any of a large number of different types of film; the molecules may stand upright, or lie flat, or oscillate though various positions, always, however, keeping the water-attracting end to the water. Proteins and the higher carbohydrates lie flat if there is sufficient space on the surface; they may tilt a little if compressed, but never stand upright. With these simple films every stage of compactness is found, from the dilute gaseous films which have the molecules lying flat and swimming about individually in the surface, to the solid condensed films where they are upright, close packed, and interlocked so as to form a two-dimensional polycrystalline structure.

Unimolecular films may, or may not, be actually present as membranes in living cells; but that their properties are of fundamental importance for cell behaviour is already clear. It is possible to imitate, quite closely, on synthetic unimolecular films of substances present in red blood corpuscles, the phenomenon of hæmolysis. Hæmolytic agents introduced into the underlying water cause a great increase in surface pressure, penetrating into the natural film so as to force the molecules apart and cause it to expand, destroying its natural cohesion. Some such penetration and expansion of the membrane round a corpuscle must occur during hæmolysis. Probably agglutination is essentially due to the penetration of substances into the film, the molecules of which orientate themselves so as to render the outer surface more hydrophobic; the attraction of the cell surface for water is thus diminished and the cells tend to clump together.

There is, as yet, no proof that the intrinsic reactivity of molecules is altered merely by adsorption at a *liquid* surface, but nevertheless the surface may greatly affect the chemical equilibrium and the velocity of chemical reaction, through two factors. First, the actual concentration of the molecular species is usually very much altered through adsorption; secondly, the accessibility of the reacting portions of the molecules may be affected by the particular orientation in the surface. For example, the oxidation of unimolecular films of unsaturated fatty acids which have a double bond in the middle of the hydrocarbon chains is much accelerated if sufficient space is allowed on the surface for the chains to lie nearly flat, so that the double bonds can easily come into contact with the oxidising agent in the underlying water; the oxidation is retarded if the film is squeezed so as to push the chains more upright and the double bonds away from the water. Electrolytic dissociation, also, is often affected by adsorption at the simplest kind of surfaces, a phenomenon which may cause indicators to play unpleasant tricks in solutions of colloidal substances. All such phenomena are, however, only effects of the changes in the environment of the reacting groups in the adsorbed molecules, caused by their crowding and special orientation at the surfaces. A *liquid* surface seems incompetent to impose on adsorbed molecules the strains necessary to activate them, and catalyse the variety of reactions which are caused by enzymes and many solid surfaces. But certain colloidal supports can certainly do this.

Enzymes consist essentially of colloidal protein particles, on a part of the surface of which there is a grouping of atoms which has specific adsorptive and activating properties. Substances in the surrounding liquid must both be adsorbed on this

active patch and be activated when there ; there must be a highly specific relation between the structure of the active patch and the substrate adsorbed from solution for both these processes to occur. These surface patches do not appear to constitute any great part of the mass of the colloidal particle, for many pure enzymes activating very different reactions are so similar in general composition that ordinary chemical analysis cannot distinguish between them. The enzyme may thus be regarded as a colloidal carrier having a specific local surface structure. The nature of the carrier is of importance, though it is secondary to the nature of the surface grouping ; if the carrier is changed the catalytic efficiency of the enzyme may, or may not, be changed. The complex phenomena of activation of enzymes are often due to the combination of two types of particle ; and among the most important activators are the sulphydryl grouping and the iron-containing part of hæmoglobin.

The discussion gave a good idea of the progress made by the new science of the molecular anatomy of surfaces ; it is well started and cannot fail to develop rapidly and increase in interest and in usefulness to the biologist, and perhaps ultimately also to the practising physician.

N. K. ADAM.

Migrations of Animals

A COMPREHENSIVE discussion which covered the movements of most of the migratory groups of animals occupied the morning of September 10 at Section D (Zoology) of the British Association at Norwich and brought together much recent information about migration and theories concerning it.

The discussion was opened by Prof. James Ritchie, of the University of Aberdeen, who dealt with the migrations of mammals and directed attention to two problems—the cause or causes of migration and the way in which migratory routes were determined. He described briefly the well-known large-scale movements of such as the lemmings in Scandinavia, the brown rats which invaded Europe from the Caspian region in 1727, the grey squirrels and martens in North America before 1866. These, due to lack of food following undue multiplication, were casual, rather sporadic, one-way movements—overflow movements and not migration proper, and they aimed at no definite goal. True migrations, regular seasonal goings and comings or two-way movements, are of two types, differing in degree rather than essence. The local migration, shown by the red deer of Scottish hills or the Wapiti deer of the Yellowstone Park in the United States, was a movement from summer feeding grounds at high altitudes to a winter range in the shelter of the valleys. Its primary urge was food.

The great seasonal migrations, impressive in extent as well as in the mass of animals taking part in them, were formerly represented by the movements of the wild horses of the steppes of Asia, of the countless antelopes of Africa, the bison, reindeer and musk-oxen of America. They were determined mainly by scarcity of food, though other 'hungers' for water or for salt, also induced regular migrations ; and their route often followed regular tracks or roads surveyed and made by far distant ancestors after trial and error towards a definite goal. Road-making is characteristic of the daily activities of mammals, and migratory tracks formed a heritable property handed down from generation to generation. Such an explanation of migration avoids the need of invoking any special migratory instinct or special sense of direction.

Dr. N. A. Mackintosh described the migrations of whales from the antarctic region where they are most abundant during the summer, gorging upon the crustacean *Euphausia superba*. In winter they move northwards to temperate waters for the breeding season, and although actual migrations have not been often traced, the circumstantial evidence is strong. For example, in the antarctic, whales fatten enormously as the summer advances, and then off South Africa whales very fat in body and yet with empty stomachs are found, clearly immigrants from the antarctic feeding grounds. Again in winter off the African coast whales bearing fresh scars were found, but when whales were caught in the antarctic the scars were healed —they had been contracted in warmer waters during the northern migration. How the migrating whales are guided on their movements is not clear : except in coastal waters landmarks seem to be out of the question, but perhaps the temperature of the water controls the movements, since the regular presence of whales seen from the *Discovery* in the antarctic shows that they frequent tongues of warm water and are obviously sensitive to temperature.

Recent discoveries regarding the migrations of birds were described by Dr. A. Landsborough Thomson, who pointed out that the old idea of narrow migration routes along coast-lines and river-valleys had been abandoned in favour of the

idea of migratory movements upon a broad front. The extraordinary complexity and variety of migration in different species, sometimes closely related, were illustrated by a series of well-chosen examples, some selected from the recently investigated movements of birds confined to tropical areas; but it was pointed out that overriding all the complexities a regularity of time and place and route characterises migratory movements as a whole. The outstanding problem still to be solved is that of route-finding, and although there are many indications that vision plays an important part (for example, fog is one of the serious disturbances of a migration) yet the orientation of a migration journey must still be looked upon as something of a mystery.

Some interesting results of marking experiments were described by Dr. E. S. Russell in discussing the migrations of fishes, where knowledge of migration is of great economic importance since the movements of concentrated shoals of food fishes regulate the fisheries. In fish-marking experiments, hundreds of thousands of individuals have been marked and a high return of 30–40 per cent gave a clear indication of the major movements, which was supplemented by the analysis of fishery statistics. Generally speaking, the migrations of fishes consist of three movements—of mature fish to the spawning grounds, generally upstream, a dispersion after spawning, generally downstream, and local seasonal migrations such as that of the tunny into the North Sea in autumn. Dr. Russell illustrated these facts by describing in detail recent observations upon the movements of cod, plaice and salmon.

The series of general papers on migration was concluded by an account of the migrations of insects by Dr. C. B. Williams. In this case, migration does not necessarily include a return flight, though in the last five years evidence has accumulated that some Lepidoptera do make a return journey. Migration is widespread in the insect world, many instances being known from the groups of Lepidoptera, locusts, dragon-flies and beetles. One of the most remarkable cases is that of the American monarch butterfly which spends the summer so far north as Alaska and winters in the southern States and Mexico, returning to a state of semi-hibernation in the same groups of trees year after year, although one or two generations have passed since the former occupants had traversed the migration route. The extraordinary movements of the world-wide painted lady butterfly were described, and it was shown that insect migration takes place in definite directions, and is independent of the direction of the wind. The understanding of insect migration is complicated by the short life of insects which makes impossible any learning of the route from direct ancestral experience.

The migration symposium was a popular feature of the Section's discussions, and was attended by a very large audience.

Character and Causes of New Stars

AT the British Association meeting in Norwich, a discussion on new stars was opened in Section A (Physics) on September 10 by the Astronomer Royal (Dr. H. Spencer Jones), and other papers were contributed by Mr. J. P. M. Prentice, Prof. F. J. M. Stratton, Prof. W. H. McCrea, Mr. E. G. Williams, and Dr. A. B. Wyse and Mr. R. H. Stoy. The following is a summary of some of the chief points which emerged.

A new star may be defined for practical purposes as a star the apparent brightness of which increases within a few days by some five magnitudes or more. The first well-authenticated historical record of a nova is of that observed in 1572 by Tycho Brahe, and since then novæ have been looked for and observed with increasing zeal. This may be illustrated by the fact that, since 1901, forty-two galactic novæ have been recorded, and of these seven have been near enough and discovered soon enough for detailed spectroscopic study. These seven include Nova Herculis 1934, discovered by Prentice, through whose promptitude in communicating the fact a spectrum was obtained by Martin at Greenwich within one hour after discovery.

The 'light-curve' of a nova in general shows a steep rise to its principal maximum, followed at first by a steep fall, and then by a more gradual fading, with small fluctuations, to something very near the pre-outburst magnitude. The case of Nova Herculis, however, showed novel features in the way of many comparable maxima, extending over some months, before the steep drop occurred. The intrinsic surface brightness, as judged by the effective temperature, does not in general change much before the principal maximum, and hence the increase in total brightness must be attributed to an increase in the radiating surface. In a typical case, the radius of the star, as defined by its photosphere, must increase about a hundredfold. In the later stages, however, the effective temperature does increase very considerably, so

that the final radius when the star has returned to approximately its initial total brightness may be perhaps 1/25 of the pre-outburst radius. The net consequence of the outburst being thus a contraction of the whole star, it results in the liberation of a vast amount of gravitational energy of which some, at any rate, must supply the energy for the increased radiation during the eruption.

The variation of brightness of a nova is accompanied by a highly complex sequence of changes in its spectrum. Before the principal maximum the spectrum is not greatly different from one of the ordinary spectral types. The absorption lines, which are then its chief feature, show by their displacement towards the violet the general swelling up of the star already deduced from its increase in brightness. After maximum, multiple absorptions appear with large violet displacements, and each in general bordered on the redward side by bands of emission the mean position of which coincides in each case with the undisplaced position of the corresponding spectral line. These features can be explained by supposing that one or more shells of gas are thrown off from the star and accelerated away from it, probably under forces due to radiation pressure. This has in some cases been confirmed by the fact that, after enough time has elapsed for these shells to attain sufficient size, it has been possible to observe them directly as a growing nebulosity around the parent star. There is also spectroscopic evidence in some cases for the ejection of matter in irregular jets rather than, or as well as, in symmetrical shells. In addition, turbulence appears to develop in the ejected matter.

In the further spectral development the absorptions gradually disappear, giving way to a bright line spectrum in which a number of 'forbidden' lines of oxygen [O I] and [O III], and iron [Fe II], make their appearance. The whole sequence is consistent with what may be expected from the increase of temperature of the parent star and the decrease in density of the expanding envelope. The final spectrum is of Wolf-Rayet type, the structure of the lines suggesting the continued emission of gas. It seems probable that the nova is then approaching a white dwarf state.

Photometric measurements of novæ spectra have recently yielded valuable information confirming both the hypothesis of the expanding gaseous shells and also the high colour temperature attained by the nuclear star in the later stages. Further, the photometry of the absorption lines due to interstellar Ca^+ yields an estimate of the distance of the nova. This method gave for Nova Herculis a distance of 1,200 light-years, which shows that at maximum it was 30,000 times as bright as the sun.

The estimated rate of appearance of novæ in the Milky Way agrees well with Hubble's estimates of the number appearing in the Andromeda nebula, which may be regarded as a comparable system. If this rate is assumed uniform, it shows that in about 3×10^9 years every star would become a nova. This is approximately equal to the lowest estimate of the age of the stars, so it seems likely that such a flare up may in fact happen to every star. The most plausible explanation of the phenomenon is provided by E. A. Milne's theory, according to which instability sets in at a certain epoch in the evolution of a star, causing it to pass over into a 'collapsed' configuration, with the liberation of a large amount of gravitational energy. The same theory shows that, if the star is originally rotating, the collapse may cause it to split into two components, which need not then remain collapsed, thus suggesting an origin for double stars.

It is extremely doubtful whether novæ constitute a homogeneous class of objects. Whereas the total brightness in most cases increases ten- or a hundred-thousand fold, it seems that the nova of 1572 underwent an increase of about 16 million fold. Similar cases have been observed in other galaxies. So the isolation of a class of *super*-novæ is indicated, and it has been suggested by Baade and Zwicky that their outbursts provide the source of cosmic radiation. Again the behaviour of stars like RS Ophiuchi and T Pyxidis makes it seem probable that there is also a class of *recurrent* novæ.

W. H. McC.

Geological Relations of Early Man in East Anglia

THE discussion on this topic, held on September 5 at the Norwich meeting of the British Association, has revealed a far greater measure of agreement between geologists and archæologists than has emerged during any previous review of the subject. The division of the East Anglian glacial deposits into four distinct groups has provided a framework into which most of the archæological finds appear to fit quite naturally; it is thus not surprising that discussion should now centre around the more obvious of the remaining doubts and difficulties.

The first of these concerns the authenticity and cultural position of the various sub-Crag industries.

The best pieces from this horizon are now fairly generally accepted as human, both by geologists and archæologists; but some enthusiasts among the latter are apt to spoil their case by the obstinate advocacy of a great deal of poorer material which, convincingly human as it may be to their experienced eyes, can scarcely be expected to impress geologists who lack their special knowledge of these early industries. In any event, it is becoming increasingly clear that no general agreement can ever be obtained as to the exact position of the beginning of the Stone Age; but it seems justifiable to record a majority of informed opinion in favour of the human origin of some at least of the flints found below the East Anglian Crags. Some archæologists claim to recognise a Chellian facies in these cultures; but there are not many who would support their reference to the Chellian as usually recognised at present.

The next difficulty is the determination of the geological position of the true Chellian culture. This is largely due to the occurrence of a depositional hiatus between the first ('North Sea') and second ('Great Eastern') glaciations. Further, with the exception of one implement found by Mr. J. E. Sainty in the North Sea Drift, all the known Chellian specimens from East Anglia are heavily abraded, and are clearly much older than the deposits in which they are now found. Mr. Sainty's implement appears to indicate a preglacial date for the industry, and this accords well with its occurrence at Abbeville in association with a Cromerian fauna; but in that case it was probably of very long duration, since the Acheulian industry does not appear in England until after the second glaciation. It is to be hoped that further study of the deposits belonging to the first interglacial period, such as occur in the Midlands, will provide some help towards the solution of this problem.

The Acheulian of East Anglia appears to belong entirely to the second interglacial period. The only possible exceptions are provided by a few pieces found by Mr. J. Reid Moir in the so-called 'Upper Chalky Boulder Clay' and associated gravels in the Ipswich district. But as this 'Upper' boulder clay is no more than a surface modification of the great sheet of Chalky Boulder Clay which covers most of Norfolk, Suffolk and Essex and is known to underlie the Acheulian brickearths at Hoxne and at Derby Road, Ipswich, it seems reasonable to regard Mr. Moir's specimens as having reached their position from the surface; this could be explained either by later solifluxion or by descent into frost cracks.

It is now generally accepted that the flake industries of Clacton and High Lodge were broadly contemporaneous with the Acheulian, although the exact parallelism of their various stages has not yet been fully worked out.

The deposits of the third ('Little Eastern') glaciation frequently contain Acheulian and Clactonian implements. They have long been known from Gresham on the Cromer Ridge and from the gravels of the Breckland; Mr. Sainty has recently been finding them at several new localities in West Norfolk.

The archæological history of the third interglacial period is a matter of doubt. Apart from a few scattered Upper Palæolithic finds, the prevalent culture belonging to this interval is a curiously mixed assemblage suggestive of a degenerate Levalloisian or even Clactonian industry with traces of Upper Palæolithic influence. As it occurs largely on surface sites of no stratigraphical value it has been somewhat summarily referred to the Neolithic by many archæologists, in spite of the fact that real Neolithic forms and technique are wanting. Mr. Reid Moir's 'Lower Floor' at Bolton's pit, Ipswich, represents this industry; it is also known from Morston in Norfolk and is probably found on many surface sites in the Breckland.

It is to be hoped that archæologists will make a detailed study of this industry, which has certain well-marked peculiarities of technique and is probably peculiar to Great Britain.

The mesolithic industries are never found in glacial deposits even where the fourth glacial period is represented, and they are therefore considered as entirely post-glacial.

Such is the state of our knowledge of these problems as revealed by the recent discussion. Other points raised were the questions of nomenclature, of the position of the Pliocene-Pleistocene boundary and of the possibility of making a detailed chronological Drift map for the assistance of the archæologists.

Prof. P. G. H. Boswell suggests that the suffix '-ian' should be uniformly adopted for all the Palæolithic industries; this would appear to be logical and to follow the standard practice of British geology. The question of the Plio-Pleistocene boundary would eventually have to be settled by international agreement, but meanwhile there would seem to be a strong case for following the palæontologists, who place it at the horizon of the appearance of *Equus*, *Bos* and *Elephas*; that is to say, below the Red Crag of East Anglia.

The possibility of a detailed Drift map would seem to be small until the Pleistocene sequence has been correlated over the whole country; archæologists will therefore have to rest content with the ever-increasing number of criteria provided by the geologists for the differentiation of the various Drift deposits. J. D. SOLOMON.

Lubrication

AT a joint meeting of the Sections G (Engineering) and A (Physics) of the British Association in Norwich, on September 9, several problems in connexion with lubrication were discussed.

The field of lubrication may be regarded from several points of view. In the first place the design of bearings of different types for various species of mechanism presents a number of novel mathematical and engineering difficulties several of which, especially in reference to the thrust bearing, were considered at the meeting.

A suitably designed bearing will make the best use of the lubricating medium, which must be automatically entrained, rejected and replenished by the action of the bearing itself.

Whilst it is satisfactory to note that there has been during the last few years a very marked improvement in the design of bearings and in the methods and materials of their manufacture, it is equally clear that progress is not nearly so rapid in the second field of inquiry, namely what constitutes a good lubricating oil. This problem becomes daily more acute, for, as emphasised by more than one speaker, the modern development of the aero engine necessitates efficient lubrication at increasingly higher temperatures.

It has, of course, long been recognised that bearings design and materials, load, speed and temperature are all important factors which influence the frictional loss when any one lubricant is employed. It is very satisfactory to note that a number of testing machines are now available in which these factors can be varied independently.

It is unlikely that testing machines of different types will place a series of lubricants in identical orders of merit. If it be accepted that the duties of a well-designed bearing is to replenish oil at least as rapidly as it is consumed, it is necessary to inquire into the factors which cause consumption of oil and the nature of the products of destruction. Presumably a bearing may fail or record a high frictional loss, not on account of undue oil consumption but through insufficient entrainment of fresh oil, a fault which may be due either to the mechanical design of the bearing or to the physical properties, especially the fluidity, of the oil itself, or to a combination of both these factors. It would appear that some time must elapse before testing machines are devised which permit us to segregate the intrinsic characteristics of lubricating oils such as life or stability, oiliness and other more well-defined properties without reference to the type of bearing.

In respect to the mode of operation of the lubricant in boundary lubrication, the thesis of the late Sir William Hardy comprised two separate hypotheses. First, that a lubricant had to contain a substance capable of forming a monolayer on the metal anchoring itself by means of a polar group to the bearing surface and presenting to the liquid interface a long non-polar chain. Secondly, that above this monolayer a relatively thick orientated film was formed, termed diachysis by Hardy, a phenomenon which apparently bears a resemblance to the so-called cybotactic properties of certain liquids.

Both industrial and research experience have proved the correctness of Hardy's first assumption, but the weight of experimental evidence is now definitely against Hardy's hypothesis of a diachytic chain as possessing any real existence in a warm and moving bearing containing a fluid lubricant.

At the same time it is evident that the simple addition of say a long chain acid to a normal paraffin is not sufficient to produce the ideal lubricant although the orientated monolayer is formed under these conditions.

Two important factors have to be taken into consideration: first, the life of a monolayer is not indefinite, indeed, there is now evidence to show that one single passage of a slide over a surface lubricated with a monolayer is sufficient to destroy the lubricating properties of the layer. It follows that the bulk of the oil must be so constituted that it can act as a reserve for the rapid supply of fresh molecules to form the monolayer.

The rise of surface temperature, which may be surprisingly high, up to the melting point of the metal, has two important consequences: first, the distribution of the lubricating semi-polar molecules between the surface and the bulk phase, if controlled by a Boltzmann distribution, will be unfavourably affected, and secondly substances prone to thermal or oxidative chemical reactions will be destroyed. Whilst little is known about the rates of such disarrangements and chemical reactions in actual bearings, electron diffraction photographs reveal the non-uniform nature of the surface, and it is not surprising that attempts are being made to improve lubricants by the addition of polymeric and micelle-forming substances which are stable towards oxygen, less readily desorbed and renewed when destroyed at rates greatly superior to the long chain fatty acids.

E. K. R.

Obituary

Dr. Peter Giles

WE regret to record the death of Dr. Peter Giles, Master of Emmanuel College, Cambridge, and distinguished philologist, which took place in Cambridge on September 17 at the age of seventy-four years.

Peter Giles was born at Strichen, Aberdeenshire, on October 20, 1860, and after graduating at the University of Aberdeen, he went up to Cambridge as a scholar of Gonville and Caius in 1882. He was placed in the first class in both parts of the Classical Tripos and in the second class in history; and he won a number of University prizes. He was elected a fellow of Caius in 1887; but in 1890 he migrated to Emmanuel, and in 1891 was appointed reader in comparative philology in succession to Dr. Peile. In 1911 he became Master of his college. Throughout his academic career he fulfilled the many duties in College and University to which he was called, with conspicuous success by the exercise of qualities which won him the affectionate respect of all with whom he came into contact.

Giles's influence in the study of comparative philology began to be felt when the exuberant enthusiasm aroused by Max Müller's early teaching was waning under the cold breath of criticism. His "Short Manual of Comparative Philology for Classical Students" (1895) introduced a new and saner method to British scholarship. Nevertheless it was only very slowly that philology came to be regarded as anything but a highly specialised and circumscribed study, which could contribute little to the analysis of the broader aspects of cultural development which absorbed the attention of archæologist and ethnologist. Here again it was the influence of Giles and his writings, and more especially his contributions to Hastings's "Encyclopædia of Religion and Ethics" and the Cambridge Histories, that did much to restore a truer sense of balance and proportion. The brilliance and sanity of his discussion of the Aryan problem, as well as the convergence of his views towards lines which were being traced by archæological research, once more directed attention to a body of evidence which, with due recognition of its limitations, students of the origins of European culture could no longer afford to neglect.

Mr. T. H. Riches

THE death of Mr. Thomas Henry Riches, on September 19, at the age of seventy years, will be much regretted by his many scientific friends. As an undergraduate at Caius College, he was much interested in zoology, and after taking his degree in 1888, he devoted some time at Plymouth to the study of the Nemerteans. Here he published an account of the local forms, and collected material for elucidating the embryology of *Cephalothrix*; though before this work could be brought to satisfy his critical and rather fastidious mind, the burden of wealth was thrust upon him and he had perforce to turn his attention elsewhere.

Throughout life, however, Riches kept in close touch with zoological developments, and when experimental heredity became prominent he embarked on breeding research with rabbits—continuing it for a number of years. Though here again he published nothing in his own name, he discovered many interesting facts which, through the medium of others, were ultimately incorporated into our standard knowledge of the genetics of this animal.

More recently, Riches undertook an investigation into the genetics of the form of achondroplasia which appears as 'bull-dog calves' in Dexter-Kerry cattle, and of the analogous monstrosities in the Scandinavian Telemark breed, and these experiments were in progress at the time of his death. Art claimed his interest as well as science, and probably many readers of NATURE will remember him as a generous benefactor to the Fitzwilliam Museum and other good causes.

THE death has occurred in Berlin of Dr. Lydia Rabinowitch-Kempner at the age of sixty-three years. She was born at Kovno in Lithuania and studied medicine at Zurich and Berne and then in Philadelphia, where she taught in the Women's Medical College during the winter, and in the summer frequently carried out researches in Koch's laboratory in Berlin. Her first scientific work to attract attention was on the presence of non-pathogenic acid-fast bacilli in 60 per cent of the specimens of butter examined in Berlin. She then devoted her attention to tuberculosis and published articles on avian tuberculosis, spontaneous tuberculosis in domestic animals, hereditary transmission of tuberculosis in birds, etc. She also carried out researches on trypanosomiasis with Koch and on plague with Walter Kempner, another of Koch's assistants, whom she married. In 1912 she was the first woman to obtain the title of professor for scientific work. For some years prior to the anti-Semitic campaign in Germany she was editor of the *Zeitschrift für Tuberkulose* and director of the Bacteriological Department of the Moabit Hospital, Berlin.

WE regret to announce the following deaths:

Prof. Max Cremer, emeritus professor of physiology in the University of Berlin, and formerly head of the Physiological Institute of the Veterinary College, Berlin, aged seventy years.

Prof. A. Guntz, professor of applied chemistry in the University of Algiers, and *correspondant* of the Academy of Sciences, Paris.

News and Views

Dr. Arnold Berliner and *Die Naturwissenschaften*

WE much regret to learn that on August 13 Dr. Arnold Berliner was removed from the editorship of *Die Naturwissenschaften*, obviously in consequence of non-Aryan policy. This well-known scientific weekly, which in its aims and features has much in common with NATURE, was founded twenty-three years ago by Dr. Berliner, who has been the editor ever since and has devoted his whole activities to the journal, which has a high standard and under his guidance has become the recognised organ for expounding to German scientific readers subjects of interest and importance. A personal friend of Dr. Berliner writes: "When addressing the editor on his seventieth birthday in the inaugurating page of a festival issue, Albert Einstein said, 'His journal cannot be imagined as absent from the scientific life of our time'. Extremely small, indeed, is the number of journals which fulfil the task of uniting by a strong bond the separated and highly specialised work of the leading students in the various domains of science. The editor's important rôle and his active contribution to the progress of research, in conducting a periodical of this kind, are of a different order of magnitude from that of an ordinary 'Fachzeitschrift'. In order to cope with his task, he is obliged to exert very definite leadership on a body of prominent men, everyone of whom is liable to see things distorted from the point of view marked by his own interests and achievements. The editor is the one who has to survey the broad stream of scientific development, to select which subject-matters are suitable for presenting to his readers, to have intimate knowledge of the abilities (scientific and otherwise) of his contributors and, finally, after deciding upon the best writer upon a particular subject, to coax him into fulfilling towards his colleagues a duty of which sometimes neither he nor they are aware and to which the man himself often feels little inclination. It would need a large volume (and, maybe, more than one) to embody only those first-class essays which would never have been written, had it not been for the impossibility of resisting our dear and esteemed friend's gentle command".

Centenary of Darwin's visit to the Galapagos Archipelago

ON September 16, 1835, in the course of the voyage of the *Beagle*, a call was made at the islands of the Galapagos archipelago in the Pacific. This visit was one of the most momentous incidents in the life of Charles Darwin, who was on board the ship as naturalist, for the observations which he was enabled to make gave that orientation to his thoughts which ultimately led him to formulate his theory of the evolution of species. He records in his diary: "The natural history of these islands is eminently curious and well deserves attention. Most of the organic productions are aboriginal creations, found nowhere else; there is even a difference between the inhabitants of the different islands; yet all show a marked relationship with those of America, though separated from that continent by an open space of ocean between 500 and 600 miles in width. The archipelago is a little world within itself, or rather a satellite attached to America, whence it has derived a few stray colonists and has received the general character of its indigenous productions. Considering the small size of these islands, we feel the more astonished at the number of their aboriginal beings, and at their confined range. Seeing every height crowned with its crater, and the boundaries of most of the lava-streams still distinct, we are led to believe that within a period geologically recent the unbroken ocean was here spread out. Hence both in space and time, we seem to be brought somewhat near to that great fact —that mystery of mysteries—the first appearance of new beings on this earth."

Galapagos Exhibition at the Natural History Museum

To commemorate Darwin's visit to the Galapagos archipelago, a selection of the more characteristic forms of the reptiles and the birds, which were the elements of the fauna that especially claimed Darwin's attention, is exhibited in the Reptile Gallery of the British Museum (Natural History), South Kensington; some of the specimens, indeed, were collected by Darwin himself. Series of mocking-thrushes (*Nesomimus*) and finches (*Geospiza*) are arranged to show the variations in structure and distribution which are described in the "Journal of Researches" and which have puzzled ornithologists ever since. The characteristic giant tortoises, and marine and terrestrial iguanas are also shown, and attention is directed to the destruction of the fauna during the past century and to the imminent danger of its disappearance owing to the introduction and uncontrolled spread of predatory domestic animals.

Darwin and H.M.S. *Beagle*

THE president of the British Association, Prof. W. W. Watts, has received from H.M.S. *Beagle* a cablegram, recalling the centenary of Darwin's landing from the former *Beagle* on the Galapagos Islands. This important event in the history of biological science was duly noticed at the recent meeting of the Association in Norwich. (See NATURE of September 14, p. 426.) The cable pays tribute to "our most distinguished passenger", and adds that "the present *Beagle* salutes the British Association, the trustees of science". An appreciative acknowledgment, wishing good luck to the present *Beagle*, has been returned.

Bicentenary of James Keir, F.R.S.

ON September 29 occurs the bicentenary of the birth of James Keir, an able chemist and the friend

of Erasmus Darwin, Boulton, Watt, Priestley and Davy. The youngest of a family of eighteen and born in Stirlingshire, after attending the High School and University of Edinburgh he entered the Army and afterwards served for several years in the West Indies. Resigning his commission in 1768, he settled in the Midlands, became connected with various industrial enterprises and devoted himself to chemistry and geology. He was in turn a glass manufacturer at Stourbridge, an assistant to Boulton and Watt at Soho and the founder, with Alexander Blair, of a soap and alkali works. With Blair, too, in 1794 he opened the Tividale Colliery. In 1776 he translated Macquer's "Dictionary of Chemistry" and in 1777 published a treatise on elastic fluids or gases. He also contributed chemical papers to the Royal Society, and in 1785 was elected a fellow. A chemical dictionary of his own, of which he published the first part in 1789, he discontinued on his becoming convinced of the weakness of the phlogiston theory. For many years he lived at West Bromwich, where he died October 11, 1820, at the age of eighty-five years.

Adam Politzer, 1835–1920

ADAM POLITZER, one of the principal founders of otology, was born at Alberti in Hungary on October 1, 1835. He studied medicine in Vienna under Skoda, Rokitansky, Oppolzer and C. Ludwig, and qualified in 1859. In 1861 he was appointed lecturer in otology, and during the following years held a number of appointments in the University of Vienna connected with his speciality, being elected professor of otology in 1895 and director of the otological clinic in 1898. In addition to a textbook on otology first published in 1878, which ran through many editions and was translated into English in 1883 and 1902, he was the author of numerous articles on the anatomy and physiology of the ear and its diseases, especially suppurative otitis media and polypi. In 1864 he helped to found the *Archiv für Ohrenheilkunde*, and in 1895 the Austrian Otological Society. The Vienna ear clinic possesses a rich collection of anatomical and pathological specimens of the ear prepared by him. His name is attached to a method of inflation of the middle ear through the Eustachian tube by a pear-shaped rubber bag introduced through the nostril. He died in his eighty-fifth year on August 10, 1920.

Louis Ranvier, 1835–1922

LOUIS ANTOINE RANVIER, the eminent French histologist, was born at Lyons on October 2, 1835. His medical education took place in Paris, where he qualified in 1865, and two years later became Claude Bernard's assistant at the Collège de France. In 1875 he was appointed to the chair of general anatomy in the Paris faculty of medicine, and held this appointment for more than thirty years. In 1886 he was elected a member of the Paris Academy of Medicine and in the following year a member of the Academy of Sciences. He also became a member of numerous foreign academies and learned societies. His principal works are the "Manuel d'histologie pratique", written in collaboration with Cornil (1869–76) and his "Traité technique d'histologie" (1875–82). He made numerous contributions to the proceedings of the Société de Biologie and Academy of Sciences, and published a large number of papers in the *Journal de l'Anatomie et de la Physiologie*, *Archives de Physiologie*, *Journal de Micrographie*, etc. The term 'Ranvier's nodes', which is familiar to every biological student, has been given to the annular constrictions of the neurilemma associated with discontinuity of the medullary sheath of the nerve fibre. Ranvier died on March 22, 1922, in his eighty-seventh year, at Vendranges, Loire, where he had been living in retirement for some years.

'Legislative Anthropology'

DR. ARTHUR MACDONALD, of Washington, D.C., and formerly fellow of Johns Hopkins University, is well known for his advocacy of the claims of 'legislative anthropology', that is, study of the legislative, political, psychological, sociological and physical status of members of a legislature or parliament. He holds that as chosen servants of the people, members of the United States Legislature, for example, coming from all sections, are truly representative, and afford a good opportunity of establishing the anthropological status of the country. He goes further and argues that a similar study in other countries would afford a basis for comparison as between nations. At present, his opportunities are confined to material from the United States. He has made a study of certain physical characters of eighty-nine members of Congress, of which the results were published in the *Congressional Record* of the Seventy-second Congress, First Session, under date May 11, 1932. The figures then given established some interesting correlations, especially when studied in their geographical distribution according to States. Dr. Macdonald has now instituted some interesting comparisons between these members of Congress and a number of the insane, although he admits that the latter have no distinctive physical character. The number of individuals measured in this category was 360. They were chosen for their intelligence and included ex-army and naval officers and professional men. The majority, however, had no more than common school education, and for the most part had practised trades. The following are some of the measurements : *Congress*—length of head, 196 mm. ; breadth of head, 156 mm. ; height of head, 139 mm. *Insane*—length of head, 190 mm. ; breadth of head, 151 mm. ; height of head, 139 mm. It is to be noted, however, that while stature and weight in members of Congress are respectively 177 cm. and 183 lb., in the insane they are 170 cm. and 150 lb. Obviously the figures need further analysis before any significant conclusion can emerge.

An Education Film—"Northern Lights"

THE sound film entitled "Northern Lights" seen recently at a private view at the offices of the Western Electric Co. at Bush House, Aldwych, London, W.C.2,

is the film record of the expedition that set sail from the Port of London in July, 1930, in the late Sir Ernest Shackleton's old ship the *Quest*, under the leadership of Gino Watkins, to explore the possibilities of an air route between England and Central Canada. It is now available under the Western Electric Company's "All-in" Hiring Service, under which films, equipment and operators can be hired under one inclusive hiring fee, and is the latest addition to a series of educational films specially suitable for schools, that includes "Climbing Mount Everest" and "With Byrd at the South Pole". The photography is of a high standard, particularly in view of the trying conditions under which much of it was done. Particularly impressive was the record of a blizzard at the Expedition's base on the east coast of Greenland, views of the driving clouds of snow on the mountains being followed by others showing the subsequent gale in the fiord, which averaged 80 miles-an-hour and reached 120 miles-an-hour in gusts. Through the spindrift could be seen the floes of ice being hurried out towards the open sea, and the whole effect, combined with the accompanying sound record of the shrieking of the wind, was extremely impressive. There were glimpses also of the Eskimos and their kayaks, and of the members of the crew learning to use these vessels for the purpose of hunting seals, and finally of actual seal hunts. A good idea is given of the laborious sledge journeys in melting snow, and on ice slopes, and of the part played by the dogs—huskies from the west coast of Greenland. The educational value of the film is considerable, and it should prove very entertaining, as well as instructive, at schools.

Extension of Messrs. Negretti and Zambra's Works

MESSRS. NEGRETTI AND ZAMBRA, whose high reputation for scientific and industrial instruments is well known, have just completed a fourth extension of their works consisting mainly of a double floor building of approximately 10,500 square feet. The first floor comprises a new electrical thermometer department and experimental department with an extension for aircraft instruments. In the assembly of certain electrical thermometers it is very desirable to have a dust-free atmosphere, and very special care has been taken to ensure cleanliness in this department. For this purpose, an air-conditioning plant is installed which supplies the shop with filtered air, and if required, heated air free from dust and dirt. The air is led through a comparatively large duct along the roof and into the shop through adjustable nozzles placed at intervals along one side of the building. As the whole building is practically air-tight, a series of exhaust fans are provided in the window frames on the opposite side of the shop for exhausting the air. This ensures a flow of pure air across the shop with no entry of impure air. Consideration has also been given to the flooring to avoid dust, and this is a wood block floor of Austrian oak. The test room is separated from the main shop by partitions, and this is likewise kept dust-free. The equipment of the test room includes standard potentiometer, millivoltmeters, thermometer-testing baths, etc. The expansion has resulted also in an enlargement of the existing machine shop and a further expansion for the manufacture of mercury-in-steel thermometers.

Archæological Investigations in Shansi, China

RECENT excavation and an archæological reconnaissance in the province of Shansi, China, by Mr. C. W. Bishop, associate curator of the Freer Art Gallery, Smithsonian Institution, Washington, D.C., have made possible a remarkably detailed reconstruction of the late neolithic culture of north China. In an interim summary report of the results issued by the Smithsonian Institution, it is stated that the human skeletal remains discovered indicate that in the main the prehistoric population is identical with that which occupies the country to-day. A village site, which was excavated, was found to consist of beehive-shaped pit-dwellings, about ten feet deep, which were entered from the top. The present inhabitants of the district live in dwellings excavated in the cliff face, sometimes in two or more tiers, the entrance being in front. The prehistoric villagers were settled agriculturists, with the dog and pig as their only domesticated animals. They cultivated their fields with a stone hoe. They wore woven clothes, as well as using bark-cloth, and must therefore have been acquainted with some plant affording fibre for textiles. They also wore skins and furs; and they wove baskets and mats. Their implements were of stone, bone, deer antler and, no doubt, wood. Adzes, axes and knives, both rectangular and semi-lunar, often perforated, were found, as well as arrow points of stone, bone and shell. Although immense quantities of potsherds were found, there were few complete vessels. It is interesting to note that the pottery falls into two classes, of which the earlier was hand-made (coiled) and the later, falling at the end of the stone age, was painted. The hand-made pottery was decorated with impressed, incised or applied ornament; the painted pottery shows a buff or red-brown ground, on which geometric designs were painted in black, red or white. There is evidence of human sacrifice, and possibly of ritual cannibalism. This culture precedes the Chinese Bronze Age, which is known to have begun some centuries before 1500 B.C.

Bureau of American Ethnology

FOLLOWING the precedent of last year, the fifty-first annual report of the Bureau of American Ethnology is reduced in size and does not include the "Accompanying Papers" describing the field-work of the staff, which for so long have made this publication year by year one of the most important contributions of the United States to the literature of anthropology. The fifty-first report covers the operations of the staff of the Bureau in office and field up to June 1934. In the interests of economy, field-work was much curtailed, and for the most part took the form of supervision of the archæological investigations which have been put in hand in the States of

Tennessee, Georgia, Florida and California by Federal authority as part of the measures under the Civil Works Administration for the relief of unemployment. Of these investigations, the most extensive were in California, where extensive excavations at the Buena Vista Lake, Kern County, under Dr. H. D. Strong and Mr. W. M. Walker revealed evidence of extensive occupation and some six hundred interments. Nearly 5,000 artefacts and specimens were obtained, as well as information which throws a flood of light on the prehistoric inhabitants of the great southern valley of California and their ethnic affiliations. Mr. J. N. B. Hewitt's study of the Iroquois continues to reveal new and interesting details in the organisation of the Confederacy of the Five Nations, and this year promises to be of exceptional importance to the student of Indian tribal relations. Incidentally, the report shows another side of recent political 'scandals', alleged in criticisms of unemployment relief, by a reference to the specially qualified unemployed who were engaged to translate or transcribe material from the Bureau's archives hitherto inaccessible to study, or in danger of perishing.

British Hardwoods

IN a paper entitled "Our British Grown Hardwood Trees", read before the Forestry Sub-section of Section K (Botany) at the meeting of the British Association in Norwich on September 5, Mr. Alexander L. Howard traced the history of the forests, their denudation and afforestation work in Britain from the time of Henry II down to the present day. After reference to the disappearance of forests in other parts of the world and the resulting troubles caused thereby, Mr. Howard turned his attention to the afforestation work proceeding in Great Britain. What we want, he says, is the largest number of trees of both softwoods and hardwoods to be planted in the shortest possible time at the least possible cost. On the latter head there will be no disagreement; on the former, a certain section of opinion in Great Britain holds that, with the present high taxation, the whole of the burden of this afforestation work, the benefits of which can only be realised by future generations, should not fall upon the present one. After an analysis of the present position of the Forestry Commission and its expenditure, Mr. Howard advocates the formation of a regular Government Department "modelled on the lines of the best-known systems at present in existence". Mr. Howard—and many will agree with him—is insistent on the importance of increasing the areas of hardwood trees in Britain.

Plant Diseases in Egypt

THE Technical and Scientific Service of the Ministry of Agriculture for Egypt has recently issued a most valuable Bulletin on "Egyptian Plant Diseases: a Summary of Research and Control" (Bull. No. 146, Govt. Press, Bulâq, Cairo. Price P.T. 5. 1935). Mr. G. Howard Jones, director of the Ministry's Mycological Section, has written the text, which is a discussion of Egypt's position in relation to plant diseases, with a list of those which have occurred up to the present. Desert on three sides, and the sea on the fourth, render that country a somewhat isolated region, whilst the flooding of the Nile and the regularity of the seasons are further peculiarities. Rigid plant quarantine is one of the most effective methods of controlling fungus diseases in such an area. Research work has been directed to the investigation of individual diseases, the selection and testing of resistant host plants, the effects of differing level of the soil water table, and the progressive simplification of disease control. The last-mentioned question is of vital importance, not only in Egypt, but wherever busy farmers have to control disease in their crops. Seed disinfection with dusts is preferable to hot water treatment or to the use of liquid fungicides. The preparation of Bordeaux mixture is a very complicated process, so much simpler spray fluids are being developed. Eight reproductions of illustrated posters, with descriptions in the native language, are included in the Bulletin. One feels that Mr. Howard Jones and his colleagues really understand the situation in Egypt, and are doing their best to control the more serious diseases. The greater part of the publication is devoted to the list of diseases of crop plants, arranged according to their hosts, whose names appear in alphabetical order.

International Agriculture

"THE WORLD AGRICULTURAL SITUATION IN 1933-4", published by the International Institute of Agriculture, Rome (25 liras), forms the fifth of the series of "Economic Commentaries" on the "International Yearbook of Agricultural Statistics". The information is presented in a slightly different form from that in preceding volumes. The first part deals with world agriculture, its conditions and trends, and describes the market conditions of the chief agricultural products such as cereals, sugar, tea, coffee, wine, tobacco, textile materials and live-stock, while the second part is concerned with the agricultural policy and conditions in each of thirty different countries. A modification of the arrangement in the previous issues has been made and now information of every kind concerning each country has been grouped together in a single article. The development in Government intervention on behalf of agriculture has necessitated considerable extension of this part of the publication and has also led to the omission of the section devoted to the action taken by voluntary organisations, since this has inevitably become of increasingly smaller importance.

Shelterbelts and Windbreaks

IN Great Britain, shelterbelts are usually constructed as a protection against wind alone. In countries possessing arid areas of large expanse, like India and Mesopotamia, they are sometimes usefully employed against driven sand and dust. In these countries, the hot weather is usually accompanied by a daily wind rising with the sun and attaining its maximum about 1 p.m. and then gradually dying away. In some cases, the wind is so strong that it

carries small pebbles with it. It is not sufficient merely to plant grass to arrest the travelling sand dunes. The best way seems to be to plant suitable trees. In a paper by Dr. R. M. Gorrie published in the *Empire Forestry Journal* (**14**, 1 ; 1935) a scheme for enlarging farming shelterbelts so that they extend from the Canadian border down to Texas is described. Thousands of farmers have accepted aid from the Department of Agriculture, and the belts that have been constructed have greatly increased the comfort in which they live. In the arid Middle West, fruit growing becomes a possibility only when a shelterbelt is made. Dr. Gorrie says that the American scheme consists in multiplying the existing small windbreaks until about 2,500 square miles of forest has been planted. The layout of the belts is determined by the worst wind, and a width of about 150 feet is usually employed. As a means of relieving unemployment the scheme proved useful. In the same number of the *Journal* Mr. C. J. W. Pitt-Schenkel describes windbreaks in Tanganyika territory. A series of windbreaks are being planted across part of the country to check erosion and to protect the grass from being dried up rapidly by the prevailing wind.

Radium Deposits in North-West Canada

In *Sands, Clays and Minerals* of June 1935, published by the Westmoor Laboratory, Chatteris, England, Dr. H. S. Spence, of the Canadian Department of Mines, gives an authoritative and well-illustrated account of the discovery, occurrence and exploitation of the pitchblende deposits found by Gilbert Labine in 1930 on the eastern shore of Great Bear Lake. Work to date has demonstrated the existence of extremely rich ore in three veins. Three months' operation of the Eldorado Company's mill showed that the raw material is of exceptionally high grade, the best being equivalent to a radium content of one gram per 6½ tons. Occurrences of native silver add to the value of the deposits, some of the ore assaying up to 9,000 oz. of silver per ton. In veins 1 and 3 and in part of vein 2 the pitchblende was originally deposited in botryoidal crusts which were later brecciated and re-cemented by quartz. In the other part of vein 2 the gangue material is not silica, but carbonates of manganese, iron and lime, together with barytes. It is this section of vein 2 which is characterised by native silver, in flakes and leaves occurring in both pitchblende and gangue.

Other discoveries of pitchblende have been made in this region ; one immediately to the east of La Bine Point ; another ten miles to the south-east ; and another at Beaverlodge Lake, a hundred miles to the south. The last of these discoveries was made by smell ! Indians had noticed a peculiar smell when camping at La Bine Point. In the winter of 1934 when the ground was covered with snow, they showed a prospector a spot on Beaverlodge Lake where they had noticed a similar smell. The snow was cleared and a pitchblende vein was disclosed beneath. An official town site has now been established at Cameron Bay, just south of La Bine Point. The Eldorado Company's radium refinery is at Port Hope, fifty miles east of Toronto, 4,000 miles from the mines. Up to June 1934, the plant had isolated 5½ grams of radium from 58 tons of pitchblende, together with 35,000 pounds of uranium compounds and 30,000 oz. of silver.

Reduction in Price of German Books and Periodicals

As a result of comments upon the excessive cost of German periodicals recently made in Great Britain and the United States, German publishers, two years ago, reduced their prices by 20 per cent. (See article by Dr. W. Bonser, Librarian of the University of Birmingham, Nature of July 1, 1933, p. 34, and again of October 7, 1933, p. 540.) Unfortunately this reduction was at once counterbalanced by the fall in the value of the pound sterling. The German publishers are, however, making a further reduction, so that now the benefit will be appreciable. We are informed that : "From September 9th, 1935, there will be a discount of 25 per cent on the published prices of all new books originating from and published in Germany, on music and on all graphical instructive material, on subscriptions to periodicals, provided they were not charged before that date". The reductions will make a great difference to all university and society libraries ; for example, the physiological *Berichte*, formerly costing 6 vols. at RM. 68 will now be at RM. 51—a saving of about £8 a year.

Recent Earthquakes

We have received from Kew Observatory a notice of a violent earthquake recorded there at 14 h. 16 min. on September 11. The epicentre is estimated to have been in about lat. 43° N., long. 146° E., or about thirty miles off the south-east coast of the northern island of Hokkaido. This point is about thirty miles to the north of the epicentre of the destructive earthquake of April 25, 1843, after which seawaves 16 ft. high swept over the coast, and about eighty miles north-north-east of that of the less destructive earthquake of March 22, 1894, which was followed by seawaves about 5 ft. high on the coast of Hokkaido and 10 ft. high at Kamaisi on the east coast of Japan. A very violent earthquake was recorded at the Observatory at 2 h. 8 min. 13 sec. G.M.T., on September 20. The epicentre is estimated to have been 7,500 miles away, probably under the Pacific Ocean near the Mariamme Islands.

String-Figures

Kathleen Haddon (Mrs. O. H. T. Rishbeth), unquestionably our foremost expert in the study of the string-figure, has published a selection of these ingenious diversions for the use of beginners ("String Games for Beginners", Heffer and Sons, Cambridge. 6*d*. net). Twenty-four figures given here will serve as an introduction to their endless variety, and afford those previously uninstructed some idea of their wide distribution in various parts of the world. Mrs. Rishbeth has drawn on her own material collected in New Guinea and Australia, on figures brought back by Dr. A. C. Haddon from the Torres Straits, and

on material from various tribes of the Indians of North America. Instructions are reduced to their simplest terms, and a brief introduction sets out the significance of the string-figure, and explains why it is of interest to science as an indication of the life and thought of the people among whom each type of game occurs. Mrs. Rishbeth has considerately supplied a suitable piece of string which is attached to the book for the use of the reader.

Health of the Navy during 1933

THE health of the Navy during 1933 is detailed by the Medical Director-General, Surgeon Vice-Admiral R. W. B. Hall, in the Statistical Report of the Health of the Navy for the Year 1933 (London: H.M. Stationery Office. 2*s*. 6*d*. net). In a total force of 83,125, the number of cases of disease and injury was 41,852, a ratio of 503·48 per thousand, an increase of 40·53 in comparison with the five years' average and an increase of 31·80 in relation to 1932. The increase appears to be mainly due to an increase in the incidence of influenza and tonsillitis. Malaria, venereal diseases, tuberculosis and injuries, all show a decrease. The total number invalided also shows a decrease. Details are given respecting cases of interest and the pathological tests and surgical technique employed.

The Natural History Museum and Broadcasts to Schools

THE trustees of the British Museum have arranged for special talks and exhibits at the Natural History Museum in connexion with the biology course being broadcast to schools on Wednesdays, from September 25 until December 11, from 2.30 to 2.50 p.m. Within the limits of the accommodation, schools may attend at the Museum and listen to the broadcast talk in the board room, and immediately afterwards visit the appropriate specimens in the galleries under the guidance of the museum guide lecturer. For the benefit of schools which prefer to receive the broadcasts in their own classrooms, a special tour of the specimens by the guide lecturer will be available every Thursday at 2.30 p.m. For schools which may find it more convenient to attend at the museum only once or twice a term, more extensive tours may be arranged if particulars of what is required be addressed to the director. Arrangements also may be made with the director for schools unable to attend on Thursday afternoon to have the same lecture tour at some other time.

Announcements

THE ninety-fourth session of the School of the Pharmaceutical Society of Great Britain will begin on October 2, when Sir Frederick Gowland Hopkins will deliver the inaugural sessional address, at 3 p.m.

PROF. ALBERT SZENT-GYÖRGYI, who discovered vitamin C in capsicum, has succeeded Prof. Szeuky as director of the First Chemical Institute and professor of organic chemistry at Szeged.

THE twenty-fourth Congress of the Italian Society for the Advancement of Science will be held in Palermo on October 12–18 under the presidency of His Excellency the Honourable Di Marzio, rector of the University.

THE German General Medical Congress for Psychotherapy will be held at Breslau on October 3–6, when the subject for discussion will be psychical treatment in relation to psychiatry, internal medicine and education. Further information can be obtained from Dr. Hausdörfer, Psychiatrische Klinik, Breslau.

THE Fishery Institute of the University of Königsberg, directed by Prof. Willen, has organised a vacation course from October 9 until October 16 at the sea fishery station at Neukuhren, Samland, consisting of lectures, practical work and excursions, to illustrate the hydrography and biology of the Baltic. Further information can be obtained from Fischerei Institut, Universität, Königsberg.

PARTICULARS of lectures, courses and classes arranged by the Warburg Institute and dealing with the survival of classical elements in European history of religion, social life, fine arts, science and literature have recently been issued. All lectures, courses and classes are open to the public, and admission is free. Further information can be obtained from the Secretary, Warburg Institute, 3 Thames House, Millbank, London, S.W.1.

THE sixth Turkish Medical Congress will be held at Angora at the end of October under the patronage of the President of the Turkish Republic and the presidency of General Ismet Inöniü, the president of Council and Prof. Refik Saydan, the Minister of Health and Social Assistance. The subjects for discussion will be rheumatism and alcoholism and drug addiction in Turkey. An exhibition of pharmaceutical products and medical instruments will be held during the Congress. Further information can be obtained from the general secretary, Prof. Fahrettin Kerim, 15 Boulevard D'Angora, Stamboul, Turkey.

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

A temporary demonstrator in botany in the University of Leeds—The Registrar (Sept. 30).

A lecturer in engineering in the Plymouth and Devonport Technical College—The Secretary for Education, Coburg Street, Plymouth (Oct. 5).

An assistant pomologist at the John Innes Horticultural Institution, 21 Mostyn Road, S.W.19—The Secretary (Oct. 7).

A chemical pathologist in the Department of Clinical Investigations and Research in the Manchester Royal Infirmary—The Director (Oct. 11).

A curator of the Zanzibar Museum—The Director of Recruitment (Colonial Service), 2 Richmond Terrace, Whitehall, London, S.W.1 (Oct. 15).

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. 517.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Dielectric Constant of Ionised Air

IN recent years, a large number of experiments have been carried out on the dielectric constant of ionised air with the object of verifying the Eccles-Larmor theory, which demands that the dielectric constant of an ionised gas should be less than unity. Study of the literature on the subject reveals, however, that most of the investigations are of a qualitative nature, and further that the experimental results obtained are often of an anomalous type, the recorded dielectric constant being frequently equal to, or greater than, instead of less than, unity.

The present note briefly describes and gives the results of an experimental investigation by which a quantitative agreement with the prediction of the theory is secured, and an insight is gained into the origin of the anomalous results by previous workers.

The principle of the experiment is the same as that employed for measuring the dielectric constant of a medium by the Lecher wire system. The air, contained in a glass tube (diameter 3 cm., length 75 cm.) and ionised by electric discharge, is placed between the Lecher wires, with the length of the tube parallel to the wires. The Lecher system is excited by an ultra-short wave valve oscillator. The wave-length in the ionised air is measured on the wires in the usual way by noting the positions of the bridge for resonance, and is compared with that measured in non-ionised air. Keeping the discharge current constant, the frequency f of the valve oscillator is varied and a series of wave-length measurements made. A graph plotted between K, the apparent value of the dielectric constant calculated from the change in wave-length, and $1/f^2$ gives a curve of the form ABC shown in Fig. 1.

Remembering that $K = 1 - 4\pi Ne^2/m(p^2 + \nu^2)$, conductivity of ionised air $g = Ne^2\nu/m(p^2 + \nu^2)$, and that resonance measurements give us wave-length of propagation $\lambda = 2\pi/\beta$, where β is wave-length constant (a function of g), e and m are electronic charge and mass respectively, ν is collisional frequency, $p = 2\pi f$ and N is electronic concentration, we can interpret the curve as follows.

From A to B the curve is nearly a straight line. In this portion ν^2 is negligible compared with p^2, and λ is very nearly equal to $2\pi/p\sqrt{CL}$ since g is small (C and L being capacity and inductance per unit length of the Lecher wires). K therefore varies inversely as f^2.

From B onward the curve takes an upward turn. The dispersion here is apparently anomalous; K seems to increase with $1/f^2$. This anomaly is due to the fact that from B the value of ν^2 becomes comparable with p^2, and the effect on λ of the leakage between the wires due to conductivity of the ionised air begins to be appreciable. β has a tendency to increase and λ, as measured from the positions of resonance, decreases. K calculated from these values of λ decreases as $1/f^2$ increases.

In an actual experiment from the results of which the curve is drawn, the following values were obtained:

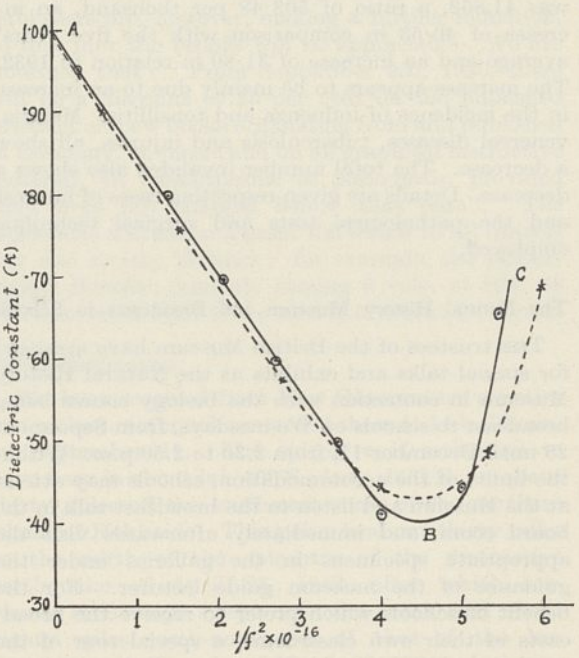

FIG. 1. Variation of dielectric constant of ionised air with $1/f^2$, where f is the wave frequency.

$N = 1{\cdot}87 \times 10^7$ electrons per c.c. (calculated from observations when $p \gg \nu$; $\nu = 1{\cdot}15 \times 10^8$ (calculated from the temperature of the electrons and the pressure in the discharge tube; temperature determined experimentally by Langmuir's probe method); $f = 37{\cdot}9 \times 10^8$ to $4{\cdot}0 \times 10^8$. A curve plotted between apparent K and $1/f^2$ as calculated from these data is shown in dotted lines in Fig. 1. It will be seen that the agreement between the experimental and the theoretical curve is as good as may be expected.

The curves thus furnish on one hand a quantitative verification of the Eccles-Larmor theory of the decrease of the dielectric constant of ionised air below unity, and also explain how, due to the conductivity acquired by the air, an anomalous increase of the dielectric constant comes to be recorded.

It may be mentioned here that in the usual experimental procedure adopted hitherto, the object was to detect, in a more or less qualitative way, the sense of the change in the capacity of a parallel plate

condenser when the air between the plates contained in a glass tube is ionised by electric discharge. The parallel plates themselves are placed either inside or outside the discharge tube. Various explanations of the observed anomaly in these experiments have been proposed. These may be classified as : (*a*) existence of quasi-elastically bound electrons (Gutton), (*b*) formation of ionic sheaths on the condenser plates when these are placed inside the discharge (Appleton), and (*c*) conductivity (Pedersen, Appleton, etc.). The Gutton effect has been examined by Appleton and shown to be a distinct phenomenon not connected with the anomaly. Sheath formation has little or no effect, as is shown by the fact that curves similar to *ABC* have been obtained by us with the Lecher wires running inside the discharge tube. It therefore seems certain that the conductivity acquired by the ionised air is the true cause of the anomalous results obtained.

A detailed account of the investigation will shortly be published elsewhere.

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Photodissociation of Nitrous Oxide

THE action of light on nitrous oxide has been studied by several workers in recent years. It was found by Wulf and Melvin[1] that N_2O, when irradiated by light of λ 2350 A., broke up into NO and N. Later on, Dutta[2] studied the absorption spectrum, and found that light was continuously cut off from a long wave-length limit λ 2750 A., and showed that the energy equivalent of this wave-length accounts for the dissociation of N_2O into NO and N, both in the normal states. I extended this work[3] in the Schumann region, and two more continuous absorptions were found beginning from the long wave-length limits λ 1850 A. and λ 1580 A., separated by a region of transparency ; it was shown that these further absorptions are responsible for raising N, one of the products of dissociation, to the metastable states ^2D and ^2P respectively. In short, the absorption of light by N_2O takes place in the following steps.

$$N_2O + h\nu_{2750} = NO\ (^2\Pi\ \text{normal}) + N(^4S) \quad . \ . \ . \ (1)$$
$$N_2O + h\nu_{1850} = NO\ (^2\Pi\ \text{normal}) + N(^2D) \quad . \ . \ . \ (2)$$
$$N_2O + h\nu_{1580} = NO\ (^2\Pi\ \text{normal}) + N(^2P) \quad . \ . \ . \ (3)$$

The values of $h\nu_{2750}-h\nu_{1850}$ and $h\nu_{1850}-h\nu_{1580}$ could be compared with the values of $^4S - {}^2D$ and $^2D - {}^2P$ respectively obtained from the classification of atomic spectrum of N.

Recently, Henry[4] has remeasured the absorption spectrum of nitrous oxide at different temperatures and obtained the long wave limit of continuous absorption as λ 2140 $\pm$ 130 A. at absolute zero, by extrapolation. This value is quite different from that obtained by the earlier investigators. Henry assumed a process of dissociation like the following :

$$N_2O\ (^1\Sigma) + h\nu_{2140} = NO\ (^2\Pi) + N(^2D) \quad . \ . \ . \quad (4)$$

This photochemical equation is claimed to explain not only the diamagnetism of N_2O (giving a $^1\Sigma$ state), but also the calculated value of the heat of dissociation of N_2, which is 6·9 $\pm$ 0·2 volts, is also found to agree with the latest value, 7·34 volts, given by Herzberg and Sponer[5]. It might be pointed out that opinions as regards the diamagnetic nature of N_2O differ, and at present there is no recent work to settle the point. There are several other points which may be put forward against the process (4) given by Henry.

The value $D_{N_2} = 6{\cdot}9 \pm 0{\cdot}2$ volts is decidedly lower than the present accepted value, 7·34 volts, given by Herzberg and Sponer. Herzberg and others have pointed out in several places that the energy of dissociation calculated from continuous absorption spectra always comes out higher than the true value. I have shown in a recent paper[6] that whenever there is a long tail of continuous absorption as in N_2O in the present case, the potential energy curve representing the interaction of the dissociated products will be very steep. Hence the absorption of light indicated by a vertical Franck-Condon transition from the ground-level will give a fairly high value of the heat of dissociation. The value of D_{N_2} calculated from such observations will be correspondingly higher than the true value, and not lower as obtained by Henry.

If the first long-wave limit of continuous absorption accounts for the dissociation of nitrous oxide into $NO(^2\Pi)$ and $N(^2D)$ as indicated by (4), the two subsequent absorptions in the Schumann region beginning from λ 1850 A. and λ 1580 A. respectively, given by equations (2) and (3), will have to be interpreted in a different manner, probably in the following way only :

$$N_2O + h\nu_{1850} = NO\ (^2\Pi\ \text{normal}) + N(^2P) \quad . \ . \ . \ (5)$$
$$N_2O + h\nu_{1580} = NO\ (^2\Pi\ \text{excited}) + N(^4S) \quad . \ . \ . \ (6)$$

From (4) and (5) we get :

$$h\nu_{1850}-h\nu_{2140} = 0{\cdot}86 \text{ volts nearly}$$

and from (4) and (6) :

$$h\nu_{1580}-h\nu_{2140} = 2{\cdot}06 \text{ volts nearly.}$$

These values are expected to give respectively the values of $^2D - {}^2P$ (= 1·19 volts) of N, and $^2\Pi\ \text{normal} - {}^2\Pi\ \text{excited}$ (= 5·61 volts) of NO approximately. The great lack of agreement here seems to throw doubt on Henry's suggestion regarding the photochemical dissociation of nitrous oxide in the quartz region. It cannot adequately account for the subsequent absorptions found by me in the Schumann region.

Further light is thrown on the problem from observations on the fluorescent spectrum of N_2O. I found[7] that when N_2O is irradiated by light having the short-wave limit at λ 1200 A., the β-bands of NO comes out in fluorescence. It was shown that in N_2O the production of the β-bands of NO can be accounted for in the following way only :

By absorption—

$$N_2O + h\nu_1 = NO(^2\Pi\ \text{normal}) + N\ \text{normal} \quad . \ . \ . \ (7)$$
$$N_2O + h\nu_2 = NO(^2\Pi\ \text{excited}) + N\ \text{normal} \quad . \ . \ . \ (8)$$

By fluorescence—

$$NO(^2\Pi\ \text{excited}) \xrightarrow[\beta\text{-bands}]{} NO(^2\Pi\ \text{normal}).$$

The excitation energy of the β-bands[8] is 128·8 k.cal., so that $h\nu_2 - h\nu_1 = 128{\cdot}8$ k.cal. If, according to Henry, $h\nu_1$ corresponds to λ 2140 A., we get $h\nu_2 = 262{\cdot}4$ k.cal corresponding nearly to λ 1090 A.

nearly. Consequently, light of wave-length greater than λ 1090 A. should not be able to excite the β-bands. Excitation can be brought about by λ 1200 A.; if $h\nu_1$ is taken to be in the neighbourhood of λ 2750 A. (Dutta), $h\nu_2$ comes out as near λ 1250 A.

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[1] Wulf and Melvin, *Phys. Rev.*, **39**, 180; 1932.
[2] Dutta, *Proc. Roy. Soc.*, A, **138**, 84; 1932.
[3] Sen-Gupta, *Bull. Acad. Sci. U.P.*, **3**, 197; 1934.
[4] Henry, NATURE, **134**, 498; 1934.
[5] Herzberg and Sponer, *Z. Phys.*, **26**, 1; 1934.
[6] Sen-Gupta, *Z. Phys.*, **88**, 647; 1934.
[7] Sen-Gupta, *Proc. Roy. Soc.*, A, **146**, 824; 1934.
[8] Jenkins, Barton and Mulliken, *Phys. Rev.*, **30**, 150; 1927.

Electron Diffraction by Vitreous Silica Powder

I HAVE succeeded in showing recently that the comparatively coarse particles of any powder are suitable for structure investigation by means of electron diffraction[1]. For this purpose a mineral or other substance is ground carefully in a small mortar. The powder obtained is placed in a sedimentation air tube like that described by Gonell[2]. When blowing the slow jet of air through the heap of powder disposed at the bottom of this sedimentation tube, only the coarsest particles will return, while the minute ones will move with the air blast to the top of the tube where there is a big receiver. By placing there a suitable holder, for example, a loop of wire with a thin celluloid film for the transmission method, or a support for the reflection method, one can collect the particles, the sizes of which depend on the speed of the air blast. It is possible also to collect the smallest particles at the bottom of the tube. For this purpose it is necessary to blow the air for a few minutes only until the smoke appears at the top of the tube, and then to wait, in the case of a tube of one metre in length, in general about 10–15 minutes. Then all particles larger than 0·1–1·0 μ in size are precipitated at the bottom of the tube, the remaining being still suspended in the air. To collect the latter on the holder it is sufficient to wait in the case mentioned above about half an hour, after which the process had to be repeated a few times to accumulate a layer of sufficient thickness. It may be noted that the diffraction haloes from the celluloid film disappear completely only when the layer is thick enough. In this way I have obtained sometimes sufficiently clear diffraction patterns from specimens, which were otherwise quite unsuitable for electron diffraction, for example, ignited magnesia, sand, cements and tripolites. Mrs. L. I. Tatarinowa has proposed another method for preparing the specimens by drying on the celluloid film a drop of liquid with a fine suspension of the substance to be studied. This method, which gives sometimes excellent specimens for electron diffraction, has an especial advantage in that it requires only the minutest portion of substance. I have used successfully both these methods.

Here I will confine myself to the case of electron diffraction by vitreous silica glass, which does not give sharp rings when exposed to X-rays. It is of interest that such an amorphous body behaves like a true crystalline aggregate (see Fig. 1). On the best photographic plates, I have succeeded in measuring sometimes up to ten and even more distinct rings, which correspond approximately to the following Bragg spacings d:

Int.	*hkl*	(observed) d	(calculated) d
Weak	—	4·40	—
Very strong	111	4·03	4·04
Strong	002	3·64	3·64
Very strong	022	2·52	2·50
Weak	113	2·17	2·17
,,	222	1·99	2·02
,,	133	1·65	1·62
Fair	224	1·47	1·46
Weak	242	1·42	1·42
Fair	044	1·26	1·25
Very weak	026	1·11	1·14
,, ,,	046	1·01	0·99

(The first extra ring belongs presumably to an adsorbed organic substance from the vacuum grease.) Some of these rings, namely, the most intense ones, have been observed by L. R. Maxwell and V. M. Mosley[3] in their work on electron diffraction by transmission of electrons through thin films of silica glass. In spite of the lack of accuracy of the measure-

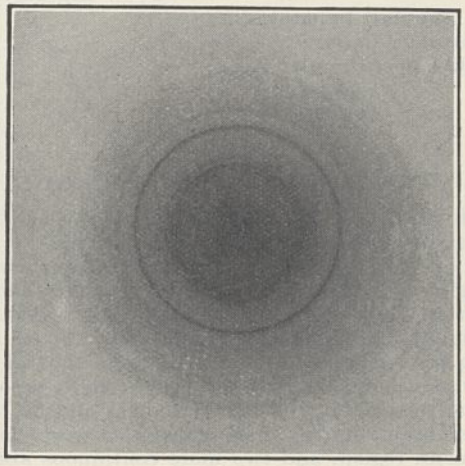

Fig. 1. Electron diffraction pattern of vitreous silica. × 2.

ments, I am inclined to think that the above results can only be interpreted as a scattering by tetragonal cristobalite crystallites constituting the vitreous SiO_2. The axial ratio is 1·06; $a = 6·87$; $c = 7·28$. The size of these cristallites, which is probably of the order of 15–20 A., as estimated by J. T. Randall, H. P. Rooksby and B. S. Cooper[4] by measuring the breadth of X-ray diffraction band, is sufficient to give very sharp diffraction rings. The electron wave-lengths in my experiments were about 0·06 A., while these authors, as well as B. E. Warren[5], used an X-ray wave-length of 1·54 A., so that the sharp electron diffraction patterns with many lines are, of course, the consequence of greater resolving power of the electron rays. Hence the method of electron diffraction is applicable to a much larger range of substances than hitherto supposed.

A fuller account is being published elsewhere.[6]

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[1] *C. R. Acad. Sci. U.S.S.R.*, No. 7–8, 461, March 1935.
[2] *Tonindustrie Z.*, No. 13, 243; 1929.
[3] *Phys. Rev.*, **47**, 331; 1935.
[4] *Z. Krist.*, **75**, 196; 1930.
[5] *Phys. Rev.*, **45**, 657; 1934.
[6] *Z. techn. Phys.* (Russian).

Induced Radioactivity of Nickel and Cobalt

USING nickel as a receiving plate for the recoil of radio-elements produced in the Fermi effect I have found, contrary to the statements of Fermi and his co-workers[1], that this metal acquires a slight activity under neutron bombardment. This effect must be attributed to nickel, because it is exhibited by chemically pure nickel plates and nickel oxide. Further investigations have shown that the induced radioactivity of nickel is composed of two parts, one decaying with a period of about 20 minutes and another with a period of the order of a few hours. The activity of both products is very small: nickel plates of 0·1 mm. thickness exposed for 12 hours to the full neutron radiation of 40 millicuries of radon mixed with beryllium give an initial effect of 1·5 impulses per minute. The long-life activity is enhanced 4–5 times, when neutrons are allowed to pass through water; the short-period product shows no increase in this case. It is therefore probable that the first product is an isotope of nickel. The possible reactions leading to this product are:

$$_{28}Ni^{58} + {}_0n^1 = {}_{28}Ni^{59} \quad . \quad . \quad . \quad (1)$$

and $$_{28}Ni^{62} + {}_0n^1 = {}_{28}Ni^{63} \quad . \quad . \quad . \quad (2).$$

Reaction (2) is more probable since its end product would be the stable isotope 63 of copper. The small relative importance of Ni^{62} in nickel would account for the smallness of the effect observed.

As for the second product of about 20 min. period, I have been led, on the ground of some rules based on a survey of artificial radio-elements, to the following reaction:

$$_{28}Ni^{60} + {}_0n^1 = {}_{27}Co^{60} + {}_1H^1.$$

In order to test this assumption, I have irradiated cobalt in a large vessel containing water. In addition to the known radio-element Mn^{56} of about 2·5 hours period[1] I have found another activity which has a period of about 20 minutes and which does not appear when no hydrogen medium is used. The initial activity due to this product is of the order of 6 impulses per minute. The corresponding reaction must be:

$$_{27}Co^{59} + {}_0n^1 = {}_{27}Co^{60}.$$

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Sept. 3.

[1] E. Fermi, E. Amaldi, O. D'Agostino, F. Rasetti, E. Segrè, *Proc. Roy. Soc.*, A, **146**, 483; 1934. **149**, 522; 1935.

Spiral Orbits and the Law of Recession

FROM certain considerations of isotropy, one of us has obtained, in a paper communicated elsewhere for publication, the line-element

$$ds^2 = -e^{\mu}(dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta d\varphi^2) + e^{\nu} dt^2, \quad . \quad (1)$$

where $\mu = \log(A + Bt + \frac{1}{2}t^2)$ and $\nu = 2 \log r$, A and B being arbitrary constants of integration. If $A = B = 0$, the geodesics give a straight line motion according to the law

$$\dot{r}/r = c/t, \quad . \quad . \quad . \quad . \quad (2)$$

where $c = -2$ or $\pm\sqrt{2}$. The two-dimensional motion is given by $\dot{r}/r = D/t$, and $\dot{\varphi} = \sqrt{(2 - D^2)}/t$, . . (3)

so that $r d\varphi/dr = \sqrt{(2 - D^2)}/D$, . . . (4)

which gives an equiangular spiral. If the spiral structure of the nebulæ is due to particles describing equiangular spirals as given by (4), and if the law of recession of the nebulæ themselves is of the form (2), then the line-element (1) seems to be of great interest in the relativistic theory of world-structure.

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Aug. 23.

Density of 100 per cent Heavy Water

THE density of D_2O was firstly estimated by Lewis and Macdonald[1] to be: $d_{25}^{25} = 1{\cdot}1056$. Later Taylor and Selwood[2] found a higher number: $d_{25}^{25} = 1{\cdot}1079$, and this figure has been used by several investigators. However, during the technical progress of concentration at the plant of the Norsk Hydro-Elektrisk Kvælstof A/S at Rjukan, indications were obtained that this figure was too high, and a number of careful pyknometer determinations of the density of 100 per cent D_2O in large quantities were, therefore, conducted.

The results obtained for the normal 100 per cent D_2O product (for which the density of the distilled electrolyte and that resulting from the combustion of hydrogen and oxygen from the cells were identical) were as follows:

$$d_{20}^{20} = 1{\cdot}10711;\ 1{\cdot}10712;\ 1{\cdot}10713;\ 1{\cdot}10714,$$

of which the highest figure ($d_{20}^{20} = 1{\cdot}10714$) must be considered to be the nearest approach to the true value. The pyknometer determinations were correct to 0·000001. The value of the density obtained corresponds to $d_{25}^{25} = 1{\cdot}1074$, that is, actually considerably lower than Taylor and Selwood's figure.

In order to determine the content of heavy oxygen in the water employed, 100 per cent D_2-gas was lead over hot copper oxide containing the normal O^{16}/O^{18}-ratio. The resulting water had a density: $d_{20}^{20} = 1{\cdot}1070$, and consequently the isotopic ratio of the oxygen in the 100 per cent D_2O products does not differ appreciably from the ordinary ratio. Concentration of heavy oxygen during electrolysis of water is, however, actually found to take place under certain conditions[3,4], and the high figure of Taylor and Selwood for the density of heavy water may be due to a higher proportion of heavy oxygen in the samples employed.

On the other hand, the density of 'light water' with a D_2O-content less than 1 : 200000 has also been determined. d_{20}^{20} for this product was found to be $0{\cdot}9999815 \pm 1\,\gamma$.

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[1] Lewis and Macdonald, *J. Amer. Chem. Soc.*, **55**, 3057; 1933.
[2] Taylor and Selwood, *J. Amer. Chem. Soc.*, **56**, 998; 1934.
[3] Washburn, Smith and Smith, *J. Res. Bur. Standards*, Nov. 1934, p. 599.
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Follicular (Œstrus) Hormone and Plant Tumours

A FEW years ago I observed that female rats and mice, given subcutaneous injections of a watery suspension of *B. tumefaciens*, or subcutaneous implantations of the crown gall tumours of pelargoniums, appeared to reach sexual maturity before control animals did. Harde[1], Yano[2], Dodds[3], and others, have given experimental proof of the possibility of a carcinogenic sensitisation of animals through administration of sexual—especially the follicular—hormones.

In previous experiments[4] it was clearly shown that the œstrus hormone had marked effects upon certain plants, and it was also observed that, when introduced in toxic doses through a petiolar stump into tomato plants, this hormone manifested its effects upwards along the stem, above the point of introduction.

In the present experiments, a similar introduction of an aqueous solution of a hormone was made into tomato plants, which were afterwards inoculated above and below the petiole with *B. tumefaciens*. Commercial crystalline œstrus hormones ('Glandubolin' of Richter, and 'Hogival' of Chinoin), prepared from urine of pregnant mares, were used; the average total dose absorbed was 434·3 mouse units per plant during the period June 8–21, 1935. In spite of the high dosage, toxic effects were almost negligible in comparison with those seen on tomato plants similarly treated in winter[4].

Thirty-one plants were treated with hormone, and a similar number served as controls; all were inoculated with *B. tumefaciens*, but twenty-one received distilled water, and ten received a deproteinised, hormone-free extract of animal tissue—in all cases via the petioles.

At the first sign of necrosis of the tumours they were cut off and weighed. The average weights of the tumours per plant were as follows:

Treatment	Position of tumours in relation to petiolar stump	
	Above	Below
Œstrus hormone	0·554 gm.	0·303 gm.
Controls:		
Distilled water	0·452 gm.	0·427 gm.
Special extract	0·407 gm.	0·423 gm.

These results indicate that though the weights of the tumours on the control plants were not significantly a function of their position, the mean weight of the uppermost tumours on the plants treated with œstrus hormone was about 80 per cent greater than the mean weight of tumours below the petiole.

The final interpretation of these observations must depend upon further work to decide whether the direction of migration of the hormone in the plant is constant, or whether it is different with physiological and toxic doses.

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Effect of Vitamin C (Ascorbic Acid) on the Growth of Plants

THE effect of vitamin C on plants was studied with sterile plant cultures. 40 mgm. of crystalline ascorbic acid was added to the liquid medium. It was found that the dry weight of the treated plants was about 35–75 per cent higher than that of the controls. The differences were greatest during flowering. The treated plants also showed a much higher content of vitamin C, particularly at the early stages. These results are illustrated by the table below. It is pointed out that the observed increase of growth is specifically due to ascorbic acid, and not merely to an addition of organic material to the inorganic medium, since a similar addition of glucose effected no increase in the growth of the plants.

'Torstai'-peas in sterile Hiltner's solution ($Ca(NO_3)_2$); initial *p*H 5·5.

Time of growth, in days	Stage of growth	Dry weight of 2 plants, in grams		Increase of crop per cent	Vitamin C per 1 gm. dry matter (ml. of indicator solution)	
		Treated	Controls		Treated	Controls
20	Before flowering	1·774	1·261	40·7	44	20
23	,, ,,	2·204	1·652	33·4	40	19
29	,, ,,	2·682	1·851	44·9	37	22
34	Start of flowering	4·641	2·666	74·1	35	24
39	Full bloom	5·692	3·835	48·4	36	30
44	Small pods	6·647	4·794	38·7	32	29
47	Full pods	7·119	4·343	63·9	25	26
50	,, ,,	7·906	5·550	42·5	24	25
52	,, ,,	8·122	5·820	39·6	23	24
55	,, ,,	8·423	6·117	37·7	21	24

Note added to proof. With regard to a communication by László Havas in NATURE of September 14, p. 435, concerning the effect of ascorbic acid on the growth of seedlings, I wish to point out that a report by me on the effect of vitamin C on plant growth[1] was published on May 8, 1935. Mr. László Havas has apparently not known of this earlier paper.

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[1] Synnöve v. Hausen, *Suomen Kemistilehti* B, **5-6**; 1935.

Mycorrhizal Habit in the Genus *Citrus*

IN a communication to NATURE, written when visiting the Citrus Experimental Station, University of California, I directed attention to the mycorrhizal habit in species of *Citrus* used as stocks for orange in Southern California, and to the possible relation of this habit with observed inconsistencies of response to the application of nitrogenous fertilisers[1]. The matter is one of considerable practical interest in view of the prevalent use of such fertilisers and the heavy cost of manuring in Californian orchards.

An investigation followed, the recently published results[2] of which justify the views expressed in my original note. Intensive study of the cytological changes in the roots of plants from experimental plots receiving different manurial treatments leads the authors to emphasise "the importance of the mycorrhizal association as a factor in the metabolism of *Citrus* root cells", and to conclude that: "the relations between the root cell and the endophytic fungus contribute to an understanding of the responses

of the tree to nitrogenous fertilizers, and to the conditions favorable for infection by the endophyte".

Mycorrhizal structure as observed in *Citrus* under cultivation in California is similar to that found in the same species under natural conditions. The remarkably wide geographical distribution of this 'Phycomycete type' of mycorrhizal association, its prevalence in plant species of the most diverse affinities, together with its recorded appearance in certain crop plants, prompts me to urge once again the need for expert diagnosis of root condition in respect to mycorrhizal equipment as an index of soil environment favourable or the reverse, and as a guide to efficient manurial treatments of crops showing regular mycorrhizal associations.

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Electrical Conductivity of Copper Oxide Films Showing Interference Colours

THE measurement of the electrical resistance of films of copper oxide on copper showing interference colours of the first order has given results varying from 0·002 to 15 ohms per sq. cm. at 25° C. On massive copper surfaces the temperature coefficient of the resistance is positive and somewhat less than that of metallic copper, while the resistance measured is very small, lending support to the view that the very fine structure of the film is very heterogeneous and minute areas of metal are probably exposed. These areas are too small for the microscope and spectrophotometer to show their presence.

With activated surfaces the electrical resistance is very much higher, and the temperature coefficient is negative, like that of the oxide. Although the surface colour showed striking homogeneity in many cases, shearing and breaking the metal showed a considerable thickness (up to 10^{-3} cm.) of activated film and graded colour sequences through the fracture corresponding to thinner films on the granules as the distance from the surface increased.

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Points from Foregoing Letters

THE variation of the dielectric constant of ionised air with wave frequency has been determined by Prof. S. K. Mitra and S. S. Banerjee. Their findings verify the Eccles-Larmor theory, which demands that the dielectric constant of an ionised gas should be less than unity, and shows that owing to the conductivity acquired by the ionised air, an anomalous increase of the dielectric constant is recorded.

Prof. P. K. Sen-Gupta adduces several arguments to substantiate his claim that nitrous oxide gas, N_2O, is broken down into NO and N by ultra-violet light of wave-lengths 2750, 1850 and 1580 A. (in which regions nitrous oxide has absorption bands), and not by wave-length 2140, at absolute zero, as claimed by Henry.

A photograph indicating the electron diffraction pattern obtained with powdered vitreous silica is submitted by N. A. Shishacow. Unlike the photographs obtained with the same material with X-ray of wave-lengths 1·54 A., the photograph obtained with electrons, the energy of which corresponds to a wave-length of 0·06 A., and have a correspondingly greater resolving power, shows distinct rings, indicating the presence of tetragonal cristobalite crystallites constituting the vitreous silica.

By bombarding nickel with neutrons from a powerful radon-beryllium source, J. Rotblat has succeeded in producing radioactivity of two life periods, of twenty minutes and two hours respectively. He ascribes the longer-lived product to the formation of an unstable nickel isotope of mass 59 or 63, and the shorter radioactivity to radioactive cobalt of mass 60, formed from nickel-like atoms of the same mass. Mr. Rotblat has further obtained the radioactive cobalt of the same life-period by bombarding cobalt of mass 59 with neutrons.

Dr. V. V. Narlikar and K. V. Sastry direct attention to a new formula for a line-element, which may prove of great interest in the relativity theory of world-structure.

New measurements of the density of heavy water, by Dr. L. Tronstad, J. Nordhagen and J. Brun, give 1·10714 as the nearest approach to the correct value at 20°C. The authors suggest that the higher value obtained by Taylor and Selwood may be due to a higher proportion of heavy oxygen in the samples employed. The density of the purest light water (free from the heavier variety) was found to be 0·9999815.

Bacillus tumefaciens injected into the stems of tomato plants produces characteristic tumours of a given average size. László Havas, by injecting aqueous solutions of sex hormones, finds that the average size of the plant tumours above the site of the injection increased, while those below the site of injection decreased. Further work is necessary before it can be determined whether the direction of migration of the hormone is constant, and whether it varies with physiological and toxic doses.

Vitamin C, added to sterile plant cultures, leads to an increase of 35–75 per cent in the dry weight of the plants, according to experiments reported by Dr. Synnöve v. Hausen. This increase is due to ascorbic acid specifically, and not merely to the addition of an organic substance, since controls using glucose produced no such increase. The greatest differences were obtained during flowering.

Recent publications by Prof. H. Reed and Mlle. Frémont from the Citrus Experimental Station, University of California, confirm views expressed in NATURE by Dr. M. C. Rayner respecting the practical significance of the mycorrhizal habit in *Citrus* cultivation. The necessity for expert diagnosis in other crop plants showing similar root relationships is urged.

Research Items

Geological Age of the Markleeberg Palæolithic Industry

THE distinctive palæolithic industry found in the gravels of Markleeberg on the right bank of the Pleisse, approximately 8 km. south of Leipzig, of which examples were first collected in 1895, and of which accounts have appeared on numerous occasions since 1911, has given rise to much controversy owing to an apparent contradiction between its position in the geological time-scale and its relation to the culture sequence of the French archæological classification. On typological grounds, the industry is regarded as a Mousterian which retains certain primitive characters in its technique and shows Acheulean influences. In a discussion of the geological evidence of the age of the deposits in which the industry appears M. R. Grahmann points out (*L'Anthropologie*, **45**, 3–4) that difficulty arises, to a great extent, from the fact that the quaternary geology of the area is only very imperfectly known. Recent research has shown that there is evidence of three glaciations, corresponding to those of northern Germany, which may be termed Elster, Saale and Vistula. Applying this scheme to the Markleeberg deposits, the evidence is interpreted as indicating the moraine of the second glaciation, the Saale, as the source of the industry. Probabilities, however, point to the industry being older, while the diversity of facies it exhibits may well be due to the moraine having gathered up the debris of a number of sites of different ages. A suggested correlation of this scheme with that of the Alpine and north European glaciations equates the Markleeberg industry with the beginning of the Riss glaciation and makes it contemporary with the French Acheulean, thus indicating a difference in the course of development of stone age industries in central and eastern Europe and the west, while tending to support the view that the former were the earlier.

Agricultural Ceremonies in the Naga Hills

IN a communication dealing with the effect of ritual upon industries and arts in the Naga Hills, Mr. J. P. Mills (*Man*, **144**, September) describes the agricultural ceremonies observed by the Nagas during the year, which have not previously been recorded. The village is a closely knit community which acts together in seeking the favour of the spirits for the crops of all. The essential act of worship is a day of rest, on which no one is allowed to work in the fields. In all, there are about seventy *kennü* days in the year ; but they are so arranged as not to interfere with agricultural operations. Thus in those months when the people are busily engaged in clearing the ground, sowing the millet or preparing for the growing of the important rice crop, few *kennü* days are observed, except here and there for rest from the work in hand. The close of a time for a particular operation, such as, for example, of the season of pot-making in January, is marked by a day of rest. Private ceremonies, from the nature of the case, do not show the same consideration for agricultural operations, and the observance of the days of abstention, such as are enjoined for sickness, a birth or death, make serious demands on time which may extend to as much as five days at a time. The agricultural year opens in January with three days of purification, after which the clearing of new *jhums* and the sowing of millet begins. In March, when it is time to think of the rice, four days between March 10 and 15 are days of *kennü* and feasting preparatory to beginning the main work of the year. At various dates in the following months there are *kennüs* to avert bad luck or damage from various causes, such as hail, grubs, ants, etc. Jungle clearing is accompanied by a great deal of feasting and jollification. *Kennüs* take place on September 10 and 11 for the solemn eating of the first fruits, and on November 24–December 5 the whole village gives itself up to the great feast which marks the end of the year's work.

Cobalt and 'Coast Disease' of Sheep in Australia

AS is well known, minute amounts of certain elements, for example, copper, manganese, zinc, boron and others, are necessary for the normal nutrition of animals and plants, and evidence has been obtained that 'coast disease' of sheep in South Australia may be due to a deficiency of cobalt (Marston and Lines, *J. Council for Sci. and Indust. Res.*, Commonwealth of Australia, **8**, No. 2, pp. 111–117). In this disease, sheep fed on certain pastures become lethargic and anæmic, waste and ultimately die. The soil in the area is deficient in certain elements, notably phosphorus, but additions of iron, manganese, arsenic, copper and phosphates failed to cure or prevent the disease. Other elements were also eliminated, and as cobalt had been found experimentally to increase the number of blood-corpuscles, it was decided to test the effect of this element. Two sheep which were almost *in extremis* with coast disease were therefore given 1 mgm. a day of cobalt in the form of cobaltous nitrate. The effect was almost immediate ; within three days the animals improved in health, appetite and body weight, and in the condition of the blood, and within ten weeks had become almost normal again.

Mollusca of Lake Geneva

AN interesting study of the ancient and modern molluscan fauna of Lake Geneva is made by M. Jules Favre ("Études sur la Partie Occidentale du Lac de Genève. 2. Histoire Malacologique du Lac de Genève". *Mem. Soc. Phys. et d'Hist. Nat. Genève*, **41**, Fasc. 3, 1935). Many species are discussed, but of special importance is the variability of *Valvata piscinalis*, which is very different at different depths. Two forms are found now living in the lake, the form *antiqua* having a thick and opaque shell, greyish yellow, pale, turriculated, with scarcely any umbilicus, which is distributed almost everywhere on the muddy bottom of the littoral and sub-littoral zone down to about 25 metres, then becoming scarce and disappearing at 40 metres, and the form *alpestris minor* having a whitish shell, diaphanous or almost hyaline with conspicuous transverse striations and large umbilicus, a much smaller form than *antiqua*. The form *alpestris minor* is now rare in the lake and localised in the vicinity of certain fields of Characeæ in the Bay of Belotte between 5·50 and 10 metres. It represents the primitive form occurring in the post-glacial sediment which has given rise to the common form *antiqua*, the latter being the best adapted to

littoral regions, thriving in the sub-littoral zone where it is not battered by the waves and tending in the littoral regions to be the typical form of *V. piscinalis*. The species established itself in the lake in Post-Glacial times very soon after the retreat of the glaciers, and was among the first of the molluscs to invade the sub-littoral region, rapidly undergoing important developments and varying greatly when large masses of Characeæ filled a certain part of the area, these algæ having a profound influence on the species. Then the original form varied in different ways according to its habitat, those on the muddy bottoms after much variation giving rise to the turreted *antiqua* with constricted umbilicus, now the commonest form to be found in the lake, those in the *Chara* beds being mainly planorbis-like flattened forms with large umbilicus. The form *alpestris minor* recalls the ancient population, and is only to be found in the fields of Characeæ.

Australian Cowries

COWRIE shells, popular with amateur collectors because of the beauty of their texture and patterns, have been well illustrated in colour in well-known monographs by the earlier workers. The difficulty of observing the living inhabitant, on account of the readiness with which it withdraws into its shell, has for the first time been overcome on a large scale by the Australian naturalist, Melbourne Ward. He has observed and made paintings of twenty species which he kept alive in his aquarium, and the paintings have served to differentiate species which on shell-characters alone seemed to be indistinguishable. Coloured figures of the living animals and their shells, with adequate descriptions, have been published in a complete list of Australian cowries (Cypræoidea) by Tom Iredale (*Australian Zoologist*, **8**, 96; 1935); and the animals are even more beautifully coloured than their shells.

Development of May-Flies

IT has long been known that certain species of Ephemeroptera, or may-flies, pass through a very large number of nymphal instars. In this respect, they only find their parallel, in other insects, among the Plecoptera or stone-flies. An account of the post-embryonic development of several species of may-flies by Mr. F. P. Ide has recently appeared (*Canad. J. Res.*, **12**, 433, April 1935). The life-histories of *Stenonema canadense* and of *Ephemera simulans* are described in detail, and those of nine other species less completely. In *S. canadense* the number of ecdyses was found to be between 40 and 45 and in *E. similans* about 30. At each moult there is some increase in size, but the significance of moulting seems to be primarily for the purpose of changing morphological structure. Every change in external structure, even to the addition of a single seta, can only be accomplished through ecdysis. The determination of the instars is stated to be possible owing to the fact that each moult results in a change in the number of segments in the caudal filaments. The author comments upon the fact that many other insects grow to a much greater size than may-flies and yet only pass through four or five moults. He concludes that it is unlikely that so many moults could be concerned primarily with increase in size and that the reason seems to be in the need for the nymph to be constantly changing its structure in order to adjust itself to environmental changes.

Intertidal Ecology

THE study of the habits and distribution of the animals and plants inhabiting the intertidal region of the shore is one of considerable difficulty on account of the complexity of the environmental factors involved. Where many factors such as wave-exposure, emersion and immersion, insolation, etc., are concerned, it is desirable to study localities with as simple conditions as possible. Kitching (*Trans. Roy. Soc. Edin.*, **58**, Pt. 2, No. 15, 1935), in describing a number of places on the Argyll coasts, has related the size and abundance of some of the most important species of animals and algæ to wave-exposure, level and angle of slope of the rock. He also gives some data with regard to the hydrogen ion concentration, oxygen content and temperature in the various places. While some of the relationships are comparatively simple, such as the limiting wave-exposure which some algæ can stand without being detached, or the inability of barnacles to survive within the 'sweep' of the larger brown algæ, many of the relationships are very much less obvious, and collection of many more observations of this nature will be necessary for their elucidation.

A Rare Carnivorous Plant

DR. JOJI ASHIDA has given a very full account (*Mem. Coll. Sci., Kyoto Imp. Univ.*, B, **9**, No. 3, Art. 5; 1934) of the opening and closing mechanism of the leaf blade of *Aldrovanda vesiculosa*, L., an animal-catching mechanism which has very seldom been studied, and never so thoroughly. Dr. Ashida was successful in growing this plant in culture throughout the year, the presence of dead leaves and stems of certain other aquatic plants proving to be the special requirement of this plant. The motile zone of the leaf blade lies at a distance of 0·15–0·25 mm. from the midrib and works apparently as the result of a loss of turgor of the inner epidermal cells on stimulation. The outer two layers, still turgid, then bend the two lobes so as to shut the leaf. After shutting, the surfaces are still compressed closer together, narrowing the cavity which encloses the animal victim. This is due to an increase of turgor and an active elongation of the outer epidermal cells; the water needed for the movement enters mainly through the outer surface. The subsequent expansion of the cavity within the closed leaf lamina and opening of the leaf is attributed to a transverse growth of the inner epidermis.

Distribution of Earthquakes in New Zealand

THE seismic record of New Zealand begins in 1848, and, from that time until the end of 1934, more than 6,000 earthquakes have been reported from various parts of the country. The distribution of these earthquakes, as regards both frequency and intensity, has recently been studied by Messrs. L. Bastings and R. C. Hayes (*Wellington Dom. Obs. Bull.*, No. 95; 1935). They divide the whole country into 19 areas roughly equal in size by lines of latitude and longitude. In the frequency map, the areas are shaded in tints depending on the percentage of the total number of New Zealand earthquakes felt within them. The highest percentage, 26·0, is reached in the district visited by the Murchison earthquake of 1929. A percentage only slightly less, 25·6, marks the western half of the central portion of the North Island, but this is due to the occurrence of more than a thousand

local shocks in and near Taupo in 1922. The district including Hawke's Bay has a percentage of only 9·0. The second map represents the maximum intensity of the earthquakes in the different areas, in six of which, at the north end of the South Island and the southern portion of the North Island, the tenth or highest degree of the Rossi-Forel scale was attained.

Theory of Elastic Solids in Practice

THE problems that arise when applying mathematical analysis to the stresses and strains in elastic solids only admit of exact solution in a few special cases. The demand for more accurate solutions has recently become urgent in the design of large electrical machines, as, owing to the improved methods of cooling now adopted, the permissible output has been greatly increased, and consequently the determination of the stresses and strains has become of primary importance. In the *Journal of the Institution of Electrical Engineers* of August, R. Poole discusses the various forces—magnetic, gravitational and mechanical—which act on the frames of large machines. It is pointed out that the effect of the magnetic pull on the frames is of great importance. He gives a method of analysis for calculating these effects which will be useful in practice, since it provides a means of showing the safe wear on the bearings of a machine and thus fixes the limits of mechanical design. As a check upon certain of the assumptions made in the mathematical treatment of the problem the author carried out photo-elastic tests upon model frames made of celluloid. The coloured photographs shown enable the distribution of the stresses and their approximate magnitudes to be seen at a glance. It is interesting to remember that these photo-elastic methods are based on the discovery made by Sir David Brewster that when a piece of glass is stressed and viewed in polarised light under certain conditions, brilliant colour effects are produced owing to the glass becoming double refracting. Prof. E. C. Coker has recently perfected an apparatus for this method of testing.

Stress and Elasticity

AMONG the papers issued by the Institution of Mechanical Engineers for written discussion (to reach the secretary before October 31) are three which are of general interest to physicists. In one of these, Dr. W. A. Scoble, the reporter, presents the fifth and final report of the Wire Ropes Research Committee, which, besides dealing with further series of tests made on ropes of different construction subjected to various degrees of loading, bending, lubrication, etc., contains an appendix reviewing the work of the Committee. This brief statement authoritatively corrects several misconceptions, particularly regarding the true factor of safety, and provides a guide as to the best conditions under which to employ wire ropes. In "Stress Waves in the Tyres of Locomotives", Prof. E. G. Coker and Dr. M. Salvadori exhibit and explain a photo-elastic investigation of the stress wave travelling in a locomotive tyre. The effects of the rail, the chairs, the spokes and the balance weight are shown in a series of diagrams. Dr. David Robertson presents a paper, "Hysteretic Influences on the Whirling of Rotors", in which are summarised the known facts concerning elastic hysteresis. It is shown that this can produce whirling when the shaft is running above its critical speed, and that the action of clamping fits, couplings and endwise friction may tend to produce similar effects. An approximate quantitative theory is evolved.

Steam Turbines

UNDER this title, the Association of Engineering and Shipbuilding Draughtsmen has issued a paper by C. S. Bradshaw (London: The Draughtsman Publishing Co., Ltd.). The series of printed pamphlets, to which it is the latest addition, consists of papers written by practical men for the use of others engaged on similar work, and the present issue is in full keeping with this tradition. The author is concerned at each stage of his examination of the subject with making typical calculations for the guidance of his reader. After treating in detail the several principles involved in the utilisation of steam in an engine of this kind, he proceeds with the preparation of the provisional design for a 3,000 k.w. impulse turbine to the extent of determining the steam consumption, efficiency and details of nozzles and blades. The author also explains the advantages of extraction turbines as developed to meet the case where, in addition to power, a supply of low-pressure steam is required for heating or industrial purposes, showing that in a particular case a saving of nearly 25 per cent in fuel may be effected. As to future design, his view is that a primary turbine will operate in the range from 3,000 to 600 pounds per square inch, the steam then passing to the main turbines, an arrangement which he considers would raise the overall station efficiency from the present figure of 26 per cent to one of 35 per cent.

Furfural Yield of Uronic Acids

THE separation of hemicelluloses from other plant constituents is a matter of some difficulty, and no satisfactory criteria of purity or homogeneity exist. Plant gums, which are also polyuronide in nature, have similarly been found to be complex mixtures without any sharply defined differences of properties. It has, however, been customary to determine the relative amounts of the major constituent groups in such preparations. By determining the evolution of carbon dioxide on distillation with 12 per cent hydrochloric acid an accurate figure for the uronic acid content is obtainable. Furfural determinations similarly give an estimate of the pentose content. Because it is known that uronic acids also yield some furfural under the conditions of that determination, a correction has been applied by many workers, based on an assumption that the yield of furfural from a uronic acid is $\frac{1}{6}$. Norris and Resch at Birmingham have critically examined this point (F. W. Norris and C. E. Resch, *Biochem. J.*, 29, No. 7, 1590; 1935) and find this assumption to be incorrect, the true value being considerably higher, and moreover influenced appreciably by the presence of other units such as hexoses. The significance of their observations will be realised when it is stated that the commonly accepted formula for pectin depends on a calculation employing the earlier erroneous factor. The conclusions of many other researches on the composition of hemicelluloses, mucilages and gums may have to be revised for the same reason. The effect of the use of the lower factor has been to cause the pentose content to be overestimated and the hexose content under-estimated. This is more serious in the case of pectin and certain gums of high uronic content than in the plant hemicelluloses, the uronic content of which is much lower.

Fire-walking

AT the suggestion of the secretary of the Institute of Physics, I attended the demonstrations of fire-walking by the Indian, Kuda Bux, on September 9 and 17. Notes on some physiological aspects of the second demonstration were published in NATURE of September 21, p. 468. One important detail should, however, be added, the time of contact of the performer's feet with the fire, which was certainly much less than five seconds.

Observations made at the first performance indicated that the feat was merely another form of the fireside experiment of picking up a hot cinder and returning it to the fire, when the fingers are not burnt, if the action is performed quickly. It, therefore, seemed probable that measurements of the rise in temperature caused by contacts of a cold substance with the fire, of similar duration to those of the walker's feet, would test the correctness of this view, and preparations were made to do this at the second trial on September 17. On this occasion, Dr. T. E. Banks, of the Physics Department, St. Bartholomew's Hospital, and Mr. G. Smith, of the London School of Hygiene and Tropical Medicine, collaborated with me in making the observations.

These comprised the measurement of the total time of contact of each foot with the hot surface; counting the number of steps; and then pressing a thermal junction on to the fire intermittently so as to imitate the period of contact of each foot and the interval between each step, the rise in temperature then being noted on the indicator. The junction consisted of a thin disc of copper, to which wires of copper and eureka were fastened. The wires were passed through holes in a piece of uralite and pulled, so as to bring the disc into contact with the uralite, so that when the disc was pressed on the fire the conditions were favourable for the absorption of heat and its retention when the junction was raised for another impact.

The arrangement was equivalent to a sensitive walking thermometer, and would certainly show a greater rise in temperature under the same conditions than the human skin, which is protected by the moisture it exudes.

Careful observation with a stop-watch having shown that the average time of contact of the walker's foot was half a second at each step, and it being noted that each foot rested twice on the surface during the passage, the junction was struck on to the surface twice in succession, a period of contact of half a second per impact being attempted. Actually, owing to the difficulty of working near the fire, this period was always exceeded, but a number of separate trials showed a rise of 15°–20°C. in the junction. This was conclusive evidence that the feet of the performer would not become hot enough for blistering to occur.

Fire-walking is really a gymnastic feat, and the agile way in which Kuda Bux walked across the fire compelled admiration, and would be difficult to imitate without much training. It would not be easy for a beginner to walk bare-footed over cold charcoal so as not to exceed the time of contact necessary for successful fire-walking. It was lack of training in this particular which prevented Mr. Moynagh and Mr. Sheepen from succeeding; but it was noticeable that even in their cases large portions of the feet were uninjured. Both were much heavier men than Kuda Bux, and this caused them to sink more deeply into the fire, and increased the time of contact. A temperature-measuring device conforming more nearly to the conditions of the skin could be made and tested on a fire, but the explanation of fire-walking is so obvious that this would be superfluous.

CHAS. R. DARLING.

Work of the Rothamsted Experimental Station

AN event of great importance in the history of the Rothamsted Experimental Station occurred in 1934, namely, the purchase of the farm and adjoining lands by the Rothamsted Trustees. Few people perhaps realise that hitherto this experimental centre, with its long-term trials known the world over, was held only on a lease, and that it was threatened by the encroachment of the builder. The sum necessary for purchase was speedily raised by public subscription. A glance at the subscription list gives ample testimony, if such were needed, of the high esteem in which the Station is held by farming organisations and business men. It is not out of place perhaps to mention here that unique organisation—the Society for Extending the Rothamsted Experiments—which was founded in 1904. This Society has not only helped financially, but, by looking ahead, has also enabled important work to be initiated without the delays that usually occur if the money question is left until it is time to start work. Among the many old and modern documents in the Station library, the minutes of this Society will be among the most interesting in years to come.

The report for 1934* opens with an account of the continuation of the experiments on yield and quality in sugar-beet, potatoes, wheat and barley. In the sugar-beet work it is pointed out that most of the information available on this crop applies to Continental conditions, and that it by no means follows that recommendations suitable abroad are applicable in Great Britain. Thus, in these trials, potash and phosphate appear to have but little effect, a result that would scarcely be expected from the data that are available on this crop.

The work on organic manures continues, and shows

* Rothamsted Experimental Station: Lawes Agricultural Trust. Report for 1934. Pp. 259. (Harpenden: Rothamsted Experimental Station, 1935.) 2*s*. 6*d*.

that there is a considerable amount to be learnt about green manuring; the investigators, however, appear to be nearer to explaining the negative results, noted in the 1933 report, obtained by the use of green manures on the light soils of Woburn. The trials with poultry manure, commenced in 1933, have been continued with market garden crops, the manure having been compared with equivalent mixtures of sulphate of ammonia and superphosphate; the nitrogen in the dried poultry manure did not prove so valuable as the nitrogen of sulphate of ammonia.

A valuable feature of the report is provided by articles on the contribution of the various departments to the study of soils and crops. Thus, work on soil physics is reported on by Dr. B. A. Keen, and that on the chemistry of soils and fertilisers by Dr. E. M. Crowther; the contribution to soil bacteriology is discussed by Dr. H. G. Thornton, and that on general microbiology by Mr. D. W. Cutler. In the Soil Physics Department, much attention has been given to the study of the plastic behaviour of soil and clay, work which is of interest to the ceramic industry as well as to the cultivator of the soil. Among the results of theoretical interest may be mentioned the grave doubts thrown on the reality of 'structure turbulence' and 'structure viscosity' in soil and clay pastes—subjects that have been extensively studied by other workers. In practical soil cultivation, the work touches aspects such as ploughing speed, and tilth. In the section dealing with soil cultivation, great importance must be attached to the studies on the effects of rotary cultivation. This method of tilth production is entirely new, and of great promise; the work at Rothamsted will give advisers and investigators definite information upon which to work. In Dr. Crowther's contribution, special interest is attached to the hypothesis which is put forward that, in a heavy soil, nitrate washed out of the surface may be stored in the structural units of the subsoil. To quote this report, "it seems possible that this hypothesis may serve to bridge the gulf between the pedologist's concern with the deeper horizons and the analyst's use of surface samples".

The Manager's report on the Rothamsted and Woburn farms, together with the notes on the weather, and on the insect and fungoid pests could not fail to interest any farmer. Indeed, the Rothamsted annual reports, in addition to their value to the agricultural scientific worker, can be recommended as deserving a place on the bookshelf of all intelligent farmers.

American Universities and Game-Rearing

THE American universities have been conspicuous in their pioneer additions of practical subjects to the university curriculum, and it is particularly interesting, therefore, that, as J. N. Darling, Chief of the Bureau of Biological Survey, U.S. Department of Agriculture, describes in a paper in the September issue of *Scientific American*, 30,000 dollars for an endowment fund for five years has been offered by an anonymous U.S. arms' manufacturer to the Biological Survey for wild-life restoration and administration training at several of the State universities. It has been announced that several State universities are to set up courses in game management with the active support of the Bureau of Biological Survey, which will supply instructors and contribute 42,000 dollars; State and game conservation organisations will also combine in the scheme, and original research in wild-life subjects will be incorporated in the training course, as is done with the forestry training.

"The reservation of enough grazing lands to maintain a reasonable supply of our big game animals can be accomplished without infringing upon the reasonable requirements of the stock growers", Mr. Darling states. "The same is true of small game species. A few large reservations of the hereditary ranges, supplemented by development for wild-life purposes of waste lands, of odds and ends such as ravines, sloughs, roadside strips, fence rows and sub-marginal tracts will be sufficient to bring back wild creatures even in our intensively cultivated areas in more abundance than has been observed for two generations. . . . On most land midway between fertility and barrenness, fish, game and furbearers can exist with far better profit to humanity than when given over to a desperate sort of agriculture. Throughout the U.S. the total drained areas equal 110,000,000 acres."

Wild-life and game animals, and especially non-migratory birds, have decreased markedly in the United States during this century, owing to extensive shooting with little organised game protection or conservation. Ten years ago, Maine alone produced more mink pelts than are now annually produced in all the United States. The trumpeter swan is confined to a few haunts, of which Yellowstone National Park is one. With State and Federal aid, a herd of 20,000 elk still exists in the Jackson Hole region of Wyoming. Within recent years the "More Game Birds in America" Foundation was formed and incorporated in New York to increase American game by the control of their natural enemies and the following of intensive game-rearing on lines similar to those adopted in Europe, particularly Great Britain, where since the passing of the Game Act of 1831, partridge have increased more than 200 per cent and pheasants more than 1,000 per cent, and in the six years 1919–25, after War-time diminution, British gamekeepers increased the nation's stock of game-birds by 900 per cent.

In 1934, Prof. A. A. Allen, of the chair of ornithology at Cornell University, succeeded in rearing ptarmigan in captivity for the first time, hatching eggs obtained in the Hudson Bay region, under bantams. The Bureau of Biological Survey already possesses divisions studying water-fowl numbers, game conservation, predatory animal and rodent control, fur resources, with considerable numbers of reserves and stations, and there is an Alaska Game Commission. Bag limits are made to protect wild geese and other birds in many States, and methods of hunting and shooting are under legal control in many States. E. H.

Royal Photographic Society

ANNUAL EXHIBITION

TO the man in the street the results of photography are 'pictures' of one sort or another, but mainly intended to be artistic. The eightieth Annual International Exhibition of the Royal Photographic Society usually emphasises in the mind of the visitor this artistic aspect of photography; in the principal gallery, for example, are one hundred and seventy large prints, all of pictorial character, whilst in another room are more than two hundred pictorial lantern slides. Photography is, however, both a science in itself and a good servant to most other sciences. This exhibition gives a suggestion of its varied problems and applications.

This year, the Eastman Pola light filters seem to be the outstanding example in the exhibition of a photographic problem solved. These filters incorporate a plane polarising material and can be manufactured in sizes large enough to cover camera lenses, and even light sources. They can be used to eliminate the glare, due to surface reflection, from all sorts of objects. Some excellent examples of this are shown, notably some photographs of polished carving and of an oil painting. In the latter, reflections from the brush-marked surface are completely eliminated. Interesting effects are also shown to be produced when one filter is placed over the light source and another, crossed with relation to the first, over the camera. For this exhibit, the Hood Medal has been awarded to Edwin A. Land.

Of educational exhibits is one by P. C. Smethurst illustrating the growth of convection currents from an electric heater immersed in a tank of water. Prints of individual states are shown and a 16 mm. motion film has been made. In another educational film, L. A. Jones shows, by the new Kodachrome colour process, growing crystals photographed through a polarising microscope. A medal has been awarded for this film.

Nor do the technical exhibits of some photographic manufacturers lag behind in explanatory value. The enormous exposure range of modern photographic materials used for ordinary photography is well illustrated by Ilford, Ltd. The same theme is taken by the Eastman Kodak Co. in relation to their automatically controlled reversal process for sub-standard cinematography. Another exhibit by Ilford, Ltd., illustrates the use of special materials for recording atomic disintegration and for mass spectrography.

In colour photography several processes are represented. Agfa Colour, Finlay, Dufay Colour and Kodachrome, of the colour transparency processes, are all represented, whilst for colour prints on paper examples of Tricolour Carbro, Vivex, Raydex and Duxochrome may be seen.

High-speed photography is this year well represented by studies of a football as it is kicked, and a tennis ball at the impact of the racquet—the ball is almost hemispherical. Exposures of 1/100,000 sec. were used for these (K. J. Germeshausen, H. E. Edgerton and H. E. Grier). Another excellent series by A. M. Rothrock and E. C. Buckley records for the first time the injection and combustion of the fuel in a high-speed Diesel engine; for this a special motion picture camera is used in which the time interval between frames is 1/2,500 sec.

Swelling of Colloids

IN the August number of the *Berichte der chemischen Gesellschaft*, Prof. H. Staudinger and Herr E. Husemann describe interesting experiments on the behaviour of certain polymerised olefines towards solvents.

It is a remarkable fact that among colloids of high molecular complexity one may find substances apparently identical in composition but possessing very different properties. In a previous paper (1934) it was shown that styrene yields two dissimilar polymers, one of which swells continuously in a given solvent until it dissolves completely, whereas the swelling power of the other is strictly limited. In the latter case, the original form of the polymer is retained after swelling, although the volume may be increased fifty- or hundred-fold, but it remains undissolved. It was found that this insoluble variety with limited swelling power is only produced when small amounts of divinylbenzene are present in the styrene, and the theory was advanced that the soluble form consists of long thread-molecules, whereas in the other case more complex 3-dimensional structures are formed.

Further study has shown that the thread-molecules are long, rigid, elastic structures, not easily deformed but soluble forming viscous solutions. When these threads are linked together by divinylbenzene bridges they may form insoluble 3-dimensional molecules unless the amount of bridging is very minute, when the effect is to produce still longer soluble threads. The products with limited swelling-power are now regarded as tangled, felted mixtures of insoluble bridged products with soluble threads. Complete extraction of the threads by the solvent is prevented by the felting. The investigation of these complex polymers has necessitated the development of a special technique, for which we are mainly indebted to Prof. Staudinger. Methods have already been worked out for the synthesis of a kind of homologous series of colloidal polymers, which are classified according to their molecular dimensions as (1) hemicolloidal, (2) mesocolloidal and (3) eucolloidal polystyrenes with molecular lengths of 20–250, 250–2500 and 2500–10,000 A. respectively. The authors have made an elaborate study of the polymerisation under varied conditions of pure styrene and divinylbenzene and of mixtures of these.

In every case the degree of polymerisation was determined by viscosity measurements, and it has been found possible to determine the minimum amount of divinylbenzene required to produce a polymer with limited swelling-power.

Educational Topics and Events

BIRMINGHAM.—Colonel H. F. Humphreys has been appointed to the recently created chair of dental surgery. He was formerly lecturer in dental anatomy and curator of the Odontological Museum in the University.

CAMBRIDGE.—The following committee has been appointed to advise the Council of the Senate in their choice of a Jacksonian professor of natural philosophy :—the Vice-Chancellor, W. Spens, Prof. Lennard-Jones, H. Thirkill, Prof. G. I. Taylor, Sir Frank Smith, Lord Rutherford, Sir William Pope and Lord Rayleigh.

The following resignations or retirements are announced :—J. T. Saunders, lecturer in zoology ; A. A. Miles, demonstrator in pathology ; Dr. A. E. Barclay, lecturer in medical radiology and electrology ; T. G. Room, lecturer in mathematics ; Dr. J. Chadwick, lecturer in physics ; Dr. N. Feather, demonstrator in physics; H. N. Green, demonstrator in pathology ; R. H. D. Mayall, lecturer in mathematics ; Dr. G. F. C. Searle, lecturer and demonstrator in physics ; Dr. S. M. Manton, demonstrator in comparative anatomy ; E. H. B. Boulton, lecturer in forestry.

R. Passmore has been elected Gwynaeth Pretty student, and Dr. M. E. Adair, of Girton College, John Lucas Walker student.

The John Wimbolt Prize has been awarded to E. D. Ward, of Gonville and Caius College, for a dissertation on "The Thermal Properties of Metals and their Engineering Significance".

At St. John's College, J. S. Marshall, Queen's University, Ontario, has been elected to an exhibition for physics, and G. H. Twigg, University of St. Andrews, to one for chemistry.

At Emmanuel College, the external studentship has been awarded to J. C. Bower (University of Melbourne), for physics.

AN account of the development of the Department of Industrial Administration in the College of Technology, Manchester, by Dr. K. G. Fenelon, has been reprinted from the "Year Book" of the Manchester College of Technology Old Students Association. The Department was founded in 1918 through the co-operation with the governing body of the College of eleven firms each of whom contributed an annual sum of £100, and was developed with the special object of providing facilities for training in the broad underlying principles of management and administration. For the first few years, the Department's activities under the direction of Dr. Stanley Kent were largely devoted to research, but Mr. Dempster Smith who succeeded him as director in 1921 proceeded to develop the teaching side. Evening courses were then established, including those on administration for engineers and administration for chemists, and a full-time two-year day course in industrial administration was introduced, which in 1926 was recognised for the associateship of the College. In 1926 a University post-graduate course in industrial administration was commenced, the first course of its type to be provided in Great Britain, and in the same year the Department was taken over entirely by the College, the original guarantors, with certain changes, continuing to act as an Advisory Committee. Dr. James A. Bowie succeeded Mr. Dempster Smith as director in 1926 and was followed in turn by Dr. K. G. Fenelon in 1931. Research at present in progress includes scientific management in textile mills, budgetary control, works organisation with special reference to engineering industries and administration and organisation of transport enterprises. Experiments have been made with the 'case method' of instruction, and the full-time courses include weekly study visits to factories, offices and business enterprises.

SCHOOLS of the largest size are to be found, as is well known, in American cities. A recent monograph on the elimination of very small schools (Bull. No. 3, 1934, of the Office of Education) reveals the surprising facts that in the United States more than 7,000 State schools have not more than five pupils each and 1,000 have only one or two. Moreover, in some States the number of such very small schools tends to increase with the substitution of larger farms for smaller and rural depopulation. At a time when school costs are bearing heavily on reduced revenues, the expensiveness of maintaining these diminutive units is directing attention to various schemes for eliminating them. Consolidation into larger units of the ordinary type is among many communities impracticable because transportation facilities cannot be provided. Considerable interest has in recent years been aroused by the use of postal tuition for secondary education, and the question has now been raised whether such correspondence lessons might not with advantage replace many of the excessively small and costly rural schools. Australian and Canadian public school administrators are well satisfied with the results of primary education by correspondence under schemes which have been in operation for some fifteen years in Australia and British Columbia and seven years in Alberta, Saskatchewan and Manitoba. A comprehensive account of the Australian schemes was published in 1931 by Melbourne University Press in association with Messrs. Macmillan and Co., Ltd. The author, Dr. K. S. Cunningham, while admitting that children so taught miss some valuable social experiences, was impressed by the compensating advantages accruing from the intellectual independence fostered in them through having to tackle their work without the present aid of a teacher.

Science News a Century Ago

The Association of German Naturalists

WRITING from Bonn on September 28, 1835, to the *Athenæum* about the German Society "Der Naturforscher und Aerzte" which had just finished its meeting, a correspondent said : "The proceedings of this body must necessarily excite an increasing interest, when its offspring, the British Association, has been growing to its present colossal dimensions, although the subjects and discussions at these Meetings are less comprehensive than at the Association, being confined to Natural History in its widest extent, Anatomy and Chemistry. The results of both have been crowned with a success little expected by those who projected them". Among the most distinguished men of science at Bonn were Von Buch, Elie de Beaumont, Constant Prevost, Alexandre and Adolphe Brongniart, Littrow, Audouin, Ritter, Jussieu, Ampère and Weber, the British men of science including Buckland, Lyell, Horner, Greenough, Gregory and Turner. The first

general meeting was held on September 18; the sectional meetings began on September 19. There were various expeditions, and during the last of these on September 26 Buckland and Von Buch were hurt in a carriage accident.

Writing of the papers in the Sections, the correspondent of the *Athenaeum* said: "The Geological was, as usual, the most popular. The question of elevated craters relating to the much-disputed theory of Von Buch, was discussed at length, and somewhat hotly, the leading speakers being Elie de Beaumont, Lyell, Prevost and Von Buch himself." Very beautiful drawings of Etna and Vesuvius were exhibited and described by Dr. Abich, of Brunswick, while among other topics discussed were Schmerling's discoveries in the bone caverns of Liége, Van Hoff's remarks on the footmarks in sandstones at Hildberghausen, and Buckland's views on the Dinotherium and on the identification of certain beds south of Liége with the Silurian system of Murchison.

"The disposition to conviviality which you noticed in the account of the Dublin Congress was not wanting in Bonn; in this respect the family likeness is most striking: eating and drinking, and giving of toasts, were by no means the least important occupations of the day. . . . The last toast which was given at Bonn, was by Dr. Froriess, of Weimar, 'The British Association and its former president, Dr. Buckland', which was drunk with enthusiasm".

Littrow Observes Halley's Comet

On October 17, 1835, *The Times* published the following note: "Vienna, Oct. 3. This morning Halley's Comet was perfectly visible to the naked eye as a star of the third magnitude, with scarcely any nebula about it. But seen through the telescope, it looked like an extensive nebula, the largest diameter of which was about 15 minutes, or half the diameter of the sun, with a very bright pretty scintillating nucleus, but still without any considerable tail. . . . As the light of the comet has so much increased within a few days, we may expect that it will be a very fine object in the second half of October. C. L. Littrow."

Baily's "Account of Flamsteed"

In astronomical circles in 1835, the publication of Baily's "Account of Flamsteed" was regarded with an interest secondary only to that shown in Halley's comet. Admiral W. H. Smyth (1788–1865) was among the early readers of the book, and on October 3, 1835, he wrote from Bedford to Mrs. Somerville: "How remarkable that the month of August this year should rattle Halley's name throughout the globe, in identity with an astonishing scientific triumph, and that in the self-same month the letters of Flamsteed should have appeared! How I wish someone would give us a life of Newton, with all the interesting documents that exist of his labours! Till such appears, Flamsteed's statements, though bearing strong internal evidence of truth, are *ex-parte*, and it is evident his anxiety made him prone to impute motives which he could not prove. The book is painfully interesting, but except in all that relates to the personal character of Flamsteed, I could almost have wished the documents had been destroyed. People of judgment well know that men without faults are monsters, but vulgar minds delight in seeing the standard of human excellence lowered".

Societies and Academies

PARIS

Academy of Sciences, August 5 (*C.R.*, **201**, 369–412). LOUIS DE BROGLIE and JEAN LOUIS DESTOUCHES: The theorem of Kœnig in wave mechanics. CHARLES NICOLLE and J. LAIGRET: Vaccination against exanthematic typhus by the living typhus bacillus, dried and coated. HENRI LAGATU and LOUIS MAUME: Variations of the physiological ratios in correlation with the disease of 'wild fire' in the tobacco leaf. Chemical differences are disclosed by the analysis of the healthy and diseased leaves, the alteration in the potash to nitrogen ratio being particularly marked. It is not yet clear whether the changes in the ratios are a cause, or a symptom, of the disease. SVEN GULDBERG: The formulæ of recurrence of the semi-invariants of Bernoulli's law and of Pascal's law with n variables. CONSTANTIN POPOVICI: The periodic solutions of S. Chapman's equation. G. BOURION: The ultra-convergence of integral series. RENÉ RETEL: Remarks on detonation in Diesel motors. The phenomenon has been studied using the Serruys optical manograph with small inertia, and, from the results, suggestions for avoiding detonation are deduced. It would appear that the presence of light products arising from cracking the fuel is the cause of detonation. MIROSLAV NÉNADOVITCH: The characteristics of certain rigid biplane cells of infinite spread. BENJAMIN GUREWITCH: A method for the study of magneto-strictive vibrations. PIERRE MESNAGE: The molecular emission spectra of some metallic salts. The spectra of the chlorides of iron, chromium and cobalt. ANTONIN ANDANT, PIERRE LAMBERT and JEAN LECOMTE: The diffusion spectra (Raman effect) and infra-red absorption spectra of saturated fatty alcohols and ethylene hydrocarbons. The Raman spectrum gives a characteristic line with the double bond: the infra-red spectrum gives two lines characterising the tertiary alcohol function. The two methods together distinguish between successive homologues and isomers. MAURICE BONZEL: The deformations accompanying the thermal treatments of cold-hardened metals. GEORGES ARDITTI: The autoxidation of normal hexadecane. Study of the oxidation of the liquid hydrocarbon at varying temperatures. For all the temperatures studied, the commencement of oxidation is accompanied by production of carbon monoxide in predominating amounts. More oxygen is used than can be accounted for in the gases produced. HENRI LONGCHAMBON: The structure of the Cevennes in the region defined by the Largentière sheet on the scale of 1/80,000. B. CHOUBERT: The Cretaceous formations of the coastal zone of Gabon. JACQUES FLANDRIN: Some features of the middle Eocene Algerian palæogeography. A. CHARLES HOLLANDE: The structure of the nucleus and its constituents: their homologation with the nucleosomes of the Schizophytes (Bacteriaceæ and Cyanophyceæ). HENRI COLIN and MLLE. ANDRÉE CHAUDIN: The diastatic hydrolysis, *in situ*, of the intercellular cement. EMILE MIÈGE: The constitution and descent of the polycarpic strains of *Triticum vulgare*. NICOLAS METALNIKOFF: The bactericidal power of water submitted to the combined action of metallic silver and a continuous electric current. The passage of a continuous electric current, 0·3–4 milliamperes under 1·5–4·5 volts, with a metallic silver anode, confers strong bactericidal

properties on water in a few minutes. Such treated water, after one to three hours contact, kills bacilli of coli, cholera, paratyphoid, typhoid and staphylococcus. The bactericidal property remains after boiling. No taste is imparted to the water, and from experiments on mice it would appear that it has no injurious effects on the organism.

CRACOW

Polish Academy of Science and Letters, July 1. W. M. JEZEWSKI, M. WIERZBICKI and J. KAMECKI: The dielectric constants of strong electrolytes of low concentrations at varying temperatures. The experimental results obtained with solutions of sodium chloride, potassium chloride, magnesium sulphate and barium ferrocyanide are in good agreement with the theory of Debye and Falkenhagen, if the orientation of the dipoles by the intense field of the ions is taken into account. T. PIECH: The dielectric polarisation of some alums. B. MILIANCZUK: The radiation of a magnetic dipole. B. MILIANCZUK: The diffraction of light in the neighbourhood of the lines of the magnetic dipoles. MME. W. CZAPSKA-NARKIEWICZ: The absorption spectra and fluorescence of some coumarin derivatives. B. KAMIENSKI and W. GOSLAWSKI: The influence of hydrogen ions on the dielectric potential and surface tension of solutions of some organic substances. L. MARCHLEWSKI and B. SKARZYNSKI: Absorption of ultra-violet rays by certain organic substances (40). L. MARCHLEWSKI and B. DABROWSKI: The determination of very small quantities of zinc by the spectrographic method. ST. KREUTZ: Calcites and other minerals characterised by their luminescence. K. DZIEWONSKI, L. GIZLER and J. MOSZEW: The reactions of some mixed aromatic ketones with bisubstituted thiourea derivatives containing different aromatic radicals. T. DOMANSKI and J. SUSZKO (1): Some transformations of the isoquinidines. (2) Niquidine. H. TELEZYNSKI: Cytological studies on an unstable strain of *Petunia violacea*. ST. MARKOWSKI: The parasite worms of *Gobius minutus* of the Polish Baltic. MME. IRÈNE LATINIK-VETULANI: Experimental researches on anoxybiosis in the different stages of development of *Rana fusca*.

ROME

Royal National Academy of the Lincei, April 7. MARGHERITA PIAZZOLLA-BELOCH: The asymptotes of a plane algebraic curve in relation to the theory of diameters. B. COLOMBO: An equation with partial derivatives of the fourth order. J. REY PASTOR: The quasi-continuous convergence of successions of functions. G. MARLETTA: Reflections on differential projective geometry. C. TOLOTTI: Einstein's gravitational equations for dynamic universes endowed with complete symmetry about a centre. A. FENICI: Centres of gravitation and centrobaric bodies. R. L. GOMES: A property of de Broglie's operator, H. O. ZANABONI: Determination of critical loads by means of the principle of virtual work. F. ZAGAR: The orbit of a third invisible body in a binary system. The utilisation of measurements of radial velocities to deduce the existence and the orbit of an invisible body revolving round one of the two components of a binary system is considered. Under definite conditions, it is possible to derive, not only the orbital plane of the invisible body, but also all the other elements except the major semi-axis. F. ODONE: Thermodynamic foundations of the theory of electrical equilibrium and of the permanent currents in metallic conductors. F. PIRRONE: Alicyclic compounds (1). Synthesis of β-ketoamines. The products obtained by the interaction of benzaldehyde, ammonia and cyclohexanone indicate that, in this reaction, the equilibrium between the enolic and ketonic forms of cyclohexanone is displaced towards the ketonic form. F. DULZETTO: New observations on the life and relation between the sexes in the young of *Gambusia holbrookii*, Grad. I. DELPINO: Notes on the diffusion of *Trutta genivittata*.

SYDNEY

Royal Society of New South Wales, August 7. G. O. K. SAINSBURY: Vegetative reproduction in New Zealand mosses. Twenty species are recorded as having peculiar brood-bodies or gemmæ on the leaves. These organisms become detached, and develop into a thread-like growth, and are eventually formed into lateral or terminal growths similar to what are known as bulbils. These structures are capable of developing into separate plants, and thus form populations by this means instead of the usual spore germination methods of reproduction.

Forthcoming Events

Monday, September 30

ROYAL SOCIETY OF MEDICINE, at 5.—W. Trotter: "General Ideas in Medicine" (Lloyd Roberts Lecture).

Official Publications Received

Great Britain and Ireland

Battersea Polytechnic. Department of Hygiene and Public Health. Calendar for the Session 1935–1936. Pp. 18. 3*d*. Domestic Science Department and Training College. Calendar for the Session 1935–1936. Pp. 32. 3*d*. Technical College for Day Students and Day School of Arts and Crafts. Calendar for the Session 1935–1936. Pp. 50. 3*d*. Evening and Afternoon Courses and Classes. Calendar for the Session 1935–1936. Pp. 30. (London: Battersea Polytechnic.)

The Institution of Automobile Engineers: Research and Standardization Committee. Fourth Annual Report, July 1st, 1934—June 30th, 1935. Pp. 19. (London: Institution of Automobile Engineers.)

Other Countries

The Carlsberg Foundation's Oceanographical Expedition round the World 1928–30 and previous "Dana" Expeditions. Dana-Report No. 7: Quantitative Investigations on the Distribution of Macroplankton in different Oceanic Regions. By P. Jespersen. Pp. 44. (Copenhagen: C. A. Reitzels Forlag; London: Oxford University Press.)

Colony and Protectorate of Kenya: Department of Agriculture. Bulletin No. 2: Diseases of Cereal Crops in Kenya Colony. By C. A. Thorold. Pp. v+66+16 plates. (Nairobi: Government Printer.)

U.S. Department of Agriculture. Circular No. 356: Trapping Experiments for the Control of the Cigarette Beetle. By W. D. Reed, A. W. Morrill, Jr., and E. M. Livingstone. Pp. 14. (Washington, D.C.: Government Printing Office.) 5 cents.

Pubblicazioni della R. Università degli Studi di Firenze. Fascicolo N.53: Osservazioni e Memorie del R. Osservatorio Astrofisico di Arcetri. Pp. iv+64+1 plate. (Firenze: R. Università degli Studi.)

Conseil Permanent International pour l'Exploration de la Mer. Journal du Conseil, Vol. 10, No. 2. Redigé par E. S. Russell. Pp. 145–241. (Copenhague: Andr. Fred. Høst et Fils.)

Publications of the Dominion Observatory, Ottawa. Vol. 12: Bibliography of Seismology. No. 5: January, February, March, 1935. By Ernest A. Hodgson. Pp. 97–114. (Ottawa: King's Printer.) 25 cents.

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