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CONTENTS

Scientific Adventure and Social Progress

THE national lecture by Dr. T. R. Glover on the challenge of the Greek, broadcast on December 19, vividly recalls in its plea for the classical discipline one of the most suggestive passages in Prof. A. N. Whitehead's "Adventures of Ideas". In brief compass, Dr. Glover set forth the antithesis which Greek customs, ways of living and outlook on life present to those characteristic of this age, and suggested certain aspects of Greek life which are worthy of our consideration.

The five aspects discussed by Dr. Glover are so interrelated that an attempt to differentiate between them in order of importance is largely beside the mark. Few to-day, for example, whether interested principally in science, in art, in industry, in politics, or in society as a whole, would deny the fundamental importance of creative thought as the mainspring of constructive action, or that such thought is one of our most urgent needs. This pre-eminent characteristic of the Greeks cannot, however, be dissociated from their capacity to interpret life, to see life steadily and to see it whole, from their essential young-mindedness and adventurousness, their individuality and passion for self-expression, their freedom of enterprise.

The tragedy of the present day lies largely in the senility of mind with which, over whole ranges of industrial, social and political problems, we are confronting opportunities which are stupendous compared with those possessed by the Greeks. There is scarcely a field of human enterprise and thought, from the unemployment situation, disarmament and tariffs to transport or county planning, in which the powers and opportunities given into our hands by science are not being misused, abused or lost through lack of courage and magnanimity. Truly did the prophet exclaim : "where there is no vision the people perish".

This inelasticity of mind has two consequences. It limits or even excludes the experiments which younger and more adventurous minds would make, and it severely discourages the multiplication of youthful and independent types of leaders. While it becomes more and more difficult for youth to gain experience of leadership and to demonstrate its capacity, the growing standardisation of life to which Dr. Glover directs attention threatens to stifle such aspirations at the source. Russia seems intent on producing citizens of a single type : Italy and Germany equally appear to discourage individuality and independence of mind ; a shrewd

observer suggests that in the United States the object of education is to turn the human mind into a card index ; and education in Great Britain is characterised by much the same standardisation and conformity to type. The danger of the breakdown of civilisation through sheer inability to maintain the quality of administration and consequent social equilibrium foreshadowed by Brook Adams in his "Theory of Social Revolution" is apparent alike in the democratic State or under dictatorship.

The contrast between this standardisation and mechanisation of life to-day and the glowing vitality of the Greeks which Dr. Glover depicted so vividly is worth consideration. The challenge thrown down is fundamentally one of thought. If the adventurous, speculative mind, dynamic and eager for novelty, which the Greeks possessed, is one of the most essential factors for recovery of control over our specialised activities, the thrusting energy of our sectional and selfish interests, and to afford free access to everything in our rich heritage of civilisation which we have the capacity to enjoy, the most 'un-Greek' thing we can do, as Whitehead points out, is to copy the Greeks.

In the very suggestion of imitation or copying there is a hint as to our fundamental trouble. In an age of unprecedented change and technical advance, a tendency to take the Greek and Roman civilisation at its best as a standard, and to aim at reproducing the excellencies of these societies, is too static an ideal and neglects the whole range of opportunity. It is no longer sufficient to direct attention to the best that has been said and done in the ancient world. The result is static repression, and promotes a decadent habit of mind that can be traced in certain countries to-day.

Undue reliance upon the past for guidance and as a standard is a danger to any age. In this present age the peril is even more acute. The increasing *tempo* of technical development makes reliance on the wisdom of the past increasingly unsound. We are living in a period of human history when, probably for the first time, the assumption is false that each generation will live substantially amid the conditions governing the lives of its fathers, and will transmit those conditions to mould with equal force the lives of its children.

This fact alone would explain many of the difficulties in which we find ourselves, our persistent pursuit in economic and international affairs of mutually inconsistent policies. The shortened time-span of technological change increases the disturbance of social and economic life by the application of scientific discovery and in turn demands greater powers of adaptation and readiness to adopt new methods akin to these characteristic of the Greek. Our training must prepare the individual to face conditions for which the past is an imperfect guide. We require such an understanding of the present conditions as may give us some grasp of the novelty which is about to affect the immediate future.

We are here confronted with that divorce between wisdom and knowledge which is an untoward characteristic of many departments of political, industrial and social life. Despite known gaps in our knowledge of the social sciences, we have already vast stores of knowledge which could be utilised for the re-building of a social order capable of meeting the new conditions and making available for all the great resources with which now for the first time science has endowed mankind. Between that age of abundance for all, and the deprivations and distresses of the present time, stand the ideas inherited from a more static age in which available resources were incredibly smaller, and the routine in which those ideas have crystallised themselves. Routine, which should be the servant of society, is in a fair way to become its master.

It is fashionable at the present time to blame the machines for the mechanisation of life and the uniformity in working and in leisure hours imposed upon whole sections of the community. To do this is to make the fundamental mistake of regarding the machine as the master and not the servant of society, and to forget that the most regrettable results of industrialisation are for the most part not the direct fault of technology but of economic developments. As regards the technical and scientific aspects, in fact, our technical and industrial development was historically unavoidable. Mechanical power, as Mumford remarks in "Technics and Civilisation", is no new thing, but in earlier ages men had saner ideas of labour-saving devices, and the water mills of the first century B.C. were welcomed by Antipater of Thessalonica as a means of enjoying the fruits of Demeter without labour. The mechanisation of industrial and social life to-day is due essentially to our failure to understand the machine and to use it to serve and not to dominate the life of man. In our search for stability we have organised society to a point at which routine, upon which

civilisation is undoubtedly founded, becomes an obstacle to progress and adaptation to the new conditions.

The absence of foresight in itself explains the lack of leadership. Men seek security in the dull conformity to type. Despite the many elements of scientific and sociological discipline required in the modern business mind, there is little of that power of general thought, undaunted by novelty, which is the gift of philosophy in its widest sense. The absence of such a co-ordinating philosophy of life permeating the community spells decadence, boredom and the slackening of effort. The mere compulsion of tradition has lost its force, or even may urge us into dangerous paths. As Whitehead reminds us, our fundamental task is to re-create and re-enact a vision of the world, including these elements of reverence and order without which society lapses into riot, and penetrated through and through with unflinching rationality. That is the challenge of the Greeks to our age, and whether we rise to the greatness of our opportunities, exploiting its adventure and mastering the network of relations which constitutes the very being of this epoch, or whether we collapse before the perplexities confronting us, depends both on our courage and our intellectual grasp.

This challenge is unescapable. Advance or decadence are the only choices offered to mankind. Perfection is essentially dynamic and not static. Whether we are at present in a period of slow decline, or whether we are in a period of transition to a new form of civilisation involving in its dislocations a minimum of human misery, it would be rash to prophesy. There are regions of human endeavour in which creative thought is still sufficiently active to inspire the hope that it may infect the more sterile regions of politics and sociology, where originality and constructive thought are so sorely needed. The trend of discussions on the relation of science to social problems within the last two years justifies the belief that in this field thought has run ahead of realisation, and that only courage and vigour are required to secure the realisation of those dreams.

The challenge presented to us so vividly alike by Dr. Glover and Prof. Whitehead is one to which the scientific worker above all should respond. He is becoming increasingly conscious that, as the exploration of the physical world proceeds apace, the reaction of the new knowledge upon the social order, of which he himself forms a part, is opening up new fields of endeavour in which his method and impartial questioning spirit can find ample satisfaction. He will remember that the great ages of the past have, on the whole, been the unstable ages: the great achievements, the adventures of the past. He will look back in a spirit of adventure, understanding the past, and look forward in the same adventurous spirit which unlocks the secret of the past, to the wide fields as yet largely untrodden, within which science may yet render its greatest services to mankind and make the rich resources of Nature available for all in a new social order worthy alike of the prodigality of Nature and of man's own rich intellectual heritage.

Reviews

Isomerism and Tautomerism

Tautomerism. By Dr. J. W. Baker. (Twentieth-Century Chemistry Series.) Pp. viii+332. (London: George Routledge and Sons, Ltd., 1934.) 25*s*. net.

THE term 'tautomerism' was introduced by van Laar in 1885 in order to describe those cases in which the compounds represented by two different structural formulæ are found to be "not isomeric but identical". A pioneer example of this phenomenon was discovered in benzene, since Kekulé, so long ago as 1870, was content to regard the single and double bonds in his formula as merely an instantaneous picture of a moving system, in which the double and single bonds were incessantly changing places. In this way he was able to account for the fact that the 1 : 2 and 1 : 6 di-derivatives of benzene are, as Laar expresses it, "not isomeric but identical". Kekulé's migrating bonds would now be described as a flow of valency electrons, and the phenomenon would perhaps be described as *electromerism*, but his fundamental ideas are still valid. Indeed, at the present day, chemists would probably be unanimous in saying that *all* the diverse formulæ which have been assigned to benzene represent merely different aspects or phases of the same molecule, which they would not attempt to isolate.

The examples cited by van Laar were, however, selected from a different range of compounds, namely, those in which a mobile hydrogen atom can occupy two alternative positions in the molecule. Their interconversion—which is now usually described as *prototropy*—instead of involving a mere shifting of bonds or wandering of valency

electrons, calls for the displacement of a much more substantial atomic nucleus, and, although this nucleus is only a proton, it has not the same mobility as an electron. Almost as soon as van Laar's theory was announced, therefore, it was proved to be wrong by the isolation as independent chemical compounds of products which he postulated to be identical, but which in fact were entirely different in their physical, and even in some of their chemical, properties. Laar's own theory of tautomerism therefore died in infancy, even if it was not actually still-born; but, since the name which he invented has survived to form the subject of the present monograph half a century later, one may well ask how this has been achieved.

The answer is in some respects a simple one. The pairs of prototropic compounds, which Laar cited as examples of tautomerism, differ as widely as any other isomers in physical properties, such as colour, solubility, melting point, etc., and are distinguished from other isomers only in their ready interconversion. In particular, compounds of this type usually revert to an equilibrium mixture in presence of a mere trace of acid or alkali. They therefore give identical chemical reactions, except under special conditions, for example, in presence of a chemical reagent which has no strong catalytic properties or may even act as an anti-catalyst. At the meeting of the British Association in Oxford, the Chemical Section, under the presidency of Prof. J. F. Thorpe, recognised this point of view by adopting more or less unanimously the definition of tautomerism in the "Oxford Dictionary". This Oxford definition describes the phenomenon of tautomerism as follows:—"This term is applied to the property exhibited by certain compounds of behaving in different reactions as if they possessed two or more different constitutions; that is, as if the atoms of the same compound or group were arranged in two or more different ways, expressible by different structural formulæ."

This anonymous definition is purely chemical in character, since it is based exclusively upon the dual reactivity of a tautomeric compound, and is independent of the possibility of isolating the two 'phases' or 'forms' from which the two types of product are derived. This aspect is indeed so important that it is probable that no better selection could be made of a characteristic on which to base a *re*definition of the term in question. Others have, however, been attempted, since Kurt Meyer in 1913, and Schmidt in 1926, have proposed to limit the phenomenon to cases of prototropy, by insisting that the two sets of derivatives must be derived from two parent substances, which *differ from one another only in the position of a hydrogen atom and of one or more double bonds*. On the other hand, the author of the present monograph wishes to widen the term to include all examples of interconvertible isomers, and is bold enough to claim "universal acceptance" for the view that "*tautomerism is to be regarded as reversible isomeric change*."

The phenomenon of 'reversible isomeric change', which the reviewer has described as '*dynamic isomerism*', was discovered eight years before the appearance of Laar's paper, by Butlerow, who also recognised that it might proceed either with or without an added catalyst. His observations provide a valid explanation of the dual reactivity which Laar explained by an untenable theory; but chemists in general have never accepted the conclusion that Laar's term should be made to cover the whole range of the phenomenon discovered by Butlerow, and in practice there are many well-established cases of equilibrium between isomers which are generally excluded from the most inclusive of working definitions of tautomerism. Thus even the author of this monograph, in spite of his all-embracing definition, has nothing to say about isomeric changes in the benzene series, such as the conversion of hydrazobenzene into benzidene, or about the Beckmann change in the oximes, or about the combined bromination and reduction (by bromine and hydrogen bromide) which converts αα′ into αβ-dibromocamphor. General usage is, indeed, opposed to describing as tautomeric any isomers which only become interconvertible under special or drastic conditions, and which under normal conditions give no indications of the dual reactivity on which the Oxford definition is based.

The author's proposal to identify 'tautomerism' with 'dynamic isomerism' is a clear violation of the agreement reached at Oxford; but it has the advantage of enabling him to extend the scope of his book to include many topics which would otherwise have been excluded. Thus, in addition to the keto-enol change in the diketones and the facile isomeric changes which give rise to mutarotation, for example, in nitrocamphor and in the reducing sugars, he has been able to include as examples of the "three carbon system" some modern variants of Butlerow's interconversion of olefines, and to discuss a series of isomeric changes in the terpene series, where the conditions are equally severe. The book therefore provides a valuable guide to the widespread researches which have developed from J. F. Thorpe's work on glutaconic acid, as well as to much of the earlier and contemporary work on related subjects.

A theoretical basis for these researches is

provided in an early chapter on the "Modern Theory of Tautomeric Change" and by reprinting in an appendix a paper by Prof. C. K. Ingold on the "Significance of Tautomerism and of the Reactions of Organic Compounds in the Electronic Theory of Organic Reactions"; and the formulæ used in the text are accompanied by the curved arrows by which the theories in question are commonly expressed. On the other hand, it may well be asked whether the author really believes in the 'bridge-bond', stretched to twice the normal length of a carbon-to-carbon bond, which he has included in one of his formulæ for anthracene (p. 275), in defiance of the physical evidence as to the intolerable strain which such an extension must impose.

The book is produced in an attractive form, with adequate subject and author indexes, and should have a wide circulation among chemists.

T. M. L.

Electron Physics

Einführung in die Elektronik: die Experimentalphysik des freien Elektrons im Lichte der klassischen Theorie und der Wellenmechanik. Von Dr. Otto Klemperer. Pp. xii+303. (Berlin: Julius Springer, 1933.) 19.80 gold marks.

PHYSICISTS have long felt the need of a book on electronic phenomena, in which experimental methods and results are collected together in a convenient form for reference. Dr. Klemperer has collected and sifted his material with great care and discrimination. As a handbook for workers with electrons, his book will be an invaluable help. A great number of useful tables and graphs are scattered throughout the work. On p. 12 we have a list of the formulæ, relationships and numerical values of the velocity and energy expressions for the electron; this is followed by a table, constructed from one given earlier by M. G. Fournier, containing numerical data for electrons of all velocities, and the curvature of their paths in different uniform magnetic fields. From the last value given we see that if an electron moves very little less slowly than light, namely in the ratio 0·99999999870 to 1 (corresponding to a volt-velocity of 10^{10}), the mass increases to 19,585 its rest value.

Details are given for obtaining electron beams of different kinds. The varying types of information given by a Wilson cloud-chamber, and an ionisation chamber, a point counter and a Geiger-Müller tubular counter are clearly contrasted. There is a very useful section on the photographic action of electrons and methods for comparing the intensity of electron beams photographically. An account of electron diffraction is given in Chap. v, which is entitled "The Electron as a Corpuscle and as a Wave". The calculations given in the book are of the simplest kind throughout. A later chapter on the atomic electrons includes a very concise but reasonably complete description of atomic structure and spectroscopic notation (for one and more electron systems). Further subjects dealt with are: photo-electric effect, thermionics, Compton effect, secondary electrons, ionisation in all its forms, interactions between free electrons and atoms, energy losses in collision, absorption of electrons and effective cross-section of atoms and molecules.

The author discloses an intimate knowledge of these different fields and gives more than a thousand references to original papers. There appear to be but few errors. We note one in the small table at the top of page 3, and on page 150, Fig. 97 for the results of Davis and Goucher's experiment is drawn too symmetrically about the x-axis. The author deserves the thanks of all colleagues who are experimenting with electrons, whether fast or slow, and also of those who wish to have a complete summary of electronics for quick reference.

H. L. B.

Dialectical Materialism

(1) *Aspects of Dialectical Materialism.* By H. Levy, Ralph Fox, J. D. Bernal, John Macmurray, R. Page Arnot, E. F. Carritt. Pp. vi+154. (London: Watts and Co., 1934.) 5*s.* net.

(2) *The Web of Thought and Action.* By H. Levy. (The Library of Science and Culture.) Pp. vii+238. (London: Watts and Co., 1934.) 7*s.* 6*d.* net.

(1) "THESE essays have arisen . . . in response to an urgent demand . . . that the philosophy guiding the practice of Modern Russia might be expounded in a form intelligible to the layman." A praiseworthy object indeed, since it is of the first importance that dialectical materialism should be lucidly expounded; then it will be possible to discuss the issues involved in the new philosophy; but few readers will get much enlightenment from this volume.

Out of the six essays, the fifth, by Mr. Bernal, alone attempts any general exposition. It is written in a tone of strident dogmatism, take-or-leave-it style. The exposition is anything but lucid; that this is not merely the judgment of a biased bourgeois reader may be gathered from the concluding essay by Mr. Carritt. The latter, who thinks that Marx would have found him a "hopeful convert", enumerates fifteen doctrines which he regards as "common to Mr. Bernal and

himself". Then he goes on to explain his disagreements with Mr. Bernal. But we need not bother about these disagreements because there are in fact no agreements. Mr. Bernal, who is allowed a postscript, says that "the fifteen articles of Mr. Carritt's cannot be said to be dialectical materialism, or even a part of dialectical materialism". He goes on to rub this in in a fashion that cannot be regarded as complimentary to the Oxford philosopher. So the inquiring reader is likely to rise up from a perusal of the book somewhat bewildered.

The four preceding essayists are more concerned with telling us about the impression made upon them by the new philosophy than by expounding it. To Prof. Macmurray, dialectical materialism is "a revolution in the conception of philosophy itself". It attracts him because "it is the one system of philosophy that recognizes the relation which necessarily exists between any philosophy whatever and the social conditions from which it arises". If this is a revolution or a revelation to philosophers, it is scarcely so to ordinary people; third-rate novelists a hundred years ago recognised that a man's philosophy was conditioned by his social status and tradition. For the rest, Prof. Macmurray is critical. Thus there is no agreement about fundamentals between the contributors; what they do share is a dislike of "capitalism". "Capitalism must strive towards high prices and scarcity," says Prof. Levy; and that of course reminds us of those recent and very successful capitalistic enterprises, Woolworths and Marks and Spencer.

Prof. Levy is the author not only of the first essay in this volume but also of the other book under review (2). The latter takes the form of conversations with "Mr. Everyman", an engineer, a politician (Sir Herbert Samuel) and others. Each conversation is followed by comments. This form of literature seems to be getting popular, but to some readers it is tedious. These conversations lack the interest of vivid reality in spite of the effort to impart it by a familiar and jocular tone; to be attractive they demand unusual imagination and literary skill, which are lacking here.

We are gradually led to the view that politics and history must be studied as sciences. But many workers in these fields would reject this view and would maintain that our difficulties largely arise from the misapplication of the methods of the natural sciences to social studies. The historian and the sociologist do not participate in these discussions. The "social historian" in these conversations is understood to have written a school textbook of physics, and his qualifications for expounding social studies are not apparent.

S.

Problems of Crossing-Over

Handbuch der Vererbungswissenschaft. Herausgegeben von E. Baur und M. Hartmann. Lieferung 19 (Band 1): *Faktorenkoppelung und Faktorenaustausch.* Von Curt Stern. Pp. vii+331. (Berlin: Gebrüder Borntraeger, 1933.) 54 gold marks.

THE physical basis of crossing-over is now one of the major problems in genetics. Its solution will require a more detailed correlation of genetical results with the behaviour of the pairing threads in meiosis than has yet been made. The very extensive genetical facts already accumulated, and set forth at length in the book before us, call for a cytological explanation; but it is safe to say that all the theories hitherto put forward are defective either in supporting observations or in interpretation or in both. Yet it appears that the problem has now reached a point where it can only be solved by the cytologists, with such further aid as genetics can give.

This most intricate problem of cytogenetics clearly involves a fuller understanding of the structure and division of chromosomes and the relations of mitosis to meiosis, as well as the precise behaviour of the leptotene and zygotene threads. The structure and division, as well as the behaviour of these threads, and the nature of the gene itself, are no less concerned in the solution of this problem. It may be expected that much of cytology in the next decade will centre about these questions. New methods of attack will have to be devised and new points of view developed.

In the present work by Prof. Stern, the abundant facts and theories of linkage and crossing-over are set forth *in extenso*. While *Drosophila* supplies the largest single body of data, yet evidence of equal importance is furnished by many other plant and animal organisms, including *Zea*, *Lathyrus*, *Primula*, *Oenothera*, *Pisum*, *Apotettix*, and others. Such phenomena as coincidence and interference in crossing-over and the linkage problems of three or more factors are discussed both theoretically and on the basis of the known results. In the cytological aspect the views of Janssens, Belling, Darlington, Sax and others regarding the rôle of chiasmata are considered. A short final section on interchromosomal linkage is devoted mainly to experimental cases in maize and *Drosophila*, with brief references to the well-known conditions encountered in *Datura* and *Oenothera*.

This book, which has involved the author in much labour, will serve as a very useful storehouse of facts and a clearly arranged work of reference for future investigators.

R. R. G.

Short Notices

Crystals and the Polarising Microscope: a Handbook for Chemists and Others. By Dr. N. H. Hartshorne and A. Stuart. Pp. viii+272. (London: Edward Arnold and Co., 1934.) 16*s*. net.

SECTIONS 1 and 2 of this book deal with crystal morphology. The information included in the fifty pages is surprisingly complete. It is to be regretted, therefore, that the authors have not made use of the stereographic projection (space could have been found by deleting the recapitulations on pp. 50 and 92). The use of etch-figures in, say, distinguishing between ortho- and clino-pinacoids and these in turn from prisms, might have added to the completeness of this portion of the book. The text is liberally illustrated with clear diagrams. (In Fig. 31, $1\bar{1}1$ should read $1\bar{1}0$ and on p. 44, lines 6, 7 and 11 from top should be . . . 2{100} . . . . 4{101} and . . . 6{$10\bar{1}1$}).

It is difficult to refer to the optical treatment (Sections 3–6) without enthusiasm. The ground covered would not be amiss in a volume of twice the size, and descriptions are throughout clear and concise. The drawings, hereabouts, serve their purpose well, those of interference brushes, viewed through differently orientated sections, being particularly useful. Some confusion may result from the authors' description of the mica plate. It is the practice in Great Britain for quartz, mica and gypsum plates to be cut with the longer edge parallel to the ε or γ axis of the ellipsoid (Miers, Tutton, etc.). In Sections 7 and 8, the authors make out a good case for the increased use of the polarisation microscope in industry and research.

The printing is clear, and authors and publishers are to be congratulated on a book, useful alike to research physicists, geologists and crystallographers, as well as to chemists. H. E. B.

Sexual Life in Ancient Rome. By Otto Kiefer. Translated from "Kulturgeschichte Roms unter besonderer Berücksichtigung der Römischen Sitten" by Gilbert and Helen Highet. Pp. ix+379+16 plates. (London: George Routledge and Sons, Ltd., 1934.) 25*s*. net.

IN matters relating to sex, the ancient Romans displayed the practical qualities which they brought to bear on all the problems of their lives, both public and private. It affected their attitude generally to all forms of erotic emotion, as well as in the relation of the sexes. For it has to be remembered that the ancient Romans, if not universally, very commonly, were indifferently homo- and heterosexual, and accepted that as a matter of course. Dr. Kiefer, in the work of which this is a translation, has explored the records of the reactions of the Roman world in marriage, in religion, in literature and in art, and finds not only that there is little of the spiritualisation of this emotion such as existed among many of the Greeks, but also that there is in it no little of a sadistic element. He is, however, by no means a supporter of the view which would ascribe the downfall of the Empire to decadent mores in relation to sex. An acute analysis of the sexual element in the character of certain of the early emperors and members of their entourage, discounts the scandals of their biographers in some, but not all, instances.

Satellite Station Tables. By C. M. L. Scott. Pp. vii+44. (London: Edward Arnold and Co., 1934.) 12*s*. 6*d*. net.

IT sometimes happens in minor triangulation that well-marked objects, which are otherwise suitable as trigonometrical points, cannot be observed from, though they are well placed for 'observing to'. Burma, with its innumerable pagodas, offers thousands of examples of this, and it is not surprising that the book under review should have been written by the port surveyor at Rangoon. These tables will save labour in cases in which there is much satellite-station work, though in ordinary minor triangulation, in which satellite stations are usually avoided, or are but rarely used, the surveyor may prefer to make his corrections by the application of elementary trigonometry.

The tables have been carefully prepared and are well set out and printed. They are suitable for the purpose intended, which is, briefly, to reduce the angles taken at a satellite station to the values which they would have had if they had been observed at the inaccessible station itself. The corrections are given to the nearest second, an accuracy more than sufficient for this class of work. The book can be recommended to those who find themselves obliged to use satellite stations frequently. The tables can, as remarked in the foreword, be made use of for tacheometrical calculations.

Introduction to Modern Physics. By Prof. F. K. Richtmyer. (International Series in Physics.) Second edition. Pp. xviii+747+6 plates. (New York and London: McGraw-Hill Book Co., Inc., 1934.) 30*s*. net.

THE first edition of Prof. Richtmyer's book has been appreciated by so many physicists that the appearance of a second edition is bound to be warmly welcomed, and it is only necessary here to note the chief changes which have been made. An adequate outline of the application of Fermi-Dirac statistics to problems in photo-electricity has been added and the chapter on X-rays brought up to date. The chapter on the structure of the nucleus has been considerably altered in view of recent work on artificial disintegration, and the neutron and positron both find a place, though perhaps a small one in the case of the latter. Two very important new chapters have been included, one on the vector model of the atom and one on the wave theory of matter. The first will be particularly helpful to students, and the latter properly completes a first-class introduction to modern physics.

A Large French Wind Tunnel

THE large wind tunnel which has just been completed at Chalais-Meudon is of considerable interest. It is the second tunnel capable of testing a full-sized aeroplane to be constructed, the first being the 60 ft. × 30 ft. tunnel at Langley Field, U.S.A., and it differs in one very important respect from any other wind tunnel, in that it is built in the open. In general design it is not unlike the tunnel built by Eiffel in 1912 at Auteuil; a type now generally known by his name. Air is drawn in through a contracting inlet and then passes as a parallel free jet across the observation chamber into a collector cone in which a gradual expansion takes place in order to recover most of the kinetic energy of the stream.

In the older Eiffel tunnels, an airscrew or a centrifugal fan at the end of this expansion cone drew the air through the tunnel, which was itself housed in a large room through which the air returned to the intake end at a low speed. As a single airscrew in the present large tunnel would be of such great diameter, the expansion cone has been allowed to discharge into a large chamber, or 'diffusor', from which the air is extracted by six airscrews, each working in a short expansion cone projecting from the back wall of the chamber. The cross-section of the tunnel is everywhere elliptical, and at the working section is 52 ft. wide and 26 ft. high. Each of the six airscrews is driven by a 1,000 h.p. variable speed electric motor, and a maximum wind speed of about 110 miles per hour is expected. As mentioned above, an entirely novel feature is that the tunnel is in the open, instead of being housed in a building, thereby effecting a very large saving in the cost of construction.

The new tunnel differs radically from the full-scale tunnel at Langley Field, which is of the return-flow type in which the air leaving the driving airscrew is guided by suitable ducts of gradually expanding cross-section back to the intake end of the tunnel, a type first successfully used by Prof. Prandtl at Göttingen. Such a tunnel is more costly than one of the French type, as there is at least twice as much ducting, but it has the advantage that the air in the tunnel is quite free from external atmospheric disturbances. The power consumption for a given wind speed is less in the return flow type; but, if the figures given for the French tunnel are realised, the difference is not very great and may well be counter-balanced by the lower constructional cost.

The one debatable point about the new tunnel is the advisability of placing such a tunnel in the open air, where the incoming air is subject to atmospheric disturbances. There is very little data on the effect such disturbances will have in a large high-speed tunnel. Some experiments made on a small model of a wind tunnel at the National Physical Laboratory many years ago showed that the disturbances in the tunnel stream were many times as great when the tunnel was in the open, even when the wind outdoors was only a light breeze, than when it was operated in the still air of a large room. This model was, however, very small, and was only operated at the comparatively low speed of 40 ft./sec., at which the dynamic pressure is comparable with the pressure changes occurring in a gusty wind of quite low velocity. In the French tunnel the speed is much higher, and moreover, the inlet and outlet ends are separated by many hundreds of feet, a dimension which may be large compared with the average extent of eddies in the atmosphere. It may be mentioned that the tunnel has been placed in a hollow, with the view of shielding it so far as possible, but even with this protection it seems unlikely that it will prove possible to use the tunnel satisfactorily if any considerable natural wind is blowing. It will be exceedingly interesting to learn how the tunnel behaves in this respect, and what is the limiting natural wind velocity at which the tunnel stream is still steady enough for normal measurements.

A great deal might be written on the relative merits of the large tunnel capable of testing actual aircraft, and the alternative of testing scale-models in smaller tunnels, with guidance on scale-effect obtained by researches in a compressed air tunnel. There is certainly one field in which the large tunnel should be exceedingly useful. In these days the most marked tendency of aircraft design is towards the reduction of resistance and the attainment of high speed. For investigations with this end in view, the large tunnel offers the great advantage that the actual aircraft can be tested with all its little imperfections, such as roughness of surface and unavoidable excrescences, and that the effect of practicable improvements in such details can be directly determined. In testing small models in normal wind tunnels or in the compressed air tunnel, there is a distinct danger that the finer detail of the actual machine may not be properly represented.

The large tunnel also holds out the possibility of testing the aircraft with its engine and airscrew running, and so of investigating the effect of attempts to reduce resistance without adversely affecting engine cooling. This class of experiment, which is of great importance, is practically impossible on small models, though it can be carried

out in a smaller tunnel than the new French one. The 20 ft. tunnel in the United States and the new 24 ft. tunnel at Farnborough were, in fact, built chiefly for such work. The cost of running a full-scale tunnel, and of the preparation of machines for test therein, is necessarily heavy, and there is the limitation that even in such tunnels as those at Chalais-Meudon and Langley Field, only a small aeroplane can be tested. The limit of span, without involving large corrections for the constraint of the limited stream, would probably be about 40 ft.

In spite of such limitations—and every type of tunnel has limitations of some kind—the new equipment should prove of great value to the French in the study of aerodynamics, and it is to be hoped that results obtained by its use will be available to the world at large. It is only by careful analysis and comparison of results obtained in various types of wind tunnel and on machines in flight that the greatest use can be made of the research work of the various institutions in different countries.

Minute Intergenic Rearrangement as a Cause of Apparent 'Gene Mutation'

By H. J. MULLER, A. PROKOFYEVA and D. RAFFEL, Institute of Genetics, Academy of Sciences of the U.S.S.R., Moscow

WHEN it was discovered that chromosome breakage and reattachment usually entail effects resembling those of gene mutations located at or very near the point of breakage, it was suggested, as one alternative interpretation of this phenomenon, that the change in position of genes near the breakage point, with respect to other genes in their immediate vicinity, might in itself be the cause of their altered mode of reaction upon the organism (Muller, 1930). This was an extension of the 'position effect' principle which had previously been proposed for the special case of the bar genes, two of which had been found to have a greater effect when in the same chromosome than when in opposite chromosomes (Sturtevant, 1925). Since 1930, numerous further illustrations have been found, by various investigators, showing the comparative regularity with which effects resembling those of gene mutations in nearby loci accompany breaks, but there has been little or nothing in their evidence that would serve to test the probability of the 'position effect' interpretation as opposed to the alternative conception that the disturbance involved in the process of breakage was of such a nature as to be likely simultaneously to upset and alter (once for all) the inner composition of genes in the vicinity. The senior author has now, however, obtained definitive evidence (see Muller and Prokofyeva, 1934) of the correctness of the 'position effect' interpretation, through the finding that different rearrangements involving the scute locus in *Drosophila* in the great majority of cases result in phenotypically different 'allelomorphs', whereas nearly identical rearrangements (scute 4 and scute *L*8) have given sensibly the same 'allelomorphs'.

The general question thus arises, what proportion of apparent mutations are only intergenic 'position effects' rather than autonomous intragenic changes? Of twenty-seven scute and achaete mutations investigated which have been produced by irradiation, it has so far been possible to demonstrate in eighteen cases that there was a breakage and re-attachment close to the scute or achaete locus. Some or all of the remainder also are probably intergenic rearrangements, for it has been found in this investigation that the rearrangements tend to fall into two categories, gross and minute, the latter being of such a nature that a genetic discrimination between them and true intragenic mutations would be very difficult, or in many cases even impossible.

One example of a minute rearrangement is scute 19, in which only a fraction of a single chromomere (or chromatin 'ring' number 2, as seen in the salivary gland) has, as shown both by genetic and cytological evidence (see Fig. 1), become deleted, by a break on each side of it within the same chromomere, and inserted into another region of the chromatin (within the right arm of chromosome 2). We accept here Koltzoff's explanation of the structure of the salivary gland chromosomes, as bundles of practically uncoiled chromonemata the adjacent chromomeres of which form the 'rings' or 'discs' (see also Carnoy, 1884, and Alverdes, 1912, 1913); our work, however, shows definitely that the genes—usually more than one per chromomere—are contained within these chromomeres. Special genetic and cytological methods explained elsewhere have shown that the displaced section of the chromomere here in question includes only about six (four to eight) genes. This case does not illustrate a method of origination of recognisable 'deficiencies' alone. If such a deficiency included but one or two genes, instead of six, it would in some cases be viable and resemble in its heredity an intragenic mutation, as other work of Muller (in press) has shown. On the other hand, the inserted section, without the deficiency, could be mistaken for a simple genic 'suppressor', especially since, having been weakened in its activity by the effect of its changed

position, it could appear as a recessive (unlike most recessives, however, a duplication of the region in which it lay would not serve to counteract it). These changes might or might not be detectable cytologically, depending on their size. If, finally, instead of having been lost or inserted into another region, the minute section dealt with in the case of scute 19 had only been inverted, while remaining otherwise in its place, the change would not only have behaved genetically like a gene mutation, but also it would have been impossible of recognition as a rearrangement, even by the new cytological method.

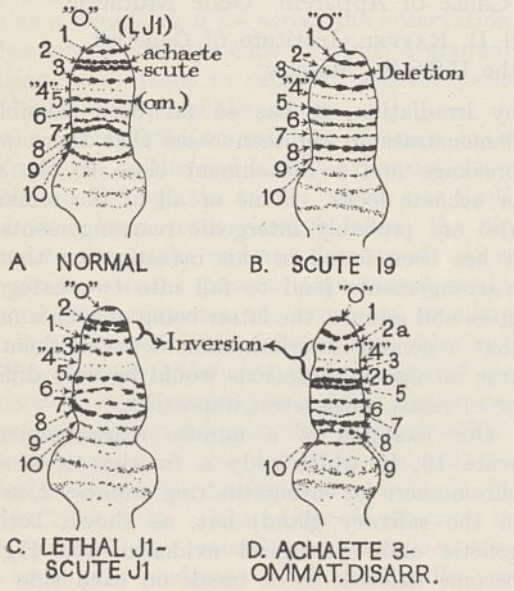

FIG. 1. Appearance of extreme left end of *X*-chromosome of *Drosophila melanogaster* as seen in the salivary gland, in normal material and in the case of three minute rearrangements. The exact or approximate () positions of the gene loci concerned are shown in the figure for the normal. All four drawings are from typical specimens and show only the terminal twentieth (±) of the entire active region of the *X*-chromosome.

The existence of minute inversions of the general type above mentioned was at first only an inference from the above and other cases of insertion, but soon actual proof of them was found. The first case in point was that of scute J1. Here cytological examination (see Fig. 1) proved that an only slightly larger section than the above, involving only two chromomeres or 'rings', 1 and 2, had become inverted (*in situ*). This was precisely the result which the senior author had been led to expect on the basis of this mutation having involved the simultaneous alteration of the effects of two nearby loci: those of lethal J1, normally to the left, as proved by genetic analysis of chromosome fragments broken between the two loci, and of scute, normally to the right. The seeming 'double mutation' here, as probably in most other cases, was simply due to the two different position effects occurring at the two different (but nearby) points of breakage and reattachment.

Another case in which the genetic expectation of a minute inversion, based on 'double mutation', was similarly confirmed by the cytological finding, was that of achaete 3 (= scute 10). Here the mutation other than that at the achaete locus was the ommatidial disarrangement 'om', which was proved to lie slightly to the right of achaete by the same method of analysis of fragments as that used before (analysis by crossing-over being virtually precluded in this as in the other two cases by reason of the small distances involved). In correspondence with this genetic situation, it was found that one point of breakage and reattachment lay within chromomere (= 'ring') 2, near the point in this chromomere where previous cytogenetic analysis by Muller and Prokofyeva (1934) had shown the achaete gene to be, while the other point of breakage and reattachment lay just to the left of or just within chromomere (= 'ring') 5, the region between these two points of breakage being exactly inverted (see Fig. 1).

Since double breaks and reattachments are not all thus accompanied by a *discernible* position effect in two demonstrably separate loci, this genetic criterion of a minute rearrangement is only sometimes provided. It is therefore evident that a minute inversion involving only a few genes (or sometimes only one gene ?) would often be not only cytologically but also genetically indistinguishable from an intragenic mutation, by any methods at present in use.

C. A. Offermann has directed our attention to the fact that there is evidence from another direction that a considerable proportion (if not all) of the apparent 'gene mutations' produced by X-rays are really the effects of changes in position caused by minute intergenic rearrangements. This evidence lies in the fact that the frequency of production by X-rays of readily demonstrable (gross) gene rearrangements is vastly greater in spermatozoa than in other cells, and that, corresponding with this, the frequency of production of apparent 'gene mutations' is also considerably raised in spermatozoa, as compared with other cells—although not nearly as much raised as is the gross rearrangement frequency (see Muller and Altenburg, 1930). Now exactly such relations are to be expected, if most of the induced 'gene mutations' are fine rearrangements, and if we accept the very probable hypothesis that rearrangements, like cross-overs, require contact between two chromonemata (or two portions of one chromonema). For the chromosomes are very much more crowded together and are more condensed in spermatozoa than in other cells. The much greater degree of crowding together would

give vastly more chance for juxtaposition of parts that ordinarily lie widely separated, and so would lead to a far higher frequency of gross rearrangements, while the greater degree of condensation would give more chance for contacts on the part of the very fine loopings that would be responsible for the minute rearrangements.

As our studies of mutations in the *X* and other chromosomes have shown that apparent replicas of practically all known 'natural mutations' in *Drosophila* may also be obtained by X-rays, the further question is raised as to what proportion of 'natural mutations' in *Drosophila* may really be minute rearrangements. This question is of moment because the range of possibilities of phenotypic change through intergenic rearrangements alone must be far from adequate for any indefinitely continued evolution. The latter must depend for the most part upon intragenic change, and hence it is important for the study of evolution, though at present seemingly so impossible, to be able to distinguish some at least of the intragenic mutations from the minute intergenic types of rearrangement. The matter acquires a greater urgency for geneticists when it is realised that they may now expect to have to meet attacks from orthogeneticists and Lamarckians, who may see in the present uncertainty regarding the 'building blocks of evolution', an opportunity of reintroducing teleological notions of evolutionary causation.

In this connexion, it must not be forgotten that all the cytogenetic investigations of species-crossing have agreed in showing that species differences in general reside in chromosomal differences and are therefore fundamentally *Mendelian* in their inheritance. When the chromosomes in species-crosses are able to undergo reduction, the species differences show spread of variation and eventual return to either parent species, whereas, when chromosome segregation is prevented—whether by asexual reproduction, by division of chromosomes at both maturation divisions (as in butterfly hybrids), or by the somatic origination of allotetraploidy—the hybrids breed true. Now Mendelian differences have been found to originate only by a sudden process—mutation. Since mutations involving intergenic changes are necessarily inadequate to provide most of the material for species divergence, it logically follows that a part of the mutations must be intragenic. It is only to be expected that many of these would be similar, in their phenotypic consequences, to effects of intergenic origin, and that discrimination between the two classes of change would present considerable difficulties. Such discrimination must, however, be eventually attempted.

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Obituary

SIR HORACE LAMB, F.R.S.

HORACE LAMB was born at Stockport in 1849. His childhood was passed mostly in a household where the strictness of the religious ideas prevailing at that time left little scope for his naturally happy nature and his great vitality. These qualities, which so endeared him to his friends in later years, began to appear at school. At Stockport Grammar School, he had the good fortune to come under a sound and kindly scholar named Hamilton, who quickly appreciated his merits, and finally sent him up to Cambridge, where in 1867 he gained a classical scholarship at Queens' College. At that time his allegiance was almost equally divided between classics and mathematics, but his visit to Cambridge, when he sat for the scholarship examination, turned the scale in favour of mathematics. On his return to Stockport he decided not to take up his classical scholarship but to sit for a mathematical one at Trinity in the following year. His interest in classics and literature, however, remained with him all his life, and had a profound influence on his children, all but one of whom turned to literature or art rather than to science.

The year of preparation for the mathematical scholarship was spent at Owen's College, Manchester, where, under Prof. Barker, Lamb first experienced the recondite joys of the higher mathematics. At Trinity, which he entered in 1868, he graduated as second wrangler, and was elected to a fellowship. At that time, and for some years afterwards, Cambridge mathematics was dominated by the tripos examinations. A young man's ability was judged entirely by his place in the tripos, and his competence as a mathematician by the ingenuity of the questions which he set when in due course he appeared as a tripos examiner. Among the more old-fashioned, it was considered rather pushing to publish original mathematical work. The proper way in which a lecturer could make known any theorem which he might discover in his teaching was to set it as a tripos question. The science of hydrodynamics was

at that time concerned almost entirely with an idealised, non-existent fluid which moved only in irrotational motion, without vorticity, and was thus well adapted for tripos questions.

Lamb, in his first course of lectures on hydrodynamics, given at Trinity in 1874, broke new ground when he gave an account of Helmholtz's great work on vortex motion. The substance of these lectures was published in 1878 as a "Treatise on the Motion of Fluids". This book, of some 250 pages, expanded in subsequent editions until as "Hydrodynamics" it covered some 700 pages. During its long career, which is still in full vigour, it has become the foundation on which nearly all subsequent workers in hydrodynamics have built. The long-continued supremacy of this book in a field where much development has been taking place is very remarkable, and is evidence of the complete mastery which its author retained over this subject throughout his life.

It is of interest to notice through the various editions of "Hydrodynamics" the continually increasing stress which is laid on the physical side of hydrodynamics. In the first edition (1879), the mathematical consequences of the conception of an ideal fluid are systematised and generalised in a form which is æsthetically very satisfying, and special problems are treated mostly as exercises of the type which occur in the tripos. In subsequent editions, problems are treated more from the point of view of their intrinsic interest as illustrating natural phenomena or experimental conditions. Numerical values are given for results which at first appeared only in symbolical form. Motions such as turbulent flow, which even now defy exact mathematical treatment, are discussed, in the later editions, in the partial and incomplete forms which they had attained at the time of publication. New developments have been brought into the scheme of the book, and it is this continuous growth as an organic whole that has enabled Lamb's "Hydrodynamics" to be still, after fifty-five years of life, the best book on the subject.

In 1875, Lamb married Miss Elizabeth Foot, the youngest sister of the wife of his old headmaster, and shortly afterwards he went out to Australia, where he had been appointed the first professor of mathematics and physics in the new University of Adelaide. Here he passed nine years, during which he established a laboratory and set the high tradition in science which Adelaide has preserved to this day. In spite of the cares of a large family, for three sons and three daughters were born while the Lamb family was in Australia, he published a remarkable series of papers on elastic and electric oscillations, and on hydrodynamics. These were all characterised by great clearness of expression, and they established his reputation as an applied mathematician so quickly and firmly that, at the earliest opportunity, which occurred in 1884, he was called back to England to the mathematical chair at Owen's College. At Manchester he threw himself into the work of the University and showed an aptitude for affairs which does not always accompany exceptional mathematical powers.

In his early days, Lamb was very fond of mountaineering, and he spent several seasons in the Alps. As soon as his children were old enough, he took them for long holidays walking in the Welsh hills or in Cumberland. Later he took them in turns to Italy, where he soon acquired a considerable knowledge of Italian art.

While in Manchester, Lamb spared no pains to make his lectures clear and well-ordered. The text-books which he published at that time bear witness to his care in that respect. At the same time, he made a number of important contributions to applied mathematics. The most noticeable characteristic of these works is the way in which the physical meaning of difficult analysis is clearly brought out. One of the most striking of Lamb's works published at this time is the complete analysis which he made in 1904 of the waves produced in an elastic solid by an impulse of short duration. He analysed the process by which a localised impulse can separate itself out into a number of disturbances of different types which travel at different speeds and therefore become separated. The seismological implications of this work have scarcely yet been fully discussed. Among other geophysical problems are the effect of vertical loading on the earth's surface (1917) and the waves in an atmosphere the temperature of which decreases with height (1910). This last paper must form the basis of any future attempt that may be made to calculate the tides in the atmosphere.

In 1920, Lamb retired from Manchester, and shortly afterwards returned to Cambridge, where his friend and colleague Lord Rutherford had just become the professor of physics. Trinity College made him an honorary fellow and he very frequently dined in hall, where his youthful nature made him very welcome to a company which included men nearly fifty years younger than himself.

At this time, Lamb's mind was much occupied with problems of aeronautical research. Until a few years ago, he was a member of the Aeronautical Research Committee, and when he retired from that body he still kept in touch with the more purely scientific side of its activities. Sometimes he helped with constructive criticism, sometimes he formulated aeronautical problems in a mathematical form, and sometimes he gave definite solutions of problems formulated by others. His services in this field were very much appreciated by those responsible for directing aeronautical research in Great Britain, and nowhere is his loss felt more deeply than among those whom he honoured by his kindly but telling criticism of their work.

In 1884, Lamb was elected to the Royal Society. He served three times on its Council and was twice a vice-president. In 1931, he was knighted. He was president of the British Association in 1925–26 and of its Section A in 1904. He died on December 4.

Lamb had three sons and four daughters. His eldest son, E. H. Lamb, is professor of engineering at Queen Mary College, London. The second, W. R. M. Lamb, is secretary of the Royal Academy and was formerly a fellow of Trinity. The youngest is Henry Lamb, an artist. One of his daughters is

Mrs. Palmer, now fellow and tutor of Newnham College, Cambridge. Another is Lady Brooke, wife of Sir J. R. Brooke, of the Electricity Commission.

This record of Sir Horace Lamb would be incomplete without referring to his sunny temperament and the vivid interest in every kind of human activity, which made him so fascinating a personality to all who had the good fortune to come into contact with him. G. I. T.

Dr. A. A. Belopolsky

Aristarch Apollonovitch Belopolsky, the well-known astrophysicist, member of the Russian Academy of Sciences since 1903, honorary director of the Pulkovo Astronomical Observatory in the U.S.S.R. and since 1910 an associate of the Royal Astronomical Society in London, passed away at Pulkovo on May 16, 1934, at the age of eighty years.

The main work of Belopolsky's long and laborious life was connected with spectroscopic investigations of the sun and stars. It was he who was charged in 1891 by F. A. Bredichine, then director of the Pulkovo Observatory, with planning the astrophysical equipment for use with the 30-in. refractor, visual at first and later for photographic records. His first observations were on Nova Aurigæ, in 1892, and since he never missed any new star, he accumulated a series of valuable spectrograms and obtained in some cases pure absorption spectra characteristic of the very first stages of the outbursts. At the same time, he made spectroscopic observations of the sun and was to the last president of the Solar Committee in the U.S.S.R. He was the first to determine, in 1915, the temperature of sunspots from his spectrograms.

In 1912 the Russian Academy of Sciences placed an order with the firm of Sir Howard Grubb, then in Dublin, for a big Littrow spectrograph, of 7-metre focal distance and a dispersion in the third order of 1 mm. = 0·76 A. Owing to the War and succeeding adverse circumstances, the instrument did not reach Pulkovo until 1923, and Belopolsky immediately took up his part of the international research on the solar rotation.

Many beautiful records and classical discoveries testify to the knowledge and the experimental skill of Belopolsky. Thus, in 1894, he discovered the velocity variations of δ Cephei associated with the changes of light. Two years later he made the same discovery for η Aquilæ and in 1899 for ζ Geminorum. In 1895 he confirmed Keeler's discovery of the rotation law of the rings of Saturn. From his examination of the spectra of γ Virginis and γ Leonis he made an important advance in the determination of the parallaxes of double stars. His favourite star, however, was Polaris, and every second year he took up the determination of its elements. A very striking achievement was his experimental proof of the Doppler effect. Already in 1894 he had set up a device consisting of a series of rapidly rotating mirrors opposed to each other, thus making it possible to get very high speeds of the reflected ray of light. In 1898 the arrangement was ready and Belopolsky was able to confirm by a purely laboratory experiment a fundamental law of modern astrophysics.

To understand this remarkable gift in the application of physics to astronomy we have to go back to Belopolsky's education. His parents were well educated but poor, and they encouraged his intellectual ambitions. The boy revelled in natural sciences, made experiments at home in physics and chemistry, and was a craftsman, achieving good results with the simplest means and making instruments practically out of nothing. He studied at the University of Moscow and graduated in 1877. F. A. Bredichine was then at the head of the Moscow Observatory; he at once appreciated the gifts of the young man and made him his assistant. In 1888 Belopolsky went to the Pulkovo Observatory, where he stayed for the remainder of his life. He published his work on sunspots and their movement in 1886. From the beginning of the *Astrophysical Journal* in 1895, he took a great interest in the periodical and was one of its associate editors.

During his career at the University of Moscow, Belopolsky had to provide for himself and knew what hardship meant. But science had captured him and he never failed her, whether in good or in hard times. He was a very kind-hearted man, with a real sense of justice and truth.

Rev. T. E. Espin

We regret to record the death on December 2 of the Rev. T. H. E. C. Espin, the well-known amateur astronomer. He began observing with a 1-in. telescope while at school at Haileybury, where his interest in the heavens was aroused by the appearance of Coggia's comet in 1872, and by his form master's lectures on his favourite hobby, astronomy.

On proceeding to Oxford, where he took his degree in 1881, Espin found his first double star with a 3-in. refractor, and evinced such enthusiasm that the Savilian professor allowed him the use of the University 13-in. At the age of twenty years he was elected a fellow of the Royal Astronomical Society, and soon afterwards was appointed special observer to the Liverpool Astronomical Society, of which he was a founder and president. At West Kirby, Wallasey and Wolsingham, where he was curate (1881–88) to his father, Chancellor Espin, a well-known ecclesiastical lawyer, he astonished the astronomical world by a survey of red stars, with a large reflecting telescope, of the whole of the northern heavens; he found 3,800, a total unequalled by any other observer. During this research more than thirty variables were discovered and observed until their range and period were determined. They included several remarkable objects, notably X. Ophiuchi, V. Cassiopeiae and R. Canum Venat. At the same time he almost doubled the known number of type IV stars. In 1899 Mr. Espin began a micrometrical examination of all stars shown on Argelander's charts—a total of well over 300,000—for new double stars, and before his death had found 2,575. For these researches, extending over forty years, and for the discovery of Nova Lacertae, he received the

Jackson-Gwilt medal of the Royal Astronomical Society.

Mr. Espin invented a spectroscope, a variable-power eyepiece and Espin's star detector. On Röntgen's discovery of X-rays, he built several high tension machines, culminating in a huge 24-plate Wimshurst, with which for many years he treated invalids from all over the country. In recent years, with the collaboration of W. Milburn, his astronomical assistant, he investigated the radioactivity of local spring waters and published the results in his observatory circular for 1933.

During the later years of his life, when he was unable to spend long hours in the observatory, Espin made and examined rock sections from his specimens collected abroad, especially of those from Vesuvius, Etna and Les Puys de Dôme. His scientific interests were thus very wide, and he brought both observation and thought to bear on many objects upon the earth as well as in the heavens. There are now few natural philosophers of his type, and his death has deprived the world of one who contributed much to its knowledge.

MR. ERNEST BINFIELD HAVELL, whose death at the age of seventy-three years occurred on December 30, was well known as one of the foremost authorities on Indian art, architecture and technology. He first went to India as superintendent of the Madras School of Art, and in 1896 was transferred to the Calcutta School, retiring from the Education Service in 1908. While at Calcutta he founded what has since come to be known as the Calcutta school of painting, and it was largely owing to his interest in indigenous industries that the village hand-loom industry was revived. An intense and enthusiastic appreciation of the aims of Indian art, especially of the Mogul and Rajput schools, was the basis of his conviction that the only future possible for a living school of art in India lay in an evolutionary development of the indigenous art, free from the influence of European ideals and methods. The enthusiastic welcome and support his views received from the Nationalist party in India proved an embarrassment rather than an assistance when, after his retirement, he endeavoured to promote in England a better understanding of India's artistic achievement. Mr. Havell was a voluminous writer on Indian art and technology, his best-known work being a "Handbook of Indian Art" (1920).

WE regret to announce the following deaths:

Mr. H. G. Ponting, the official photographer to the Scott Expedition of 1910–13 to the South Pole, on February 7, aged sixty-four years.

Prof. Arthur Thomson, emeritus Dr. Lee's professor of anatomy in the University of Oxford, president of the Anatomical Society of Great Britain and Ireland in 1906, on February 7, aged seventy-six years.

News and Views

Ethnographical Films

CONSIDERABLE interest has been aroused by a recent announcement that the Trustees of the British Museum have accepted the donation of a cinematograph film of the life of the Worora tribe of the Kimberley district of north-west Australia. The film was presented by Mr. H. R. Balfour of Melbourne. It was taken on the Government Native Reserve of Kunmunya, and shows the present conditions of native life. Technological processes, such as the making of stone axes and spear heads, in which these people are specially skilled, the making of fire by twirling one stick on another, the spinning of human hair for thread and the like are shown as living crafts. The 'shots' also include ceremonies and dances and an emu corroboree. The film has already been shown to missionaries, learned societies and medical students in Australia; but as is explained by Sir George Hill in a letter to *The Times* of February 7, owing to the fact that it was taken on a Government reserve, under the regulations of the Commonwealth Government, it cannot be shown commercially. With the permission of the Trustees of the Museum, arrangements have been made for the film to be shown at a meeting of the Royal Anthropological Institute to be held on March 19 at the London School of Hygiene and Tropical Medicine, but only fellows of the Institute and their guests can be admitted. A description of the film has been supplied by the Rev. J. R. B. Love, who is superintendent of the reserve and is well acquainted with the language of the Worora.

ALTHOUGH this film will, no doubt, prove of the greatest interest as an ethnographical record, it is by no means unique. The cinematograph camera has long been used as an adjunct to ethnographical exploration. One of the earliest records of this kind was the series taken by Prof. C. G. Seligman when a member of the Cooke Daniels–Seligman expedition to New Guinea thirty years ago, which was shown at the Leicester meeting of the British Association in 1907; and the late Sir Baldwin Spencer showed a detailed record of the life and corroborees of the natives of northern Australia at a meeting of the Royal Anthropological Institute in 1914. The diffidence felt by the Trustees of the British Museum in accepting the gift, notwithstanding the fact that it was a 'non-flam' film, has directed attention to the fact that the British Museum possesses one other film only, and that there is no official collection in Britain of these extremely valuable records of the life of primitive peoples, now rapidly passing away.

THE possibility of forming such a collection or repository was one of a number of points connected with the making, selection and preservation of cinematograph films of anthropological and ethnographical

interest, which was referred to a special committee appointed by the recent International Congress of Anthropological Sciences held in London in August last. The committee is international in its composition, Great Britain being represented by Capt. T. A. Joyce of the British Museum. The matter, however, is not to be allowed to rest there so far as Great Britain is concerned; and it is announced in the February issue of *Man* that the British Film Institute has established a Scientific Research Panel of its Advisory Council, of which Prof. J. L. Myres will act as chairman, to collect information as to the extent to which the cinematograph has been used in scientific work, details of methods and difficulties in technique, and particulars of films of scientific interest which have not been put into circulation through the ordinary commercial channels. The Panel will welcome information on any of these points; communications should be addressed to the Secretary, British Film Institute, 4 Great Russell Street, London, W.1.

City and Guilds (Engineering) College, London

In speaking, at the jubilee celebration of the City and Guilds (Engineering) College, Prof. H. E. Armstrong directed special attention to the origin of the Imperial College, tracing this and the general development of scientific activity at South Kensington mainly back to the late Lord Playfair, in particular to his appointment at the Museum of Practical Geology, the home of the Geological Survey, about 1843. South Kensington, he believes, is still without any memorial of the great 'little' man. Discussing the history of the Royal College of Chemistry, established in Oxford Street in 1845, now the Royal College of Science, Prof. Armstrong said that the funds were chiefly obtained from the farming community, owing to the enthusiasm aroused by Liebig in his tour throughout agricultural England in 1842–43. When the Royal College of Science was opened, its rural promoters had looked forward to the development of the school in the interests of agriculture. Man may propose but professors dispose: nothing was further from Hofmann's genius. Agricultural chemistry, Prof. Armstrong said, is not taught in England in a way in the least comparable with that in which engineering has been taught in the Guilds Colleges. He ventured to express the hope that, by the time the College of Chemistry celebrated its centenary, it will have learnt what its original purpose was and will seek to fulfil this. By that time perhaps the world will have recognised that no other subject is so worthy of chief attention as is agriculture.

Speaking of his work at the Central, after referring to the importance attached both there and at the Finsbury College to engineering as a necessary subject in the chemist's course, Prof. Armstrong said of the engineer: "I made no attempt to teach him chemistry: that I soon found to be impossible. I tried to teach him through simple acts of chemical inquiry, to experiment with a purpose; to observe accurately: above all to describe his work in lucid English: to take notes, in short, the hardest task of all. My schoolmastering was not popular with many, at the time. In after years I have had my full reward, as not a few have told me that my insistence on their learning to help themselves has been of special value to them". He ended by saying: "At this, perhaps the most critical and solemn moment of my life, in the interests of our national engineering efficiency, I would plead for the recovery of the original spirit and a reconstitution of the College as a separate entity."

Sir Alfred Ewing and Seismometry

Dr. C. Davison writes: "During the five years (1878–83) that Ewing spent in Japan, like other English teachers in Tokyo he was infected by the enthusiasm of Prof. John Milne, and became one of the first members, and afterwards a vice-president, of the Seismological Society of Japan founded by Milne in 1880. At one of the early meetings of the Society in that year, Ewing described his seismograph for horizontal motion, in which he preceded Rebeur-Paschwitz in devising a horizontal pendulum with two fixed supports. In 1881, he followed with an account of a seismometer for vertical motion, this, with the preceding, forming the well-known instrument made by the Cambridge Instrument Co., Ltd. In the following year, he devised his duplex pendulum seismometer. The horizontal pendulum was erected in the Engineering Laboratory of the University of Tokyo in November 1880, and, at several later meetings of the Seismological Society, he exhibited the diagrams obtained with it. The interest aroused by these early accurate records of the movements of the ground during an earthquake can be readily imagined. Shortly before he left Japan, Ewing wrote his great memoir on 'Earthquake Measurement', in which he described the various forms of known seismographs and their underlying principles (*Tokyo Univ. Sci. Dept. Mems.*, No. 9; 1883). Soon after this, his active interest in seismometry seems to have ceased, for, after his return to Great Britain, he made only one new contribution, that on seismometric measurements of the vibrations of the Tay Bridge during the passing of railway trains (*Roy. Soc. Proc.*, 44, 394–402; 1888). In these experiments made with a duplex pendulum seismometer, he showed that the greatest lateral and longitudinal movements of the bridge were about $\frac{1}{10}$ in. and $\frac{1}{40}$ in. respectively."

Research Laboratory at the National Gallery

Towards the end of 1934, the Trustees of the National Gallery approved a scheme for the establishment of a laboratory to undertake the physical examination of pictures by means of X-rays, ultra-violet and infra-red radiations, and by micrographic methods. They also appointed a committee, consisting of Sir Henry Lyons, Sir William Bragg, and Dr. H. J. Plenderleith, to act as an advisory body, should need arise: the laboratory is in charge of Mr. F. I. G. Rawlins. A considerable amount of the plant has already been installed, and work has begun with photomicrographic investigations, and to some extent with ultra-violet light. At the present rate of progress

it is expected that the laboratory will be fully equipped by the end of April. The X-ray apparatus will contain several novel features. In addition, a number of ancillary researches are being initiated, including the microscopical examination of woods used for panels: it is hoped that this inquiry will produce valuable data for making the description of works in future editions of the catalogue more exact, as well as being a help in the question of attribution.

Large Sunspot Group

A MODERATELY large sunspot group which formed on February 5 has attracted, for its size, an undue amount of notice in the daily Press. The group occupies about 800 millionths of the sun's hemisphere, and a spot of these dimensions will be no uncommon occurrence during the next six or seven years, as the sunspot cycle passes through its maximum in 1938. Actually, a larger group, occupying 1000 millionths of the sun's hemisphere, has already appeared since the last minimum in 1933. This group had its central meridian passage on April 21.9, 1934 (see the *Observatory* for February 1935, where an account of 1934 sunspot activities will be found). The present spot is, however, not without interest. No spot was detected on a photograph exposed at Greenwich on February 5 at 10^h, but at 11^h a spectroscopic disturbance was *seen* in the spectrohelioscope, which seems to have been the genesis of the actual spot. On account of cloud, no photoheliogram was taken on February 6, and the spot appeared fully developed on February 7. The spot's latitude is 14° S., and it was born west of the central meridian. Its central meridian passage—if it survives—will take place on March 14 next. The spot is of such a size that it could just be seen by the naked eye if it was on the central meridian. Near the limb, where the spot appears foreshortened, a spot of this size would be invisible. It is interesting to note that the number of naked eye sunspots per annum follows the ordinary sunspot curve very closely, and that the 11-year cycle could well have been discovered by an observer provided only with a smoked glass—and a good climate.

Natural and Artificial Clouds

IN his Friday evening discourse at the Royal Institution on February 8, Sir Gilbert Walker discussed natural and artificial clouds. Apart from cumulus clouds of various types, the causes of the geometrical patterns that are to be seen in the sky must be sought in the behaviour of layers of fluid which are made unstable either by heating them from below or cooling them from above. It has been known for fifteen years that a stationary liquid when unstable develops a polygonal pattern, and that an unstable liquid flowing down a trough forms pairs of vortices rotating in opposite directions, with their axes parallel to the direction of flow, or of shear. Sir Gilbert's pupils have carried these investigations further, and A. Graham used a wind tunnel formed with a heated iron plate as lower surface; its upper surface was a cool glass strip 8 ft. long and 9 in. wide, a third of an inch above the iron plate. When pulled by a motor, this gave variable rates of shear in the air. The former explanation of clouds occurring in long rolls or in a rectangular pattern as caused by Helmholtz waves was shown to be unsatisfactory; and it was verified that while a rapid shear due to motion exceeding one inch a second produces longitudinal cells, one less than a fifth of that rate leads to transverse cells, and an intermediate rate to a rectangular pattern. Various types of longitudinal clouds were discussed, and Sir Gilbert withdrew his former explanation of spirals in these clouds as due to stream lines, showing that there are normally two equidistant spirals like those in a twistdrill, and that these appear to be the two component vortices intertwined. Photographs of clouds were used to demonstrate the formation of a number of patterns of clouds at different heights; and an account was given of the explanation suggested by A. Graham of the paradox that, in the laboratory, liquid rises in the axis of a cell while in air there is descent there. Attention was also directed to the existence of clouds due to instability or the sun; and to the use of clouds of longitudinal and rectangular patterns for long-distance gliding under the name of 'cloud-streets'.

Structure of the Universe

SPEAKING to the Durham University Philosophical Society on February 1 at Armstrong College, Newcastle-upon-Tyne, Dr. Herbert Dingle, assistant professor of astrophysics at the Imperial College of Science and Technology, gave a historical account of the development of our ideas of the structure of the universe. Defining the 'universe' as the whole of physical existence, he pointed out that this apparently general subject demands a treatment which is in many respects unique. The idea of infinity became general with the Renaissance, and this seemed to place the conception of the whole universe beyond the power of the finite mind, until Newton restored the possibility with his implicit concept of universal law which was everywhere applicable. There have been two criticisms of this; a valid objection, that this extension of locally derived law may be incorrect; and an invalid one, based on our imperfect knowledge of atomic processes, which ignores the fact that the laws of a whole can be arrived at without combining the laws of elementary parts. Towards the end of last century, it was argued that the Newtonian law of gravitation was inconsistent with an infinite extension of uniformly distributed matter, of however low a density. Relativity theory, however, made such homogeneity acceptable. The Einstein, de Sitter and expanding universes are widely known nowadays, but Dr. Dingle made it clear that there is nothing esoteric about such theories, and that their underlying principles might have been expected from recent observations even if they had not been discovered when they were. It was stated also that there is no objection to belief in an infinite space, if one is willing to admit that in Einstein's space-time it may be quite beyond physical exploration.

The Uncertainty Principle

IN a lecture delivered to the Physical and Chemical Society of University College, Nottingham, on February 4, Prof. E. Schrödinger directed attention to the difficulties and contradictions which arise from attempts to unite quantum theory with geometry and with the theory of relativity. Although the first researches on wave mechanics used the relativity ideas, they are really in flat contradiction to them. The theory of relativity supposes that rods and clocks can be used to measure exact lengths and times, and that in some way velocities can also be measured accurately. Unfortunately, Heisenberg's uncertainty principle, which appears to be inherent in quantum mechanics, lays down that simultaneous accurate measurements of position and velocity are impossible. Moreover, the regulation of a clock is not possible to more than a limited degree of accuracy, except when the clock is infinitely heavy. Similar considerations forbid us to apply our ideas of Euclidean geometry, based upon ideal rigid measuring rods, to small physical regions. Physicists have at least as much confidence in the special theory of relativity as in quantum theory; the problem of devising a unified theory appears to be still unsolved.

A French Chemical News Service

WE have before us the first number of *Les Nouvelles de la Chimie*—a new monthly paper issued in Paris. It resembles in its general appearance a daily paper, a fact which may seem unusual in England; in France there exist already several medical news journals having the same format. The front page of the new journal contains news items, interviews and similar topical material; on the second page we find a review of general scientific activities in the universities and laboratories, while the third and fourth pages are devoted to general technical and economic information. The editor of the new paper is M. Jean Gérard, the active director of the Maison de la Chimie and its Centre of Documentation. We understand that if the new venture fulfils the expectations of its promoters, it will develop into a weekly and finally into a daily news service covering not only the field of chemistry but also that of science in general.

Baffin Island Survey

THE annual report of the Canadian Department of Marine for the fiscal year 1933–34 contains some interesting information respecting the operations of the Canadian Hydrographic Service during the period under review. Among other technical observations, the Service carried out a survey of the Baffin Island coast, of which the following extract is a partial description. "In aspect, the south-eastern coast of Baffin Island is very bleak, bare rugged hills of gneiss and granite rising to elevations about 600 feet close to the sea and to greater heights inland. The ragged shore is broken by numerous fiord-like inlets, but from Pritzler Harbour to Barrier Inlet, 45 miles north-northwestward, the shore is fronted by many islets, rocks and shoals of a most dangerous character. The 50-fathoms contour, which lies at an average distance of 3 miles off the islands, should be considered the danger line. The country is quite uninhabited except for some Eskimos who travel gregariously along the coast in whaleboats (omiaks). These natives appear to be of a very good type—healthy, honest and well adapted to the rigours of the country. Their habitat is both the north and south coasts of the long peninsula which separates Frobisher bay from Hudson strait. The small, swift rivers which flow into the heads of the inlets are well stocked with a fine species of salmon trout weighing up to 8 lbs.; this food, together with seal, constitutes their chief diet. At certain times a caribou hunt takes place and the hunters travel inland for several days to secure fresh meat. In addition, the country also provides aquatic fowl, ptarmigan, arctic hare and an occasional walrus or polar bear."

Reversing Falls at Barrier Inlet

AFTER recording the absence of good ship harbourage between Pritzler Harbour and Barrier Inlet, the report of the Canadian Department of Marine goes on to describe the physical features of the latter, which is an arm of the sea extending 12 miles inland. At the entrance, it has a width of about a mile and a half, but two miles inside, the width contracts to three quarters of a mile. The channel is still further constricted at this point by a number of rocky islets, connected at low stages of the tide and leaving only two narrow passage-ways less than a hundred yards wide. "The free flow of the tide in and out of the inlet being thus constricted at the narrows, a 'head' of water is formed and creates a reversing falls. At the time of low tide on October 1, there was a sheer outward waterfall 8½ feet in height, and the lowering of the fiordal waters continued for a space of 2½ hours whilst the tide was rising outside at the foot of the cataract. Slack water occurred for a few moments when the flood tide reached the elevation of the water in the fiord but almost immediately the inward rush of water formed whirlpools and great eddies and soon waves, 6 feet high, careened wildly from side to side. A boat attempting to pass through at such time would be engulfed."

American Museum of Natural History: New Director

ACCORDING to *Science* of January 15, Dr. George H. Sherwood has resigned his post as director of the American Museum of Natural History to give his entire time to the School Service Section as curator-in-chief of education. Dr. Sherwood will remain honorary director of the museum. Dr. Roy Chapman Andrews will succeed Dr. Sherwood as the active head of the museum. As leader of the Central Asiatic Expeditions of the American Museum of Natural History, Dr. Andrews took his first expedition into the field in 1916 to work in the territory of Tibet, South-west China and Burma. His second expedition went into North China and Outer Mongolia in 1919, and the third expedition has worked in Central Asia, especially in Mongolia, since 1921,

where it uncovered some of the richest fossil fields in the world. Dr. Andrews was awarded the Elisha Kent Kane Gold Medal of the Philadelphia Geographical Society, previously given to only eight explorers. Brown University and Beloit College have both conferred on him the degree of honorary doctor of science. He has been given the Hubbard Medal of the National Geographic Society in recognition of his discoveries in Asia. He is well known as a lecturer and author of popular books and articles on the results of his various expeditions, including a large volume covering his entire field work in Mongolia and China up to the present time entitled "The New Conquest of Central Asia".

Organisation of Museums

THE Madrid Conference on Museography on October 28–November 1, 1934, attended by seventy-five experts representing twenty different countries, was noteworthy for the publicity it gave to the organic life led by museums outside their actual exhibition galleries, quite as much as for the success of the Conference in paving the way for a general treatise on the principles and practice of museums. The main object of this Conference, organised by the International Museums Office and the International Institute of Intellectual Co-operation, was to collect observations and the results of actual experience from as large a number of museums and countries as possible, rather than the formulation of general rules. The agenda of the Conference included discussions on the general principles of the architecture of a museum, on museum equipment both in exhibition and other public rooms and in the museum services; on lighting, heating, ventilation and air-conditioning; the conversion of ancient monuments and other buildings into museums; general principles regarding the enhancement of works of art; methods of presenting collections; organisation of stores, reserves and study collections; permanent and temporary exhibitions; problems arising from the growth of collections; exhibition material; plans of rooms and the numbering and labelling of exhibits. A number of special questions such as collections of sculpture, decorative and industrial art, folk-art and ethnography, and graphic and numismatic collections were also discussed. The Academy of Fine Arts, Madrid, was specially fitted up for the Conference by the Spanish Government, and the International Museums Office lent a considerable amount of graphic and photographic documents to illustrate the papers.

Electric Discharge Lamps for Road Lighting

IN many of the long stretches of main roads between towns and villages the only practical way of lighting at present seems to be by means of the lamps on the vehicles. In a paper on "Electric Discharge Lamps and Road Lighting" read to the Institution of Automobile Engineers on December 11, Mr. H. Warren and Mr. L. J. Davies show how the length of the permanent illumination of roads can be extended, with acceptable economy, by means of the new discharge lamps, when care is taken to distribute the light scientifically by means of suitable lanterns. Controlling the reflective properties of the road surfaces has also to be taken into consideration. With mercury and sodium vapours we have two substances which, when excited in the correct way, produce a sufficient proportion of energy in the visible spectrum to give a two- or three-fold increase in efficiency over incandescent lamps. A fifty-fold efficiency is theoretically possible, but the practical utilisation of electrical discharges has just made a beginning. At present, electric discharge lamps for street lighting are of two main types, high-pressure mercury vapour and sodium vapour. The former type of lamp is most favoured in Great Britain, while on the Continent and in America the sodium vapour lamp is most used. Mercury discharge lamps have an excellent 'luminous output' during their lives, which are longer than those of other forms of lamp. The colour of the lamp, when viewed directly, is greenish-white. In the colours radiated, blue, green and yellow predominate, but red is practically lacking. By incorporating cadmium with the mercury a satisfactory red tinge can be introduced, but at a slightly lower efficiency. The colour correction of these lamps is receiving a great deal of attention in commercial research laboratories at present.

Continuously Evacuated Radio Transmitting Valves

AT the meeting of the Wireless Section of the Institution of Electrical Engineers on February 6, a paper entitled "Continuously Evacuated Valves and their Associated Equipment" was read by Mr. C. R. Burch and Dr. C. Sykes. This paper describes the development of demountable thermionic transmitting valves of various power ratings, the valves being evacuated continuously by means of oil condensation pumps. This work has arisen out of some experiments carried out in 1929 on the distillation of lubricating oil in a molecular still. It was found that one of the fractions was about a thousand times less volatile than mercury, so that if such a liquid could be used as the working fluid in a condensation pump, a vacuum of the order of 10^{-6} mm. should be attainable without the use of liquid air or other refrigerants; and such a vacuum is quite adequate for valve exhaustion. These expectations have been fully realised in the development of oil-condensation pumps which will work against a fore-vacuum of 0·05 mm. and will produce a vacuum of 10^{-3}–10^{-6} mm. at a speed of 20 litres per second. Such pumping equipment is described in the paper in some detail, and reference is made to its application to the production of thermionic valves of a power rating ranging from 20 kw. to 500 kw. for high-frequency furnaces and for radio transmitting stations. Several valves of the 30 kw. order have been in use on commercial radio traffic at the Post Office station at Rugby for long periods, and they have given satisfactory service. A 500 kw. valve is in the stage of experimental trial on the long-wave transmitter at Rugby. The relative merits of these valves and those of the sealed-off type were discussed

briefly in the paper, and were enlarged upon by several speakers in the discussion which followed the reading of the paper.

Deep-Sea Observations with the Bathysphere

FOUR years ago, Dr. William Beebe and Mr. Otis Barton descended in their 'bathysphere'—a steel ball fitted with quartz windows—to a depth of a quarter of a mile below the surface of the ocean off Bermuda. During the season of 1934 they successfully established a new depth record of 3,028 ft. In the *National Geographic Magazine* of December 1934 and the *Bulletin of the New York Zoological Society* of November–December 1934, interesting articles deal with the fitting-out, operation and scientific observations made, during these latest dives. Excellent photographs in the text provide a word picture of the undertaking, and a series of coloured plates give vivid impressions of the strange and bizarre forms of life as seen by Dr. Beebe through the windows of the ball and described over the telephone line between the bathysphere below and the parent ship at the surface. Three deep-sea fish, new to science, are described, including the five-lined constellation fish, *Bathysidus pentagrammus*, which Dr. Beebe speaks of as one of the most gorgeous deep-sea inhabitants he has ever seen. Five rows of photophores emitting yellow and purple light produced a beautiful pattern of illumination through the darkness. From this and other records, there can be little doubt as to the success and scientific value of this daring method of observation.

Optical Research

AT the meetings of the Institut d'Optique, held periodically at the Sorbonne and generally under the chairmanship of Prof. Charles Fabry, director of the Institut, the communications considered relate as a rule to one particular branch of the subject, and the *Revue d'Optique Theorique et Instrumentale* issues a separate copy of the proceedings which may run to as much as 50 pages. Last year, the January meeting dealt with the employment of liquid prisms in spectrographs, that of March with interference methods of studying movements of the air, the April meeting with ultra-violet polarimetry and with the densities of photographic images, and the June meeting with the light of the night sky. In several cases the subject is introduced by a short sketch of past work on it and its present aims and problems, given by the president, and descriptions of current methods and instruments by specialists in the subject follow. These pamphlets seem capable of affording great assistance to those requiring brief résumés of the present positions of the various branches of optical research.

Systematics of the Diptera

MR. P. H. GRIMSHAW has recently published a useful article entitled "Introduction to the Study of Diptera, with a Key for the Identification of Families" (*Proc. Roy. Phys. Soc., Edin.*, **22**, Pt. 4, July 1934). The paper gives a clear account, accompanied by illustrations, of the various structural features of importance in classification. A list of the chief general works on the order is provided and a diagnostic key to all the existing families. The key is translated and adapted from Lindner's "Fliegen der palaeartischen Region" and should prove especially valuable to those entomologists who are not specialists in the insect order concerned.

Review of Seismology

THE National Research Council of the National Academy of Sciences at Washington is issuing a series of bulletins on the physics of the earth, to give scientific workers who are not specialists in the subjects treated an idea of the position and problems of various branches of geophysics. Among the bulletins in this series which have already been issued are those on volcanology, the figure of the earth, meteorology, the age of the earth and oceanography. Recently, Bulletin No. 90 on seismology has appeared. It has been prepared by a Committee of which Prof. J. B. Macelwane is chairman. Within 219 pages it includes twenty chapters, and gives a very valuable and interesting general view of the subject. Chapters by the chairman include—the definition and classification of earthquakes, tectonic earthquakes, plutonic earthquakes, rock fall earthquakes, body waves, reflection and refraction of seismic waves, surface waves and paths and velocities of seismic waves within the earth; H. O. Woods contributes articles on volcanic earthquakes, field investigation and surface geology in relation to the 'apparent' intensity; articles by H. F. Reid deal with magnetic effects, earthquake mechanics and with the focus. The principle of the seismograph is described by J. A. Anderson, and P. Byerly contributes five articles on analysis of seismograms in earthquakes, records at intermediate and great distances, time distance curves, reduction of trace amplitude, and seismic geography. The Bulletin has numerous bibliographies and is priced at 2 dollars.

Books on Anthropology and Archæology

CATALOGUE No. 574 (Anthropology and Folklore—Archæology and Ethnography) issued by Messrs. Francis Edwards, Ltd., 83 High Street, Marylebone, London, W.1, including both new and second-hand books, though, naturally, the latter predominate, contains just under a thousand items. On looking through the list, two points occur, one being the high average in the quality of the books from the point of view of the anthropologist, and secondly the fact that, with certain exceptions, the prices do not rule high. With regard to the first point, the subjects covered by the catalogue, it is almost needless to say, have been a happy hunting ground for the wilder theorist and speculation has been rife in their literature. It is evident that here on the whole a wide discretion has been exercised in selection. The question of price is no less interesting. It is not intended to convey that this catalogue is an exceptional opportunity for bargain hunters—although it would be possible to form from its pages an excellent nucleus of a reference

library in anthropology at a very moderate price—but rather that the rarities, and even some of the older standard books which command a high price, are becoming increasingly rare. Among the items to be noted are some complete runs of scientific publications, such as the Folklore Society's publications and those of the Royal Anthropological Institute, some lengthy runs of *Archæologia* and a virtually complete set of the *Journal of the African Society*, of which certain numbers are now impossible to obtain, except by fortunate accident. A noteworthy item is Edge-Partington's ethnographic album of the Pacific, of which, it is thought, not more than half a dozen copies are now in existence in private hands.

Announcements

THE following have recently been elected foreign members of the Royal Academy of Sciences, Stockholm: Prof. Robert Robinson, professor of chemistry in the University of Oxford; Prof. F. D. Adams, emeritus Logan professor of geology in the McGill University, Montreal; Prof. Ejnar Hertzsprung, professor of astrophysics in the University of Leyden, Holland; and Prof. A. V. Hill, Foulerton research professor of the Royal Society, formerly Jodrell professor of physiology in University College, London.

AT the annual general meeting of the Royal Astronomical Society held on February 8, the following officers were elected: *President:* Mr. J. H. Reynolds; *Vice-Presidents:* Prof. S. Chapman, Dr. H. Spencer Jones, Dr. H. Knox-Shaw, Prof. F. J. M. Stratton; *Treasurer:* Sir Frank W. Dyson; *Secretaries:* Mr. W. M. H. Greaves and Dr. W. M. Smart; *Foreign Secretary:* Prof. Alfred Fowler.

MR. B. H. WILSDON has been appointed to the post of director of research to the Wool Industries Research Association at Torridon, Headingley, Leeds. Since 1929, Mr. Wilsdon has been assistant director and superintendent of the Building Research Station of the Department of Scientific and Industrial Research. He was educated at Lincoln College, Oxford, and after a period of research there, went to India as a professor of chemistry, afterwards gaining varied experience in applied research in agriculture and organising the Irrigation Research Institute of the Punjab. Besides publishing work on chemical and physical subjects, Mr. Wilsdon has done pioneer work on the application of statistical methods to industrial problems of specification and standardisation.

In NATURE of February 9 (p. 212), it was stated, following the Report for 1933–34 of the Department of Scientific and Industrial Research, that the new process of the Wool Industries Research Association for the production of unshrinkable fabrics is being exploited under mill conditions and that materials should be available to the public early this year. We are informed by the Association that work still remains to be done on the problems which occur in transferring the operation of such a process from the laboratory to a commercial scale, and that "it is certain that underwear or other knitted materials, finished by application of the W.I.R.A.'s new unshrinkable process, will not be available to the Trade before 1936".

THE Secretary of State for the Colonies has made the following appointments: Mr. R. M. Gambles, to be veterinary officer, Cyprus; Mr. J. D. Tallantire, to be superintendent of agriculture, Nigeria; Mr. J. M. S. Usher-Wilson, to be superintendent of agriculture, Nigeria; Mr. R. L. Brooks (deputy conservator of forests), to be conservator of forests, Trinidad; Mr. P. E. Carcenac (assistant conservator of forests, Mauritius), to be assistant conservator of forests, Malaya; Mr. J. de Meza (veterinary bacteriologist), to be chief veterinary officer, Nyasaland; Mr. J. C. Muir (superintendent of agriculture, Gold Coast), to be senior agricultural officer, Zanzibar; Mr. F. B. L. Butler (grader and inspector, Agricultural Department, Kenya), to be chief grader and inspector of produce, Agricultural Department, Cyprus.

THE twenty-fifth Dutch Congress of Natural Science and Medicine will be held in Leyden on April 23–25 under the presidency of Prof. J. van der Hoeve with Prof. L. G. M. Baas Beching as president of the biological section and Prof. E. Gorter as president of the medical section. Further information can be obtained from the general secretaries, Dr. D. Coelingh, Regenteslaan 2, and D. N. R. Pekelharing, Jr., Meentweg 48, Bussum.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—Probationer mapping assistants to H.M. Land Registry—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1 (Feb. 21). A head of the Engineering Department of the Willesden Technical College—The Secretary, H. M. Walton (T.), 10 Great George Street, Westminster, S.W.1 (Feb. 22). A lecturer in electrical engineering at Norwich Technical College—The Principal (Feb. 25). A lecturer in electrical engineering at Chesterfield Technical College—The Director of Education, County Education Office, St. Mary's Gate, Derby (Feb. 25). A computer (Class II, male or female) for the Ordnance Committee, Royal Arsenal, Woolwich, S.E.18—The Secretary (Feb. 25). A principal of the South-East Essex Technical College—The Director of Education, County Offices, Chelmsford (Feb. 28). A lecturer in pathology in the University of Bristol—The Registrar (March 1). A lecturer in bacteriology in the University of Manchester and assistant bacteriologist in the Public Health Laboratory—The Secretary, University, Birmingham 3 (March 1). Junior scientific officers at the National Physical Laboratory to work in the Aerodynamics and Radio Departments—The Director (March 4). Probationary assistant engineers in the Post Office Engineering Department—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1 (March 7). A lecturer in anatomy and deputy-director of the Department at St. Thomas's Hospital Medical School, Lambeth Palace Road, London, S.E.1 (March 16). Laboratory assistants (male) at the Experimental Station, Porton, near Salisbury—The Commandant.

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. 271.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Viscosity of Helium I and Helium II

DETERMINATIONS have recently been made in the Cryogenic Laboratory at Toronto of the viscosity of liquid helium in its two states, helium I and helium II.

Helium I denotes the liquid as it first forms at a temperature of 4·2° K. When the pressure above the liquid is progressively reduced, the temperature falls and the liquid bubbles freely as it boils under the reduced pressure. Suddenly, when a temperature of 2·2° K is reached, the liquid changes its state—a change indicated by complete cessation of boiling, although the temperature continues to fall as pumping is continued.

The viscosity of liquid helium was measured, step by step as the temperature was reduced, by means of observation of the logarithmic decrement and periodic time of the oscillation of a circular metal cylinder submerged in the liquid helium. The cylinder was 2·5 cm. in diameter, and 8·5 cm. in length over all, the top and bottom being bevelled in the form of cones, each 2·1 cm. in height. From the top of the cylinder a stiff phosphor-bronze rod 0·07 cm. in diameter extended 62·5 cm. The rod and cylinder were suspended by a fine phosphor bronze ribbon 14·0 cm. long. The rod was sufficiently long to ensure that the suspension wire was kept at room temperature.

Fuller reports of the experiment will be made elsewhere: the results only are announced here.

Helium I at 4·2° K:	$\eta = 0{\cdot}00011$	c.g.s. units
Helium I at 2·3° K:	$\eta = 0{\cdot}00027$	,, ,,
Helium II at 2·2° K:	$\eta = 0{\cdot}000033$	,, ,,

To show the definiteness of the viscosity change we may cite the following. During the course of the experiments the cylinder was set swinging in helium II (<2·2° K) and the pressure over the helium liquid was allowed to change to that corresponding to a temperature of 2·7° K. The cylinder continued to oscillate throughout the interval of this change of temperature, but as the state of the liquid changed from II to I, there was a very distinct and abrupt change in the logarithmic decrement, which corresponded to the above changes in the coefficient of viscosity.

This work was carried out by Messrs. Wilhelm, Misener and A. R. Clarke.

E. F. BURTON.

McLennan Laboratory,
University of Toronto.
Jan. 9.

An Application of Infra-Red Photography to Palæobotanical Research

TRANSFER preparations of fossil plants, particularly those of Carboniferous age, provide the palæobotanist with the plant remains separated from the rock matrix and mounted on a transparent base of Canada balsam or cellulose ester. While many of these fossil remains are translucent and give the investigator the opportunity of studying some of their microscopic features by transmitted light, many are opaque with ordinary types of illumination.

FIG. 1. Photographs of transfer preparation of a fossil plant: (1) by ordinary photographic plate; (2) by panchromatic plate; (3) by infra-red plate.

It has been found that some of these apparently opaque fossils are translucent with respect to infra-red rays, and photographs taken on plates sensitive to the infra-red part of the spectrum reveal quite a considerable amount of detail otherwise invisible. The accompanying illustration (Fig. 1) includes (1) a photograph by transmitted light of a fossil plant of Coal Measure age taken on an ordinary photographic plate; (2) is the same subject taken on a panchromatic plate with a dark red filter; and (3) is the same subject taken on an infra-red plate with an infra-red filter. The exposure required with the panchromatic plate was considerably longer than that required for the two other photographs. The exposure with the infra-red was one minute. The magnification is in each case 6·5.

It is clear that since this fossil is a thin layer of coal, this method of examining carbonaceous fossil plants may be very effective in coal petrology in the examination of coal in thin sections.

JOHN WALTON.

Department of Botany,
University, Glasgow.
Jan. 15.

Scattering of Hard γ-Rays and Annihilation Radiation

To determine the relative importance of the annihilation of positive electrons in the phenomenon of the 'scattering' of hard γ-rays, observations were made on the secondary γ-radiation from thin lead foils irradiated with thorium C″ γ-rays (25 mgm.). With a scattering angle of about 140°, 0·8 cm. effective lead filter was sufficient to absorb practically all the Compton scattering, and still leave predominant the softer of the two components in the anomalous scattering, namely, the component which has been attributed to the annihilation of positive electrons.

A sheet of paraffin wax was placed in front of the source to reduce to a minimum the number of positive electrons falling on the scatterer. Measurements were made on the secondary γ-radiation from foils of varying thicknesses (t) down to thicknesses of the order of, and appreciably less than, the average range (R) of the positive electrons, expected from theory, from the γ-rays used. If the annihilation hypothesis is correct, the 'scattered' radiation under these conditions should, in the region $t \sim R$, decrease much more rapidly with decreasing t than its first power, owing to the escape of the positive electrons from the foil before annihilation. This rapid decrease was actually found, the effect of the thinnest foil used ($\sim 0{\cdot}002$ cm.) being only about 30 per cent of the value corresponding to a linear variation with t. This shows that at least about 70 per cent of the scattered radiation under these conditions is due to annihilation[1].

To test further the annihilation theory of the origin of the *soft* component, it was compared, under practically identical conditions, with the Compton scattering through 79°, this angle of scattering giving Compton radiation of the same wave-length, namely h/mc, as that of the theoretical annihilation radiation. Both in frequency and intensity the soft component was found to agree fairly well with the theoretical expectations, and there is no question, according to the present experiments, of the annihilation radiation being only a small fraction of the theoretical value, as maintained by Bothe and Horn[2]. The theoretical intensity was estimated in the usual way from the number of positive electrons produced by the primary γ-rays according to Dirac's theory[3].

To investigate the *hard* component in the anomalous scattering, observations were made with different thicknesses of lead filter in the path of the secondary rays, up to 5 cm. of lead at 140°, and up to 7 cm. at 80°. While a slight progressive hardening was found with increasing filter strength, throughout this range, there was no evidence for secondary radiation of primary hardness. Actually, with the maximum filter thickness, the secondary radiation was definitely softer than the hard γ-rays from radium C. The latter correspond to a quantum energy of about $1{\cdot}9 \times 10^6$ volts, while the effective primary radiation in the above experiments has a quantum energy of $2{\cdot}65 \times 10^6$ volts.

The initial intensity of the hard component from lead is of the order of 15 per cent of that of the half-million volt radiation. It is somewhat anisotropic, being more intense at 80° than at 140°. The anisotropy is more pronounced for light elements. These results are qualitatively in agreement with the supposition that the hard component is due to X-radiation from Compton electrons, and the annihilation of positive electrons before reaching the end of their range, the degree of anisotropy of such tertiary radiations being dependent on the atomic number through the nuclear scattering of the secondary electrons. The importance of the first of these processes has already been emphasised by Lauritsen and Oppenheimer[4], and from more recent and detailed calculations by Wheeler and Plesset[5] it appears that the two processes will account for at least a large part of the hard component.

A fuller account of the experiments described in this note, and of a more detailed analysis of the results when completed, will be published in due course. The experiments were carried out at the laboratory of the Institute for Theoretical Physics, Copenhagen, and I should like to take this opportunity of thanking Prof. N. Bohr for his kind interest in the investigation, and also Dr. J. C. Jacobsen and Mr. K. F. Brostrøm for their valuable assistance in the experimental work.

E. J. WILLIAMS.
Institute for Theoretical Physics,
Copenhagen. Jan. 12.

[1] Cf. earlier experiments by the writer using 0·1 mm. lead foil and radium C γ-rays (NATURE, **133**, 415; 1934).
[2] *Z. Phys.*, **88**, 683; 1934.
[3] Oppenheimer and Plesset, *Phys. Rev.*, **44**, 53; 1933. Bethe and Heitler, *Proc. Roy. Soc.*, **146**, 83; 1934.
[4] *Phys. Rev.*, **46**, 80; 1934.
[5] To be published in the *Physical Review*. These authors have also considered other possible effects, including the Raman scattering of the primary radiation, and found them to be unimportant.

Colchicine and Tumour Growth

THE finding of considerable numbers of mitotic figures in the hæmopoietic organs of normal healthy animals and in the neoplastic tissues of tumour-bearing animals after colchicine administration has led many students to suspect an inter-relationship between mitosis and the alkaloid. But the effect of colchicine in slowing down the rate of growth of neoplastic tissue has not been reported.

Following on some earlier observations (unpublished, 1927) which I made in conjunction with the late Prof. M. R. J. Hayes on the beneficial effects of deep X-ray therapy on neoplasms in patients suffering from acute attacks of gout, which were being treated with colchicum, a series of experiments was recently planned with the object of determining to what extent the colchicine might affect new growths.

In one of these, a group of twelve tumour-bearing mice (*M* 63), were injected subcutaneously on alternate days with small doses of colchicine (kindly supplied by the director of the Wellcome Bureau of Scientific Research, where the work was carried out). Treatment lasted for a period of two weeks. Twelve other tumour-bearing mice were used as controls. The tumours at the end of the first week showed much less growth as compared with the controls; while at the end of the second week there was no macroscopically recognisable tumour tissue present in 66·6 per cent of the injected animals, and only minute nodules could be detected in the remaining 33·3 per cent. These nodules finally showed complete regression, and no tumour tissue could be recognised eight weeks later. The controls in all but one instance showed a marked development of the tumour. In another series, the percentage of animals in which there was no recognisable tumour tissue at the end of two weeks was 100 per cent.

From the effects observed in these tumour-bearing mice, it was thought advisable to determine what

effects, if any, could be obtained in dogs with spontaneous tumours. Of several dogs treated or undergoing treatment with colchicine, the changes observed in a spontaneous tumour in the peritonsillar region in one of these animals is sufficiently striking to warrant recording.

Case history: Sealyham, 11 years old. Difficulty in swallowing biscuits observed about August 26, 1934. By September 30 a marked tendency for holding his head on the left side had developed. On November 19 it was difficult and painful to open the mouth. The difficulty in deglutition had increased, and the animal was unable to bark. On examination there was seen an ulcerated tumour on the left side of the bucal mucous membrane just ventral to the anterior pillars of the fauces on the left side, about the size of a walnut. The dog was admitted to the Royal Veterinary College on December 19, 1934, and injections of colchicine were begun, following on the clinical diagnosis of epithelioma. Injections were continued on alternate days and on January 9, 1935, a small portion of the tumour was excised for histological examination. The clinical diagnosis was confirmed. The administration of colchicine was continued and the tumour inspected daily. There was a progressive diminution in the size of the growth, and on January 29 only a small scar remained at the site of the original growth.

These experiments are being continued with various transplantable tumours, and a number of animals with spontaneous tumours are being treated with colchicine.

The significance of these and other facts relating to the effects of colchicine in man and other animals, as well as the effects of such agents as X-rays and radium in combination with colchicine on new growths, will be published and discussed in collaboration with Dr. G. M. Findlay, of the Wellcome Bureau of Scientific Research, to whom I am indebted for facilities and assistance in carrying out this research.

E. C. AMOROSO.

Royal Veterinary College,
London, N.W.1.
Feb. 4.

Identity of Vitamin B_2 and Flavine and the Nomenclature of Vitamins

ELVEHJEM and Koehn have stated[1] that vitamin B_2 and flavines are not identical. Now Elvehjem and Koehn work with chicks, while Goldberger and others, who were the first to adopt the notation '*P-P* factor', which was afterwards called vitamin B_2, have used dogs and rats for their experiments. The first symptom that they describe for their rats was "a tendency of the lids of one or both eyes to adhere together with, in some instances, an accumulation of dried secretion on the margins of the lid".

It is precisely this pathological condition which we have been able to cure by lactoflavine. The lactoflavine that we used was prepared from milk, according to the methods devised by Kuhn. Further, Miss Chick and others, who were among the first to use the notation vitamin B_2, found that a preparation of egg-white is rich in vitamin B_2. Mr. Tierie, in our laboratory, found, on exposing that extract from egg-white to sunlight, that the vitamin is lost; this suggests that this vitamin, which Miss Chick called vitamin B_2, is a flavine. Therefore I think that Kuhn is right in calling his lactoflavine vitamin B_2.

These investigations demonstrate, I think, that we are adopting the wrong method in our nomenclature of vitamins by denominating them according to the letters of the alphabet. When we isolate more of them—and I am sure there are still several as yet unknown vitamins—we have the trouble of giving them the right letters, and there is again the danger that two investigators may claim the same letter for quite different substances, as is the case with vitamin B_2. Also, the old system is not at all logical: vitamins B_1 and B_2 are not only quite different substances, but have also very different actions; on the other hand, vitamins D_1 and D_2 probably do not differ very much in structure, and in action differ only quantitatively.

I should like to propose, therefore, to omit all these letters in the denomination of vitamins. The vitamins that are isolated in a pure state should be given their proper names, as has already been done for some of them. So long as they remain unisolated, they may receive a provisional name, just as in the case of hormones. Hence vitamin A may provisionally be called anti-xerophthalmic-vitamin.

Further, I propose to call the present vitamin B_1 in the future aneurin (from a[nti-poly]neur[itis vitam]in). I think I have some right to propose this, as Dr. Donath and I were the first to obtain this vitamin in a crystalline state.

Of the other B-vitamins, one is called flavin. Whether this is the specific anti-pellagra vitamin or not may soon be known, when the pure flavin is tested on human pellagra patients.

Vitamin C is already called ascorbic acid by Szent-Györgyi, which name has come into general use.

One preparation of vitamin D is already called calciferol. As soon as the antirachitic factor from cod liver oil, which is certainly a different substance from calciferol, is prepared in a pure state, it will receive a name.

The E vitamins may provisionally be called sex-vitamins or anti-sterility vitamins.

It is a pity that there is no international committee to regulate this nomenclature.

B. C. P. JANSEN.

Laboratory for Physiological Chemistry,
University, Amsterdam. Jan. 24.

[1] NATURE, **134**, 1007; 1934.

Aluminium Chloride as a Catalyst of Hydrogen Interchange

THE Friedel Crafts reaction:

$$RCl + C_6H_6 \xrightarrow{AlCl_3} C_6H_5R + HCl$$

suggests the use of $AlCl_3$ as a catalyst for the interchange of hydrogen between benzene and hydrogen chloride. We have found this expectation confirmed in the following experiments: 0·5 gm. of $AlCl_3$ was brought into contact, for three hours, in a vessel of about 100 c.c. capacity, with a mixture of ordinary benzene and hydrogen chloride containing 13·4 per cent D, the temperature in two runs being 25° and 50° respectively:

Temp.	Benzene.	Pressure of hydrogen chloride.	Per cent D in hydrogen chloride after treatment.
25°	0·107 g.	178 mm.	1·23
50°	0·095 g.	297 mm.	1·08

From the analysis of the hydrogen chloride given in column 4, it follows that in both cases more than 90 per cent of the D had passed over from the hydrogen chloride into the benzene. This has been confirmed by analysing the benzene formed. We have found indications that under the above experimental conditions the reaction proceeds to some extent, even when no $AlCl_3$ is present; but in this case it goes at a much slower rate.

J. KENNER.
M. POLANYI.
University of Manchester. P. SZEGO.

Crystal Structure of Cyanuric Triazide

IN connexion with the discussion on dipole moments held by the Faraday Society at Oxford in April 1934, Sir William Bragg described[1] briefly the results of a research, which I had been making on the structure of cyanuric triazide. A Fourier analysis of the measured X-ray intensities of (*hkio*) planes showed the three nitrogen atoms of the azide group to be in a straight line[2]. Details of the research were promised later and were held up for an absolute intensity determination to be made. The calculations are now completed and will, I hope, be published soon.

Mr. E. W. Hughes has now published[3] a structure which resembles mine, but differs from it in certain important features. He shows the azide group as departing from linearity by 15°, while I find that any departure from the straight line could not exceed 3° or 4°. The distances between the centres of the atoms in the cyanuric ring he finds to be all equal, thus indicating an oscillating double bond as in benzene. I find these distances alternately larger and smaller, corresponding with fixed single and double bonds respectively. The inter-atomic distances which I find are not in complete agreement with his. Mr. Hughes's estimates of the intensity of X-ray reflections were made by eye and I cannot think this a sufficiently safe or accurate method for the purpose. My measurements were made by means of a Robinson photometer and put on an absolute scale by the accurate method of the ionisation chamber.

I. ELLIE KNAGGS.

Davy Faraday Laboratory,
Royal Institution, W.1.

[1] NATURE, **134**, 138; 1934.
[2] *Trans. Far. Soc.*, **30**, 826; 1934.
[3] *J. Chem. Phys.*, 1; 1935.

Spectra and Latent Energy in Flame Gases

IN a recent letter on the above subject, Prof. W. T. David[1] points out that after flame has travelled through an inflammable gaseous mixture, the gases remaining emit luminous (visible and ultra-violet) radiation for a considerable period of time if their temperature is kept up. In an investigation carried out at the United States Bureau of Standards, accounts of which have already appeared[2,3,4], evidence of prolonged emission in the infra-red was obtained from observations of flame in the cylinder of an engine delivering power.

Infra-red radiation (to about 11μ) was recorded from explosions in a small single cylinder L-head engine, through fluorite windows let into the engine head. The fuels used were benzole, and benzole blended with a low-grade petrol. Observations were made of a small depth of charge perpendicular to the direction of flame travel, so that radiation was successively recorded from unburned charge ahead of the flame front, from the flame front, and from gases remaining behind the flame front. Curves of radiation against crank angle were initially horizontal, rose sharply (at the instant visible flame appeared under the window in use) to a maximum, and then decreased gradually.

From gases under a window adjacent to the sparking plug, radiation from non-knocking explosions reached a maximum slightly before maximum pressure was recorded in the cylinder, and at the same instant visible flame appeared under another window, slightly more than 10 cm. away in the direction of flame travel. (This distance corresponded to 20°–25° of engine crank rotation.)

From gases in the 'knocking zone', radiation from non-knocking explosions continued to rise for 20° of crank angle after the arrival of visible flame: in knocking explosions visible flame arrived earlier, and a higher maximum radiation was reached, 15° later as against 20°. For both non-knocking and knocking explosions, maximum pressure in the cylinder preceded maximum radiation.

Later in the cycle, both radiation and pressure curves for knocking explosions were below those for non-knocking, indicating greater loss of energy from the charge involved in the knock.

The fact that radiation through a given window continued to rise for approximately 20° of crank angle after the arrival of flame under that window was taken as evidence that formation of H_2O and CO_2 molecules continued for at least this period, and probably longer, after inflammation. Some doubt was consequently expressed concerning the assumption, based on oxygen determinations at successive moments during the cycle, that combustion is completed in a narrow flame front[5].

It may be that, in an engine cylinder, some metastable H_2O and CO_2 molecules are formed, which then part with their latent energy, either communicating it to neighbouring molecules or emitting radiation on the wave-lengths characteristic of H_2O and CO_2. This would make it easier to reconcile the 20° lag between the appearance of flame and the attainment of maximum radiation in the infra-red, with the shorter period required for combustion to be completed in a narrow flame front. It is also possible that the phenomenon of fuel-knock may be connected with the proportion of metastable molecules formed during combustion.

SYDNEY STEELE.

7, Sefton Avenue,
Widnes, Lancs.
Dec. 9.

[1] NATURE, **134**, 663; 1934.
[2] Steele, NATURE, **128**, 185–6; 1931.
[3] Steele, *Ind. Eng. Chem.*, **25**, 388–93; 1933.
[4] Marvin, Caldwell and Steele, National Advisory Committee for Aeronautics, Technical Report No. 486; 1934.
[5] Withrow, Lovell and Boyd, *Ind. Eng. Chem.*, **22**, 945; 1930.

Diamagnetism of Light and Heavy Water

THE molecular diamagnetism of light water, 12·97, has been closely approached in the values hitherto published for heavy water: 12·90[1] and 12·76[2]. A coincidence has been observed in this department by J. H. Cruickshank, using a Curie-Chéneveau magnetic balance: the molecular diamagnetism of heavy water was $12{\cdot}96 \pm 0{\cdot}02$. Additional measurements

on light/heavy water mixtures, containing 44, 62 and 87 per cent of heavy water, showed strictly additive susceptibility. H_2O, D_2O and HDO therefore appear to have identical molecular diamagnetisms, and to have no influence on one another's magnetism.

J. H. Cruickshank, however, has carried out a more refined measurement, and noticed a peculiar lag in which appears an observable magnetic difference between the two waters. The change in susceptibility of freshly melted water, the temperature of which had been allowed to rise to that of the balance, 18° C., was followed over a period of 30 minutes after melting by continuously reading the deflexions. The readings gradually increased to a maximum at 20 minutes after melting, and then fell slightly to a constant value.

According to recent views[3,4], the state of co-ordination of water is such that the molecules are, for geometric reasons, held farther apart than they would be in a state of closest packing. Therefore, although the local effect of co-ordination is to lower the diamagnetism at the bonds, the volume effect prevents depression at other points and keeps the diamagnetism up. In ice, co-ordination is a maximum; in freshly melted water, there is a lag in deco-ordination shown by a continuous change in the susceptibility. This change is an increase to begin with, because the deco-ordination local effect (with its rise of diamagnetism) is predominant. Later, the corresponding volume effect (with its fall of diamagnetism) becomes more effective, as seen in the development of a maximum value.

In heavy water, both the increase in susceptibility to the maximum value and the subsequent fall to constant value are less than in light water, but take place in the same time. Deco-ordination in heavy water tends to take place less readily than in light; but the higher degree of co-ordination in the equilibrium state, and the accelerating effect on deco-ordination of the higher initial temperature, 3·8° C., counteract this tendency, with the result that equilibrium is reached in the same time as for light water. The rise to and the fall from the maximum susceptibility are less because the total loss of co-ordination required to reach equilibrium is less and thus there is less scope for display of lag.

It has been assumed that the temperature of the water rose to 18° C. before the observations were begun, but the rise in susceptibility due to a still rising temperature requires to be added to the rise in susceptibility due to the local effect of deco-ordination. This makes the rise to the maximum greater than the fall to the equilibrium.

During an ordinary determination of susceptibility, the lag described here escapes observation because it is finished long before the constant can be determined.

The same experiment was tried with benzene m.p. 5·4° and aniline m.p. −8°, but in neither case was a maximum observed, although it could be seen repeatedly with the waters.

FRANCIS W. GRAY.
JAMES H. CRUICKSHANK.
Department of Chemistry,
University, Aberdeen.
Dec. 17.

[1] Selwood and Frost, *J. Amer. Chem. Soc.*, **55**, 4335; 1933.
[2] Cabrera and Fahlenbrach, *Naturwissenschaften*, **22**, 417; 1934.
[3] Bernal and Fowler, *J. Chem. Phys.*, **1**, 515–548; 1933.
[4] R. H. Fowler, *Proc. Cam. Phil. Soc.*, **30**, 225–241; 1934.

Spectrum of Doubly Ionised Iodine

WORK on the identification of the lines belonging to this spectrum was begun more than four years ago and a preliminary announcement on a clue obtained which was expected to lead to an analysis of the spectrum was made at the time in these columns[1]. That clue, however, did not lead to the expected result, and had to be abandoned. Finally, it was realised that the only way of solution, though necessarily a very lengthy and tedious one, was to find all possible differences between the wave-numbers ascribed to this spectrum.

For this purpose the measurements made by Kerris[2] were used and, confining the frequency differences up to within about 15,500, nearly 35,000 subtractions were effected. From these has been sorted out what is believed to be a genuine regularity among 50 lines of the spectrum. The agreement among the various differences occurring in this intercombination is of the order of 0·2. This has led to the identification of most of the terms in the 6*s* and 6*p* levels and a few in the 5*d* level. The relative values of the terms are :—

6*p* level :	0, 68·5, 1731·0, 2790·7, 4851·0, 5071·4, 6587·1, 8193·7, 10965·2, 12988·9.
6*s* level :	28222·3, 29630·3, 29908·9, 30272·0, 30503·0, 32839·7, 35299·4.
5*d* level :	24618·6, 27004·7, 40686·6.

Details of the work up to date are being sent for publication in the *Indian Journal of Physics*.

J. B. SETH.
Physics Laboratory,
Government College, Lahore.
Dec. 24.

[1] NATURE, **127**, 165; 1931.
[2] *Z. Phys.*, **60**, 20; 1930.

'Viscacelle' as a Material for making Compensating Plates and Wedges for the Polarising Microscope

'VISCACELLE' (cellulose sheet manufactured by Messrs. Courtaulds by the viscose process and used extensively as a wrapping material) is birefringent. There seems little doubt that this property is due to a net orientation of the long cellulose molecules caused by the unidirectional tension to which the sheet is subjected while being 'spun'. Under this tension, the molecules may be expected to arrange themselves so that their length directions are parallel or nearly parallel to the direction of tension. This explanation is supported by the fact that the direction of tension (revealed on cut sheets by parallel streaks) is the 'slow' direction of vibration.

The accompanying table gives some relevant properties of specimens of different grades of 'Viscacelle' supplied by Messrs. Courtaulds. The relative retardations were deduced from the polarisation colours by means of Lévy's colour chart of birefringences.

Manufacturer's Classification	Thickness (mm.)	Polarisation Colour and Relative Retardation (mμ)
300 Ordinary, Grade 1	0·020 − 0·025	(3 layers) purplish red, *c.* 575
300 Ordinary, Grade 2	0·020 − 0·025	(3 layers) orange red, 450–480
400 Ordinary, Grade 1	0·025 − 0·030	(3 layers) bright blue, *c.* 650
600 Ordinary, Grade 1	0·040 − 0.045	(1 layer) pale yellow, 300–340 (2 layers) bright blue, *c.* 650
300 Moistureproof, Grade 1	0·020 − 0·025	(3 layers) bright blue, *c.* 650

The figures show that the thinnest specimens ("300" grades, 0·020–0·025 mm.) have, in single layers, relative retardations approaching, though in the main somewhat greater than that of the quarter-wave mica plate, and a strip of the material bound between two glass slips by means of pieces of gummed label can in fact be used as a satisfactory substitute for this accessory. Three layers of the "300 Ordinary" mounted in the same way can be used in place of the unit retardation selenite plate, whilst a step-wise pile of strips affords an alternative to the mica stepped wedge or quartz wedge. The colours given by such a wedge appear to be quite normal.

It must be emphasised that the figures in the table refer to particular specimens. However, I have examined a number of other specimens taken from proprietary articles without finding wide deviations, and it seems that the birefringence of the material may be taken as roughly constant for a given thickness. It may happen that several specimens of the "300" thickness have to be tried before one is found from which a sensitive red can be built up. It may be mentioned that the higher birefringence of the moistureproof sample (last in table) as compared with others of the same thickness is not connected with its protective coating, for when this was dissolved off with a mixture of acetone and ethyl acetate, no apparent decrease in the birefringence was observed.

I am indebted to Messrs. Courtaulds for supplying graded samples and for information concerning the manufacture and properties of the material.

N. H. HARTSHORNE.

University College,
Swansea.
Jan. 10.

Dimensions of Electric and Magnetic Units

IF in a recent letter[1] Sir James Henderson uses the word 'dimensions' in its customary sense of relation to the units of length, mass and time, he is arousing false hopes by suggesting the possibility of a 'discovery' of the dimensions of μ_0 and K_0, for these dimensions, and not merely the numerical values of the quantities, are both completely arbitrary, depending upon the units of measurement which may be selected.

It has indeed been proved that $A^2/\mu_0 K_0 = c^2$ where A is the quantity appearing in Ampère's equation and c is the velocity of propagation of electromagnetic waves in a vacuum, but it still remains true that μ_0 and K_0 may each be separately given any values whatever. In some systems of units which have been adopted or discussed, for example, in the Gaussian system, separate values have been assigned to each; in other systems, as in the 'electrostatic' and in the 'electromagnetic' system, a value has been assigned to either K_0 or μ_0 and the other obtained from it by an arbitrary assumption such as $A = 1$, while other recently discussed systems are founded upon the adoption of two independent arbitrary assumptions from which the values of K_0 and μ_0 can be deduced, but for purposes of measurement, as distinguished from historical or more or less sentimental considerations, a system depends only upon the values of K_0 and μ_0 characteristic of it and not at all upon the methods by which these values were finally reached.

It is true that the electronic theory asserts that a magnet is not merely equivalent to but identical with a certain system of electrons in motion, but the argument that this identity necessarily requires the adoption of a system of units in which $\mu_0 = 1$ or in which mL must be dimensionally equal to iL^2 is altogether unsound.

Sir James may readily convince himself of this by the examination of the following simple example. The modern form of the electronic theory obviously suggests the existence of a 'natural' system of electromagnetic measurement in which the unit of electric quantity will be the electron and the unit of magnetic moment will be the Bohr magneton. The 'natural' unit of current will be such that a current i will involve the net passage of i electrons per unit of time and the 'natural' unit of quantity of magnetism will be such that two equal and opposite quantities m of magnetism separated by one unit of length will have a magnetic moment of m magnetons. On this system it is obvious that mL is dimensionally a numeric while the dimensions of iL^2 are L^2/T, and it is easily deducible that the dimensions of K_0 are T^2/ML^3 and of μ_0, T^2/ML^5. The numerical values of these quantities will, of course, depend upon the units of length, mass and time adopted.

It is scarcely necessary to remark that the theoretical charms of such a 'natural' system are totally eclipsed by its practical inconveniences.

L. R. WILBERFORCE.

University of Liverpool.
Jan. 21.

[1] NATURE, **135**, 105; 1935.

Structure of the Caudal Fin of the Cod

WITH reference to Dr. Whitehouse's suggestion[1] that the caudal fin of the cod is of a normal homocercal type, may I state that I have just completed a study of the development of this fin, as a result of which I can affirm that, while it certainly preserves indications of its homocercal origin, it would be misleading to apply the term 'homocercal' to it in its present form.

Whereas in the homocercal fin practically the whole of the web is supported by morphologically ventral skeletal elements belonging to the hypochordal lobe, in the Gadoid fin the upper half of the web is supported by morphologically dorsal elements which arise in a dorsal fin fold, this growing back to fuse with a corresponding ventral fin fold and thus form the symmetrical web. Now Agassiz[2] long ago showed that, because the homocercal fin developed as an exaggeration of heterocercy, the terminal 'axial lobe' of the embryonic caudal fin (in which is included the tip of the notochord) forms a small dorsal lobe to the developing definitive fin. He was, however, unable to find this lobe in the cod, as can be well understood from my own observations, which show that it is suppressed between the developing dorsal and ventral components of the fin; it is here, in other words, medial rather than dorsal in position.

For this and other reasons the term 'pseudocaudal' appears to me to be the most satisfactory designation for the Gadoid fin. A full report and discussion of my results will be published elsewhere.

E. J. W. BARRINGTON.

Department of Zoology,
University College,
Nottingham.
Jan. 14.

[1] NATURE, **135**, 70, January 12, 1935.
[2] *Proc. Amer. Acad.*, **13**; 1877.

Evolution and Human Origins

MY attention has been directed to the leading article in the issue of NATURE of January 26 in which criticisms are made on an address by me to the Victoria Institute recently. I have no desire to enter into further written controversy on the subject just at present, and you might probably be unable in any case to afford space for it in the pages of NATURE. If, however, no notice were taken of the objections urged, it might be considered that silence gave consent or that no answer is possible. I beg therefore by your courtesy to say that when, as seems probable, a new edition of the address is published, careful consideration will be given to the arguments in your leading article and such counter-arguments or replies presented as are necessary or possible. This will probably be a more convenient way of dealing with them than extending the controversy at the present time in the pages of your valued periodical.

Sidmouth, South Devon. AMBROSE FLEMING.
Feb. 3.

More Work for the R.S.P.C.A.

MUCH satisfaction must have been felt by lovers of the lower animals in reading the review in NATURE of February 2 (p. 164) of the work accomplished by the R.S.P.C.A. since its foundation in 1824. It encourages one to hope that the Society will delay no longer in pressing for prohibition of the cruel practice of docking the tails of horses.

It is not likely that any serious opposition would be offered to such legislation as may be necessary to render docking a penal offence. Something might be accomplished if horses mutilated and disfigured in this senseless manner were disqualified as prize-winners in the show ring; but that would not act as universal prohibition. One has but to watch horses thus mutilated when turned out to grass in summer to realise what they suffer from swarms of flies.

Fortunately, the practice of docking is not nearly so general as it used to be. During the Peninsular War, the Duke of Wellington required all cavalry chargers to be so treated in order that they might be distinguished from those in the French army. At the present time, however, the horses of British cavalry and those in all racing and most hunting establishments are not docked; but many farm horses and trotting cobs are still subject to the removal of some of their lower vertebræ.

HERBERT MAXWELL.

Monreith.

Points from Foregoing Letters

THE behaviour of liquid helium indicates that it exists in two forms, helium I and helium II. Their viscosities have been determined in Prof. E. F. Burton's laboratory at Toronto. It appears that when helium I, which is formed at 4·2° K, is further cooled, it becomes more viscous down to 2·3° K; at 2·2° K the liquid suddenly becomes more fluid as it changes into helium II.

Thin layers of carbonaceous fossil plants such as are present in coal, while opaque to ordinary light, allow the passage of infra-red radiation. Prof. John Walton submits photographs of a fossil plant taken in red and infra-red light, the latter showing marked internal structure.

It has been suggested that γ-radiation may be changed into positive electrons and vice versa. Dr. E. J. Williams finds that very thin lead foils (about 0·002 cm. thick), when irradiated with γ-rays from thorium C″, yield less than the calculated amount of secondary γ-rays. This he interprets as evidence that the positive electrons produced by the original γ-rays escape from the lead-foils before they are 'annihilated' and changed into the softer secondary γ-rays. The more penetrating γ-rays scattered by lead-foil are ascribed to γ-radiation from recoil electrons and to the annihilation of positive electrons before reaching the end of their journey.

Colchicine, the active substance from the seeds and corm of the meadow saffron, hitherto used in the treatment of gout, has been found by Dr. E. C. Amoroso to be effective in treating a spontaneous tumour in a dog. Dr. Amoroso also states that colchicine has effected the regression of tumours transplanted on mice.

Prof. B. C. P. Jansen supports Kuhn's claim that lactoflavine is identical with the originally described vitamin B_2, since both have identical effects on dogs and rats and are rendered inactive by exposure to sunlight. Prof. Jansen advocates the use of descriptive names instead of letters to indicate the various vitamins.

Prof. W. T. David has put forward the view that 'metastable molecules' account for the after-glow of gases following upon an explosive reaction. Dr. S. Steele recalls previous observations showing prolonged emission of infra-red radiation during the explosive reactions which take place in a combustion engine. He suggests that in an engine cylinder some metastable H_2O and CO_2 molecules may be formed.

The magnetic susceptibility of freshly melted water increases during the first twenty minutes and then falls to a constant level. This is explained by Dr. F. W. Gray and Mr. J. H. Cruickshank as due to the lag in the rearrangement of the water molecules (each molecule of H_2O is surrounded by four others in a more or less tetrahedron fashion; this arrangement is somewhat different in ice and in water). With heavy water a similar but less pronounced change with time is observed.

Dr. N. H. Hartshorne directs attention to the fact that transparent cellulose sheets behave towards light in a manner similar to that of crystals of mica, selenite and quartz, and in appropriate thicknesses may be substituted for them in making compensating plates and wedges for the polarising microscope.

Commenting on a letter from Sir James Henderson, Prof. Wilberforce shows that the accepted theory of the identity between magnetic phenomena and electronic motion does not establish, as a necessary deduction, the equations $\mu_0 = 1$, $K_0 = 1/c^2$, but on the contrary suggests a different 'natural' system of electromagnetic measurement attractive in theory but inconvenient in practice. The theory of dimensions has often been useful in deducing new physical laws.

Research Items

The Bones of Comenius. Very shortly after the death of the great Czech scholar, John Amos Comenius, in Holland in 1670, his fame, and even his last resting place were forgotten owing to disturbed conditions both in his native land and in Holland. In the earlier part of the nineteenth century his memory was revived; but notwithstanding an abortive attempt to fix the site of his grave in 1871, it was only after the close of the War that the Czechoslovakian Government was able to make arrangements with the Dutch authorities for the disinterment of his remains. This was made possible by the discovery of the register recording his interment in November 1670, not in the 'great church' of Naarden, as had previously been thought, but in the 'Walloon' church. This edifice, after a varied history, had long been occupied as a military barracks. The records showed that the body of Comenius had been deposited in a 'common' grave, in which two further interments had followed after considerable intervals. Largely owing to the interest of Mr. R. J. Vonka, of the Czechoslovakian Legation, and Dr. R. A. B. Oosterhuis, of Amsterdam, this grave was identified and one of the three skeletons provisionally identified by its position and general condition as that of the great scholar. The remains have been examined and measured in detail by Prof. A. J. P. van den Brock and Prof. J. Matiegka, who after a close comparison with portraits of Comenius and such information as is available, pronounce the identification to be in all probability well founded. The skull is hyperbrachycephalic (cephalic index of 89·71), hypsicephalic (vertical index 77·64), eurymetopic and mesoprosopic. The orbits are large and the nose thin. The form and dimensions of the skull, in fact, are such as are frequently encountered in Czechoslovakia. Among the more noteworthy features are the breadth of forehead and the fact that, notwithstanding the age of the subject at the time of death, the sutures of the skull had not closed. The discovery of the remains and their character and method of identification are described in *Anthropologica* (Académie Tchèque des Sciences et des Arts, Prague, IIme Classe, 1933, just received).

Prehistoric Rock Paintings in Abyssinia. The Abbé Breuil describes in *L'Anthropologie* (44, No. 5–6) a number of rock-paintings in the Harrar (Abyssinia) which he examined in 1933, when Dr. Paul Weinert was engaged in the excavation of the palæolithic cave of Porc-Epic at Diré-Daoua. One series of paintings was in the cave and a second was on a rock discovered by P. Azais at Sourré, sixty kilometres from Diré-Daoua. The cave of Porc-Epic is situated at the top of a cliff about 200 metres above the right bank of the River Diré-Daoua. Its deposits, separated by two thin layers of stalagmite, belong to mesolithic and upper palæolithic cultures analogous to those of Kenya and South Africa. In the upper and middle deposits, moustero-solutro-aurignacian implements are associated with geometrical microliths and a coarse pottery. On the right wall are a number of drawings, all more or less schematic, which are partly covered by deposits and, consequently, are older than the more recent stalagmite. The figures are highly conventionalised and, therefore, difficult of identification. Approximately, however, a list can be established which includes twenty human figures comparable to the most schematic of southern Spain, one elephant, one lion, two carnivores with pointed muzzle and ears, thirteen antelopes, three Bovidæ, etc. Nearly all are in bright red, but there are the remains of earlier figures in yellow ochre and a reddy-brown. The only remarkable figure is that of a stag, which is compared with a similar figure from Zara-Brouk (Addiet). The paintings on the rock at Sourré are of varied dating, distinguishable by the superpositions. They fall into eight classes which belong to two main periods, the five earlier stages being naturalistic, while of the later three, two are schematic phases united by a period of transition. There is a hunting scene, but all the remaining figures are of a pastoral character. They recall pre- and proto-dynastic Egypt. The identification of certain of the Bovidæ raises an interesting point bearing on the domestication of these animals.

Mitogenetic Radiation. The announcement, twelve years ago, by Gurwitsch, of the emission of radiations from rapidly growing tissues, occasioned no little interest and even surprise in biological circles, coming as it did from a histologist with so high a reputation. Many have been the attempts to repeat his observations, but the results of succeeding investigators have yielded positive and negative results as consistently as the tossing of a coin. Dr. J. B. Bateman has rendered valuable service to biological workers in carrying out a critical survey of the literature of the last dozen years dealing with this subject ("Mitogenetic Radiation", *Biol. Rev.*, **10**, 1, 42; 1935). The weight of the evidence tends slightly against the existence of such a phenomenon, and there is no ground at all to support the view that mitogenetic radiations, if they exist at all, have anything to do with ultra-violet radiation.

Statistics of Variations. Dr. Hans Günther has recently published a little book which serves as a short but useful introduction to the statistics of variation ("Die Variabilität der Organismen und ihre Normgrenzen". Pp. 132. Leipzig: Thieme, 1935). It is divided into fourteen sections, some of which may be mentioned as indicating its scope and character: the causes and categories of variation, statistical and biometrical methods, the conception of the norm and of the abnormal, the limits of variation and of the norm, various types of biological statistical analysis, and special methods for the comparison of variations, as between, for example, races, populations, the sexes, the right and left halves of the body and different stages of development. Various general questions regarding the nature and limits of variations are discussed.

Lamellibranchs and a Cruciform Muscle. Mr. Alastair Graham, following up his recent investigations of the cruciform muscle of certain Lamellibranchs (NATURE, Sept. 29, 1934, p. 500), has compared in detail the anatomy of five bivalves belonging to the Tellinacea, *Gari tellineella*, *Tellina crassa*, *Macoma balthica*, *Scrobicularia plana* and *Donax vittatus* together with *Cultellus pollucidus* as typical of the Solenidæ, and *Solecurtus scopula* and *S. chamosolen* as representing the *Solecurtidæ* (*Proc. Roy. Soc. Edin.*, **54** (2), No.

15, 1934). The result of this work, as was foreshadowed in the previous paper, shows that the Solecurtidæ should be classified with the Tellinacea rather than with the Solenidæ. The Solecurtidæ, in common with the Tellinacea, possess a cruciform muscle and in many other respects resemble that group, whereas in the Solenidæ the cruciform muscle is absent. The Solecurtidæ have, however, several features which are characteristic of the Solenidæ and there appears to be an undoubted relationship. As the author suggests, "the Solecurtidæ are to be regarded as a group of Lamellibranchs linking the Tellinacea with the Solenacea, but themselves retaining many more primitive features than do the Solenacea, and therefore falling themselves into the former group". The Solenidæ probably separated from the ancestral forms of the Solecurtidæ and the other Tellinacea before the evolution of a cruciform muscle had taken place, and since their separation have evolved along a well-defined line of their own. It is an interesting fact and one not easily explained that in the two estuarine species of the Tellinacea, *Macoma balthica* and *Scrobicularia plana*, the length of the intestine has become greatly elongated by coiling.

New Fresh-Water Mollusca. Mr. Alan Mozley has described several new fresh-water molluscs from northern Asia (*Smithsonian Miscellaneous Collections*, **92**, No. 2; 1934). These were collected during a journey made in the years 1932 and 1933 through certain parts of Siberia and northern Kazakstan, the object of the expedition being to investigate the molluscan fauna of the region. The new species are all very like known British forms, a *Valvata*, a *Lymnaea*, a *Planorbis* and a *Physa*, and there are three new sub-species of *Lymnaea* (*Galba*) *palustris* described. The descriptions are of the shells alone, in some cases at least, only dead shells being obtained. *Valvata antiquilina*, n.sp., from Lake Khomotenoze, apparently lived at some former time when the water-level stood considerably higher than at present. *Limnaea palustris sandalensis*, n.subsp., comes from a small somewhat saline lake on the Steppe Sari Dala, south-west of Pavlodar, northern Kazakstan. Although distinguishable, these four sub-species resemble one another closely.

Tortrix Moth Pests of Fruit Trees. Messrs. G. L. Hey, of the Murphy Chemical Company, and F. J. D. Thomas, of the East Malling Research Station, have recently published an account of their investigations into the biology of *Cacœcia* (*Tortrix*) *podana*, Scop. (*J. Pomol. and Hort. Sci.*, 12, No. 4, pp. 293–310, December, 1934). The paper is the first of a series which is intended to include descriptions of a considerable number of Tortricidæ which infest fruit trees in Britain. *C. podana* was first described in 1854, and is now distributed throughout Europe, though it has not yet reached the United States. Characters of the larva in all its seven instars are described in the paper under review, and its depredations in each stage are considered. The pupa and mature insect receive shorter treatment. An extensive list of host plants, and a graphic description of damage done, give an idea of the economic significance of the pest. Methods of control depend upon the host plant. Larvæ can be removed from rhododendrons by spraying with lead arsenate, while this wash has little effect on the pest as it occurs on fruit trees, where the method of feeding is different. Traps placed around a bright light at night exterminate considerable numbers of mature moths, and several parasites of the larva are known.

A Wilt of Snapdragons. A serious disease of snapdragons recently occurred near Pretoria, South Africa. It was very swift in its action, for affected plants were often apparently healthy one day, and permanently wilted the next. The young roots and the base of the stem rotted and were frequently discoloured. The cause of this troublesome malady was investigated by Dr. Margaretha G. Mes ("A Wilt of Snapdragon, *Antirrhinum majus*, in South Africa", *S.A. J. Sci.*, **31**, pp. 281–287, Nov. 1934). Two fungi were isolated from diseased tissues, one belonging to the genus *Phytophthora*, and the other to *Fusarium*, but infection experiments demonstrated that the former was the real pathogen. *Fusarium* was, however, responsible for discoloration of wilted plants. The disease-producing organism was identified as *Phytophthora pini*, var. *antirrhini*, but appears to have been classified also as a form of *P. cactorum*. Zoospores have been demonstrated, and the antheridia and oogonia are typical of the genus.

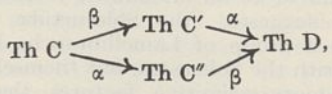
Vernalisation. Since the publication of Bulletin No. 9 on vernalisation by the Herbage Bureau, Aberystwyth, research on the subject has been proceeding rapidly in the U.S.S.R. The many conflicting statements that have appeared in the scientific and popular literature, however, have made it desirable that an authoritative account of the subject should be given, and the Bureau, with the collaboration of Prof. N. A. Maximov, of the Institute of Grain Husbandry, Saratov, U.S.S.R., has issued a further publication, "The Theoretical Significance of Vernalization" as Bulletin No. 16 in the Herbage Publication Series (Aberystwyth: Imp. Bur. Plant Genetics, 2*s*. 6*d*.). Since the discovery that by subjecting partially soaked seed to low temperatures, winter varieties of cereals could acquire the properties of spring varieties, that is, yield the same summer, the investigations have been extended to other types of plants. In the case of soy bean and cotton, vernalisation is effected by exposure of soaked seed to sufficiently high temperatures, after which fruit is formed successfully, even if subsequent temperatures would normally be too low. On the theoretical side, Lysenko's views are discussed in full, the most important of which seems to be that growth and development are essentially different phenomena. The plant, although in an apparently dormant condition, may be undergoing transitional developmental processes which can be profoundly affected by external conditions. Changes in the nature of the plant's composition are also brought about by vernalisation, both the colloidal properties of the protoplasm and the staining reaction of the embryonic tissue being altered after treatment. The first idea, that vernalisation actually accelerated plant development, is now regarded as needing modification. The truer interpretation seems to be that part of the growth period, which normally takes place in the field, can be transferred back to the early germination stages. The question as to whether or not vernalisation is an irreversible process is still a debatable point.

Recent Changes of Level in Japan. In the latest number of its *Bulletin* (**12**, 851–860; 1934), the Earthquake Research Institute has issued a valuable series of plates that illustrate recent changes of level

in Japan. During the last two years, a new line of precise levels has been carried out along the route bordering the east coast from near Tokyo northwards to Kamaisi and thence across the Main Island to Akita. Throughout the whole course of more than 350 miles, the crust since the last surveys (usually made between 1894 and 1900) has, with a few small exceptions, subsided. The principal movements are described by Messrs. T. Terada and N. Miyabe (*Tokyo Imp. Acad. Proc.*, **10**, 557–560; 1934). They consist of V-shaped depressions, one of which, about 100 miles north-north-east of Tokyo, has reached a depth of 32 in. in about thirty-six years. It lies in a line with the valley of the River Natui, a zone of frequent earthquakes. Another, of about 6 in. in thirty-four years, occurs on the cross-country route about 36 miles south-east of Akita. Some miles nearer the latter town, the curve of depression shows a marked break where it crosses the fault associated with the severe earthquake of March 15, 1914.

The Oxygen Afterglow. E. M. Stoddart (*Proc. Roy. Soc.*, A, Dec. 1, 1934) has investigated the afterglow obtained in oxygen, both in electrodeless high-frequency discharges and in discharges between aluminium electrodes. Pure oxygen showed no afterglow with electrodeless excitation, whether or not the surfaces of the tube were 'poisoned' with water vapour. This poisoning had been found by former workers to be necessary for the afterglow. No afterglow was produced by the addition of various other gases including nitrogen. With the electrode discharge, no afterglow was found with pure oxygen, but the addition of a little nitrogen produced a powerful afterglow. By connecting the tube with a trap cooled in a carbon dioxide freezing mixture, nitric oxide was shown to play a part in the afterglow. The afterglow gradually disappeared and nitrogen peroxide could be recovered from the cooled trap. No nitrogen peroxide was found in the electrodeless discharges. A spectral examination of the afterglow showed weak diffuse bands which are not oxygen bands. The author concludes that nitric oxide is formed by a process involving the metal electrodes in the tube, and that the emitter is the same as is present in the chemi-luminescence of nitric oxide and ozone.

The Limits of the Continuous β-Ray Spectrum. H. O. W. Richardson has recently discussed the low energy β-rays of radium E and W. J. Henderson has investigated the high energy limit of the β-rays from thorium C and C″ (*Proc. Roy. Soc.*, A, Dec. 1). The deposit of radium E was made on a thin aluminium foil and was placed in a Wilson expansion chamber. The energies of the electrons were deduced from their range, and in evaluating the distribution, corrections were made to allow for the loss of the ends of tracks by passing out of the illuminated field and in other ways. A number of the tracks observed are of secondary origin, but there is some evidence of a low energy group of β-rays from radium E. The paper by W. J. Henderson describes an analysis of fast γ-rays from thorium C and C″, using the semicircular magnetic focusing method with a pair of Geiger-Müller counters as a detector. The counters are mounted so that a β-ray passes through both counters, which are separated by a thin mica sheet. Only coincident discharges of the counters are recorded, and this method reduces by a factor of 25 the effect of the γ-rays from the source, which would otherwise mask the β-rays completely in spite of the lead screening. The distribution curves for the sources of thorium B + C + C″ slope steeply down to an end point at $2{\cdot}25 \times 10^6$ volts, while those for the sources of thorium C″ prepared pure by recoil have an end point at $1{\cdot}795 \times 10^6$ volts. Beyond these limits there is a slight background and a line at Hρ 10,280 known to arise from thorium C″. The experiments show that in the two alternative modes of decay of thorium C,



the maximum energies by the two paths balance exactly. This is in accordance with the theoretical suggestions of Ellis and Mott, according to which the maximum energy of the β-rays represents the difference in binding energies between the parent and product nuclei. The energy missing when a β-particle of lower energy is emitted has not yet been traced.

Magnetic Properties of Bivalent Samarium. Although bivalent samarium compounds have been reported as non-existent, P. W. Selwood (*J. Amer. Chem. Soc.*, **56**, 2392; 1934) has prepared the dibromide by heating the tribromide in hydrogen and has measured its magnetic susceptibility. This is found, at various temperatures between about 100° and 400° abs., to be almost the same as that of tervalent europium. This is the result which would be anticipated from the Sommerfeld-Kossel rule, which states that ions with equal numbers of electrons often have very similar properties. The arrangement of electrons in tervalent europium is (from the $4f$ shell outwards) $4f^6 5s^2 5p^6$. In bivalent samarium it is probably the $6s$ and one of the $5d$ electrons which are lost, $4f^5 5s^2 5p^6 5d (^2 6s)$. The remaining $5d$ electron, however, migrates to the $4f$ shell, thus producing a configuration identical with that of tervalent europium. The result is of added interest because both samarium and europium have anomalous temperature coefficients of magnetic susceptibility. A previously reported discrepancy in the susceptibilities of the compounds Sm_2O_3 and $SmBr_3$, of tervalent samarium, was not found.

Atomic Weight of Protactinium. A specimen of protactinium oxide which showed no impurities by the X-ray method has been prepared and utilised in the determination of the atomic weight of protactinium (A. V. Grosse, *J. Amer. Chem. Soc.*, **56**, 2501; 1934). Potassium protactinium fluoride, K_2PaF_7, crystallises in beautiful colourless needles, can be dried to constant weight, and can be reconverted into the oxide by treating with sulphuric acid, diluting, precipitating with ammonia and igniting. In two determinations, 0·091907 gm. and 0·070047 gm. of K_2PaF_7 gave, respectively, 0·056274 gm. and 0·042913 gm. of Pa_2O_5. The atomic weights of protactinium calculated are 230·4 and 230·8, the mean value, 230·6 or 231 ± 0·5, being in good agreement with Aston's mass-spectrograph results on actinium lead (AcD = 207). The compound $PaCl_5$, discovered by Grosse (*J. Amer. Chem. Soc.*, **56**, 2200; 1934), might be more suitable for the precision atomic weight determination planned, but larger quantities of protactinium (which is now available for use in ordinary chemical manipulations) are desirable.

Chlorophyll

THE green colouring matter of plants is a wax-like material of complex chemical structure to which the name chlorophyll was given by Pelletier and Caventou in 1817. It is insoluble in water but soluble in alcohol, ether and other organic solvents. Early investigations of chlorophyll which are important are those of Brewster and Stokes, on the absorption spectrum and fluorescence, and of Edward Schunck on the chemical side. Schunck studied particularly the action of acids on chlorophyll and found that important changes in its physical and chemical properties resulted. The first really fundamental investigations on the chemical structure of chlorophyll were those of Willstätter and his collaborators[1] which showed that there are two green pigments present in leaf-green, namely, chlorophyll-*a*, with the formula $C_{55}H_{72}O_5N_4Mg$, a bluish-black solid giving greenish-blue solutions; and chlorophyll-*b*, a greenish-black solid giving pure green solutions.

On hydrolysis, chlorophyll yields an alcohol, phytol, $C_{20}H_{40}O$, which has been synthesised, and a complex containing four pyrrole nuclei, the composition of which has been determined by examining the decomposition products phytochlorin-*e* from chlorophyll-*a* and phytorhodin-*g* from chlorophyll-*b*, these two substances being usually called now chlorin-*e* and rhodin-*g*. By the action of acids on chlorophyll, a product free from magnesium, called phæophytin, is obtained, separable into two components, *a* and *b*. This in its turn, on treatment with hydrochloric acid, yields two phæophorbides, *a* and *b*. By the further degradation of chlorophyll and its derivatives many products are obtained, known as porphyrins.

Since Willstätter's pioneer work, the investigation of chlorophyll and its derivates has been continued mainly by Hans Fischer[2], who has carried out some important syntheses, and by J. B. Conant[3], and their collaborators. The results obtained by these two groups of investigators sometimes differ in points of detail[4]. The present article has the object merely of recording some recent new work on the subject, the present position of which must be sought in the sources given in the references.

A method which has been used in attempts to determine the relations between different substances is hydrogenation. Dietz and Werner[5] now propose to discard this method as leading to very puzzling results difficult to reconcile with other reactions of the substances. Thus, two porphyrins which appear to be isomeric, rhodoporphyrin and isorhodoporphyrin, differ by 0·8–1·2 molecules of hydrogen absorbed, whilst they are interconvertible in 50 per cent sulphuric acid at room temperature. Transformation also occurs slowly in cold concentrated hydrochloric acid and more rapidly in glacial acetic acid with dry hydrogen bromide. If the difference in hydrogen absorption is regarded as indicating a difference in hydrogen content, the acid transformations must be reductions, which seems very unlikely.

The hydrogenation results show only a small difference between the chlorins and true porphyrins. If these results are accepted, chlorophyll and the chlorins are to be regarded as dihydroisoporphyrins in basic structure and also isomeric with true porphyrins, as Fischer postulates. The American workers, however, while continuing to assume that the fundamental nucleus of chlorophyll and the chlorins is that of a dihydroisoporphyrin, postulate that it is also that of a dihydroporphyrin, these being of an equal state of hydrogenation.

A very interesting new method of attack has now been developed by Conant, Chow and Dietz[6], namely the potentiometric titration in acetic acid solution of the basic groups in chlorophyll derivatives. The chlorophyll nucleus and those of its derivatives contain four pyrrole or modified pyrrole rings. An important problem in connexion with the fine structure of the nucleus is the determination of the relative basicities of the four pyrrole nitrogen atoms, which add together to determine the basic character of the whole molecule. Willstätter had utilised the variation in basicity in the chlorophyll series in the method of acid fractionation, which made possible the separation of chlorophyll derivatives in solution, and had also obtained qualitative evidence of the greater basicity of two of the nitrogen atoms by the isolation of dihydrochlorides.

Conant and his collaborators have now supplied quantitative evidence on this problem by a series of potentiometric titrations in glacial acetic acid using a chloranil electrode and perchloric acid as titrating agent, a method which had previously been studied[7]. This electrode makes use of an oxidation-reduction system similar to that in the quinhydrone electrode. Chloranil and its reduction product provide the system in equilibrium with hydrion:

$$C_6Cl_4O_2 + 2H^+ \rightleftharpoons C_6Cl_4(OH)_2 + 2\oplus,$$

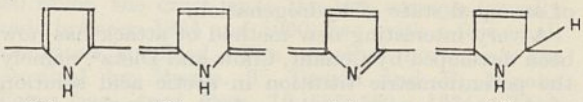
and a *p*H scale can thus be derived from it. When the solvent is glacial acetic acid, this *p*H scale will not, of course, be related directly to the standard hydrion activity as defined for aqueous solutions, but it may be defined in terms of an acidity function by a method discussed by the authors. For comparative purposes this is a secondary consideration, and the values of *p*H in acetic acid may be calculated by a formula similar to that used for the quinhydrone electrode in aqueous solutions, a particular value being taken for the standard potential. If the reaction between chlorophyll base (B) and acid proton (H^+) is formulated as $B + H^+ \rightleftharpoons BH^+$, the value of pK^1, the dissociation constant of the chlorophyll base, will then be given by:

$$pK^1 = p\mathrm{H} + \log (BH^+)/(B)$$

in which all symbols refer to the acetic acid solutions. The ionic strength of the solution (which influences the activity coefficients of the solutes) was kept constant at $\mu = 0{\cdot}2$ by adding the required amounts of the neutral salt trimethylammonium perchlorate. The values of pK^1_1, pK^1_2 and pK^1_3, for the dissociation of the first, second and third basic groups, corresponding to titration mid-points for each range, were read directly from the titration curves at added aliquots of 0·5, 1·5 and 2·5 mols of titrating agent, in accordance with the usual *approximate* theory for calculating *pK* from the *p*H titration values.

In this way, the values of pK^1 for a series of simple nitrogen compounds (positively and negatively substituted pyrroles, a dipyrrylmethane, two *N*-methyl methanes and a methylethylmaleic imide) were first determined. These are all about $-2{\cdot}3 \pm 0{\cdot}3$, indicating that the pyrrole group is a very weak base. If pyrrole is regarded as a substituted ammonia, the two α, β-unsaturated linkages appear to control the

diminution in basic character of the ammonia nitrogen. All the chlorophyll derivatives examined contain at least one and possibly two of the very weakly basic groups (*a*) or (*b*) :



(*a*) pyrrole (*b*) isopyrrole (*c*) pyrrolenine (*d*) hydropyrrole

and they gave pK_3^1 values of $-1{\cdot}9$ to $-2{\cdot}4$.

With very few exceptions, all these compounds also contain one rather strongly basic group with a pK_1^1 value of $+1{\cdot}8$ to $+2{\cdot}3$, which, as titrations of two methenes indicated, was probably the oxidised pyrrole or pyrrolenine ring (*c*), having one α,β-unsaturated linkage and a tertiary nitrogen atom. Pyridine has also a pK^1 value of $+2{\cdot}93$, which is the lower limit of basic strength in the glacial acetic acid system. This system gives satisfactory results for basic strengths of compounds such as urea, which have pK in water of about zero, and compounds so weakly basic (for example, acetanilide and acetamide) that they cannot be measured in water.

The porphyrins stand out as a group from all other chlorophyll derivatives in containing *two* relatively strong basic groups, of average pK^1 of $+2{\cdot}5$. The chlorins are differentiated from the porphyrins in having only *one* relatively strongly basic group, with $pK^1 = +2{\cdot}1$, and one group intermediate in basicity between the pyrrole and pyrrolenine groups, possibly an oxidation or reduction product of the latter in which the character of the nitrogen atom is changed. The basicity of this group is influenced by substituent groups and is comparable with the basicity of urea and acetoxime. This result leads to a correction of a previous formula for chlorin *f*, which is now supposed to contain a hydropyrrole nucleus (*d*) in place of one of the two pyrrolenine rings previously assumed by Conant.

The true chlorophyll-*a* compounds, the phæophorbides, are found to contain one relatively strongly basic and one very weakly basic group, as in the chlorins. The intermediate group, however, is less basic than in the chlorins ; but whether this difference is significant of a radically different structure is difficult to say. In the *b* series, rhodin-*l* is the simplest compound and corresponds with chlorin-*f* in the *a* series. The two basic groups in rhodin-*l* are weaker than in the *a* series, but rhodin-*g* is very similar to chlorin-*e*. Methyl phæophorbide-*b* is markedly different from the *a* compound in the relatively strongly basic group. It appears that the extra oxygen atom in the *b* series affects the basicity of all the compounds, which would be unlikely if it were in the side chain of the propionic acid group, as postulated by Fischer.

The interpretation of the results of the new potentiometric titration experiments is still incomplete and rather tentative ; but it is clear that the method promises to throw light on the structure of compounds containing basic groups, and its extension from the chlorophylls and porphyrins into other fields is obvious.

[1] Summarised in R. Willstätter and A. Stoll, "Untersuchungen über Chlorophyll", Berlin, 1913.
[2] Pedler Lecture, *J. Chem. Soc.*, 245 ; 1934.
[3] Many papers in *J. Amer. Chem. Soc.*, 1929 to date.
[4] Critical summary of the literature by K. F. Armstrong, *Chemistry and Industry*, 809 ; 1933.
[5] E. M. Dietz and T. H. Werner, *J. Amer. Chem. Soc.*, **56**, 2180 ; 1934.
[6] J. B. Conant, B. F. Chow and E. M. Dietz, *J. Amer. Chem. Soc.*, **56**, 2185 ; 1934.
[7] J. B. Conant and T. H. Werner, *J. Amer. Chem. Soc.*, **52**, 4436 ; 1930 ; J. B. Conant and B. F. Chow, *ibid.*, **55**, 3745 ; 1933.

Fuel Research in Great Britain*

THE work of the Fuel Research Board touches many aspects of the technology of fuel, and the annual report for the year ending March 1934 therefore provides a useful review of the problems before the coal and other fuel industries.

In the first place, the report emphasises the steady accumulation of information by the survey of the coalfields of Great Britain, the value of which becomes increasingly evident as the demands on the properties of fuel become more exacting.

Reference is made to the fall in demand for large lump coal in recent years. Formerly, collieries made great efforts to avoid breaking coal because the consumer was prepared to pay, for size, a premium which was disproportionate to the calorific value of the coal itself. Actually the consumer paid his premium for a fuel the cleanness of which was visible to the eye. Now more than 77 million tons of coal is washed and its quality can be guaranteed, irrespective of size. Industrial fuel is nearly always wanted in small pieces, especially when firing is automatic. The modern house has little room for storage, and the householder wishes to avoid the trouble and dirt of breaking coal. One can foresee a time when the large lumps will become unsaleable, and already some collieries are seeking the best and most efficient manner of breaking down lump coal without the undue formation of dust. Many difficult problems arise when coals are broken, such as the best treatment of wash water containing dust, and the staff of the Fuel Research Board is engaged on their examination.

A section of the report deals with the liquid fuels from coal. A small fraction of the needs of Great Britain is covered by the by-products of coal carbonisation, that is, benzole and coal tar oils. Most of the liquid fuel is imported from distant parts where Nature has provided a bounteous though, from our point of view, ill-placed supply of oil. The geographical distribution of petroleum provides food for speculation as to what the distribution of man might have been had he known of the existence of the oil earlier, or had understood how to obtain, control and distribute the natural gas which accompanies oil in such abundance. Industries might have been very differently situated, and it is improbable that men would have toiled against the hazards of coal-getting if such an ideal fuel as methane were available without effort. Even as it is, Governments all over the world are exerting themselves to turn solid into liquid fuels by processes which are technically speaking heroic but, judged by ordinary standards, uneconomic. The studies of the Fuel

* Department of Scientific and Industrial Research. Report of the Fuel Research Board for the Year ended 31st March 1934, with Report of the Director of Fuel Research. Pp. vii+178. (London : H.M. Stationery Office, 1934.) 3*s*. net.

Research Board on this problem are interesting because so much of the experience in this field is in private hands.

It is shown that a large proportion of coal tars—indeed practically the whole of a low temperature tar—can be hydrogenated to first-class motor spirit, and a larger plant for this purpose is being erected. As regards the hydrogenation of coal itself, the influence of minor inorganic ingredients is receiving special attention. Lubricants are not less important than the fuels and it is found that although some are obtainable from coal products, they are not yet suitable for common use.

Considerable attention is being given to the use of pulverised fuel at sea. The 'grid' burner for pulverised fuel devised at the Fuel Research Station is now in commercial use. Favourable reports are received of the use of pulverised fuel with this burner, and it is claimed to be, in general operation, equal to oil firing in similar furnaces, but more economical both thermally and in cost.

A new feature is the appointment of a 'scientific panel' of academic chemists, who are to engage upon more academic investigation bearing on fuel processes. The Board is also giving financial support, but unfortunately on a scale reduced in 1931, to other investigations in university laboratories. H. J. H.

University and Educational Intelligence

CAMBRIDGE.—R. I. N. Greaves, of Clare College, has been appointed University demonstrator in pathology. Dr. J. D. Boyd, of the Queen's University, Belfast, and R. S. Handley, of Gonville and Caius College, have been appointed University demonstrators in anatomy.

THE University Catholic Societies in Great Britain, twenty-three in number, are federated in an organisation which is linked with other national student federations through "Pax Romana", an international secretariat to which papal recognition was, for the first time, formally accorded last April. The British federation has marked its sense of the importance of this event by publishing in its Year Book for 1934–35 somewhat detailed expositions of its aims and policy and those of Pax Romana, and a report on a pilgrimage to Rome of a party of 130 of its members. Its general aim is to assist in the "Catholic education of persons of academic standing", the process being developed *pari passu* with secular studies and comprising, in addition to religious exercises, Catholic philosophy, Catholic social principles, Catholic missionary efforts and Catholic "action in the world at large". Further light on its outlook is to be found in the report, published in the Year Book, of the proceedings of its annual meeting held at Edinburgh on June 29–July 2, 1934. Here the general theme of the discussions was "The Catholic Approach to Knowledge", the chief contributions being papers read by Prof. G. Temple of King's College, London, on "Man and Knowledge" in which the supreme importance of metaphysics was urged, by Prof. E. T. Whittaker on "Man and the Universe" and by Mr. J. A. Lauwerys, of the University of London Institute of Education, on "Man and Life", in which he stresses, as in his book on "Education and Biology", a vitalistic point of view and the importance of teleology.

Science News a Century Ago

Social Economics

On February 16, 1835, a paper by Lieut.-Col. Sykes was read to the Statistical Society entitled "On the Increase of Wealth and Expenditure in the Various Classes of Society, as indicated by the Returns made to the Tax Office, by Exports, Imports, and Savings Banks". The classes included in this review were the gentry, the trading and manufacturing bodies and the depositors in savings banks, and the author gave some interesting particulars regarding the increase of capital employed in various articles of trade and luxury. The increase in population of England, from 1821 to 1831, he said, had been 11·3 per cent (from 11,760,555 to 13,091,005) and for the entire population of Great Britain and Ireland the increase had been somewhat more, from 21,726,924 to 24,306,719. In the same period, the poor rates had risen from £6,674,083 to £8,316,617. The total number of depositors in the savings banks was 475,155 and the amount deposited £15,715,111. In concluding his paper, Col. Sykes said it had been his object to offer a practical illustration of the facilities the Statistical Society afforded to everyone to collate facts with the view of showing the actual state and past changes in the condition of society.

Civil List Pensions for Men of Science

The recognition by the Government a century ago of eminent men of science led in the first place to the conferment of several knighthoods. It was next resolved to grant Civil List pensions. The first of these was awarded to Airy, then thirty-four years of age. On February 17, 1835, Sir Robert Peel wrote to Airy and in the course of his letter he said: "I consider you to have the first claim on the Royal Favour which Eminence in those high Pursuits to which your life is devoted, can give, and I fear that the Emoluments attached to your appointment in the University of Cambridge are hardly sufficient to relieve you from anxiety as to the Future on account of those in whose welfare you are deeply interested."

"The state of the Civil List would enable me to advise the King to grant a pension of three hundred pounds per annum, and if the offer be acceptable to you the Pension shall be granted either to Mrs. Airy or yourself as you may prefer."

"I beg you distinctly to understand that your acquiescence in this Proposal, will impose upon you no obligation personal or political in the slightest degree. . . ."

Airy replied from the Observatory, Cambridge, on the following day, thanking Sir Robert Peel, and asking that the pension might be settled on Mrs. Airy. Peel replied on February 19, saying: "I will give immediate directions for the preparation of the warrant settling the Pension on Mrs. Airy. . . . I assure you I never gave an official order which was accompanied with more satisfaction to myself than this."

Wheatstone on Musical Sounds

At King's College, London, on February 17, 1835, Wheatstone delivered an introductory lecture on musical sounds. A report of the lecture appeared in the *Athenaeum* of February 21, 1835. After showing how the oscillations of bells and string and wind instruments could be made visible, Wheatstone went on

to the consideration of that modification of sound which constitutes its pitch, and showed that it depends on the frequency of vibration; he also explained the several modes by which this frequency could be estimated. He made experiments with Robison's stop-cock and Cagniard de la Tour's syren, and referred to the standard of pitch proposed by Chladni. He next dealt with the various experiments made with the view of determining the limits of audibility, with respect to the human ear, dealing particularly with those of Wollaston and Savart, and explained the origin and formation of musical scales. He concluded his lecture with an exhibition of Trevelyan's experiments on the vibration of heated plates, and a mode of producing sounds by an electromagnetic apparatus.

One of Faraday's Unsuccessful Researches

At intervals throughout the year 1835, Faraday worked on the preparation of fluorine. He had completed the long series of experiments by which he had laid the foundations of electro-chemistry, and had not yet begun his researches on electrostatics. In the course of his determinations of electrochemical equivalents, he had found that fused salts as well as aqueous solutions could be electrolysed, in certain cases with the separation of the elements in a free state; and he proposed now to apply the method of electrolysis to fluorides in the hope of devising a method of producing fluorine. Thus on February 19, 1835, the "Diary" records the construction of an electrolytic retort, of platinum, with electrodes of the same metal, in which experiments were begun on the electrolysis of fused lead fluoride. This research was unsuccessful as regards the production of fluorine. It came between two of his great periods of discovery, and was given up at the end of 1835, so that he might begin the electrostatic experiments with the great cube in the Royal Institution lecture theatre. It is of interest as an investigation which is described at some length in the "Diary", but of which no record appears in his published work.

The South Magnetic Pole

At a meeting of the Royal Society on February 19, 1835, E. Rudge read a paper "On the Probable Position of the South Magnetic Pole". The recent discovery of the site of the North Magnetic Pole, which had resulted from the experiments of Capt. James Ross, had suggested to the author the inquiry whether any similar indications of an approach to the South Magnetic Pole could be gathered from any observations then on record. With this view he gave a table of the observations made by Tasman in 1642 and 1643, during his voyage of discovery in the Southern Ocean, extracted from his journal. From this it appeared that Tasman on one occasion noticed the continual agitation of the horizontal needle, in south latitude 42° 25′ and longitude from Paris 160°. On the presumption that the South Magnetic Pole, said the author, was at that time near this spot, and that it had since been retrograding towards the east, he conjectured that it would now be found in or about the 43rd parallel of south latitude; and to the south-east of the Island of Madagascar, a situation extremely convenient for ascertaining its exact position, which he considered an object of great theoretical as well as practical importance.

Societies and Academies

LONDON

Royal Society, February 7. E. N. DA C. ANDRADE and P. J. HUTCHINGS: Mechanical behaviour of single crystals of mercury. In the mercury crystal the rhombohedral faces are glide planes, and the short diagonal is the glide direction. The crystal twins under strain on a plane through the long diagonals of two opposite faces acting as glide planes. In simple glide, twinning takes place when the twinning plane makes an angle of 45° with the axis of the wire. The rhombohedral face and the hexagonal basal plane are equally close-packed, but the former contains a much more closely packed line than does the latter. Double and triple glide can take place. Hardening on one set of glide planes hardens the whole crystal. The critical shear stress at −43° C. is 9·3 gm. wt. per sq. mm. E. N. DA C. ANDRADE and J. C. MARTINDALE: Structure and physical properties of thin films of metal on solid surfaces. The films were prepared by cathodic sputtering under carefully controlled conditions, with a water-cooled anode. The films obtained were uniform, and appear to be amorphous with all types of microscopic examination. When they are maintained at a temperature of about 230° for silver, and somewhat higher for gold, the first stage of crystallisation takes place, which consists in the formation of birefringement aggregates, of the order of 1 μ across, showing the spherulitic figure in polarised light. Prolonged heating at a somewhat higher temperature leads to rapid growth of the particles, which eventually become well-formed cubic crystals, all arranged with the (111) faces parallel to the supporting surface. The first aggregates are formed by the movement of the upper layers of the films, which are about 50 atoms thick, the further growth of the crystals being accompanied by the formation of areas from which the metal has retreated, leaving a thinner film. Crystallisation in such thinner films does not take place until a much higher temperature is reached than that required for the thicker films. M. BORN: On the theory of optical activity. This paper contains a detailed development of the theory of rotatory power given by the author in 1915. The molecule is considered as consisting of a set of isotropic oscillators coupled by Coulomb forces. The interaction is calculated by the perturbation method. The resultant formula is rather complicated but can be simplified very much for special cases. A molecule consisting of two equal pairs of oscillators perpendicular to one another and to their central line is worked out in detail; it gives the angle of rotation of the expected order of magnitude.

DUBLIN

Royal Dublin Society, December 12. KENNETH C. BAILEY: Thermal decomposition of hydrogen peroxide in presence of glass wool and copper sulphate. Hydrogen peroxide decomposes very slowly in the absence of suitable solid surfaces, even in markedly alkaline solution. In presence of glass wool, the decomposition is probably complex, and approximately correct results are obtained by using the equation $v = 15[H_2O_2]\,[OH'] + 7 \times 10^{-5}\,[H_2O_2]$, the *amount* of glass wool present having very little influence on the velocity, although the stopping of the reaction in absence of solid surfaces suggests that both first and second order reactions are probably

heterogeneous. In presence of glass wool on the surface of which copper has been adsorbed, the reaction is of zero order, and probably takes place in two stages, a peroxide of copper acting as intermediate compound. It seems certain that this reaction follows an entirely different course from that on the surface of glass wool alone, copper ions in solution having little or no effect. J. LYONS: The influence of physical and mechanical treatment on the firmness of butter. When the cream is cooled to a low temperature immediately after pasteurisation, it gives butter which is considerably firmer than cream which is not so cooled. Pasteurising cream at unnecessarily high temperatures reduces the firmness. The fat content of the cream used for churning and the moisture content of the butter and size of the fat globules in the cream appear to have little influence on the firmness. The firmness of butter does not appear to be improved by holding it at a low temperature over a long period.

PARIS

Academy of Sciences, January 2 (*C.R.*, **200**, pp. 1–100). JULES DRACH: The logical integration of equations of dynamics with two variables. Conservative forces. Cubical integrals. Movements in the plane. LOUIS BLARINGHEM: The acclimatisation and degenerescence of varieties of brewing barley, *Hordeum distichum*. Discussion of the conditions necessary for the maintenance of the stability of hybrid barley. MAURICE GIGNOUX and LÉON MORET: The tectonic of the external border of the zone of the Flysch of Embrunais, between the Brac and the Durance (Piolit and Autanes massifs, Haute-Alpes). S. JANCZEWSKI: The complex equations of Fredholm with uniform nuclei. C. POPOVICI: The kinematic equilibrium. ANDRÉ WEIL: Almost periodic functions. A. DINGHAS: Remarks on two theorems of the theory of functions. JULIUS WOLFF: The conservation of the angles in the conformal representation of a domain in the neighbourhood of a boundary point. FERNAND HOLWECK: Improvements in the elastic pendulum. Recent gravimetric linkages between the reference station of the French network and that of neighbouring countries. F. PRUNIER: An experiment of Sagnac with a flux of electrons. P. LANGEVIN: Remarks on the preceding communication. ALBERT ARNULF: The resolving power of optical instruments as a function of the acuteness of vision. N. THON: The capacity of polarised mercury at very low frequencies. After studying and eliminating certain sources of error, the author finds, contrary to the experiments of Erdey-Gruz and Kromey, that there is complete agreement between the capacities calculated starting with the cathode and anode polarisation. CHARLES HAENNY: The variations of the magnetic double refraction of cerous salts in solution. RAYMOND LAUTIÉ: Latent heat of vaporisation and characteristic temperature. ARNALDO PERES DE CARVALHO: Contribution to the study of phototropy. Three new phototropic bodies. MARCEL CHÂTELET: Some reactions of cobalt sulphate dissolved in glycerol. MAURICE DODÉ: The study of the decomposition products of ammonium perchlorate. At temperatures less than 300° C., chlorine, oxygen, water and nitrous oxide are the main products of decomposition: at higher temperatures the reaction becomes explosive and nitric oxide appears in the place of nitrous oxide. JEAN CALVET: The annealing of pure aluminium and its possible utilisation as a criterion of the purity of the metal. The samples studied ranged between 99·96 and 99·9986 per cent of aluminium, and the differences between the velocities of annealing are so large that a study of annealing after rolling into sheets forms a very sensitive test of the purity of the metal. JULES GARRIDO: The crystalline structure of manganite. STOYAN PAVLOVITCH: The action of heat on some natural oxides of manganese. A. KAZMITCHEFF: The tectonic structure of the Cannes-Antibes region (Alpes Maritimes). PAUL FALLOT and LOUIS DONCIEUX: The age of the Flysch of the periphery of the limestone chain of the Rif. F. LINK: The density of the upper atmosphere calculated from twilight phenomena. The theory of meteors of Lindemann and Dobson led to higher densities for the upper atmosphere than those generally accepted. The author, using a totally different method, confirms these results. JOSEPH DEVAUX: Study of the albedo of snow in the infrared spectrum. Starting with the band due to the water vapour in the air, melting coarse grained snow absorbs practically the whole of the solar radiation. R. BUREAU: The foci of atmospherics and their localisation. MLLE. COLETTE GAUTHIER: Singular reaction of a bean (*Phaseolus Mungo*) to a lesion of the seed. EMILE MIÈGE: The variations of the characters of seeds of elementary species of *Hordeum distichum*. RENÉ HAZARD: The action of sparteine on the inversion of the hypertensive effects of adrenaline by three phenoxyethylamines. PAUL WINTREBERT: The irregular mitoses of the vitelline merocytes in the course of embryogenesis of selacians (*Scylliorhinus canicula*). MAURICE PIETTRE, AUGUSTIN BOUTARIC and MME. MADELEINE ROY: The study of some proteins in aqueous solution. GEORGES CRUT: The comparative study of the action of hydrogen ions and of thrombase on the coagulation of fibrinogen. J. VELLARD and M. MIGUELOTE-VIANNA: Blood modification in cancer subjects treated with snake poison. Study of the effects produced by small repeated doses of snake poison. The necessity of extreme caution is emphasised.

BRUSSELS

Royal Academy (*Bull. Classe Sci.*, No. 11). TH. DE DONDER: The system adjoint to a linear system of partial derivatives of several unknown functions (2). CL. SERVAIS: Geometry of the tetrahedron (12). LUCIEN GODEAUX: Second order involutions of space. A second order involution produced by a birational transformation of the seventh order, having a single fundamental curve of the first kind of order eight and genus five, first investigated by Montesano, is considered. TH. DE DONDER: Vortical gravific. A gravific theory is developed in which the potentials $g^{\alpha}_{\alpha\beta}$ are antisymmetrical. This *vortical* gravific completes the classical gravific constructed from symmetrical potentials, $g_{\alpha\beta}$, and furnishes a unitary theory of the electromagnetic field. MARCEL WINANTS: Solution of a problem in limits concerning the equation $\frac{\delta^3 z}{\delta x^3} = \frac{\delta z}{\delta y}$. M. KOURENSKY: Integration of systems of partial differential equations of the first order containing two unknown functions of three independent variables. YVONNE DUPONT: Electromagnetic couples and angular momenta in the gravific of Th. De Donder. (2) The antisymmetrical electromagnetic tensor is expressed in terms of the polarisation tensor and of the two electromagnetic potentials generalised by J. Géhéniau. GEORGETTE

SCHOULES: Application of generalised statistical mechanics to the calculation of the entropy of gases with rigid molecules. De Donder's generalised statistical mechanics is used to calculate the entropy of a gas of rigid molecules. With the classical statistics the formulæ of Ehrenfest and Trkal are obtained. The Bose-Einstein and Fermi-Dirac statistics are also employed and a general formula for the entropy in terms of the energy is deduced. M. BERTRAND: Mechanism of pulmonary ventilation in the turtles. The triphasism of the respiratory movements is caused by the occlusion of the glottis. The expiration which precedes the central pause is purely passive. Z. M. BACQ: Physiological observations on the heart, the muscles and the nervous system of an ascidian (*Ciona intestinalis*). The chronotropism of the heart of *Ciona intestinalis* is not modified by non-toxic doses of adrenaline, acetylcholine or the ions of potassium, calcium and barium.

Forthcoming Events

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

Sunday, February 17

BRITISH MUSEUM (NATURAL HISTORY), at 3 and 4.30.—Dr. Isabella Gordon: "Deep-sea Crustacea".*

Monday, February 18

BRITISH MUSEUM (NATURAL HISTORY), at 11.30.—A. C. Townsend: "The Linnæus Collection in the Library".*

CHADWICK PUBLIC LECTURE, at 5.15—(at the Royal Society of Tropical Medicine and Hygiene, Mansion House, 26 Portland Place, W.1).—Dr. William A. Robson: "A Hundred Years of Public Health Administration".*

UNIVERSITY OF LEEDS, at 5.15.—Prof. B. Melvill Jones: "The Stalling of Aeroplanes".*

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Major R. E. Cheesman: "The Islands of Lake Tana".

Tuesday, February 19

ROYAL HORTICULTURAL SOCIETY, at 3.—Annual Meeting. Lord Aberconway: Presidential Address.

Wednesday, February 20

ROYAL SOCIETY OF ARTS.—Lieut.-Col. J. D. Restler: "Water Supplies from Underground Sources".

INSTITUTE OF PHYSICS, at 8—(at the Science Museum, South Kensington). Informal discussion on "Modern Magnetic Materials and their Application".

Thursday, February 21

ROYAL SOCIETY, at 4.30.—Dr. F. W. Aston: "The Isotopic Constitution and Atomic Weights of Hafnium, Thorium, Rhodium, Titanium, Zirconium, Calcium, Gallium, Silver, Carbon, Nickel, Cadmium, Iron and Indium". J. M. Stagg: "The Diurnal Variation of Magnetic Disturbances in High Latitudes".

Friday, February 22

INSTITUTION OF CHEMICAL ENGINEERS, at 11—(at the Hotel Victoria, Northumberland Avenue, London, W.C.2).—Thirteenth Annual Corporate Meeting.
W. Macnab: "Chemical Engineering in Explosives Manufacture" (Presidential Address).

INSTITUTION OF MECHANICAL ENGINEERS, at 5.30.—Annual General Meeting.
Dr. H. E. Merritt: "Worm Gear Performance".

INSTITUTION OF PROFESSIONAL CIVIL SERVANTS, at 5.30—(at the Royal Society of Arts).—R. A. Watson Watt: "The Cathode Ray Oscillograph".*

ROYAL INSTITUTION, at 9.—Prof. A. O. Rankine: "Some Experiments in Gravitation and Magnetism".

Official Publications Received

GREAT BRITAIN AND IRELAND

Department of Scientific and Industrial Research. Report for the Year 1933–34. (Cmd. 4787.) Pp. iv+192. (London: H.M. Stationery Office.) 3*s.* net.

Department of Scientific and Industrial Research. Report of Test by the Director of Fuel Research on the Plant of the British Coal Distillation Company, Ltd., at Newbold, Leicestershire, Test carried out 11th to 25th March 1933. Pp. iv+29. (London: H.M. Stationery Office.) 9*d.* net.

Report on the Third Mycological Conference, 1934. Pp. 32. (Kew: Imperial Mycological Institute.) 2*s.* net.

OTHER COUNTRIES

Denkschriften des Schweizerischen Naturforschenden Gesellschaft. Band 69, Abh. 2: Die Mittlere Kreide in den helvetischen Alpen von Rheintal und Vorarlberg und das Problem der Kondensation. Von Arnold Heim und Otto Seitz, unter Mitarbeit im Felde von Siegfried Fussenegger. Pp. xi+185–310+3 plates. (Zürich: Gebrüder Fretz A.G.)

Publications of the Dominion Observatory, Ottawa. Vol. 12: Bibliography of Seismology. No. 3: July, August, September, 1934. By Ernest A. Hodgson. Pp. 47–64. (Ottawa: King's Printer.) 25 cents.

Mysore Geological Department. Bulletin No. 15: Cummingtonite in the Limestones of Kudurekanave (Mysore State). By B. Rama Rao. Pp. iv+36+7 plates. (Bangalore: Government Press.) 1 rupee.

The Coconut Research Scheme (Ceylon). Bulletin No. 1: Report on the Soap Industry in Ceylon. By Dr. R. Child. Pp. iv+45. (Lunuwila: Coconut Research Scheme.)

League of Nations: Health Organisation: Permanent Commission on Biological Standardisation. Report of the Second International Conference on Vitamin Standardisation (London, June 12th to 14th, 1934). Pp. 13. (Geneva: League of Nations.)

A Study of the Life History and Food Habits of Mule Deer in California: a Contribution from the Wildlife Division, United States National Park Service. By Joseph S. Dixon. (Reprint from California Fish and Game, Vol. 20, Nos. 3 and 4.) Pp. 146. (Sacramento: California State Printing Office.) 25 cents.

Baltische Geodätische Kommission. Sonderveröffentlichung No. 3: Bestimmung der Längenunterschiede der Landeszentralen im Jahre 1929, 2: Die Berechnung der Längendifferenzen der Landeszentralen, von F. Pavel; Die Berechnung der Längendifferenzen der Landeszentralen, von Ilmari Bonsdorff. Pp. 49+91. (Helsinki.)

Proceedings of the American Academy of Arts and Sciences. Vol. 69, No. 11: New Bands of the Ionized Nitrogen Molecule. By F. H. Crawford and P. M. Tsai. Pp. 407–437. 60 cents. Vol. 69, No. 12: The Relation of the Eyes to Chromatophoral Activities. By G. H. Parker, F. A. Brown, Jr., and J. M. Odiorne. Pp. 439–462+1 plate. 60 cents. (Boston, Mass.)

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