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Population Problems

THAT population size and composition exert a profound influence on many of the social, political and economic problems which beset a nation, and that it will be possible to make a fairly accurate forecast of changes in these qualities at different times in the near future, though well established, is not generally understood. Hence addresses such as the recent Huxley Memorial Lecture on the "Restrictive Law of Population" by Prof. Johan Hjord\*, and publications such as the newly-issued broadsheet of P.E.P. on "Future British Population"†, are to be welcomed and commended to the notice of all those who, for this reason or that, must, now in 1934, take account of the warrantable view that in 1976 the population of Great Britain will be less than, perhaps far less than, 33 million, and that in it the children will be outnumbered by the old. The voice that then will make itself heard will be that of secure senescence, and largely female at that. In 1901 there were 12 million children in Great Britain; in 1951 there may be just over 6½ million; the present number of women of sixty-five years of age and over will be doubled during the next fifty years and will increase by 50 per cent within the next seventeen.

Times have changed, and changed considerably, since the publication of the "Essay on Population". There is no longer any danger of the means of subsistence becoming disproportionate to the number of human individuals dependent on them, for, thanks to developments in the methods of food production, the relation of man to the resources of his environment has been completely reversed. We can produce food of the highest quality, in quantity far in excess of the needs of the sum total of human individuals at present living on the earth; we can force temperature, humidity and light into harmony with our various requirements. Thanks to chemistry, we are becoming more and more freed from our dependence upon animals and plants for commodities that are essential to our well-being, and, furthermore, through developments in reproductive physiology, we are now able deliberately to control the reproductive rate of a human society.

Thus it is that the Malthusian threat of overpopulation has lost much of its force; in fact, in

\* The Restrictive Law of Population. By Prof. Johan Hjord. (Imperial College of Science and Technology: Huxley Memorial Lecture, 1934.) Pp. 46. (London: Macmillan and Co., Ltd., 1934.) 1s. net.

† Future British Population. Planning: No. 27. May 22, 1934. (P.E.P., 16 Queen Anne's Gate, London, S.W.1.)

most European countries, and in the United States of America, already in its place there is an increasing fear that the peoples are failing to maintain themselves numerically. In Great Britain the population is already ceasing to increase, and if no further change in the fertility and mortality rates occurs, it can be assumed that a stable age composition in the population will ultimately be reached, and that thereafter the population in each subsequent generation will become progressively, perhaps even alarmingly, diminished. Indeed, it may dwindle away in spite of all improvements in personal and public hygiene which tend to reduce mortality. All the evidence that is available shows that such speculations as these are entirely warrantable.

It becomes a matter of supreme importance, therefore, to those who wish to see the continuance of ourselves as a people, to inquire into the causes of the numerical decline of a population. It is necessary to ask and to answer such a simple question as why it is that people have children at all. The child, which seems to be regarded as a welcome reinforcement by those who speak in the name of the State, as often as not is looked upon by the parent as an inconvenient burden. It seems to be commonly suggested that man, and especially the female of the species, exhibits a definite biological urge toward reproduction. This may be, but the view has no experimental foundation, and its investigation is complicated by the fact that, in our society at least, the mother enjoys certain economic and social advantages. Of all the factors which are recognised as affecting the reproductive rate of a people, it is generally agreed that the one which is mainly responsible for the dwindling of a population is the progressive fall in the average number of children born to each married woman, and it would seem to be established that a people of which the average woman has less than one female offspring is doomed to extinction.

It must remain an unanswered question for the moment as to whether or not it matters very much to the world as a whole and to its further evolution that a particular people, through progressively falling fertility, should disappear. All that we can do is to search for information into the causes that operate in the production of a dwindling population in order to obtain a knowledge of the factors involved, so that this may be made available for incorporation into any programme relating to population size which may be

formulated in the future. Manifestly, the problem stated in its simplest terms is that of removing such obstacles to parentage as exist in a particular society.

A great many facts relating to the growth of human populations are already in our possession, but concerning their explanation there is still much disagreement. We know that, in general, the reproductive rate in an industrialised community is lower than that in an agricultural; that a preponderance of Catholics in a community is commonly associated with a high fertility; that the reproductive rates of people living under different social conditions and belonging to different occupational classes differ more or less widely one from the other. But to find a satisfying explanation for these facts is not simple. If Roman Catholics are remarkable for their high fertility, the Jews, who have a sex ethic that is comparable, show a low reproductive rate. The differential fertility of the different social classes and of the rural community as compared with the urban may be nothing more than evidence that differences in the social environment can yield differences in the expression of certain biological variables.

It has not yet been shown that removal of inequalities in the environment would not produce equality in respect of reproductive rate. Indeed, there are reasons for holding the view that the differential fertility of the social classes is tending to disappear. It has been too easily assumed, perhaps, that a widespread use of contraceptives is in itself a sufficient explanation of a falling birth-rate. It is difficult to accept this statement in view of the fact that legalised abortion and active birth control propaganda in the U.S.S.R. do not seem to affect the growth of a people eager and able to expand.

One thing is certainly true, and that is that a population can only maintain itself if every woman in it bears on the average three children. This of course means that whilst many will bear none, others must bear four and five, and the problem facing those who wish to see our population maintain its present level is that of obtaining in the population a sufficient number of more-than-three-children families.

It may be assumed that in Great Britain, as in other countries, a low fertility is the result of urbanisation. In the social structure, with its tradition which appeals to the incentive of private profit, and in which there are great inequalities in respect of wealth, with an improvement in the

standard of living of the people, there have come into being many and varied distractions which can be regarded as alternatives to parenthood. The political emancipation of women and their desire for economic liberty have resulted in competition between women and men in businesses and professions, and motherhood no longer offers a satisfactory career to great numbers of women. The standards of feminine beauty require habits and physical attributes which cannot easily be harmonised with the realities of child-bearing, and undoubtedly one of the most important factors which tend to cause family limitation has been the conferring of an economic advantage upon persons who exhibit a low reproductive rate. There are in Great Britain hundreds of young married couples who are determined not to have children, at least yet awhile, for the simple reason that, conditions of life being as they are, they much prefer to have other things.

The economic barriers to fertility can be overcome by such measures as family endowment, which removes the economic inequality between those who have many children and those who have none, by ruralisation, by giving leave on full pay to women in confinement, but when these things have been done there still will remain the underlying psychological causes of self-imposed sterility. In days gone by, when distractions were fewer, when children were an asset, when the man with a quiver full was most highly respected, when opportunity was plentiful, there being no reason to doubt that the child would enjoy the same opportunities as did his parents, it mattered not that sexual activity was so commonly followed by reproduction. But in these days, it is becoming increasingly common for parentage to cease to be a casual affair and to be a matter of deliberate choice. In the future there will be no such thing as an unwanted child. The problem, in its ultimate analysis, therefore comes to be that of cultivating the wish to have children, and of creating a type of society in which the child shall have a definite function.

If the population of Great Britain dwindles, it will not be because our descendants will be less fecund than were our ancestors, but because they will choose, or will be forced, for economic or other reasons, to limit the number of children entering into an unsatisfactory environment. When the world is fit for children to live in, they will be born; whilst things are as they are, it is perfectly reasonable to limit their numbers.

### Experiment and Theory

*Molecular Hydrogen and its Spectrum.* By Prof. Owen Willans Richardson. (Yale University: Mrs. Hepsa Ely Silliman Memorial Lectures.) Pp. xiv+343. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1934.) 13s. 6d. net.

ANYONE seriously engaged in the pursuit of scientific knowledge, and with a mentality broader than that of the self-sufficient 'research worker', will at one time or another have been confronted with the question as to the importance of his own investigations. Aside from the viewpoint *sub specie æternitatis*, from which the playing of the child in the sand and the discovery of the laws of the physical world appear equally important—or unimportant if one prefers—this question will by everyone be admitted to be entirely justified. An answer may perhaps be given in somewhat the following way: the more radical the change in our theoretical notions which an experiment necessitates, the more important the experiment; the larger the group of hitherto unexplained facts to which a theory opens an interpretation, the more important the theory. In these times, when new scientific views penetrate quickly, the frequency with which a scientific publication is quoted by investigators (other than its author) may serve as a quantitative measure of this importance.

Looking at the modern scientific output, one must confess that a good deal of experimental work done to-day is bound to fall into oblivion rather quickly. But while this work still represents a certain amount of conscientious labour and there is, as with a defaulted bond issue, always still a chance that it may become of value, there is no such excuse for the airy castles of speculation of those who forget that the mathematics of the theoretical physicist is a necessary evil and that an accumulation of equations without a physical idea, related in a recognisable way to the empirical reality, does not deserve to be called a theory.

Prof. Richardson is one of the enviable persons who have been able to combine experimental research with theoretical investigation, and through this fortunate circumstance to advance physical science in very diverse directions. The present book, devoted exclusively to the hydrogen molecule and its spectrum, and to a large extent a summary of his own work, illustrates clearly the interaction between experiment and theory. Here is a mass of experimental facts, a spectrum of so involved

an aspect that for a long time it was neither classified as a line spectrum nor as a band spectrum, but put into a category all by itself under the name of many-lined spectrum. Only on the basis of the firm belief that the interpretation of the evidence from so simple an atomic system as  $H_2$  must in the end appear simple itself could give the courage to tackle the analysis of the spectrum in question. This conviction has been fully rewarded, and indeed, the complete understanding of the structure of this simplest of molecules thus obtained has been material in the elucidation of a number of other problems that had long been puzzling to the physicist.

In the earlier chapters of the book the reader is made acquainted with the various quantum numbers and symmetry properties that serve to classify the stationary states of a diatomic molecule. Then the selection and intensity rules are discussed, which determine so markedly the character of a band spectrum. Regarding the application of the theory to the experimental facts, as carried out principally by Richardson and his pupils, by Dieke and by Weizel, it should be stressed that we owe to Prof. Richardson the clear recognition of the two non-intercombining term-systems of  $H_2$  as singlet- and triplet-systems, as well as a trustworthy spectroscopic determination of the dissociation energy of the  $H_2$ -molecule in its ground state; a quantity of great interest both to the physicist and to the chemist, the value of which had been oscillating for a number of years between rather wide limits. Also the term-system of  $H_2$ , besides that of  $He_2$ , furnishes an interesting illustration of the phenomenon of  $L$ -uncoupling.

The determination of the electronic levels of  $H_2$  was of great importance in connexion with the theory of chemical binding which Heitler and London originally developed for this molecule, and led Hund to a complete level diagram connecting the atomic and molecular states of hydrogen. The analysis of the  $H_2$ -spectrum was also essential in the discussion of the intensity alternation as observed in many  $H_2$ -bands. In conjunction with the quantitative intensity measurements of Ornstein and his students it enabled us to ascribe to the H-nucleus a spin of  $\frac{1}{2}$  and to make sure that it obeys the Dirac-Fermi statistics. This latter result, together with the explicit knowledge of the rotational levels of  $H_2$  as gained from analysis of the spectrum, again made acute the problem of interpreting the behaviour of the specific heat of hydrogen at low temperatures.

After Dennison had shown that this behaviour can be explained by considering the gas as a mixture of molecules in even and odd rotational states, which in general will not be in thermodynamic equilibrium, it was only a short time before other workers demonstrated this experimentally by separating the two components, para- and orthohydrogen.

The book under review is a monument to the co-operation between theory and experiment. All physicists will be obliged to its author and to the Silliman Foundation for making the results of researches scattered in many different publications available in this compact and well-produced book.

R. DE L. KRONIG.

### The Thermionic Tube

- (1) *Theory of Thermionic Vacuum Tubes: Fundamentals, Amplifiers, Detectors*. By Prof. E. Leon Chaffee. (Electrical Engineering Texts.) Pp. xxiii+652+6 plates. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1933.) 36s. net.
- (2) *Electron Tubes and their Application*. By Prof. John H. Morecroft. Pp. xiii+458. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1933.) 28s. net.
- (3) *Lehrbuch der Elektronen-Röhren: und ihrer technischen Anwendungen*. Von Prof. Dr. H. Barkhausen. Band 2: *Verstärker*. Vierte, vollständig umgearbeitete Auflage. Pp. xvi+289. (Leipzig: S. Hirzel, 1933.) 7.50 gold marks.

(1) **T**HE author warns us that this imposing volume is, "according to present plans", the first of two; the second, to deal with "power amplifiers and oscillators, gas-content tubes, rectifiers &c.", can scarcely fail to reach a comparable size. This probable development to some thirteen hundred pages is not an exaggerated measure of the progress made in the theory and practice of thermionic tube technique since 1920, when the classical volume of van der Bijl could be compressed into 390 open pages. Van der Bijl's book was then unique, invaluable, indispensable; Chaffee's present work is its natural and worthy successor. It contains nearly everything, within the limits indicated, that even the specialist is likely to require as a basis for his own work, and its list of references confirms the impression of encyclopædic completeness. But ought it not to be labelled vol. 1?

The book opens a little weakly, but gathers firmness of touch as it develops. The introductory chapter, and the four-and-a-half forbidding pages of symbols which precede it, have a flavour of pedantry and over-elaboration which does less than justice to the author's handling of his main material. The second chapter is also disappointing; the rudiments of atomic theory are treated at unnecessary length, while Planck's constant suddenly appears, with no introduction at all, several pages before it is equally summarily dismissed in three inadequate lines.

At this point, however, the author reaches the real business in hand, and the temporary reversion to laborious systematisation in a brief chapter on nomenclature and letter symbols has no permanent ill-effect. Incidentally, however, this chapter itself indicates the solution for the admitted difficulties of symbolisation, for it shows how easily the inconvenient and inconveniently situated list of symbols, already mentioned, could have been compressed into a single page on a final 'throw-out' sheet to unfold clear of the text, or, less satisfactorily, inserted in an end pocket. The change would afford an opportunity for inserting some missing symbols. The task of many readers might, too, have been lightened by the freer use of a device, adopted in places by the author, of marking with an asterisk matter which may be omitted at a first general reading.

Minor defects are not difficult to find, but they are rare in proportion to the monumental scope of the treatise, and such as have been discovered will do no harm to any reader capable of using the book as it deserves to be used. That Eccles should not be named or credited with the invention of the extremely convenient and now universal nomenclature of "diode, triode . . . pentode . . ." (which the author uses throughout) might be excused were Richardson not, rather unnecessarily, mentioned as inventor of the substantive "thermion" (which the author immediately rejects). There is no mention of Round's signal service in bringing to practical application the screen-grid tube, which Hull and Williams, in the paper cited by the author (and to which he gives considerable and deserved credit) left with the disclaimer: "It will be understood that the purpose of this paper is scientific, and bears no relation to commercial development. Tubes of the type described are not being manufactured, nor is their immediate production contemplated, so far as the authors are aware." Round's work in this connexion gives

him a less qualified claim to a place in the name index than the one actually admitted.

No serious reader will believe the author when he seems to assert that amplifiers and relays are one and the same kind of thing, or when he seems to say that a modulator tube should be identical with an oscillator tube, or when he seems to say that slow electrons are less easily deflected by a magnetic field than are fast electrons. Nor will "Brücke" for "Brüche" break down the bridge between the reader and the original paper on "Experimente zu Störers Polarlichttheorie". More serious than any of these lapses, perhaps, is the failure to quote, in the appropriate place on page 398, the important device of adding decoupling resistances to battery circuits common to several stages of an amplifier. This process, which some of us in affectionate gratitude call 'Ferrantising', avoids the difficulty, which affects also the circumstances discussed on page 456, of providing condensers of sufficiently low impedance at low frequencies to make an effective shunt across such low resistances as are presented by accumulators and filaments.

There is evidence of the inclusion of much original work in addition to the systematic re-treatment of the work of others. The discussion of the overall characteristics and behaviour of the complete system of tube and associated circuits, including the very important problems of input and output impedance and of equivalent circuits, deserves special mention. The book is very complete, and it has no present rival.

(2) Prof. Morecroft shares with Prof. Chaffee a certain shakiness of hand when he takes up his pen for chap. i, but he too makes a quick recovery. That the 'easy bits' are the most difficult to write is no new discovery, but these erudite writers really ought to submit the manuscript of their first chapters to their youngest students for approval. A salutary change between the things said at too great length and those left out would result.

It is not at all a destructive criticism to say that Morecroft's work is more slender and superficial than Chaffee's. These are, indeed, its essential merits, and it will do much to stimulate the best of its readers to go on to Chaffee, vol. 1, and to fill the temporary void left by the absence of Chaffee, vol. 2. The stimulation is not notably helped by the classical 'carrot and donkey' method of which the author is over-fond, both in the fine structure, where the reader first feels that he has

been left with an inadequate treatment, and then discovers that his troubles are cleared up two pages or so later, and in the main plan, where the uses of the principal devices are relegated to chapters much later than those in which the devices are introduced and described. The irritated 'donkey' may kick over the traces before he is assuaged by the deferred 'carrot'.

The book gives an excellently up-to-date survey of the whole field, generously interpreted to include not merely the devices which the English reader will go on calling 'valves', but also photoelectric cells, cathode ray oscillographs, the many recent gas- and vapour-filled tubes, and even thermocouples. The young engineer entering industry from the technical school, to whom the work is addressed, will be a dull 'donkey' indeed if he is not fired to enthusiasm by the author. Heat-shielded cathodes, giving emission currents of 1.5 ampere per watt of heating supply, ultramicroimeters measuring deflections of a few atomic diameters, thermionic ammeters measuring currents of six electrons per second, and photoelectric eyes which can see fourteenth magnitude stars, are very succulent 'carrots' indeed.

(3) Prof. Barkhausen's classical work, in three volumes, is now passing through its fourth edition. Vol. 1 on general principles appeared in 1931, vol. 2 on amplifiers is now before us, vol. 3 on receivers is in preparation, all having been rewritten. A work by Prof. Barkhausen, a work which has survived to a fourth edition, and a work thus brought up-to-date, needs no discussion; it has commended itself.

### Morphogenesis in the Animal Embryo

*The Elements of Experimental Embryology.* By Julian S. Huxley and Dr. G. R. de Beer. (Cambridge Comparative Physiology.) Pp. xiii + 514. (Cambridge: At the University Press, 1934.) 25s. net.

THIS work is a rather surprising addition to the Cambridge Comparative Physiology series—surprising partly because it is twice as heavy as any of the earlier members of the series, and partly because it deals with what may perhaps be called one of the backward branches of biological science. While the analysis of animal chemistry and animal energetics advances very rapidly in precision, the analysis of animal morphogenesis lags far behind. If, for example, we turn

to the study of animal behaviour, we find the observable phenomena described in terms of (a) the physico-chemical properties of nerve cells and (b) the manner in which the cells are arranged in the nervous system; and while our understanding of the facts of the first group—of such processes as nervous conduction, excitation, inhibition and so forth—is rapidly advancing and increases almost literally from day to day, we know relatively little of the processes which have led the neurones to assume the patterns in which in fact they lie, and which determine, equally with their physico-chemical properties, the reactions which the organism will give in any given circumstances. The reason for this discrepancy is not far to seek. Physiological analysis depends very greatly, for its ideas and methods, on physics and chemistry, and in these sciences the emphasis has lain on quantities rather than on shapes.

The authors of the volume under review are fully alive to this difficulty. They have not attempted to review in their book all that is known about morphogenesis, but restrict themselves to what Wilhelm Roux termed the pre-functional stage of development, that is, to the stage which begins with an undifferentiated, or relatively undifferentiated, egg, and ends with an embryo in which the main organs are laid down and the tissues histologically differentiated, adding only a brief chapter on the effects of function, both on the organ which functions and on other organs. Moreover, they have restricted themselves in another way. They do not attempt to analyse the processes involved in terms of physics and chemistry. In their view, the field is not yet ripe for that harvest. They work on what they term "the biological level". To quote their preface:

"The prime aim of the worker approaching the problem on the physiological level will always be to analyse the processes involved in terms of physics and chemistry. The worker on the biological level will aim at discovering general rules and laws which he is content to leave to his physiological colleague for future analysis in more fundamental terms, but which, meanwhile, will give coherence and a first degree of scientific explanation to his facts. Both methods are necessary for progress; and while most biologists hope and expect that one day their laws will, thanks to the labours of their physiological colleagues, be made comprehensible in the most fundamental physico-chemical terms, they can reflect that it is they who must first reveal the existence of these laws before the physiologist can hope to begin his analysis."

In pursuing this aim, the authors have amassed and classified a vast amount of very entertaining facts. Their method is to take as type the development of the amphibian embryo, on which of recent years a large amount of important work has been done, and then to turn to other animals to see how far the conclusions reached in connexion with frog and newt eggs can be usefully extended and generalised. At first sight their volume contains more anecdote than law—it is a fascinating and exciting browsing-ground—but as one reads there does emerge a framework of general principle, a series of fundamental biological facts for the physiologist to explain. Let us hope that he will read this volume and take up the challenge.

As one expects from the authors, the book is thoroughly up to date, and, by gathering together a great amount of work along different lines, brings out suggestive relationships and generalisations. There is an excellent bibliography, and important work that appeared after the book was in page proof is summarised in an appendix. Occasionally criticisms suggest them-

selves, especially when the authors veer towards the physiological level. For example, in discussing the development of pigment cells in the fish *Lebistes* they write: "Specimens reared on white backgrounds have contracted melanophores, few in number; specimens reared on dark background have expanded melanophores in large numbers. Functional activity increases rate of multiplication". There is, of course, no reason to suppose that an expanded melanophore is more "functionally active" than a contracted one. The evidence collected to suggest that minute differences in oxygen supply between the ends of egg-cells is a factor in determining polarity is perhaps unconvincing in the light of recent investigations on the shape of the curve relating oxygen tension to oxidation rate in single cells. These are, however, small points, and in collecting this great array of fact and subjecting it to a preliminary regimentation the authors have, it is hoped, greatly assisted and accelerated the ultimate analysis to which they look forward.

G. P. W.

### Short Reviews

Board of Education: Science Museum. *Handbook of the Collections illustrating Aeronautics. 2: Lighter-than-Air Craft; a Brief Outline of the History and Development of the Balloon and the Airship, with reference to the National Aeronautical Collection, and a Catalogue of the Exhibits.* By M. J. B. Davy. Pp. 112 + 32 plates. (London: H.M. Stationery Office, 1934.) 2s. 6d. net.

MR. DAVY, the officer in charge of the Aeronautical Collection at the Science Museum, South Kensington, has, with the issue of this book, completed a series of three, which constitutes a very completely annotated catalogue to the collection of aeronautical exhibits at that Museum, in addition to providing a concise and useful history of aeronautics in Great Britain. The companion volumes, already issued, are vol. 1 "Heavier-than-air Craft", and vol. 3 "Propulsion of Aircraft".

These books are astonishingly full of 'meat' presented in an orderly and readable manner, and read in conjunction with visits to the collection cannot fail to educate visitors in the part that Great Britain has played in the development of the science of mechanical flight, a history which is all too little known or appreciated. It is a pity that in a few instances the author does not stick to the definitions laid down in the "British Standard Glossary of Aeronautical Terms". Many of these are admittedly subjects of controversy, but confusion of terms can only be removed by strict loyalty to the agreed authorities in the matter.

For example, chap. v is headed "Pressure Type Airships". This term was deliberately omitted from the British Standard Glossary in favour of the two sub-divisions non-rigid and semi-rigid airships.

The book is divided into chapters dealing with the early speculations as to lighter-than-air flight; hot-air balloons; spherical hydrogen balloons; early dirigible balloons or airships; non-rigid and semi-rigid airships, and rigid airships. It covers a period from Roger Bacon (1214) to a reference to the Akron disaster in the U.S.A. (1933). The illustrations are particularly good, and add considerably to the usefulness of the volume.

*The Ape and the Child: a Study of Environmental Influence upon Early Behavior.* By Prof. W. N. Kellogg and L. A. Kellogg. (Whittelsey House Publication.) Pp. xiv + 341 + 33 plates. (New York: McGraw Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1933.) 12s. 6d. net.

If a baby ape were brought up in human surroundings and treated like a human child, how far would it acquire human characteristics? This is one of the problems Prof. and Mrs. Kellogg have tried to solve in the unique experiment related in this book. Gua, a female chimpanzee, was reft from her mother at the tender age of 7½ months, and brought up in the Kellogg household with their son Donald, who was 2½ months older. They lived together as companions and

playmates for nine months, being treated in every way as nearly as possible alike, and they became great friends. A very detailed study was made of their sensory and motor capacities, their power of learning, their rate of maturation. The little ape showed herself surprisingly intelligent, though not quite up to the level of the child; in some respects, as in muscular strength and co-ordination, she was the child's superior, due in part to her more rapid rate of development. Simple things she learned more rapidly than the child, probably for the same reason.

A detailed comparison with the behaviour of an ape brought up in the normal way is unfortunately not given, but it is clear that Gua was considerably affected and stimulated to higher flights by her new and exciting psychological environment. "It is clearly in defence of the capacities of the animal that the results of the present research are most significant. They strongly suggest that, if given sufficient opportunity, the animal subject may considerably outdo himself, particularly if he belongs at a high level in the biological scale" (p. 322). There is a vast amount of useful material in the book for the student of child and anthropoid psychology.

E. S. R.

*A Text-Book of Inorganic Chemistry.* Edited by Dr. J. Newton Friend. (Griffin's Scientific Text-Books.) Vol. 6, Part 2: *Phosphorus*. By Dr. Edmund B. R. Prideaux. Pp. xxviii+238. (London: Charles Griffin and Co., Ltd., 1934.) 18s. net.

THE part of Friend's "Text-Book of Inorganic Chemistry" which deals with phosphorus and its compounds has been written by Dr. Prideaux on similar lines to those in which the other elements have been described, and maintains the characteristic features of the series. This statement implies that the book is traditional rather than modern in its methods and outlook, and is therefore of more value as an index to the published literature than as a stimulant to research in its broader aspects. Since Dr. Prideaux is keenly interested in problems of valency, in reference to which he has himself made original contributions, it is an anomaly (for which the editor is perhaps responsible) that, although data are cited for the parachor of phosphorus oxychloride, no reference is made to their interpretation by means of a semi-polar bond, and that when, in certain rare instances, structural formulæ of compounds of this type are set out in full, the atom of phosphorus is associated with five bonds.

The book may therefore be commended without reserve to those who wish to study fundamental chemistry, undefiled by any taint of modernism; but it will disappoint those who may consider that the problems of molecule-building are too important to be discussed adequately in three paragraphs of less than half a page each in a book of more than 200 pages.

*Handbuch der Chemotherapie.* Von Dr. Viktor Fischl und Prof. Dr. Hans Schlossberger. Teil 2: *Metallderivate*. Pp. xi+359-898. (Leipzig: Fischers medizinische Buchhandlung, 1934.) 55 gold marks.

THIS second volume completes the work (the first volume of which was reviewed in NATURE, 132, 694; 1933) and is provided with an adequate index covering the contents of the two volumes. The issue of a third volume comprising a general section on theories of chemotherapy has been postponed with the laudable object of preventing the book from becoming at once too bulky and too costly. The projected third volume will either appear as an independent work or be added if and when a new edition is required.

The metallic derivatives (including those of fluorine and iodine) are treated on the same plan and with the same clarity and precision as the metal-free organic compounds in vol. 1. Of special value are the introductory historical surveys of the therapeutic use of each element.

One third of the book is devoted to arsenic compounds, of which there is a very full account. Incidentally, the Styrian arsenic eaters are said to have taken the trisulphide, whereas it is generally understood that they consumed the oxide. Special sections are devoted to the compounds of antimony, bismuth, copper, silver, gold, mercury and the rare metals.

The work forms a valuable addition to the literature of the subject, and the authors are to be congratulated on its speedy completion.

*The African To-day.* By Prof. Diedrich Westermann. (Published for the International Institute of African Languages and Cultures.) Pp. xv+343. (London: Oxford University Press, 1934.) 7s. 6d. net.

THOSE who wish to know something of present-day conditions in native Africa and to understand why and how things have come to be as they are, may take up this book with confidence that what is essential will be found in its pages and for the most part told at first-hand. Dr. Westermann explains the ethnic composition of the African peoples, their linguistic affinities, and demonstrates the constituents of their culture. In the case of the last named, taking each aspect in turn, religion, social organisation, economics, material culture and the like, he shows how they have come into contact with European civilisation, the resulting modification in each instance, and its effect on native life generally. Tendencies and possibilities are carefully considered.

The book should be read in conjunction with the scheme for African research of the International Institute of African Languages and Cultures, more familiarly known as the 'Five Year Plan', to which indeed Dr. Westermann makes frequent reference. The prolegomena to that plan and Dr. Westermann's book give a plain statement of facts, which should not be ignored in the future political and economic policy of Africa.



## Surface Tension\*

By DR. ALLAN FERGUSON

OUR subject is very closely associated with the comprehensive topic of cohesion, a topic which attempts an answer—not to the problem, *why* we are here to-night, which is a matter for the theologians to discuss—but the problem, *how* we are here, in our present habits, and not as a chance medley of unattracting atoms. To attempt to answer such a query takes us very far towards the fundamentals of atomic structure and behaviour, but the problem, as we envisage it in the light of to-day's theories, still bears a strong resemblance to the problem as it was posed, and answered, by van der Waals. How comes it that, if material particles attract each other, the whole structure of the universe does not collapse under these attractions? We can formulate an answer to the question if we take into account the thermal motions of the particles. "In nature it is cohesion between atoms which tends to produce condensation and solidification, and temperature which tends to produce dissociation. . . . Temperature is a manifestation of kinetic energy and cohesion of potential energy and the interplay of these two forms of energy is responsible for many of the observed physical properties of matter" (Lennard-Jones). Cohesion and temperature—these, then, are the protagonists who play out the drama.

The main change of view during the last generation depends on the change which has taken place in our concept of the ultimate material particle and the structure of the atom. The billiard ball atom of the nineteenth century physicist served its purpose well, and subserves a useful function to-day. It is not surprising that so naïve an extrapolation of our large scale processes should ultimately break down—the surprising matter is that the extrapolation should have proved so brilliantly successful as it has done. Such a type of atom was assumed to have a definite size, and this notion of clear-cut dimensions was not lost when it was found that the concept was not fine-grained enough to interpret successfully radioactive phenomena, and the nuclear atom displaced it. Here the concept of size was associated with the dimensions of the electronic orbits and, though the atom became a far more complex system, there was no haziness about the notion, apart from the difficulty of an exact determination of its dimensions.

We have changed all that to-day. We cannot hope to locate our electrons precisely and the definite orbit of the electron of the nuclear atom is now replaced by a *probability pattern*, the density of the pattern at any point measuring the probability of finding an electron there. Fortunately, the uncertainty which we have introduced into our concepts has not seriously altered our views concerning the order of atomic magnitudes, inasmuch as the probability of finding

an electron in any particular pattern becomes infinitesimal outside regions of the magnitude of about one hundred millionth of a centimetre. We may still, therefore, keep to an interpretation of the size of an atom which, despite a little cloudiness at the edges, does not differ materially from the interpretation based on the older concepts.

What are, then, the dimensions of the atoms and molecules with which we have to deal? Any example that we may give to illustrate the meaning of such atomic magnitudes merely transforms an inconceivably small number into an inconceivably large one; let it suffice to say that if we could curb the liveliness of the hydrogen atoms and lay them in order on a sixpence, it would take some eight hundred million years of unceasing work to cover the coin, if we laid our atomic bricks at the rate of one a second.

We shall, therefore, picture a liquid as a congeries of such particles in lively thermal motion, attracting and being attracted according to a law which we need not attempt to specify more closely than by saying that the attraction of any one molecule on its neighbours falls off very rapidly as the distance increases. If then we draw round any one molecule, well in the interior of the liquid, a small sphere the radius of which we may term the range of molecular attraction, the central molecule will experience no resultant force due to the attractions upon it of its neighbours within this sphere.

It is otherwise if the central molecule is at a distance from the surface of the liquid which is less than the radius of this sphere. Part of the sphere is now outside the liquid, the molecules therein are missing, and do not contribute their share to the force on the molecule at the centre of the sphere, which molecule therefore experiences a force urging it into the liquid. To transport a molecule from the interior of the liquid into the liquid surface against such a force requires, therefore, the expenditure of *work*; and inasmuch as the conveyance of molecules into the surface means an extension of the surface, to extend a liquid surface necessitates the expenditure of work. Stretch a sheet of rubber, and notice that we have to do work to extend the rubber surface.

We must not press simple analogies too far, but it is legitimate to assume that the surface of a liquid behaves as if it were in a state of tension, and the tension in the surface across a line of unit length drawn in the surface is called the *surface tension* of the liquid. We may demonstrate its existence by forming a soap film on a circle of copper across which a loose thread of cotton has been tied. Destroy the film on one side of the thread, and the thread is pulled by the tension of the film on the other side into a very perfect arc of a circle. This tension differs for different substances,

\* From a Friday evening discourse delivered at the Royal Institution on February 16.

as we may show by pouring a little alcohol on to a thin film of coloured water at the bottom of a glass dish, and noting how a clear space is formed in the middle of the dish where the alcohol—the liquid of weaker tension—was poured in.

For any one liquid, the tension decreases with increasing temperature. We may show this by scattering lycopodium on the surface of water in a dish, and bringing a heated bit over the centre of the dish. The greater tension of the cold water is clearly shown by the way in which the central space is swept clear of the powder. Following Lord Kelvin's dictum that we know something about a quantity when we can make measurements thereon, it may not be amiss to state that the law connecting surface tension ( $\gamma$ ) with temperature ( $\theta$ ) is  $\gamma = \gamma_0(1 - b\theta)^n$ , where  $b$  is very accurately the reciprocal of the critical temperature, and  $n$ , which varies only slightly from liquid to liquid, may be assumed to have a mean value of 1.2. This relation holds good for *unassociated* liquids. A film of oil covering a thin rod breaks up into a series of regularly spaced drops, illustrating the instability of a liquid cylinder the length of which exceeds its circumference. A similar result may be illustrated for a liquid annulus by cutting a narrow circular groove on the lower surface of an iron disk, placing the disk on a horizontal glass plate and filling the groove with mercury. On lifting the disk, the ring of mercury breaks up at once into a series of regularly spaced drops.

These drops take on an approximately spherical form, and the tendency to sphericity becomes more pronounced as the drops become smaller, and those forces, such as the weight of the drop, become increasingly unimportant in comparison with the surface forces. A spherical surface is that surface which, for a given volume, has a minimum area, and this tendency to the exposure of the smallest possible extent of surface illustrates the principle that a dynamical system tends to take up a position in which its potential energy is a minimum.

Another experiment we owe to the ingenuity of Major C. E. S. Phillips. Two light vertical rods serve as supports. To the top of one is fixed a *circular* microscope cover slip with its plane horizontal; the other support carries a horizontal *square* cover slip. Two other slips, one square, one circular, carry fastened to their upper surfaces long and light straw pointers. Lay these on the top of the fixed slips, and, clearly, you can spin them round as you will. But now place a drop of water between each of the pairs of slips, and endeavour to revolve the upper movable slips. The circular one moves freely over its circular fellow and remains with its pointer pointing in any direction which you choose to give to it. Displace the square one, and it snaps back into a perfectly definite position of equilibrium in which the upper slip is exactly congruent with the lower. It is a delightful experiment, and one is tempted to say of it, *mutatis mutandis*, what Præd said of the Vicar's sermons.

These few fundamental principles, consistently applied, will serve to elucidate a great many problems in which surface energy plays a dominant part.

But we must hasten to the second part of the discourse, which is concerned with a very commonplace phenomenon—that of the detachment of a drop of liquid from a vertical tube. Study the process at any slowly dripping tap, and you will see that, although the initial stages may very easily be examined, the final stages of detachment occur with a rapidity which makes it impossible for the eye to follow them. How may we slow the process? Aniline and water are almost immiscible, and the density of aniline is but slightly greater than that of water. If, therefore, we form an aniline drop at the end of a vertical tube dipping into water, we may project the image of the drop on to a screen, and study the circumstances of its detachment with much greater ease.

Pitch is a queer substance: to forces of short duration it behaves as a solid; leave it to itself, and it will flow like a liquid. Pitch in a funnel gives a very perfect drop of pitch pendent from the stem of the funnel. It seems static enough; but although it flows, like Cæsar's Arar, *incredibili lenitate*, nevertheless it *does* flow, as a few months' inspection would show.

Yet another way in which we can slow down the process. A sheet of indiarubber is stretched, tambourine fashion, across a circular frame, and held in position by a serving of cord and a tourniquet. If water is slowly run into the tambourine, the rubber first assumes a lenticular form and then takes on a position of equilibrium in which a pronounced waist is seen in the profile of the drop. This position, impossible as an equilibrium position in a water drop, is possible here because the tension in a rubber surface increases with the extension, whereas the tension in a liquid surface is, under conditions of constant temperature, independent of the extent of the surface. This experiment was shown by Lord Kelvin at the Royal Institution in his Friday evening discourse of January 29, 1886. If his biographer ("Life of Lord Kelvin", p. 854, vol. 2) is a veracious chronicler the growth of the drop "furnished an exciting episode in the lecture, which culminated when finally the elastic film gave way and the drop burst over the lecture table, splashing the nearer members of the fashionably attired audience".

Even in 1886, it was possible to take an instantaneous photograph of the detachment of a drop of ink from a funnel; to-day the progress of high-speed cinematography has made it possible to follow the details of the process with the camera. A high-speed camera, developed in the Bell Telephone Laboratories in conjunction with the Eastman Kodak Company, makes it possible to take photographs at a normal rate of a thousand per second and, by overvolting the motor, we have been able to increase this rate to nearly two

thousand per second. Obviously at these speeds the intermittent jerking of the film through the camera is impossible, and the film hurtles past the lens at a uniform speed of close on thirty miles an hour when the motor is overvoltage. Between the lens system and the vertically descending film is a prism which can be rotated about a horizontal axis at a maximum speed of eighty thousand revolutions per minute, and this prism permits twice in each revolution of the passage of light from lens to film, and therefore exposes an image on the film for a period of the order of one five-thousandth of a second. There is no special difficulty in the illumination of the object; in all the experiments to be described a thousand watt lamp and a simple projector gave all the illumination necessary. A special feature of the camera is a two-dialled clock; one of the dials rotates once a minute and registers seconds; the other dial rotates once in a second and is graduated into five hundred divisions in such a way that thousandths of a second may be estimated. An auxiliary prism throws the images of these dials on the film, and the time relations of the phenomenon under observation may therefore be registered with very high accuracy.

Readers of the fantasies of Mr. H. G. Wells will remember that delightful story in which the hero takes a drug which temporarily alters his time-scale of living. Under its influence he writes a three-hour article at what he presumes is his normal rate; when the effect of the drug has worn off he finds that he has accomplished his task in a few minutes. He takes a walk, and notices a bee flapping its wings lazily in the wind; he accelerates his speed, and is brought up by a smell of burning—the rapidity of his motion through the air has caused his trousers to singe.

Suppose, then, we make an attempt to enter a world the time scale of which is such that we can study the manner in which a drop detaches itself from a tap—we can do this by running a film taken by the high-speed camera through the projector at a rate of fifteen or twenty pictures a second. We have altered our time scale in the ratio of about a hundred to one. In this way (Fig. 1, B) all the stages of the detachment of a drop, and the lenticular form, the waist formation, the drawing-out of a long neck and the final detachment of the drop and its accompanying satellite can be followed with the greatest ease.

But the most interesting application of kinematography of this type which I have as yet

been able to make, is the study of the beautiful phenomena described some thirty or forty years ago by Prof. A. M. Worthington, who photographed the splash of a drop of liquid into liquid, of a solid sphere into a liquid, and of a liquid drop falling on to a solid plate ("A Study of Splashes", 1908). That something odd happens

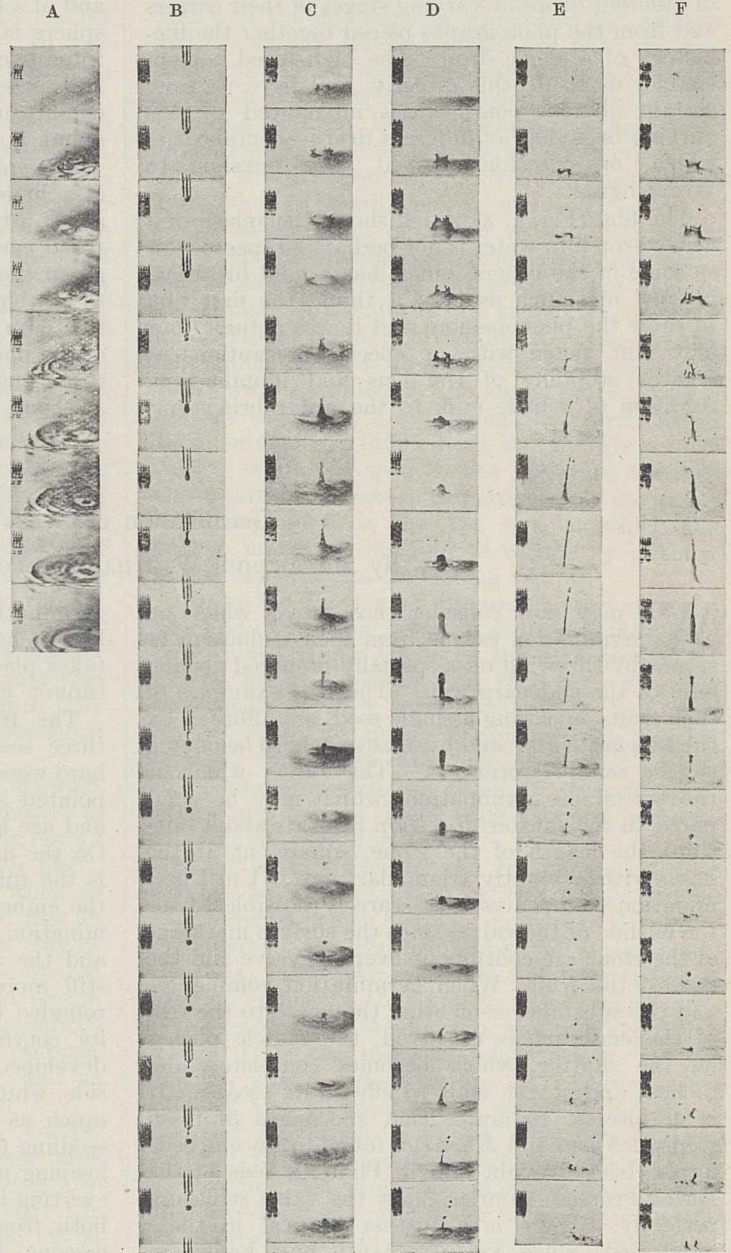


FIG. 1.

when, *ex. gr.*, a drop of water falls on a smoked glass plate is well seen on these slides, the radial striations on which show that the drop has been throwing out arms in what, at first sight, seems a very queer fashion.

Worthington investigated the phenomenon by taking an instantaneous photograph of, say, a

drop of water falling into milk at a certain stage of its fall and then, by an ingenious timing device, ensured that a second drop, released under conditions identical with those of the first drop, should be illuminated instantaneously at a stage of its fall one five-hundredth of a second later than that stage at which its predecessor was illuminated; and so on. Worthington, in fact, took photographs of different drops at varying stages of their careers and from the photographs pieced together the life-history of a single drop. The high-speed camera enables us to do this directly, and frees us from certain obvious complexities introduced by the varying behaviour of different drops—complexities which, on occasion, proved very puzzling to Worthington.

The film (Fig. 1, A) which shows the splash of a water drop into water is not perhaps so spectacular as some of the others, but it has a mild historical interest inasmuch as it is, I think, the first film to show the phenomenon, and it was actually our first film, taken with no special precautions as regards stopping of the lens and illumination. Addition of a little milk to the water brings out

the detail, and it is most interesting to note how closely the story follows that unfolded by Worthington's pictures. We see the effect of a low fall, about 40 centimetres (Fig. 1, c) and of a high fall, about a metre (Fig. 1, d), the high fall showing very beautifully the stages in the process of bubble formation on the surface of the liquid. In Fig. 1, e and f, are shown the effects of a low and of a high fall due to an ordinary rough marble sphere falling into a liquid. The whole story of these events is told in something of the order of half a second, and the slow motion projection enables us to multiply this period by a factor of about a hundred.

The splash of a drop of mercury on a glass plate is a little more difficult to follow—it is over in about a twentieth of a second, and even the high-speed camera is not quick enough to enable us to grasp the complete detail. Nevertheless, we hope to be able to speed up the camera still further, and this gain of speed, with the aid of the technique of the photographer, may make it possible to show to an audience even so evanescent a phenomenon as this.

### Germination of Seeds\*

By SIR ARTHUR W. HILL, K.C.M.G., F.R.S.

WE may now consider those seeds which on germination escape from their endocarps or stones by throwing off a specially-prepared portion only of the endocarp wall. The best examples of such fruits, enclosing a single seed, are afforded by the tupelos, *Nyssa*, and by *Mastixia*, both belonging to the family Cornaceæ. The valve, which is thrown off on germination, which may be compared to the shutter of a shop front, is about one-third the length of the stone, square-cut at the base, with a bluntly triangular apex. Until germination commences it is scarcely possible to see the outline of the valve, since the surface markings of the stone are continuous over the valve and the rest of the fruit. When germination commences and the substance cementing the valve to the rest of the endocarp is dissolved, the radicle pushes off the shutter, which becomes completely detached, and so the embryo effects its escape. It is of interest to notice that specimens of fossil seeds of *Nyssa* and *Mastixia*, found in Eocene beds in the Isle of Wight and in Pliocene beds of the Dutch-Prussian frontier, show the valve structure perfectly. There is a further interest in these fossil seeds, since *Nyssa* to-day is only known in the eastern United States, the Himalayas and the Malayan Islands, and *Mastixia* in India and the East Indies.

The cornels, *Cornus*, have fruits of a similar character, but differ in having two seeds enclosed in an endocarp, which necessitates the splitting off of two shutters, one for each embryo, when

germination commences. As in *Nyssa*, the shutter has a horizontal base, and before germination takes place the presence of the valves or shutters cannot be detected.

The fruit of *Canarium* (Bursaceæ) contains three seeds enclosed in a stony endocarp. The hard woody valves or shutters are triangular-ovate, pointed at the apex and horizontal at the base, and are about two-thirds the length of the stone. On the inside they are concave. The seed cavity is the full length of the stone and the radicle of the embryo is at its broader upper end. On germination, the radicle pushes the shutter upwards and the arch of the hypocotyl raises the shutter still more. The embryo, however, is well surrounded by its seed-coats and in order to extract its cotyledons properly a peg-like structure is developed at the apex of the radicle on the seed side, which grows over the lower edge of the stone much as in the vegetable marrow. The young seedling thus treads on the floor of its prison box, keeping it firmly on the soil, while the hypocotyl, exerting its full pressure, withdraws the cotyledons both from their own seed-coats and from their wooden, box-like prison.

The seeds of the teak tree (*Tectona grandis*, Verbenaceæ) show a similar arrangement of shutters. Here, however, there are four cavities in the endocarp and the four shutters extend nearly the whole length of the stone. When the shutters are thrown off on germination the destruction of the prison has been so complete that only the partition walls remain. *Saccoglottis*

\* Continued from p. 859.

and *Aubrya* (Humiriaceæ) may be mentioned in passing, since in them five embryos may be incarcerated, each in its separate cell. They too escape by taking down the shutters.

*Davidia*, another of the Cornaceæ, a remarkable Chinese tree introduced to cultivation a few years ago—which, when in flower, resembles a large wash of white pocket handkerchiefs hung out to dry—has the most complicated of the shutter devices for imprisoning or safeguarding the seeds. In this plant seven or more seeds may be contained in each stony endocarp and, as they lie close together, only one seedling is likely to survive owing to overcrowding, since they cannot get away from their fellows. The protection for the embryos is admirable, but almost over-ingenious, since the object in view, the propagation of the species, is somewhat defeated when so many good seedlings must eventually perish. This almost suggests a 'slum' analogy! The hard stony endocarp of *Davidia* is deeply fissured and when ripe no trace of the shutter-like valves can be seen. The shutters, however, as a cross section shows, are all prepared and ready to be loosened when the opportunity comes. The shutters are similar to those already described—some two thirds the length of the stone, long, narrow and thick, and hollowed on the inside. On germination not only is the shutter thrown off, but also a portion of the endocarp wall or rib between each shutter is shed, and this portion, no doubt, serves to cement the seeds or ovules all the more securely and hermetically in their narrow cells. As I have already mentioned, however, many of the escaped prisoners die of starvation due to overcrowding, since they are unable to move away from the neighbourhood of their former prison.

I must now direct attention to a somewhat different method of imprisonment by means of cork-like stoppers and lids. The fruit of the mare's tail, *Hippuris*, a well-known British water plant, contains a single seed, and the endocarp, which in this case is not hard and stony, is shaped like an ovoid bottle and corked at the neck by a plug or stopper of hardened tissue. It may be compared to a test tube plugged with a stopper of cotton wool. On germination, the radicle of the embryo within the cavity or tube forces out the stopper, like the ejection of a champagne cork, and so effects its escape.

The large, woody, spherical fruits of *Northea seychellana* (Sapotaceæ) show a small circular area at one end, which proves to be a cap fitting into and closing an orifice, beneath which lies the radicle of the embryo. This cap is pushed off on germination and the shoot apex is pulled out into freedom through the orifice by the lengthening of the stalks of the cotyledons which, themselves, remain within the seed.

It is when we come to examine the fruits of various members of the Anacardiaceæ, the family to which the cashew nut, mango, pistachio nut and other edible fruits belong, that we find some remarkable contrivances for the protection of the

seeds, and equally ingenious devices by which they make their escape on germination.

*Hæmatostaphis*, the blood plum of Nigeria, is an example of a stony endocarp with a lid containing a single seed. On removal of the flesh of the fruit a small lid-like structure can be seen at the apex of the stone, which forms a close-fitting stopper, hermetically sealing the orifice of the cavity in the endocarp in which lies the embryo with its radicle directly under the lid. On germination the lid separates into two halves, like a pair of doors, which are pushed aside by the emerging radicle. Before germination there is no indication that the lid is a double structure which can be thrown open for the exit of a visitor, like front doors of a millionaire's mansion!

The Kaffir plum of South Africa, *Sclerocarya caffra* and *Dracontomelon* from the East show similar devices to *Hæmatostaphis*, except that in the former, three, and in the latter five, embryos are enclosed in each stony endocarp. The cavities containing the seeds or embryos are in each case closed with a cap-like lid, in shape like a circular military cap, some 3 mm. thick, hollowed out on the inner side and thinned out at the lower corner. This is the weak spot in the armature through which external moisture can enter when the fruits are sown, and it is also the spot at which the embryo makes its attempt at escape by pushing up the cap with its developing radicle.

During the War some fruits were picked up in the East end of London, after an air raid; they were sent by the Home Office to the Pharmaceutical Society for examination and thence to Kew for determination, as it was thought they had been dropped from an enemy aeroplane with sinister purpose, since they were succulent and edible. The fruits proved to be those of *Dracontomelon sinense* and had no doubt been dropped by some sailor home from the East!

A yet more elaborate and complicated device remains to be described in this same family *Anacardiaceæ*, which has been evolved in the genus *Pleiogynium*, the Burdekin plum of Queensland, Australia. Here the seeds are not only enclosed in stony endocarps, but also to ensure more complete protection of the embryo, the middle portion of the fruit—the mesocarp—has become stony, and the stony endocarps are, in addition, surrounded and enclosed in an outer, woody box, like the proverbial pessimist who considers it essential to wear braces in addition to a belt! Here, again, the protection seems to have somewhat overshot the mark; for some twelve seeds are imprisoned in this outer turbinate, woody box (2.8 cm. in diameter), and ultimately, on germination, only one of the seedlings is likely to survive in the competition with its close neighbours.

Each stony endocarp in this enclosing box has a lower tubular portion more or less fused with the tissues of the mesocarp, and an upper cap-like portion firmly cemented to the lower part, which becomes detached on germination and is pushed

through the orifice in the mesocarp so that the embryo can emerge. The caps are somewhat similar to those of *Sclerocarya* and *Dracontomelon*, but they are triangular in section and hollowed within to contain the upper part of the embryo. In shape they resemble a French forage cap.

The extreme case of wastage of effort is that of the Brazil nut, *Bertholletia*. When you purchase Brazil nuts, you rarely, if ever, see the fruit body in which they are contained. The well-known 'nuts' are the seeds with their strong, woody seed-coat; but they are contained in a large, woody, spherical fruit some six inches in diameter, with a wall half-an-inch thick and as hard as well-seasoned oak, with a smooth, glass-like inner layer. At one end of the ball there is a small orifice firmly plugged by a stopper, and inside the 15-20 seeds are so neatly packed, with their thin edges inwards, that the hollow wooden sphere is completely filled, and no space is wasted. When conditions are favourable for germination, the seeds inside all commence to germinate at once. The orifice, half-an-inch across, however, is their only means of escape, as the fruit wall remains hard and intact. The result may be compared with the rush of a crowd on the call of "Fire" at a theatre. Everyone tries to get out at once and only one out of

the 15-20 prisoners survives! Surely this is a case where the means have defeated the end.

Tennyson may well have had the Brazil nut in mind when, referring to Nature, he wrote:

"So careful of the type she seems,  
So careless of the single life;

That I, considering everywhere  
Her secret meaning in her deeds,  
And finding that of fifty seeds  
She often brings but one to bear,

I falter where I firmly trod,"

Why should some seeds, like those of many orchids and lilies, papery in their texture and almost transparent, survive perfectly well in a dormant condition for a long period, while others need a strong protective envelope?

All these questions relating to the nature of the life in a dormant seed, whether germination may be immediate or may be long delayed, and the ingenious methods of germination, afford problems of much interest; all the more so since they are so illusive and because our attempts to solve them are confronted by so many difficulties.

## Possible Production of Elements of Atomic Number Higher than 92

By PROF. E. FERMI, Royal University of Rome

UNTIL recently it was generally admitted that an atom resulting from artificial disintegration should normally correspond to a stable isotope. M. and Mme. Joliot first found evidence that it is not necessarily so; in some cases the product atom may be radioactive with a measurable mean life, and go over to a stable form only after emission of a positron.

The number of elements which can be activated either by the impact of an  $\alpha$ -particle (Joliot) or a proton (Cockcroft, Gilbert, Walton) or a deuteron (Crane, Lauritsen, Henderson, Livingston, Lawrence) is necessarily limited by the fact that only light elements can be disintegrated, owing to the Coulomb repulsion.

This limitation is not effective in the case of neutron bombardment. The high efficiency of these particles in producing disintegrations compensates fairly for the weakness of available neutron sources as compared with  $\alpha$ -particle or proton sources. As a matter of fact, it has been shown<sup>1</sup> that a large number of elements (47 out of 68 examined until now) of any atomic weight could be activated, using neutron sources consisting of a small glass tube filled with beryllium powder and radon up to 800 millicuries. This source gives a yield of about one million neutrons per second.

All the elements activated by this method with intensity large enough for a magnetic analysis of

the sign of the charge of the emitted particles were found to give out only negative electrons. This is theoretically understandable, as the absorption of the bombarding neutron produces an excess in the number of neutrons present inside the nucleus; a stable state is therefore reached generally through transformation of a neutron into a proton, which is connected to the emission of a  $\beta$ -particle.

In several cases it was possible to carry out a chemical separation of the  $\beta$ -active element, following the usual technique of adding to the irradiated substance small amounts of the neighbouring elements. These elements are then separated by chemical analysis and separately checked for the  $\beta$ -activity with a Geiger-Müller counter. The activity always followed completely a certain element, with which the active element could thus be identified.

In three cases (aluminium, chlorine, cobalt) the active element formed by bombarding the element of atomic number  $Z$  has atomic number  $Z - 2$ . In four cases (phosphorus, sulphur, iron, zinc) the atomic number of the active product is  $Z - 1$ . In two cases (bromine, iodine) the active element is an isotope of the bombarded element.

This evidence seems to show that three main processes are possible: (a) capture of a neutron with instantaneous emission of an  $\alpha$ -particle; (b) capture of the neutron with emission of a

proton; (c) capture of the neutron with emission of a  $\gamma$ -quantum, to get rid of the surplus energy. From a theoretical point of view, the probability of processes (a) and (b) depends very largely on the energy of the emitted  $\alpha$ - or H-particle; the more so the higher the atomic weight of the element. The probability of process (c) can be evaluated only very roughly in the present state of nuclear theory; nevertheless, it would appear to be smaller than the observed value by a factor 100 or 1,000.

It seemed worth while to direct particular attention to the heavy radioactive elements thorium and uranium, as the general instability of nuclei in this range of atomic weight might give rise to successive transformations. For this reason an investigation of these elements was undertaken by the writer in collaboration with F. Rasetti and O. D'Agostino.

Experiment showed that both elements, previously freed of ordinary active impurities, can be strongly activated by neutron bombardment. The initial induced activity corresponded in our experiments to about 1,000 impulses per minute in a Geiger counter made of aluminium foil of 0.2 mm. thickness. The curves of decay of these activities show that the phenomenon is rather complex. A rough survey of thorium activity showed in this element at least two periods.

Better investigated is the case of uranium; the existence of periods of about 10 sec., 40 sec., 13 min., plus at least two more periods from 40 minutes to one day is well established. The large uncertainty in the decay curves due to the statistical fluctuations makes it very difficult to establish whether these periods represent successive or alternative processes of disintegration.

Attempts have been made to identify chemically the  $\beta$ -active element with the period of 13 min. The general scheme of this research consisted in adding to the irradiated substance (uranium nitrate in concentrated solution, purified of its decay products) such an amount of an ordinary  $\beta$ -active element as to give some hundred impulses per minute on the counter. Should it be possible to prove that the induced activity, recognisable by its characteristic period, can be chemically separated from the added activity, it is reasonable to assume that the two activities are not due to isotopes.

The following reaction enables one to separate the 13 min.-product from most of the heaviest elements. The irradiated uranium solution is diluted in 50 per cent nitric acid; a small amount of a manganese salt is added and then the manganese is precipitated as dioxide ( $MnO_2$ ) from the boiling solution by addition of sodium chlorate. The manganese dioxide precipitate carries a large percentage of the activity.

This reaction proves at once that the 13 min.-activity is not isotopic with uranium. For testing the possibility that it might be due to an element 90 (thorium) or 91 (palladium), we repeated the reaction at least ten times, adding

an amount of uranium  $X_1 + X_2$  corresponding to about 2,000 impulses per minute; also some cerium and lanthanum were added in order to sustain uranium X. In these conditions the manganese reaction carried only the 13 min.-activity; no trace of the 2,000 impulses of uranium  $X_1$  (period 24 days) was found in the precipitate; and none of uranium  $X_2$ , although the operation had been performed in less than two minutes from the precipitation of the manganese dioxide, so that several hundreds of impulses of uranium  $X_2$  (period 75 sec.) would have been easily recognisable.

Similar evidence was obtained for excluding atomic numbers 88 (radium) and 89 (actinium). For this, mesothorium-1 and -2 were used, adding barium and lanthanum; the evidence was completely negative, as in the former case. The eventual precipitation of uranium- $X_1$  and mesothorium-1, which do not emit  $\beta$ -rays penetrating enough to be detectable in our counters, would have been revealed by the subsequent formation respectively of uranium- $X_2$  and mesothorium-2.

Lastly, we added to the irradiated uranium solution some inactive lead and bismuth, and proved that the conditions of the manganese dioxide reaction could be regulated in such a way as to obtain the precipitation of manganese dioxide with the 13 min.-activity, without carrying down lead and bismuth.

In this way it appears that we have excluded the possibility that the 13 min.-activity is due to isotopes of uranium (92), palladium (91), thorium (90), actinium (89), radium (88), bismuth (83), lead (82). Its behaviour excludes also ekacæsium (87) and emanation (86).

This negative evidence about the identity of the 13 min.-activity from a large number of heavy elements suggests the possibility that the atomic number of the element may be greater than 92. If it were an element 93, it would be chemically homologous with manganese and rhenium. This hypothesis is supported to some extent also by the observed fact that the 13 min.-activity is carried down by a precipitate of rhenium sulphide insoluble in hydrochloric acid. However, as several elements are easily precipitated in this form, this evidence cannot be considered as very strong.

The possibility of an atomic number 94 or 95 is not easy to distinguish from the former, as the chemical properties are probably rather similar. Valuable information on the processes involved could be gathered by an investigation of the possible emission of heavy particles. A careful search for such heavy particles has not yet been carried out, as they require for their observation that the active product should be in the form of a very thin layer. It seems therefore at present premature to form any definite hypothesis on the chain of disintegrations involved.

<sup>1</sup> E. Fermi, *Ricerca Scientifica*, 1, 5, 283; 6, 330. NATURE, 133, 757, May 19, 1934. E. Amaldi, O. D'Agostino, E. Fermi, F. Rasetti, E. Segre, *Ricerca Scientifica*, 8, 452; 1934.

## Obituary

SIR ROBERT CARLYLE, K.C.S.I., C.I.E.

ALTHOUGH even now natural science finds no place as a compulsory subject in the competitive examinations for the higher ranks of the public service, nevertheless the Indian Civil Service has often included in its ranks a few staunch supporters of the man of science. In this select band the late Sir Robert Warrand Carlyle, a kinsman of the 'sage of Chelsea', whose death in his seventy-fourth year occurred at Florence on May 23 last, takes an honoured place. Four years ago he was seriously injured by a motor-lorry in Essex, an accident which was followed by repeated attacks of pernicious anæmia which even his robust constitution could not long withstand.

Educated at the University of Glasgow and Balliol College, Oxford, Carlyle passed the Indian Civil Service Examination in 1878 and was duly posted to Bengal. In 1894 he reached the rank of magistrate and collector and served for many years in the District of Darbhanga, in which in 1904 Lord Curzon founded the Pusa Agricultural Research Institute. After eight years' service as a district officer he was called to headquarters at Calcutta, first as Inspector General of Police and then as Chief Secretary to the Government of Bengal.

In 1907 Carlyle was selected for service under the Government of India as Secretary to the Department of Revenue and Agriculture, and for the next three years came in the closest touch with most of the scientific workers employed by the Central Government, both administratively and also as chairman of the Board of Scientific Advice.

With characteristic thoroughness, Carlyle applied himself to a close study of these somewhat unfamiliar activities, and also made a point of getting into personal touch with the workers themselves. In this latter task he was greatly assisted by Lady Carlyle, who took a deep personal interest in her husband's work and freely devoted her great social gifts to the entertainment of a constant stream of official visitors, many of whom were connected with some branch of science. After three years' service as Secretary, Carlyle was promoted in 1910 to a seat in the Viceroy's Council, his charge including the Department of Revenue and Agriculture and also the Public Works portfolio, an appointment he held until his retirement in 1915.

Carlyle was thus closely connected with the scientific activities of the Government of India for an unbroken period of eight years, during which he was particularly interested in agricultural research. He was a great friend to the Pusa Research Institute, which he visited on many occasions, and he also found time to attend the meetings of the Board of Agriculture. Under his fostering care the Institute developed with great

rapidity: the workers were constantly encouraged to give of their best. The agricultural departments in the provinces were not forgotten. Large sums of money were placed at their disposal for extensive seed farms for the production of pure seed of the new varieties of wheat created at Pusa and at other centres. A new cane-breeding station was founded in South India at Coimbatore.

Carlyle did much to foster and promote the co-operative credit movement and to bring about effective liaison between its officers and those of the agricultural departments working in the Districts. Other interests included the encouragement of the Indian Science Congress, the meetings of which his officers were permitted to attend while on duty, and at which they were given the greatest freedom in the reading and discussion of papers. Carlyle was always insistent that the scientific workers under the Government of India should look upon themselves as free and independent investigators and not as members of a bureaucracy.

The well-being of agricultural research and the development of the co-operative credit movement were only two of Carlyle's interests. He did much to encourage the scientific study of forestry; he took a deep interest in the Survey of India and in the planning of New Delhi. In these and other similar activities, the scientific workers concerned always found in him a sympathetic and responsive chief and one who spared no pains to understand their point of view and to make them feel that, so far as in him lay, they could rely on getting a square deal.

DR. J. D. GIMLETTE

DR. JOHN DESMOND GIMLETTE, whose death on April 24 we regret to record, was born on February 28, 1867. After gaining medical qualifications (M.R.C.S., L.R.C.P., London), as from St. Thomas' Hospital, he at first designed entering practice in the English colony at Lisbon. Later he joined the medical service of the Federated Malay States (Selangor, Perak and Pahang), eventually becoming Residency surgeon for Kelantan and Kota Bharu.

In Malaya, Dr. Gimlette soon became interested in native medicaments and poisons, a subject which occupied him up to the end. In Kelantan, a region little tainted by Western influences, his opportunities were enhanced by innate knowledge of the language and by the confidence which his frank and sympathetic nature impressed on the Malay. Jealous in regard to native secrets, they allowed him to witness, for example, mysteries such as those of Main Peteri, which are recounted in his work "Malay Poisons and Charm Cures" (Third edition, 1929. London: Churchill).

Though much had been done botanically by Ridley, Burkill, the workers at Buitenzorg



amongst others, by his medical knowledge Dr. Gimlette was to forge a link between the plant as such and as a drug. A happy collaboration with Mr. I. H. Burkhill led to the publication of a translation of the "Malay Book of Medicine" by Inche Ismail (*Gardens Bulletin*, Singapore, 6, 1930); to this is appended a 'catalogue raisonnée' of very great value. Thereafter, in conjunction with Messrs. Skeat and Thomson, he started on a more comprehensive and ambitious work to be entitled 'The Malayan Medical Dictionary'. This work, though more than half done, is interrupted by his death; however, it is hoped that his collaborators will be able to complete it without undue delay. He was also the author of many minor contributions on medical subjects. During the War he was in charge of a hospital ship (*Essiquibo*).

From his retirement from active service, Dr. Gimlette was condemned to a sedentary life through the unfortunate loss of a leg from intense erysipelatus infection, but he stuck to his self-imposed tasks with courage and pertinacity. With the cardinal virtues of sincerity and thoroughness, no more loyal or lovable friend could be

found, and there are very many who mourn his loss, whilst admiring his constancy of purpose in good and in failing health, though withal cheerful and of good heart.

A final note of sympathy must be struck for his devoted widow, two small daughters, his sisters and other relatives. H. E. DURHAM.

WE regret to announce the following deaths :

Dr. E. W. Nelson, chief of the U.S. Federal Bureau of Biological Survey, known for his work on the birds and mammals of North and Central America, on May 19, aged seventy-nine years.

Sir Walter P. Buchanan-Riddell, Bt., principal of Hertford College, Oxford, in 1922-29, chairman of the University Grants Committee, on June 5, aged fifty-five years.

Mr. J. J. Fahie, author of several standard volumes on the life and work of Galileo, on June 12, aged eighty-seven years.

Maj.-Gen. George O. Squier, K.C.M.G., member of the U.S. National Academy of Sciences, known for his work in connexion with electrical communications, on March 24, aged sixty-nine years.

## News and Views

### International Conference on Physics

A MEETING of the International Union of Pure and Applied Physics will be held in October next in London and a joint conference will be held with the Physical Society, under the presidencies of Prof. R. A. Millikan and Lord Rayleigh. The last meeting of the Union took place in 1931 at Brussels (see NATURE of September 19, 1931, p. 485), when an invitation from the Royal Society to meet in London was withdrawn in order to enable the Union to accept the American invitation for a meeting at Chicago at the Century of Progress Exhibition in 1933. Prof. R. A. Millikan was elected president, but on account of economic conditions the meeting was cancelled and the Royal Society renewed its invitation to meet in London. The invitation was accepted and the meeting will be held on October 1-6. The work of the Union will include consideration of the report of the Commission on Symbols, Units and Nomenclature appointed at its last meeting. The Commission, under the chairmanship of Sir Richard Glazebrook, has dealt with electrical, calorimetric and thermometric units and work has also been done in connexion with radiometric and acoustical units. Dr. Hales' committee on Instruments and Instrumental Methods will, it is anticipated, desire to consult the Union on a number of questions. Apart from this formal business, it was felt that the occasion should also be utilised for international discussion on a subject or subjects now attracting general interest; certain aspects of the solid state of matter were suggested as suitable.

THE Physical Society had already decided to hold a Conference on Nuclear Physics and it was agreed to combine the two proposals. Thus the meeting will

take the form of an International Conference, on the joint invitation of the International Union and the Physical Society, under the presidencies of Prof. Millikan and Lord Rayleigh; the details are being arranged by a committee representing the two bodies. The discussion on nuclear physics will be opened by Lord Rutherford with a general survey of the subject. Subsequent papers will deal with cosmic radiation,  $\beta$ -ray transformation of radioactive elements, artificial transmutations by  $\alpha$ -rays, neutrons, protons and diplons and new types of radioactivity, and the constitution of atomic nuclei. Sir William Bragg will deliver an opening survey in the discussion on the theory of the solid state of matter. Papers on interatomic forces will be divided into three groups dealing with electrovalent linkings, covalent linkings and van der Waals attractions; as special consideration will be given to the action of these forces in metals at the Aberdeen meeting of the British Association, this particular section of the subjects will not be so fully considered at this discussion. Another group of papers will deal with the possible existence of a secondary structure in crystals, coarser than the fine structure detected by X-rays, and its relation to physical properties. The names of delegates of national unions adhering to the International Union of Physics should be sent to the secretaries of the Conference not later than August 1. Invitations are being sent to a number of physicists known to be interested in these subjects; others desiring to attend should send in their names not later than September 1. All communications should be addressed to the Secretaries, International Conference on Physics, Royal Society, Burlington House, London, W.1.

### Memorial to Sir Walter Morley Fletcher

THE public life of Great Britain suffered a loss of more than common magnitude through the death of Sir Walter Morley Fletcher, first secretary of the Medical Research Council, on June 7, 1933. He was then in his sixtieth year and in the height of those powers which he had used without stint in the advancement of knowledge for the relief of human suffering. Walter Fletcher gave richly to the common weal, and it is fitting that some worthy tribute of an enduring kind should be paid to his memory. An appeal has therefore been issued over the signatures of the Lord President of the Council, the president of the Royal Society and representatives of aspects of science and medicine with which Sir Walter Fletcher was particularly associated. It is considered that the tribute should consist in the first place of a personal memorial, and secondly of the inception of some scheme for the furtherance of the cause which Sir Walter Fletcher had so much at heart. It is therefore proposed first to commission a portrait bust, to be placed in a suitable setting in the entrance hall of the National Institute for Medical Research, at Hampstead. The remainder of the sum collected will then be used as a fund for building—at the farm premises of the National Institute at Mill Hill—a Walter Fletcher Laboratory, to be devoted particularly to those nutritional studies in which he was so keenly interested. This will not only provide an appropriate memorial, but also it will make an urgently needed contribution to the national equipment for work in what is at present among the most important of all branches of medical research. All subscriptions should be sent to the Secretary, Fletcher Memorial Fund, 38 Old Queen Street, Westminster, S.W.1.

### Telford Centenary Exhibition

THOMAS TELFORD, the distinguished civil engineer, died at his house at 24 Abingdon Street, Westminster, on September 2, 1834, at the age of seventy-seven years, and a few days later was buried in the nave of Westminster Abbey. For the last thirteen years of his life he was president of the Institution of Civil Engineers, and in connexion with the centenary of his death the Institution has arranged an exhibition which was open for inspection at the conversazione this week and will remain open each day at 10 A.M.—5 P.M. until June 22. The materials for the exhibition have been gathered together mainly through the efforts of Sir Alexander Gibb, whose forbears were associated with Telford in some of his works. Telford's whole life was devoted to engineering works of national importance, and his steady rise from a stone mason, working on Somerset House, to the head of his profession, was due to his wide knowledge, energy and sound judgment. He constructed many hundreds of miles of roads, more than a thousand bridges, some of the most important canals in Great Britain and also did valuable work on harbours. His most famous works included the Ellesmere Canal with the great Pont Cysylltau Aqueduct, the wrought iron suspension bridge over the Menai Straits and St.

Katherine's Docks. He took the liveliest interest in the formation and growth of the Institution of Civil Engineers, presenting to it a collection of books for the formation of a library and bequeathing to it several thousands of pounds. The exhibits collected for the occasion of his centenary relate to nearly all his activities and include plans, drawings, reports, note books, letters, portraits, etc. A carefully annotated catalogue has been prepared which itself forms a valuable addition to the material relating to the great engineer.

### History of Derbyshire Industries

THE Newcomen Society held its summer meeting in Derbyshire on June 6–9, and the members were able to pay visits to many interesting works. These included the Old Crown Derby China Works, the quarries of the Clay Cross Lime Co., the hosiery works of Messrs. George Brettle and Co., Ltd. and the Mill Close Lead Mine, Darley Dale. At various places, some interesting machines and engines were inspected and at the works of the D.P. Battery Co. two very fine water wheels were seen. After the Society's dinner on June 7, two papers were read, one on the High Peak Railway, and the other on the history of some Derbyshire industries. The latter was by Mr. Rhys Jenkins, who gave in it brief reviews of the lead, iron and other industries from the earliest records. Lead mining and smelting was carried on in Derbyshire by the Romans, and a number of pigs of lead with Latin inscriptions have been found. It is stated that there are no fewer than 4,000 disused lead mines in the county, and that some seventy years ago the output was 4,000 tons per annum. The lead smelting works near Lea appear to be the last in the county. Definite evidence of iron working go back to the twelfth century, and Mr. Jenkins traced the development from that time onwards. One interesting feature was the records of distinct industries in various localities, chains being made in one place, sickles and scythes in another, and so on. About a century and a half ago, there was a flourishing industry at Hartshorn, when hundreds of gross of wood screws were made weekly. Of Lombe's famous silk mill erected two centuries ago, nothing now remains; but its erection was an outstanding event in the history of machine building.

### High Speed Precision Photography

AN interesting demonstration was given on June 12 of a new development in the taking and timing of serial photographs of objects moving at high speed. The apparatus, which is easily portable, is the combined work of the Western Electric Co. and Kodak Limited. It was demonstrated that 2,500 exposures per second could be made of objects in normal daylight or illuminated with ordinary  $\frac{1}{2}$ -watt type lamps on the standard small size Kodak film. The interest in the camera lies in its extreme simplicity. As the film has to move across the focal plane with speeds up to 50 feet per second, the usual intermittent motion must be dispensed with and a uniform motion substituted. Mounted between the lens (Kodak

anastigmat  $f/1.8$ ) and the film is a small slab of glass which rotates about an axis parallel to its own plane and passing through the middle of the slab. This gives a lateral motion to the image in the same direction as that in which the film is moving. Exposure is only allowed when the slab is approximately normal to the optic axis, when the lateral speed of the image will be  $\omega T (\mu-1)/\mu$ , where  $T$  is the thickness of the slab and  $\omega$  its angular velocity. There is no mechanical shutter other than the mounting of the slab, which intercepts the light twice for every complete revolution, and this combined motion of film and image takes the place of the more usual motion hitherto adopted. The image of a moving dial is projected on to the corner of each exposure by an accessory internal optical system. The motion of the dial is controlled independently by a 200-fork controlling a synchronous motor. The time spacing on the image can be read to  $\frac{1}{10000}$  sec. The demonstrations of muscular reaction times and of splashes were extremely good, but it was noticed that in the comparatively simple image of a falling steel ball, there was a slight elongation.

#### International Broadcasting Union

THE International Broadcasting Union (or the Union Internationale de Radiodiffusion—to use its official title) is making its first official visit to Great Britain at the meeting which is being held in London from June 12 until June 20. The issue of *World Radio* of June 8 contains a series of articles describing the organisation and work of the Union. When the Union was founded in London in March 1925, eight European countries were represented, and according to the minutes of that meeting it was estimated that the broadcasting stations in Europe at that moment radiated a total energy of 80 kilowatts, of which 43 kilowatts emanated from stations in Great Britain. At the present time, in the tenth year of the Union's existence, twenty-five countries have members within the Union and the radiated energy of more than 250 stations included within what is officially recognised as the European zone is about 4,250 kilowatts. The particular function of the Union with which the listening public is probably most familiar is that of 'policing the ether'—in other words, maintaining the wave-lengths of stations so far as possible uninterrupted by those of other stations.

THIS, however, is only one of many useful and essential duties performed by the Union with the aid of commissions dealing with legal, programme, relay and technical matters. In the course of its work, a spirit of co-operation has been established among the European broadcasting authorities as a result of their common membership of the Union, and in addition strong and valuable links have been forged with the broadcasting organisations of other continents, notably the great American chains and the corporation which controls Japanese broadcasting. Moreover, the Union has striven throughout its existence to promote that good understanding between nations, which is one of broadcasting's most valuable contributions to national life. Since

the inception of the Union, the president of the Council has been Sir Charles Cappendale, one of the controllers of the B.B.C., while Mr. A. R. Burrows, a pioneer of British broadcasting, has filled the post of secretary-general in a popular and efficient manner at the Geneva office of the Union.

#### British Antarctic Expedition

SOME further details of Mr. J. R. Rymill's forthcoming antarctic expedition are published in the *Geographical Journal* of June. It is hoped to leave Great Britain early in September in the *Penola*, a three-masted topsail schooner of about 200 tons with a length of 112 ft. The *Penola*, which is fitted with a 100 H.P. Diesel engine, was built in 1908; she is of oak, and is now being reconditioned and sheathed with greenheart at Southampton. A De Haviland Puss Moth aeroplane, capable of carrying three men, or two men with a survey camera, is being taken. Sixty dogs from West Greenland and twelve sledges will be carried. Messrs. Hampton and Stephenson, with the dogs and much of the equipment, will leave for the Falkland Islands in July, and Mr. Rymill with the rest of the expedition sailing in the *Penola* will meet them there in October. *Discovery II* is to assist in the transport of stores as far as Deception Island. Beyond that, the plans of the expedition will depend on the state of the ice, but it is hoped to set up the base house on Hearst Land in order to explore east and west by sledge. It may, however, be necessary for the ship to return to Deception Island if no good harbour is found in the far south. The expedition proposes to return to England in May 1937.

#### Jubilee of the Society of Dyers and Colourists

COMMEMORATING the foundation, fifty years ago, of the Society of Dyers and Colourists, a jubilee issue of the Society's *Journal* has recently been published. Of the twenty-two articles which it contains, some are reviews of the advances which have been achieved during that time, and others deal chiefly with the present state of knowledge in various departments of the science and art of dyeing. A foreword is contributed by Prof. G. T. Morgan who, as an active worker in dye chemistry and as president of the oldest chemical society in the world, refers to the rise of the British colour industry and to the means whereby Parliament has safeguarded its growth. Mr. J. Huebner contributes an interesting account of the early history of dyeing, and Mr. A. H. Brewin sketches the history of the Worshipful Company of Dyers, London. Prof. A. G. Green discusses landmarks in the evolution of the dyestuff industry during the past half-century, and Dr. H. Levinstein contributes some pertinent observations on British patent laws. Articles on the constitution of cellulose by Prof. W. N. Haworth, on substitution in the benzene nucleus by Prof. R. Robinson, and on the relation between the constitution and substantivity of dyes by Prof. P. Ruggli serve as a reminder, should any be necessary, of the close dependence of a successful chemical industry on researches in 'pure' chemistry. Among the other articles, no less interesting because

of a technical character, are accounts of progress in various dyeing, cleaning, bleaching and finishing operations applied to textiles, furs and leather, and a review of the chemistry and technology of rubber and synthetic resins. The price of the special issue is 25s., but members of the Society may purchase one copy at a privilege price.

#### The National Physical Laboratory

THE report of the National Physical Laboratory for the year 1933 is a quarto pamphlet of 264 pages and 50 figures, many of them plates, and provided with an index of 10 pages. The condition of industry has reduced the demand for routine tests of instruments and for investigation of problems of manufacture, but the research programmes of the Executive Committee and of the Boards and Committees of the Department of Scientific and Industrial Research have been pressed forward. An important and promising method of bringing provincial industries into touch with the Laboratory has been tried during the year, by the senior members of the staff lecturing on the general work of the Laboratory and on specific problems of local industries at many large towns in the country. Each department of the Laboratory provides its report, and each report contains matter of great interest which is well illustrated by figures and easily followed. The Radiology Division has, for example, investigated the effect of heat treatment on metals which have been cold-worked previously, and finds that a magnet steel retains its magnetic properties better when in a state of strain than when the strain is relieved by heat treatment, and that transformer steel is the better for being free from internal strain. On one hand, the Department has tested for internal flaws two Diesel engine connecting rods of 4-in. diameter, and on the other, for the Medical Research Council, the structure of human teeth.

#### Quieter Motor-Cars

A RECENT report by Science Service gives a résumé of the discussions during the annual general meeting of the Society of Automotive Engineers at Detroit. It was stated that in the earlier days of motoring the thrill of passing another motorist was incomplete unless your motor had a louder and deeper roar than his. Now motorists are worried even by the amount of noise their tyres make. Modern car mechanisms are so improved that at speeds below 40 miles an hour this noise is clearly audible. In fact some motorists utilise it to keep the speed constant. The low buzz or flutter is due to the trapping of air in parts of the tyres. Noise in motor-cars can be eliminated in two ways, either by absorption or cancellation by interference. In mufflers which absorb sound, the sound energy is converted into heat by resonators owing to the friction of waves passing through small holes and the use of porous materials. Mufflers that depend on wave interference get one part of the sound in opposition in phase with the other, so that they partially cancel. One new type of muffler passes part of the exhaust gas

through a venturi tube and it then operates the windshield cleaner. A silencer which utilises both resonance chambers and absorbing materials is sometimes effective in preventing intake noise (power roar). The noise to passengers can be considerably reduced by padding the bodies of the saloon by sound absorbing material in the same way as the acoustical properties of radio studios can be improved. One result of making motor-cars quieter is that the driver often unconsciously increases the speed.

#### Venereal Disease in Literature

IN a paper on this subject read on May 30 before the Medical Society for the Study of Venereal Diseases, Dr. J. D. Rolleston said that in no department of medicine is a knowledge of the lay writers on the history of the subject more necessary than in the domain of venereal disease. The information furnished by poets, dramatists, novelists and historians forms a valuable supplement to that derived from the study of contemporary medical works. In a survey of non-medical literature from the earliest times down to the present day containing any references to the three principal venereal diseases, Dr. Rolleston came to the following conclusions. There is no definite evidence that syphilis existed in Biblical times, classical antiquity or the Middle Ages. In striking contrast with the absence of any certain reference to the existence of syphilis in Europe before 1495, an immense amount of literature, lay as well as medical, dealing with the new disease followed that date. On the other hand, gonorrhoea, of which the first description is in Leviticus, dates from remote antiquity, but for about 250 years was identified with syphilis, the popular monosyllables for the two diseases being applied indiscriminately in lay literature to syphilis or gonorrhoea. Chancroid was probably as old as gonorrhoea and was well known in classical antiquity and the Middle Ages.

#### Human Sterilisation

THE April number of the *Eugenics Review* is largely devoted to the subject of sterilisation. Major Leonard Darwin makes a detailed analysis of the report of the Departmental Committee known as the Brock Report, Dr. E. Mapother discusses the necessary safeguards in eugenic sterilisation and Prof. Hans Maier of Zurich contributes an article on practical experience of sterilisation in Switzerland, where it has been practised in certain cantons under medical supervision for more than fifty years. The legal aspects of sterilisation in Great Britain are discussed by Mr. Cecil Binney, and Dr. C. C. Hurst contributes a paper on the genetics of intellect. An account is also given of discussions in the House of Commons, and the speech of Mr. Hugh Molson, M.P., in moving that H.M. Government give immediate consideration to the recommendations made unanimously by the Committee is reproduced in full. In all cases, emphasis is laid upon the need that sterilisation should be voluntary, and with proper safeguards, as any element of compulsion defeats its own ends.

### Cancer Research

IN March 1933 the International Cancer Research Foundation, established by Mr. William H. Donner of Philadelphia, awarded a sum of £1,000 per annum for a period of two years to the Research Institute of the Cancer Hospital (Free), London, in support of investigations into factors which underlie the origin of malignant growths. This grant has provided two research scholarships which are held by G. A. D. Haslewood, who is working with Dr. J. W. Cook in the Research Institute, and by Miss Edna Roe, who is studying the molecular structure of carcinogenic compounds by physical methods, under Dr. Mayneord in the Physics Section of the Radiological Department of the Cancer Hospital. The grant has also defrayed a part of the cost of this work. Under the direction of Dr. Cook, Haslewood has recently prepared a very active cancer-producing compound, methylcholanthrene, from another compound, deoxycholic acid, which is known to occur in the human body. To assist in further developments of this work, the Trustees of the International Cancer Research Foundation have now decided that this grant shall be continued for an additional three years, until June 1, 1938.

### Ross Institute Industrial Advisory Committee

DETAILS of the activities of this Committee in promoting health in the tropics are given in the report of a meeting held on March 27, with Mr. G. H. Masefield in the chair. As a result of health measures introduced in the copper mines of Northern Rhodesia, at Zambezi Bridge, and in the tea gardens in Assam, sickness due to malaria has been much reduced. Dr. McCombie described an experiment in a tea garden with the drugs atabrin and plasmoquin as preventives of malaria, with a saving of 1,941 sick-days among the coolies, but the treatment is too costly to be a business proposition (11 annas per head). On the same estate anti-mosquito-larval measures proved much cheaper (2.6 annas per head), and resulted in a saving of 7,068 sick-days. Reference was made to the 'eye-fly pest' in India and Ceylon, caused by numbers of a small fly (*Microneurum funicola*) which settle upon the eye, and by the bacteria which they carry induce ophthalmia. The breeding habits of this fly have still to be discovered, but by providing infected cases with wire gauze spectacles, these epidemics may be controlled in large measure by preventing carriage of infection.

### Official Chemical Appointments

THE Institute of Chemistry has recently issued the eighth edition of the "List of Official Chemical Appointments" (Institute of Chemistry, 30 Russell Square, London, W.C.1. 1934. Price 5s.). Since the seventh edition was published three years ago, much revision has been necessary; but the list is now a useful, up-to-date compendium of official appointments. It consists of a list of official appointments in Great Britain, Northern Ireland and the Irish Free State; a list of appointments in the British Dominions, Colonies, Protectorates, Egypt

and the Sudan Provinces; information concerning societies and institutions devoted to chemical interests; and statutes, orders, etc., which affect official chemical appointments. Names of university professors, lecturers and demonstrators, and public and secondary school masters are also included. There are indexes of names and places respectively. A full contents, classified, and with each group arranged alphabetically, renders a general index unnecessary. This is a useful list, well arranged, so that reference is an easy matter.

### Pollen Carried by Dust Storm

MR. O. C. DURHAM, chief botanist of the Abbott Laboratories in North Chicago, exposed collecting slides through the period of the remarkable dust storm recently experienced in the United States. His collections, as a result of the examination of these slides, indicate a fall of some 34.7 tons of dust per square mile, of which no less than 3.4 tons would be represented by oak pollen. This percentage of pollen certainly seems a striking phenomenon and has its interest in connexion with the use made of pollen distribution in strata of vegetable remains, as an indication of the vegetation in these areas at the period when the remains were deposited. Mr. Durham's observations are reported by Science Service, Washington, D.C., under date May 14.

### Micrometer Scales on Photomicrographs

IN the May issue of *Watson's Microscope Record*, J. A. Lord pleads for the inclusion of a scale of measurement on each published photomicrograph, so that a visual estimate of the size of the objects represented is readily possible. He also points out the desirability of including such a scale of measurement on lantern slides made from photomicrographs so that, irrespective of initial or final magnifications, the dimensions of the objects can be estimated as seen on the screen. Appended to his article is a convenient form of scale by the aid of which a micrometric scale, correct for each given magnification, can quickly be marked upon a photograph or a lantern slide.

### Greenland Whale at the Natural History Museum

THE skeleton of a Greenland whale, which has been presented by the president and council of the Royal College of Surgeons to the trustees of the British Museum, has been removed from the College and will shortly be erected in the new Whale Hall at the Natural History Museum. The specimen was originally purchased by the College in 1864 from Prof. Reinhardt, of Copenhagen. Although the Greenland whale is commonly used as a textbook example of the Cetacea, complete skeletons of this species are very rare in museums, and in Great Britain there appears to be a record of only one other, a young one, which is in the Anatomical Museum of the University of Edinburgh.

### The Men of the Trees

THE ninth annual report of this voluntary society, which attempts to bring together those interested in trees, their planting, cultivation and protection,

shows that it is still active and growing in membership ("The Men of the Trees." Ninth Year's Report and Review of the Tree Year 1933. Pp. 36+4 plates. London: Hon. Secretary, 32 Warwick Road, S.W.5. 6d.). Whilst the death duties cause the break up of many old well-wooded estates and realisation upon their timber, the Forestry Commission still suffers under a cut of £400,000, so that its planting programme is inevitably cut down. Under these conditions, there is ample room for the activities of this society, which in its ninth annual report gives an extensive account of an important statement upon the position of forestry in the Empire made at the annual meeting of the society by Prof. Troup, of the Imperial Forestry Institute, Oxford.

#### Works on Astrology and Alchemy

AN interesting catalogue of second-hand books on astronomy, astrology, alchemy and the occult sciences has recently been published by Émile Offenbacher, 10 Rue Pasquier, Paris, 8<sup>e</sup>. Among the more attractive items may be noted the first Italian edition of Euclid, with a commentary by Tartaglia (1543), a first edition of Galileo's "Istoria e dimostrazione intorno alle macchie solari" (1613), a second edition of Reisch's "Margarita philosophica" (1504), a copy of Thomas Radini's "Sideralis abyssus" (1511), and the first edition of Kertzenmacher's "Alchimia" (1538). A score of books on the Rosy Cross are included, and all the items appear to be very moderately priced. Bibliographical notes are given in sufficient detail, a feature which, with the numerous illustrations, will make the catalogue a useful book of reference even when the books it describes have found scattered homes in the libraries of collectors. We hope that M. Offenbacher will give us further catalogues of the same kind, for they represent a real contribution to the history of science.

#### Announcements

THE Albert Medal of the Royal Society of Arts for 1934 has been awarded to Sir Frederick Gowland Hopkins, president of the Royal Society, for his researches in biochemistry and the constituents of foods. The medal is awarded annually "for distinguished merit in promoting arts, manufactures, or commerce".

PROF. A. C. SEWARD, professor of botany in the University of Cambridge, has been elected a foreign member of the Botany Class of the Royal Swedish Academy of Sciences.

SIR FREDERICK GOWLAND HOPKINS will unveil a plaque to William Hyde Wollaston at 14 Buckingham Street, W.1, on Wednesday, July 4, at 3.30 p.m.

PROF. P. L. MERCANTON, professor of meteorology and geophysics in the University of Lausanne, has been appointed director of the Central Meteorological Station of the Commission fédérale suisse de Météorologie, in succession to Dr. J. Maurer, who has recently retired.

THE following appointments in the Colonial agricultural service have been made by the Secretary

of State for the Colonies: Mr. A. K. Briant, to be agricultural superintendent, St. Vincent; Mr. M. Halerow, to be agricultural officer, Kenya; Mr. N. M. Wight, to be district agricultural officer, Tanganyika; Mr. H. W. Jack (economic botanist, Federated Malay States), to be director of agriculture, Fiji; Mr. F. L. Squibbs (assistant agricultural officer, Dominica), to be director of agriculture, Seychelles.

It is announced in the *Times* of June 9 that the Belgian National Scientific Research Fund has made a grant of 750,000 francs (more than £7,100) for the erection in Brussels of the Albert Library in memory of the late King of the Belgians. The Société Financière Mutuelle Solvay has subscribed 500,000 francs.

ADVISORY leaflets on matters of interest to farmers, recently issued by the Ministry of Agriculture and Fisheries, include one on the use of seaweed as manure, pointing out its special value for crops which require a large amount of potash and are benefited by salt. Other leaflets deal with birds of agricultural significance (more or less); they include the kestrel, landrail and nightjar. Another describes the activities, life-history and control of the turnip gall weevil.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A principal of the Municipal Technical College, Halifax—The Education Officer, Education Offices, West House, Halifax (June 18). An assistant master to teach surveying and general science at the Pontardawe Mining and Technical Institute—The Director of Education, County Hall, Cardiff (June 18). A teacher of botany and chemistry at the Ashford and Folkestone Technical Institutes—The Principal, Technical Institute, Ashford (June 22). A lecturer in chemistry at Chesterfield Technical College—The Clerk to the Governors, Technical College, Infirmary Road, Chesterfield (June 23). A City electrical engineer for Plymouth—The Town Clerk, Municipal Buildings, Plymouth (June 25). A mining instructor at the County Secondary School and Cumberland Technical College, Workington—The Principal (June 23). A teacher of general chemistry at the Northern Polytechnic, Holloway, London, N.7—The Clerk (June 27). A veterinary officer to the County Borough of Wallasey—The Town Clerk, Town Hall, Wallasey (June 28). A junior lecturer in electrical engineering at the Military College of Science, Red Barracks, Woolwich, S.E.18—The Commandant (June 30). A district agricultural organiser for the East Anglian Institute of Agriculture, Chelmsford—The Clerk of the Council, County Hall, Chelmsford (July 2). An assistant lecturer in anatomy and an assistant lecturer in physiology at the University College of South Wales and Monmouthshire, Cardiff—The Registrar (July 7). A teacher of domestic science at the Princess Mary's Village Homes (Home Office 'Approved' School), Addlestone, Surrey—The Secretary. An assistant lecturer in mathematics at University College, Hull—The Registrar. A second assistant port engineer to the Basrah Port Directorate, Iraq—The Crown Agents for the Colonies, 4, Millbank, London, S.W.1.

## Letters to the Editor

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

The Factor  $\frac{137}{136}$  in Quantum Theory

It has been suggested by W. N. Bond<sup>1</sup> that, in some or all of the attempts to determine  $e/m$  experimentally, the quantity actually found is  $\frac{136}{137} e/m$ ; for if the experimental results are corrected in accordance with this hypothesis, they are found to be in satisfactory accordance with my theoretical values of the fine-structure constant (137) and mass-ratio (1847.6). R. T. Birge<sup>2</sup> has confirmed this; and, quoting three important recent determinations of  $e/m$ , he has shown that the agreement is extremely close.

On theoretical grounds it seems likely that Bond's hypothesis is right. In my earliest paper on the subject<sup>3</sup>, I gave the value of the fine-structure constant as 136, since I found the Coulomb energy of two elementary particles to be  $1/136r$  in natural quantum units. This energy was  $\frac{137}{136}$  times too large, because I had not allowed for the 137th degree of freedom arising from the indistinguishability of the particles. Bond's hypothesis implies that I am not the only victim of this mistake; current quantum theory in deriving from observational data the proper-energy or mass  $m$  of an electron has also obtained an energy  $\frac{137}{136}$  times too large. If so, the cause is presumably the same, namely, neglect to take into account the degree of freedom due to indistinguishability.

There is nothing mystical in the effect of indistinguishability. It occasions, not an objective difference of behaviour, but a difference in what we can ascertain about the behaviour, and hence a difference of treatment. In the dynamics of two particles, we have to describe the change with time of the positions, momenta and spin-components (or of a probability distribution of them) of the particles which we call No. 1 and No. 2; and also we have to describe a growing uncertainty whether the particle, called No. 1 at the time  $t$ , is the original No. 1. If the probability that it is the original No. 1 is  $\cos^2\theta$  (so that the probability that it is the original No. 2 is  $\sin^2\theta$ ) the permutation variable  $\theta$  will be a function of the time and have all the properties of a dynamical variable, giving therefore an extra degree of freedom of the system and having a momentum (energy of interchange) associated with it. When, however, the particles are distinguished without uncertainty,  $\theta$  is constrained to be zero, and this degree of freedom is lost.

Thus for the treatment of two indistinguishable particles, we have to start with an a priori probability distributed over a closed domain of 137 dimensions, whereas for two distinguishable particles it is distributed over a closed domain of 136 dimensions. Naturally, the average values of characteristics of the distribution are slightly different in the two treatments. In particular, the energy tensor of the a priori probability distribution, which is identical with the metrical tensor  $g_{\mu\nu}$  of macroscopic theory,

is different. Hence the two kinds of treatment are associated with different metrics of space-time. It seems clear that a factor  $\frac{137}{136}$  (neglected in current quantum theory) will be introduced by the change of metric when we equate the space occupied by the indistinguishable particles of quantum theory to the space occupied by the distinguishable parts of our measuring apparatus.

It may be asked: Why does this factor affect the mass of the electron but not that of the proton? The discrimination is, I think, not strictly between the proton and electron, but between the resultant mass ( $M + m$ ) which is nearly the mass of a proton, and the reduced mass of the relative motion  $Mm/(M + m)$  which is nearly the mass of an electron; for it is in the relative motion that the question of distinguishing the two ends of the relation arises. It may also be asked why the factor  $\frac{137}{136}$  which refers especially to a system of two particles, applies irrespective of the number of particles. The answer is that the metrical ideas of quantum theory are borrowed from those of relativity theory; and since the latter are based on the interval between two points, the former refer correspondingly to the wave function of two particles.

A. S. EDDINGTON.

Observatory, Cambridge.  
June 5.

<sup>1</sup> W. N. Bond, NATURE, 133, 327, March 3, 1934.

<sup>2</sup> R. T. Birge, NATURE, 133, 648, April 28, 1934.

<sup>3</sup> A. S. Eddington, Proc. Roy. Soc., A, 122, 358; 1929.

## Production of Very Low Temperatures by the Magnetic Method: Supraconductivity of Cadmium

A YEAR ago the first experiments for producing very low temperatures by adiabatic demagnetisation of certain paramagnetic substances, as suggested by Debye<sup>1</sup> and Giauque<sup>2</sup>, were carried out, by Giauque and MacDougall<sup>3</sup>, and also by de Haas, Wiersma and Kramers<sup>4</sup>. Continuing our former experiments<sup>5</sup> on the magnetic method, we have constructed an apparatus for investigations in the region of lowest temperatures. As we shall soon give a detailed report of some calculations and experimental work, we will mention here only some of our results.

We succeeded in so choosing the conditions that, on one hand, the removal of the heat of magnetisation was completed in a few minutes; on the other hand, the condensation of the residual gas on the cooled substance took place very rapidly, the latter being necessary for keeping the low temperatures attained. Hence one had to keep the magnet switched on only for a few minutes.

Using 0.5 gm. of manganese ammonium sulphate, a substance we found to be most suitable, we reached 0.1°, starting at 1° and 6,000 gauss (a stronger magnet was not at our disposal). The temperature was determined by measuring the susceptibilities and extrapolating as in the experiments mentioned above, this procedure being subject to the same objections as discussed there. The thermal insulation in our arrangement was such that it took, for example, one hour and a half to warm up from 0.18° to 0.26°.

We then made experiments in cooling down other substances with the paramagnetic salt, looking first for supraconductivity in the case of cadmium. For this purpose a tablet was pressed out of equal volumes of cadmium and manganese ammonium sulphate.

The experiments showed that cadmium becomes supraconductive. This was recognised by the appearance of persistent currents, a method of observation similar to that used by Tuyn and Kamerlingh Onnes<sup>6</sup> in investigating powdered substances. The same mutual inductance, which served for the measurement of the susceptibility of the salt, was used to detect these persistent currents. Extrapolation to zero measuring field gives a transition point of about 0.6°.

Clarendon Laboratory,  
Oxford.

June 3.

N. KÜRTI.  
F. SIMON.

- <sup>1</sup> P. Debye, *Ann. Phys.*, **81**, 1154; 1926.  
<sup>2</sup> W. F. Giauque, *J. Amer. Chem. Soc.*, **49**, 1864; 1927.  
<sup>3</sup> W. F. Giauque and D. P. MacDougall, *Phys. Rev.*, **43**, 768; 1933.  
<sup>4</sup> **44**, 235; 1933.  
<sup>5</sup> W. J. de Haas, E. C. Wiersma and H. A. Kramers, *Physica*, **13**, 175; 1933. **1**, 1; 1933.  
<sup>6</sup> N. Kürti and F. Simon, *Naturwiss.*, **21**, 178; 1933. N. Kürti, *Z. phys. Chem.*, **B**, **20**, 305; 1933.  
<sup>7</sup> W. Tuyn and H. Kamerlingh Onnes, *Leiden Comm.*, 181.

### Phase Variations of Reflected Radio-Waves, and a Possible Connexion with the Earth's Magnetic Field in the Ionosphere

THE apparatus used for measuring the phase variations of the reflected radio-waves, already described<sup>1</sup>, consists of a transmitter, modulated by the alternating 42-cycle current to emit periodic signals of, say, 1/1000 sec. duration. The receiver consists of a one-stage screen-grid high-frequency amplifier, a plate-circuit detector and a final one-stage continuous current amplifier. The observations are made by a cathode ray oscillograph, the spot of which is deflected along the time axis by the same alternating current. The detector valve is made to oscillate at a frequency little different from that of the transmitter, then beat curves are observed on the oscillograms corresponding to the reflected wave trains.

The position of the beat curve is a measure of the virtual height of reflection. Moreover, when the echoes do not present phase variations (optical path constant), the beat curves are absolutely fixed; this is due to the fact that the oscillating detector is synchronous with the transmitter at the beginning of the emission of the signal. When the phase of the reflected waves changes (by variation of the optical path), the beat curves present an apparent movement, from which, as in an interferometer, it is possible to determine the velocity and the sense of the optical path variation. (For an optical path change of even a fraction of a wave-length, the modification of the beat curve is easily visible.) When the ionic density increases, the optical path diminishes, and inversely.

The most interesting phenomenon that I have observed is that the two echoes produced by the magneto-ionic double refraction sometimes present phase variations of opposite sense. This can be explained, in the present state of our knowledge, only by admitting a variation of separation of the two echoes, possibly following a change of intensity of the earth's magnetic field in the ionosphere. Whatever effects the change of ionic density, it causes optical path variations in the same sense for the two echoes. In correspondence with the periods during which I have observed phenomena of this

type, even the magnetic field at the earth's surface shows remarkable variations.

Researches are in progress to investigate further the relationship between such variations in the ionosphere and magnetic conditions at the earth's surface.

IVO RANZI.

"A. Righi" Physical Institute,  
University of Bologna, Italy.  
May 22.

<sup>1</sup> *Nuovo Cimento*, p. 258, 1931. *Rend. Accad. Lincei*, **16**, 40; 1932. *NATURE*, **132**, 174, July 29, 1933.

### Radio Exploration of the Ionosphere

PROF. APPLETON's recent letter<sup>1</sup>, reporting the measurement of the magnetic intensity  $H$  in the upper ionised region of the atmosphere, illustrates anew the power and value of radio methods of upper-air investigation. It affords clear evidence, which probably few workers on the earth's magnetism expected ever to gain, of the decrease of the field with height. This decrease is predicted by the Gaussian potential theory, but not without some small uncertainty, due to the slight non-uniformity of the earth's magnetisation, and also to the existence of electric currents in (and perhaps beyond) the atmosphere.

Should it become possible to determine  $H$  by radio methods to within 1 per cent, the results may afford a check on the magnetic theory, provided that we know also the height to which the measures refer. At present there is difficulty in interpreting the 'equivalent heights' attained by radio waves, and therefore the immediate value of Prof. Appleton's measures of  $H$  may lie chiefly in the independent estimate of height which they afford, by inference from magnetic theory. In the latitude of Great Britain, and except in periods of notable magnetic disturbance, the theory seems quite adequate for this purpose. Nearer to the auroral zone, however, where the upper-air electric currents are both more powerful and more localised, the radio measurements of  $H$  may become of great value in mapping the magnetic field.

S. CHAPMAN.

Imperial College of Science,  
London, S.W.7.  
May 31.

<sup>1</sup> *NATURE*, **133**, 793, May 26, 1934.

### Absorption Spectra of Aldehydes

1. RECENT observations of the ultra-violet absorption bands in the vapours of a series of homologous aldehydes have disclosed a vibrational structure, which is very similar throughout the series, since 35 measurements have given an average separation of 1025  $\text{cm}^{-1}$  in the spectra of the higher homologues, although this interval increases to 1053  $\text{cm}^{-1}$  in acetaldehyde. The corresponding frequency 1187  $\text{cm}^{-1}$  in formaldehyde has been attributed to a nuclear

vibration of the excited molecule  $\begin{matrix} \text{H} \leftarrow \\ \text{H} \leftarrow \end{matrix} \text{C} \rightarrow \leftarrow \text{O}$ , and there can be little doubt that we are now dealing with a similar nuclear vibration  $\begin{matrix} \text{R} \leftarrow \\ \text{H} \leftarrow \end{matrix} \text{C} \rightarrow \leftarrow \text{O}$  of the other aldehydes.

2. The maximum absorption is approximately constant at about 2900 Å. or 34,500  $\text{cm}^{-1}$ . In



the case of formaldehyde this electronic excitation has been shown unambiguously by Dieke and Kistiakowsky<sup>1</sup> to be associated with a change of electric moment in the  $y$ -plane, that is, perpendicular to the C=O axis and in the plane of the two hydrogen atoms. The excitation of the other aldehydes may be presumed to proceed in the same way. Mulliken<sup>2</sup> has pointed out that such an electronic transition will appreciably affect the C-H bonds, a conclusion which Norrish<sup>3</sup> had reached previously on chemical grounds.

3. These considerations may be extended to the ketones  $\begin{matrix} R^1 \\ R^2 \end{matrix} > C=O$ , where our own preliminary observations on acetone showed ill-defined separations of about  $1100 \text{ cm.}^{-1}$ . The separations described by Bowen and Thompson<sup>4</sup> are twice as large and irregular in magnitude; moreover, the frequency  $2900 \text{ cm.}^{-1}$  of the Raman line with which they compare these separations, is characteristic of valency vibrations involving hydrogen atoms, rather than those postulated under (1) above. It is, therefore, clear that further confirmation is required before these larger separations can be accepted as characteristic of the  $>C=O$  group.

4. Striking results have been obtained with acrolein which (through the kindness of Prof. W. L. Bragg) we have examined with the 21-foot grating at Manchester. In all other aldehydes except formaldehyde, the fine structure is either too complex to be analysed at present, or too diffuse to be recorded in detail. The absorption spectrum of acrolein, however, shows several bands which have a fine structure rivaling those of the diatomic gases in simplicity and sharpness. These bands consist of sharp regularly spaced lines, of which as many as 20 may be seen in a range of less than 20 Å. They resemble the rotational lines of the  $R$ -branch of a diatomic molecule; but they present a remarkable anomaly, which does not appear to have been observed previously, since the moment of inertia of the ground state calculated on the assumption that the lines constitute single rotational series is different for the various bands, instead of being constant throughout.

C. P. SNOW.

E. EASTWOOD.

Laboratory of Physical Chemistry,  
Cambridge.  
May 6.

<sup>1</sup> *Phys. Rev.*, **45**, 4; 1934.

<sup>2</sup> Private communication.

<sup>3</sup> *Trans. Farad. Soc.*, **26**, 391; 1931.

<sup>4</sup> *NATURE*, **133**, 571, April 14, 1934.

### Relation of Materials of the Cell Nucleus to the Lethal Action of Ultra-Violet Radiation

SEVERAL workers have suggested the possible relationship of materials of the cell nucleus to the lethal action of ultra-violet radiation<sup>1-4</sup>, but there seems to have been no systematic study of the problem heretofore.

The lethal action of such radiation for cell life has been found to begin abruptly at about 2950 Å., and to continue for shorter wave-lengths<sup>5-11</sup>. By exposing such materials as thymus nucleic acid, adenine, uracil, etc., to ultra-violet radiation through various long-wave pass filters and studying their absorption before and after irradiation, we have found 2950 Å. to be approximately the longest wave-length effective in their destruction.

Absorption studies of uracil<sup>12</sup>, etc., in concentrations approximately that in which these substances appear in the cell nucleus, show them to have marked absorption in the ultra-violet shorter than 2900 Å. The long-wave leg of the absorption band rises steeply between 3000 Å. and 2900 Å., its position agreeing closely with the wave-length threshold for the lethal action of ultra-violet radiation on bacteria.

Finally, thymus nucleic acid, yeast nucleic acid, etc., have been found to have marked absorption maxima at about 2600 Å.<sup>12,13</sup>. This agrees quite closely with the optimum wave-length region for the lethal action of ultra-violet as found by various workers<sup>8,9,11,14-17</sup>.

These three types of results indicate that materials of the cell nucleus play an important part in the lethal action of ultra-violet for at least many kinds of micro-organisms.

When the rays shorter than about 2900 Å. are filtered out, the irradiation of nuclear compounds has been found to bring about absorption changes indicative of the formation of isomers or more complex compounds. The possibility that these products of long-wave irradiation may be growth promoting or cell-division promoting is being investigated.

Full details of these experiments will be published elsewhere.

JOHN R. LOOFBOUROW.

FRANCIS F. HEYROTH.

Basic Science Research Laboratory,  
University of Cincinnati,  
Cincinnati, Ohio.  
May 7.

<sup>1</sup> Mme. Victor Henri, *C.R.*, **158**, 1032; 1914.

<sup>2</sup> Galeotti, *Ann. Inst. Pasteur*, **30**, 49; 1916.

<sup>3</sup> Bowie and Hughes, *J. Med. Res.*, **23**, 223; 1918.

<sup>4</sup> Gates, *Science*, **68**, 479; 1928.

<sup>5</sup> Barnard and Morgan, *Brit. Med. J.*, 1269; 1903.

<sup>6</sup> Henri and Schintzler, *C.R.*, **149**, 312; 1909.

<sup>7</sup> Cernovodeanu and Henri, *C.R.*, **158**, 1032; 1914.

<sup>8</sup> Newcomer, *J. Expt. Med.*, **28**, 841; 1917.

<sup>9</sup> Browning and Russ, *Proc. Roy. Soc., B*, **90**, 33; 1917.

<sup>10</sup> Burger, *Bull. Bas. Sci. Res.*, **2**, 46; 1928.

<sup>11</sup> Meier, *Smithsonian Miscellaneous Collections*, **87**, 1932.

<sup>12</sup> Heyroth and Loofbourow, *J. Amer. Chem. Soc.*, **52**, 3441; 1931.

<sup>13</sup> Heyroth and Loofbourow, in publication.

<sup>14</sup> Gates, *J. Gen. Physiol.*, **14**, 31; 1931.

<sup>15</sup> Bang, *Mitteilungen aus Finsens Med. Lysinstitut*, **9**, 164; 1905.

<sup>16</sup> Weinstein, *J. Opt. Soc. Amer.*, **433**; 1930.

<sup>17</sup> Loofbourow and Cameron, *Bull. Bas. Sci. Res.*, in publication.

### Hæmorrhages in Chicks Reared on Artificial Diets: a New Deficiency Disease

DURING work on the sterol metabolism of chicks<sup>1,2</sup>, it was observed that the animals often exhibited extensive internal hæmorrhages when they were fed a ration consisting of vitamin A-free casein 20, Marmite 10, salt mixture 4.5, starch 65.5 and varying amounts of cod liver oil concentrates. The hæmorrhages were subcutaneous or intramuscular on the breast, legs and wings, and were accompanied by certain pathological changes in the horny stratum of the gizzard.

The disease closely resembles scurvy, but it has been shown that vitamin C either in the form of lemon juice (up to 77 c.c. in 59 days) or pure ascorbic acid (given by mouth or subcutaneously) in very large doses was without the slightest influence on the occurrence of the symptoms. It has nothing to do with lack of vitamin A, D, B<sub>1</sub>, B<sub>2</sub>, 'fat' or cholesterol.

When chicks are fed a ration consisting entirely of cereals or seeds plus salts, the hæmorrhages fail

to occur. The cause of the disease must therefore be a deficiency in an antihemorrhagic factor different from vitamin C and occurring in cereals and seeds.

The histological features of the symptoms as well as the concentration and further characterisation of the antihemorrhagic factor are being investigated further.

H. DAM.

Biochemical Institute,  
University,  
Copenhagen.  
May 2.

<sup>1</sup> H. Dam, *Biochem. Z.*, **215**, 485; 1929.

<sup>2</sup> H. Dam, *Biochem. Z.*, **220**, 159; 1930.

### Optical Rotatory Power

AN interesting mathematical derivation of the rotatory power of a simple organic compound has just been published by S. F. Boys<sup>1</sup>, from which conclusions are drawn regarding, *inter alia*, the influence of solvents upon the magnitude of the rotation. The author's comments on the effects of association and his classification of active solutes into three main groups, namely, non-polar, polar and those capable of entering into co-ordination or complex union with the solvent, are in agreement with the views arrived at by one of us from experimental data<sup>2</sup>.

We are at present engaged in investigating the behaviour of optically active saturated hydrocarbons towards change of solvent, using *d*-pinane, methyl menthane and other compounds as the non-polar solutes. We find that the rotation in such cases is chiefly governed by the refractive index of the solvent medium. This point is illustrated by the following values for *d*-pinane in dilute solution:

#### *d*-Pinane in Solution ( $c=3.5$ ).

Solvent	$n_D$	$[\alpha]_D$	Solvent	$n_D$	$[\alpha]_D$
Acetonitrile	1.3460	+18.7°	Methylene dichloride	1.4237	+21.0°
Methyl alcohol	1.3312	19.3	Heptane	1.3867	21.1
Acetic acid	1.3715	19.5	Chloroform	1.4464	21.8
Nitromethane	1.3813	19.8	Carbon tetrachloride	1.4607	22.9
Acetaldehyde	1.3316	20.1	Methyl iodide	1.5293	23.6
Hexane	1.3760	20.1	Methylene iodide	1.7559	26.6
Acetone	1.3589	20.9	Carbon disulphide	1.6204	28.1

A large number of aromatic solvents have also been examined, which fall into their appropriate positions in the above table. The refractive indices quoted are those of the pure solvent, but the results strongly support the prediction of S. F. Boys that the rotation of non-polar solutes will be dependent on the refractivity of the solution. An interesting point is that the specific rotation of pinane in the homogeneous state ( $n_D$  1.4624,  $[\alpha]_D$  +22.95°) is practically unaltered when the compound is dissolved in carbon tetrachloride (see table). In this case solvent and solute have almost identical refractive indices.

Similar results are being obtained with other hydrocarbons, full details of which will be published later.

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May 16.

<sup>1</sup> *Proc. Roy. Soc., A*, **144**, 655, 675; 1934.

<sup>2</sup> Rule and co-workers, *J. Chem. Soc.*, 384, 1217; 1933; and earlier papers.

### Raman Spectra of Benzene and Hydrogen Iodide in the Liquid and Solid State

A SYSTEMATIC investigation at low temperatures of the oscillation and rotation Raman spectra of simple molecules as they are affected by their state of aggregation and by temperature seems to us of great importance; for the transition from the gaseous to the liquid state will show mainly the influence of density, while in the transition from the liquid to the solid state the orientation of the exchange forces due to the crystal structure may have some influence on the Raman lines. Moreover, having ascertained the dependence of the Raman spectra upon temperature, we are in the position to say something about the magnitude of the exchange forces and the rotation of the molecules in the crystal.

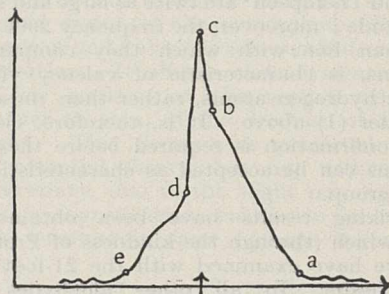


FIG. 1.

The whole investigation makes the utmost demands upon the low temperature apparatus as well as upon the spectroscopic arrangement. We have constructed a low temperature apparatus, which enables us to prepare a clear and transparent crystal and to keep it at a constant temperature ( $\pm 0.1^\circ$  C.) between  $+30^\circ$  and  $-150^\circ$  C. for any length of time (up to 100 hours); the type of spectrograph used is the big Steinheil with three glass prisms. In order to get the best possible results from it, we have increased the rigidity of its mechanical parts and have regulated the temperature of the room. As source of light we employed the line  $\lambda$  3888 Å. from a helium discharge tube to avoid any disturbance by a continuous background (for the details of the apparatus see the paper shortly to appear in *Z. phys. Chem.* (B)). The following are data for the spectrograph: dispersion at  $\lambda$  4200 Å., small camera ( $f=270$  mm.) 21 Å./mm., large camera ( $f=650$  mm.) 8.7 Å./mm.; diameter of the camera lens 65 mm.

We have obtained the following results:

#### Benzene.

$\nu_R$ (cm. <sup>-1</sup> ) for liquid	992.2	983.3	1176.7	1605.3
$\nu_R$ (cm. <sup>-1</sup> ) for solid	990.5	982.3	1174.7	1602.9
Decrease (in wave numbers)	1.7	1.0	2.0	2.4
Decrease (per thousand)	1.7	1.0	1.7	1.5

There is thus a small decrease in the wave numbers if we go from the liquid to the solid state. This change, which is much larger than the uncertainty of  $\nu_R$  (not more than 0.1–0.3 per thousand) means a small weakening of the binding forces of benzene in the solid state. The half-width of the line 992.2 cm.<sup>-1</sup> will be less than 4 cm.<sup>-1</sup>, in accordance to Grassmann<sup>1</sup>.

#### Hydrogen Iodide.

Gaseous state <sup>2</sup>	2233	cm. <sup>-1</sup>
Liquid	2164.9 $\pm$ 1.0	cm. <sup>-1</sup>
Decrease	68.1	cm. <sup>-1</sup>
Decrease per thousand	31	
Solid state	2159.9 $\pm$ 1.0	cm. <sup>-1</sup>
Decrease	5.0	cm. <sup>-1</sup>
Decrease per thousand	2.3	

For liquid hydrogen iodide we find a Raman line of a very diffuse character. As in the case<sup>2</sup> of hydrogen chloride and bromide, it has a complex structure. The wave numbers in the liquid and solid state as compared with the gaseous state are given in the accompanying table. The structure of the line in the liquid may be seen from Fig. 1. The points marked on the curve have the following wave numbers: *a*, 2178 cm.<sup>-1</sup>; *b*, 2167 cm.<sup>-1</sup>; *c*, 2165 cm.<sup>-1</sup>; *d*, 2162.5 cm.<sup>-1</sup>; *e*, 2151 cm.<sup>-1</sup>. It may be emphasised that the structure and the wave numbers are not very accurately known.

From these results, it will be seen that although the low temperature apparatus already used is quite adequate for our purpose, a spectrograph of higher dispersion will be necessary if we are to carry this investigation further. We have therefore begun to construct a new type of spectrograph with a liquid prism.

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May 2.

<sup>1</sup> Grassmann, *Z. Phys.*, **82**, 767; 1933.

<sup>2</sup> E. O. Salant and A. Sandow, *Phys. Rev.*, **37**, 373; 1931. E. O. Salant and D. Callihan, *Phys. Rev.*, **43**, 590; 1933.

### Magnetic Moment of the Deuteron

In a previous note<sup>1</sup> we reported, together with Mr. Frisch, on experiments concerning the deflection of a beam of 'ordinary' hydrogen molecules in an inhomogeneous magnetic field. From these experiments, we were able to derive the magnetic moment of the proton. The value obtained was 2.5 nuclear magnetons (not 1, as expected theoretically).

We have now performed similar experiments with a beam of 'heavy' hydrogen molecules and derived in a similar way the magnetic moment of the deuteron. The value obtained is about 0.7 nuclear magnetons<sup>2</sup>.

A detailed account of these experiments will appear in the *Physical Review*.

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O. STERN.

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May 10.

<sup>1</sup> NATURE, **132**, 169, July 29, 1933.

<sup>2</sup> The value given in the *Bulletin of the American Physical Society* (vol. 9, p. 29, 1934, No. 2) is wrong, due to an error in the calculations.

### Electron Microscopy of Biological Objects

In a recent paper Ruska<sup>1</sup> demonstrated experimentally the possibility of surpassing considerably the resolving power of an ordinary microscope by the use of an electron microscope. This high resolving power cannot be applied in biological research, however, without developing a new histological technique to prevent the destruction of the organic cells by the intense electronic bombardment.

To overcome this difficulty, it seems that there are the following possibilities:

(1) Intense cooling of the object (for example,

by contact with an extremely thin metal foil which is cooled by conduction).

(2) Impregnating the object with a substance which makes the object less destructible.

(3) Impregnating the object in such a way that a framework of the object is preserved although the object itself is destroyed.

(4) Combining methods (1) and (2), or (1) and (3).

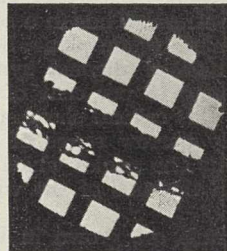


FIG. 1. × 65.

We obtained the best results by using the third method. To arrive at good results by this method the following conditions must be satisfied by the metallic or other framework: It must be (a) geometrically similar to the object; (b) of high melting point and good thermal conductivity; and (c) of high atomic weight.

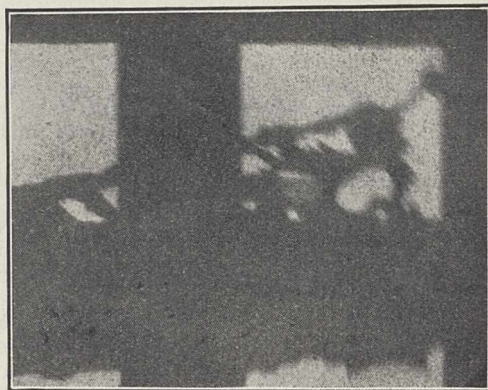


FIG. 2. × about 450.

Figs. 1 and 2 show the results we obtained. They represent a 15 μ section of a *Drosophila intermedia* leaf on a copper net. Fig. 1 is enlarged 65 times and Fig. 2 about 450 times. The resolving power can be estimated from the sharpness of the border of the copper wire; it corresponds to about 1 μ. The microscopic object was impregnated with osmium, as is done in the usual microscopy. From the above photographs, it seems that the osmium impregnation method can be applied—perhaps with some modifications—to electron microscopy.

The photomicrographs were taken with an electron-microscope of the magnetic type, the description of which will be published later.

L. MARTON.

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May 7.

<sup>1</sup> E. Ruska, *Z. Phys.*, **87**, 580; 1934.

### Strength of Metal Single Crystals

In the course of some experimental work on single crystals of cadmium, which I have been carrying out under Prof. E. N. da C. Andrade, I have found that the condition of the surface exercises a surprisingly large effect on the initial strength of the crystal. It is well known that glide commences in a single crystal when the shear stress on the glide plane, and in the glide direction, reaches a certain value, known as the critical shear stress. Thus in a series of crystals grown from cadmium (glide plane, hexagonal base; glide direction, axis of digonal symmetry), which proved to contain 0.15 per cent of lead and 0.15 per cent of zinc, this critical shear stress lay within the comparatively narrow range of 50–59 gm. wt. per sq. mm., while the angles which the hexagonal planes made with the axis of the wire varied from 8° to 72°.

When the crystals are grown in the presence of oxygen, there is a marked increase in the resistance to shear, values as high as 120 gm. wt. per sq. mm. being obtained. As neither nitrogen, carbon dioxide nor water vapour produces a similar effect, the increased resistance to shear is attributed to a film of oxide formed on the surface of the metal. Oxidation of the wires subsequent to their conversion into single crystals has the same effect, and even keeping the wires in a damp atmosphere at room temperature for several weeks produces a measurable effect. Removal of the oxide film by brushing the surface with dilute sulphuric acid reduces the critical shear stress to the normal value of about 60 gm. wt. per sq. mm.

The effect cannot be attributed to any strength of the oxide film, since, first, there are considerations to show that it can only be a few atoms thick, and, secondly, there is a growth of the resistance to shear as deformation proceeds, and not the weakening which must ensue on rupture of the oxide film if its tensile strength were in question.

To eliminate the effect of impurities, and of surface film, cadmium was carefully purified by sublimation *in vacuo*, which left no lead that could be detected, and less than 0.1 per cent of zinc, and oxide-free crystals were grown from it. A single crystal prepared in this way showed a critical shear stress of only 13.7 gm. wt. per sq. mm. This seems to confirm the hypothesis of Haase and Schmidt<sup>1</sup> that crystals of perfectly pure metal would be unable to withstand even the smallest shear stress. It may be noted that A. W. Hanson<sup>2</sup> has just published some results for very pure zinc, which bring the critical shear stress down to 9.1 gm. wt. per sq. mm., but he does not refer to any influence of surface factors.

It seems clear, then, that the ideal metal lattice has very little or no strength, slip starting at the surface and proceeding inwards, and that surface films of a certain character can prevent initiation of slip, and so greatly strengthen the crystal. The analogy offered by the behaviour of rock salt, where the surface is of such significance, as evidenced by the behaviour under water, will readily occur.

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May 11.

### *Zostera* Disease on the Coast of County Cork, I.F.S.

In view of the widespread effects of *Zostera* (sea-grass and eel-grass) disease and the interest which it has aroused, the following brief note appears to be worthy of publication. *Zostera* was first noticed to be affected by some sort of trouble in Castle Haven during the summer of 1932, when the extensive meadows near and north of Castletownshend were much less luxuriant than usual. (Just off Castletownshend the plants are usually extremely robust and of great length.) By the summer of 1933 the meadows had vanished. At Lough Ine the various beds were unaffected until late in 1933. By December those in fairly deep water between the Coosh and the mainland, in the southern region of Barloge Creek and the two large meadows in Southern's Bay just below the Rapids, which are exposed at very low water, were very worn in appearance. By the middle of February this year they had disappeared, as had those which formerly all but covered the floor of the inner part of the Goleen, except for their dead remains. At the end of March it was found that a further bed had completely disappeared from the Ballyally side of the Coosh. By this time new growth had started in the Goleen and very soon became vigorous, whilst by the end of April there was strong growth over large areas in Barloge Creek, but no sign of any in Southern's Bay.

Three chief points of interest emerge from these observations: the disease seems to be spreading very slowly along the south coast of Ireland, having taken two years to travel the six miles which separate Castle Haven from Barloge Creek: recovery has been extremely rapid: *Z. marina*, *Z. nana* and the hybrid were equally affected and have made equally rapid recoveries. All three occur in the Goleen, *marina* alone in the other localities. I am told that at Castle Haven there has been no recovery but a simultaneous decrease in flatfish.

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May 22.

### Control of Chromatophores in *Leander serratus*

THE phenomena of colour-change in prawns are well-known<sup>1,2</sup>, and the mechanisms controlling these phenomena understood in the main<sup>2,3</sup>. Certain details, however, require further explanation, and among them are the following:—

It is stated<sup>2</sup> that for *Palæmonetes varians*, a form very similar to *Leander*, the effect of (a) darkness and (b) light on a white background, is the same; red and yellow chromatophores contract and reflecting yellow chromatophores expand. The reverse condition is produced by light on a dark background.

I find that in *Leander*, conditions (a) and (b) produce similar but not identical effects. The reflecting yellow chromatophores, fairly numerous in *Leander*, do not expand and contract automatically in a reverse direction to red and yellow types (which are under hormone control) but behave independently and according to light intensity. Thus, irrespective of the background, they expand in good light and contract in dim light or in darkness. They also continue to do this in eyeless animals where the red and yellow chromatophores are no longer under control. It is already known<sup>1,4</sup> that in certain

<sup>1</sup> *Z. Phys.*, 33, 413; 1925. See also H. J. Gough, D. Hanson, and J. J. Wright, *Phil. Trans.*, A, 226, 1; 1924.

<sup>2</sup> *Phys. Rev.*, 45, 324; 1934.

Crustacea there is a primary direct action of light on the chromatophores as well as a secondary action through the eyes, and this primary action undoubtedly plays a part in the colour-change of *Leander*.

A further difference shown by animals in conditions (a) and (b) respectively lies in the behaviour of the deep-seated chromatophores. In light these are expanded, so that the course of nerve-cord and dorsal blood-vessel, round which many are located, can be plainly seen, and the animal appears translucent. In darkness these chromatophores are contracted, and the animal appears opaque.

Again, there is a very marked difference in the position of eye pigments in animals in conditions (a) and (b). In darkness the eye looks black and has an enormous pupil: in light on a white background it shows a black core and pale margin, while in light on a dark background it looks black all over and shows no pupil.

Thus darkness, and light combined with white background, produce different results on the eyes and on certain of the chromatophores of *Leander*. Light, however, is not the only factor that can affect the chromatophores, for a considerable expansion of red and yellow types may result from excitement or muscular activity.

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May 19.

- <sup>1</sup> Keeble and Gamble, *Phil. Trans. Roy. Soc.*, B, 196, 295; 1904.  
<sup>2</sup> Perkins, *J. Exp. Zool.*, 50, 71; 1928.  
<sup>3</sup> Koller, *Z. vergl. Physiol.*, 12, 633; 1930.  
<sup>4</sup> Stephenson, *NATURE*, 130, 931, Dec. 17, 1932.

#### Occurrence of an Enteropneust in Wales

A SMALL Enteropneust was found by us while shore-collecting on the Anglesey coast of the Menai Straits at the beginning of April 1934. Since then we have obtained a number of specimens from this locality. The animals live in clean sand near the low water mark of spring tides at depths down to nine inches. They were found in association with *Arenicola marina*, *Ensis ensis*, *Echinocardium cordatum* and *Anmodytes*.

Its identification as a species of *Dolichoglossus* is justified by the absence of an appendix to the stomochord, of synapticulæ between the gill bars, of genital wings and liver diverticulæ, and the presence of a well-developed ventral non-branchial part of the pharynx, of relatively large ova in the ovaries of female specimens, of an elongated proboscis and of a single proboscis pore on the left side.

The records of occurrence of adult Enteropneusts around the coasts of the British Islands are few, although there is a number of records of the occurrence of *Tornaria* larvae. A fragment of a large *Balanoglossus* sp. was obtained in 1900 on the Galway coast and Tattersall obtained several specimens of a species of *Dolichoglossus*, which he named *D. ruber*, near extreme low tide mark off Coastguard Point, Ballynakill Harbour, Co. Galway<sup>1</sup>. Assheton<sup>2</sup> obtained specimens of *Dolichoglossus* in the littoral zone at Aros in the Sound of Mull, off the west coast of Scotland in 1907, which proved to be a new species, *D. serpentinus*. Since then Meek<sup>3</sup> has recorded a single specimen of *Glossobalanus*, dredged near the Farne Islands, off the coast of Northumberland, which he named *G. marginatus*. So far as we are aware this is the first record of

the occurrence of adult Enteropneusts on the coast of Wales and the fifth for the British Isles.

Although our specimens appear to differ in coloration from *D. ruber*, Tattersall, and in external proportions from *D. serpentinus*, Assheton, some time must elapse before we can determine whether it belongs to either of these species. So far, the internal anatomy of neither *D. ruber* nor *D. serpentinus* has been described in detail.

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Bangor, Caernarvonshire.

- <sup>1</sup> W. M. Tattersall, "Ann. Rep. Fish., Ireland", 1902-3, Pt. II, App. VII, 1905.  
<sup>2</sup> R. Assheton, *Zool. Anz.*, 33; 1908.  
<sup>3</sup> A. Meek, *Q. J. Micro. Soc.*, 66; 1922.

#### The Theory of Two Factors versus the Sampling Theory of Mental Ability

DR. WILLIAM BROWN has published in *NATURE* of May 12 a communication on "The Theory of Two Factors versus the Sampling Theory of Mental Ability". The matter is too involved to be discussed adequately in a letter, but I wish to record that I do not agree that this otherwise very valuable experiment is an *experimentum crucis* between my views and those of Prof. Spearman, partly because I do not think Dr. Mackie's formulæ are applicable in this way, but mainly because the tetrad-differences had been trimmed down to the narrow scatter shown, by the choice of tests, by the rejection of one of those originally chosen, by the rejection of one of the remaining correlation coefficients, and by the elimination by partial correlation of a large group factor. It is not in dispute that by these means a set of tests can be arrived at which give zero tetrads within the limits of sampling error and can then be described by a parameter *g* and as many parameters *s* as there are tests. I would like to add that I admire and value the work done by Dr. Brown and Dr. Stephenson in arriving at the present series of tests.

GODFREY H. THOMSON.

The University, Edinburgh.  
May 19.

#### Distribution of Separates of Certain Papers by the late Dr. Bashford Dean

THERE have been placed in my hands, by Mrs. Bashford Dean, for distribution among students of fishes, certain reprints of Dr. Dean's studies on the archaic fishes, found among his effects after his untimely death.

If research men who are interested in the morphology, anatomy and embryology of the cyclostomes, sharks and ganoids will go through Dr. Dean's bibliography either in vol. 1 of the "Bibliography of Fishes" or in Art. 1 of the Bashford Dean Memorial Volume, and will indicate to me what articles they desire, I will forward these so far as they are available.

It may be some time before the actual sending out can be done, but I should like to have all requests in before the distribution is begun.

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## Research Items

**Bride-Wealth in a Tanganyika Tribe.** The function of bride-wealth, the handing over of property to the parents of the bride, among the Wabena of the Ulanga Valley is discussed by A. T. and G. M. Culwick in *Africa*, 7, No. 2. The manner of complying with the custom is subject to wide variation, which suggests that features belonging to mother-right and father-right exist side by side. In former days, bride-wealth consisted of three hoes, which were then of much greater value than they are now. Each hoe was regarded as a separate payment, and fulfilled a special function. The presentation of the first hoe took place after arrangements for the betrothal had been made by an intermediary. The man then built a hut for himself and his bride near her father, for whom he was expected to work. This payment did not constitute a binding contract; but the arrangement was confirmed by the payment of the second hoe. It could not then be set aside on the girl's part without reason; but until she had borne a child, the husband could send her back to her father if he wished. In this event, if his reason were not good, the father might not return the two hoes. The husband still remained under the control of his father-in-law's family after the second payment, and was not emancipated from it until the payment of the third hoe had been made. Even then he continued to render the family certain services, and could not live more than a few miles away without their approval. Although a man had much greater power over his children when the payment was complete, they continued to render greater respect to their mother's brother than to their father. The custom has been much modified in recent times by economic causes, which have increased the amount payable and given the husband greater freedom from the control of the bride's family.

**Rock-Engravings in Tripolitania.** Some of the results of a recent journey of archaeological exploration in Tripolitania are described by Paolo Graziosi in *L'Anthropologie*, 44, No. 1-2. Until last year when two expeditions were at work, one being led by Dr. L. Frobenius, little was known of the rock-engravings of Fezzan and nothing of the stone age industries of that area. The oasis of Brach was made the headquarters of the Italian expedition, but for Wadi el-Agial, Oubari served as the base. In the neighbourhood of Wadi Marsil, near Hamada el Homra, engravings of Bovidae were found, of which one bore a spheroid between its horns, indubitable sign of Egyptian influence. One of the drawings appeared to be a rhinoceros, but was probably a badly-drawn member of the Bovidae. Two large figures of ostriches were found near El-Gheriat. In style these recall the oldest engravings of southern Oran. Two areas which proved very rich were the Wadis Zigza and Massauda. At the former the superimposition of engravings made a relative chronology possible which could be equated with variation in patina, style and technique. The most ancient engravings showed giraffes in a fine naturalistic style. The lines were deeply engraved and highly patinated. Similar figures at Djebel el Ouenat have been demonstrated by the Abbé Breuil to be related to Bushman drawings. Another group of later date shows an antelope, an aurochs and a number of Bovidae in profile, but

with the horns represented as if seen from above. A third large group is composed entirely of domestic animals. Here also is a human figure in a crouching attitude, which to a certain degree recalls South African art, but also has undoubted Egyptian affinities. Among the latest engravings, but still anterior to the 'camel' period, are a number of vehicles drawn by horses and driven by men. At Massauda were many rock-shelters with engravings. Among the most ancient, special mention is made of an elephant hunt, in which three elephants face two men armed with bows. A third man lies on the ground, while others are under the animals. The most numerous groups are of domestic animals and men, some ithyphallic.

**Investigations in a Japanese Lake.** S. Yoshimura has recently described his researches into the biology, physiography, physics and chemistry of a small mountain lake near the Japan Sea ("Limnological Reconnaissance of Lake Busyû, Hukui, Japan." *Sci. Rep. Tokyo Bunrika Daigaku*, C, No. 1, vol. 1, 1932). An attempt was made by the Hukui Fisheries Station to utilise this lake for the culture of cold-water fishes. Lake Busyû, which is elongated from north to south with its basin in the form of a pail, lies in a deep and narrow valley, the river entering from the south and flowing out at the north to enter the Japan Sea. The water is very turbid, greenish brown from the suspension of silt particles, and with no vegetation on the shores owing to the fluctuations in water-level. The surface is very hot and the bottom very cold, the water weakly acidic, the surface water slightly supersaturated with dissolved oxygen, not due to the assimilation of the phytoplankton but to the sudden rise of water temperature in this layer which is exposed to the surface by the sinking of water-level towards the summer. The stratification of oxygen is very complex, which is an unusual feature in Japanese lakes. There is no specially deep hollow but the shallow bottom is so steeply inclined that it cannot retain fine deposits. What deposit there is is not decomposed mud but detritus of leaves and land plants. The lake is regarded by the author as of the rich oligotrophic type. The organic life consists of diatoms, rotifers, cladocerans and copepods in the plankton, several fishes in the nekton and in the benthos *Tubifex* at the bottom in great abundance (16-20 metres), *Endochironomus* dominant at 10-15 metres and a few *Tanytus* and *Chironomus plumosus* in the shallow bottom. Fishes such as *Salvelinus* and *Coregonus* transplanted to the lake can survive.

**Isopods from the "Discovery" Expedition.** Miss Edith M. Sheppard, in her monograph on the family Serolidæ (Isopod Crustacea, Part 1, "Discovery Reports", vol. 7, 1933) not only describes the collection made by the R.R.S. *Discovery II*, the R.R.S. *William Scoresby* and the staff of the Marine Biological Station of South Georgia during the years 1925-32, which is the most complete ever made both of species and specimens, but also gives a revised account of the genus *Serolis* with diagnostic characters of all known species, together with notes on their geographical distribution and general morphology. Seven of the "Discovery" species are new to science, and of the fifteen shallow-water species (excluding

two which are doubtful) previously recorded from these waters, all except three have again been found. The genus, with the exception of one species recorded from San Diego, California, is entirely restricted to the southern hemisphere. Most of the species are confined to shallow water and the deep sea forms are comparatively few in number but have a much wider vertical as well as horizontal distribution. The species fall into four groups: (1) outside the antarctic convergence; (2) inside the antarctic convergence; (3) round the shores of Kerguelen Island, Crozet Island, Marion Island and Prince Edward Island; (4) off the shores of South and East Australia. From analysis of the adult females in the present collection, the author finds that breeding goes on throughout the year, and that the number of females in the non-breeding condition is comparatively small.

**Microsynangia of the Medulloseæ.** Under the title "The Structure of Certain Fossil Spore-Bearing Organs believed to belong to Pteridosperms", Prof. Halle (*Kungl. Svenska Vet. Akad. Handl.*, Bd. 12, No. 6) makes a valuable contribution to our knowledge of the microsynangia of several genera attributed to the Medulloseæ. A new group, Whittleseyinæ, based on the microsynangia, is proposed, under which name are united several late Palæozoic spore-producing organs characterised by very long tubular sporangia, an unusually strong vegetative development of the synangium and unusually large spores. *Goldenbergia*, nov. gen., hitherto believed to be a seed of the genus *Rhabdocarpus*, is now shown to be a large synangium formed of 12-16 tubular sporangia arranged in a single whorl enclosing a central cavity, whilst the supposed leaves or pinnules of *Whittleseyia elegans* are shown to be cupule-like synangia, campanulate in shape and formed of very long tubular sporangia. *Boulaya*, *Aulacotheca*, nov. gen. (*Holcospermum*), *Codonothea* and *Dolerotheca*, nov. gen. (*Dolerophyllum*) are referred to this group. The genus *Potonia* is treated as the type of a second group, recalling the Whittleseyinæ but differing in structure and in the size and type of the spores. In *P. adiantiformis* and *P. (Neuropteris) Carpentieri*, the probably free sporangia are shown to be long and tubular and to radiate from the bottom of the low, wide cup, which seems to be formed by a pinnule, the fructification being superficially likened to the capitulum of a composite. *Zeilleria fructifications* are also shown to be synangia of the Whittleseyinæ type, though there is no evidence that this genus belongs to the Pteridosperms.

**Origin of Cultivated Tobacco.** The origin of cultivated tobacco, *Nicotiana Tabacum*, is a problem of considerable genetic interest. In 1927, Clausen put forward the hypothesis that it was derived from a hybrid of *N. sylvestris* and *N. tomentosa* in which the chromosome number had been doubled. This was based upon the fact that: (1) *N. Tabacum* has  $n = 24$  chromosomes, while in the other two species  $n = 12$ , (2) when either of these species is crossed with *N. Tabacum* the  $F_1$  hybrids show  $12_{II} + 12_I$  chromosomes in meiosis, indicating that each had a haploid set homologous with 12 of the *Tabacum* chromosomes. Dr. D. Kostoff (*Bull. Appl. Bot.*, Ser. 2, No. 5; 1933) has recently reported upon extensive crosses involving these three species and also *N. Rusbyi*, a woody-stemmed species nearest *N. tomentosa*. He points out difficulties with the above hypothesis, based partly on the absence of woody varieties of

*Tabacum*, partly on the fact that many varieties of tobacco have pink flowers, while those of *N. sylvestris* are white and those of *tomentosa* and *Rusbyi* rose-green, and partly on the chromosome behaviour in the various hybrids. Brieger has also argued against Clausen's hypothesis on the basis of similar experiments. Kostoff produced the triple fertile species hybrid *N. Tabacum*  $\times$  (*N. sylvestris*  $\times$  *N. Rusbyi*) which he calls *N. triplex*; this appears to have originated from an egg cell of tobacco (with 24 chromosomes) meeting a male nucleus having 12 *sylvestris* and 12 *Rusbyi* chromosomes. The hybrid thus has a complete haploid set of all three species and combines all their characters. It is, moreover, cytologically balanced and produces normal gametes. Nevertheless, it shows variations, and from numerous cytogenetic studies of its hybrids the conclusion is reached that while tobacco did not arise from the present *sylvestris* and *tomentosa*, yet it probably was derived from related forms which perhaps no longer exist.

**Winter Pruning of Apple Trees.** The practice of pruning was devised long before the opening of the Christian era, yet it is only in recent times that an attempt has been made to understand the fundamentals of the process. Hatton, Grubb and Amos, working at the East Malling Research Station, began experiments, and issued an early report in 1923. Their work has been continued by Dr. R. C. Knight, who has recently published a further paper ("The Influence of Winter Stem Pruning on Subsequent Stem- and Root-Development in the Apple", *J. Pom. and Hort. Sci.*, 12, No. 1, 1-14, March 1934). The earlier results are confirmed by improved experiments on more than five hundred trees of several varieties and grafted upon different rootstocks. Winter pruning decreases the production of new roots, but increases shoot formation, though often at the expense of radial thickening. There is, indeed, a decrease in the total amount of shoot growth, considered as extension growth plus increase in girth, and the relation of new shoot growth to new root growth is remarkably constant. No influence of stem pruning on the type of root system was found. The practical point, that it is better to prune immediately after planting if extension growth is required, emerges from a consideration of the results.

**Condensation of Water in the Atmosphere.** M. G. Bennett has reviewed (*Quart. J. Roy. Met. Soc.*, Jan. 1934) the present state of our knowledge in regard to the condensation of water in the atmosphere, the theory of which is found to be very much more complex than was formerly supposed. Measurements of the sizes of droplets in fog and cloud made independently by several observers within the last thirty years, and especially within the last three or four years, are commonly held to suggest that the masses of the droplets are integral multiples of one of two standard minimum sizes, which appears to imply that the production of the larger drops takes place by the union of the smaller drops and not by their continuous gradual growth by condensation. It was found further that the concentrations of chlorides in the droplets were integral multiples of the smallest concentrations ever observed. It might be supposed that some very simple account of the process of drop formation could be based on these observations, but according to Bennett, any such account is incomplete. Another difficult problem is the question whether a

cloud or fog which is not subjected to changes of relative humidity is stable or whether it will tend to coagulate into larger drops. The electric charges carried by the droplets affect their vapour pressure slightly according to a relationship worked out by J. J. Thomson, the radius of curvature of the drops and the surface tension of the liquid being among the additional controlling factors, but the effect on the vapour pressure of the charges that have been measured is extremely small in the case of droplets as small as those in a fog; such charges may, however, affect the rate of coagulation of the droplets into drops. It is evident that the parts played both by the electrical charges and by the relative humidity in the growth and coagulation of drops in cloud and fog remain to be discovered.

**Scattering of Hard X-Rays.** A number of formulæ have from time to time been used for the intensity of the Compton scattering of hard X-rays, in particular one derived by Klein and Nishina on relativistic quantum mechanics. J. Read and C. C. Lauritsen (*Phys. Rev.*, April 1) have tested this formula experimentally using a high-potential X-ray tube and a crystal spectrometer. The absorption per electron was measured in carbon and aluminium over a wavelength range of 20–50 X-units (250–600 kv.). Over this range, the photoelectric absorption by the electrons is small and nuclear absorption is not to be expected, while the Klein–Nishina result differs appreciably from those given by the older theories. The experiment shows that the Klein–Nishina formula probably gives the correct scattering coefficient within one per cent over this wave-length range.

**Fine Structure of X-Ray Absorption Edges.** It is well-known that when X-rays are absorbed by a solid, the short wave side of the absorption edge shows in general a pattern of maxima and minima. According to a theory of Kronig, the electron extracted from the atom may only move through the periodic field of the lattice with certain discrete energies, the forbidden energies corresponding to Bragg reflections of the electron waves. This effect must be integrated to allow for the motion of electrons in all directions through the lattice. The theory is confirmed by investigations of the absorption edges of nickel, iron and chromium in the pure metals and in alloys of gradually varying lattice constant. D. Coster and G. Klammer (*Physica*, January) have investigated the fine structure of the potassium and chlorine *K*-edges in potassium chloride crystals, using a vacuum spectrograph. The fine structures observed with these two elements were totally dissimilar, and if Kronig's view of the effect is to be applied to ionic crystal lattices, it seems that the rules which govern the transitions of the *K*-electrons to the crystal lattice are quite different in the case of the  $\text{Cl}^-$  ion and the  $\text{K}^+$  ion.

**Optical Isomerism of the Menthols and Menthylamines.** Prof. J. Read and Mr. W. J. Grubb have now described (*J. Chem. Soc.*, March) the isolation and characterisation of "the last of the menthols", namely, *d*-*neo*-*iso*-menthol, thus bringing to a successful conclusion a brilliant series of researches carried out by Prof. Read and his colleagues upon the highly complex group of menthylamines and menthols, all the stereoisomerides of which have now been isolated and characterised. Some idea of the

formidable nature of the problem involved will be formed when one realises that the *cis-trans* isomerism of the parent menthone molecule is complicated not only by the asymmetry of two dissimilar carbon atoms at the points of attachment of the methyl and isopropyl groups but also by the development of a third 'centre of asymmetry' at the position of the original keto-group. Thus menthylamine and menthol each give rise to eight optically active isomers, of which only four are needed for complete characterisation. In addition, there are the corresponding inactive *dl* forms to be considered. Comparison of the optical rotatory powers of the various compounds of the whole group reveals a complete parallelism between the amines and the alcohols, thus showing that the four sets of compounds are stereochemically analogous, although the relative molecular configurations are not yet to be regarded as finally settled. This work forms a valuable contribution to the study of stereochemical problems.

**Propane-treated Automobile Oil.** Science Service, Washington, D.C., has recently issued a Mail Report describing a new method of production of lubricating oil. Propane, as a liquified natural gas, is mixed with asphaltic base petroleum. The two liquids separate out into two layers, but not until the propane has extracted the desirable components from the asphaltic layer. The propane layer is then recovered with nitrobenzene, which cleans it from traces of remaining asphalt, and the lubricant is finally obtained by evaporation of the propane solution. Oil equal, if not superior, to Pennsylvania oil as at present refined can be produced in this way from cheap western oil. Proof of its efficiency is furnished by the results of stringent practical tests. Cylinder tops, lubricated with propane-treated oil, after 60,000 miles of high-speed duty, were less than one thousandth of an inch out of the perfect circle. Normally, under similar strain the tops would have been deformed into an oval shape. Comparatively easy production and efficient performance of such oil under test have done much to discount alarm caused by threatened exhaustion of good Pennsylvanian oil, since Texas, Oklahoma and California are now in a position equally with Pennsylvania to meet the demand for this product.

**Colour Temperatures of Stars.** In the *Observatory* of May appears an account of a paper by Messrs. Greaves, Davidson and Martin, to appear shortly in the *Monthly Notices of the Royal Astronomical Society*, describing a revision of the fundamental scale of colour temperatures which the authors have worked out at Greenwich. They have improved their photometric technique, but the change in the temperature scale is primarily due to a general revision of laboratory standards of colour. The temperatures which these authors actually find are very noteworthy, as they are markedly higher than previous estimates of colour temperature and ionisation temperature. For example, the Greenwich temperature for the mean *A0* star is now 18,000°—to be compared with 11,000° quoted by Russell, Dugan and Stewart ("Astronomy", Ginn and Co., New York, 1927). The Greenwich work comes on top of some recent observations which indicate that the colour temperature of the sun is about 6,800°, that is to say, definitely higher than the effective temperature, 5,740°. The Greenwich workers find 6,800° for the mean colour temperature of a number of *G0* stars.



## Chemical Syntheses under Pressure

BY invitation of the president, Prof. G. T. Morgan, an ordinary scientific meeting of the Chemical Society was held at the Chemical Research Laboratory on Thursday, June 7, when three papers were contributed illustrating recent researches in the Laboratory on syntheses of organic substances under pressure.

Mr. R. Taylor described the circulatory plant (afterwards seen in operation) employed in studying condensations between carbon monoxide and hydrogen at 400° and under 250 atmospheres in the presence of various catalysts, with a rate of circulation of about 80 litres of compressed gas per hour. In these researches, attention has been directed specially to the production of alcohols other than methyl alcohol (methanol). With a catalyst consisting of cobalt sulphide mixed with oxides of copper and manganese, an optimum yield of ethyl alcohol was obtained, although this synthesis was always accompanied by large amounts of methane. Systematic fractionation showed that more than ninety per cent of a product (b.p. 783°) consisted of alcohols with unbranched chains, among which *n*-hexyl and *n*-heptyl alcohols were identified. Branched chain products were represented by *isobutyl* alcohol, 2-methylbutanol and 2-methylpentanol. A manganese-chromium catalyst strongly alkalisied by rubidia gave a product in which all alcohols identified above the C<sub>3</sub> compound had branched chains. Another catalyst containing cobalt and strong alkali gave a mixture of branched and straight chain alcohols.

The chemical reactions involved in these syntheses were discussed, and successive aldolisation and hydrogenation were suggested as the directive mechanism. For straight chain alcohols, acetaldehyde (a product actually identified in these condensations) must be present to provide the active hydrogen for aldolisation, and its condensation with propaldehyde would eventually lead to *n*-amyl alcohol. When propaldehyde furnishes the active hydrogen, the final product is 2-methylpentanol. It may become possible to build up alcohols with a predetermined number of carbon atoms.

Dr. D. V. N. Hardy indicated an alternative mechanism by which it is supposed that carbon monoxide is added directly to alcohols with production of acids, which may then be reduced to aldehydes and alcohols. The condensations between methyl alcohol and carbon monoxide have been studied at 320°–340° under a pressure of 150 atmospheres in the presence of phosphoric acid. The gas was circulated at a rate of 2 cubic metres per hour, and 120 gm. of methyl alcohol vapour was introduced into the system during the same period. Acetic acid and methyl acetate were obtained, together with an oily layer containing high boiling hydrocarbons from which hexamethylbenzene was isolated. When 2 per cent by weight of copper phosphate was added to the phosphoric acid, this oily layer was no longer formed and larger proportions of acetic acid and its methyl ester were obtained. Some dimethyl ether was identified, but as it did not accumulate in the system it may be regarded as a reagent. These experiments favour the view that a methylene radical is produced which unites with carbon monoxide to form ketene, this reactive compound being then hydrated and methylated to acetic acid and methyl acetate respectively.

Dr. D. D. Pratt discussed the use made of autoclaves

in practically all research sections of the Laboratory. These autoclaves, which have been constructed in the laboratory workshop, have capacities ranging from 50 c.c. to 10 litres; they are capable of withstanding pressures of 200 atmospheres at temperatures up to 450°.

Phenols, aromatic hydrocarbons and bases undergo carboxylation when condensed with carbon dioxide under pressure in presence of catalysts such as aluminium and zinc chlorides.

High pressure aminations of alcohols and phenols have led to significant results. Resorcinol and orcinol heated to 200° with aqueous ammonia give rise to *m*-aminophenol and 5-amino-*m*-cresol respectively. In similar circumstances resorcinol and ethylamine furnish *m*-ethylaminophenol, an important colour intermediate.

Autoclave experiments have been made on the reactions between hydroxylic compounds and ammonium chloride. At 300°, ethyl alcohol gives a mixture of mono-, di-, and tri-ethylamines, separated by fractionation through a Dufton column. At 320°–350°, phenols are converted into a mixture of primary and secondary amines. This amination, which is particularly successful with *m*-cresol and symmetrical xylenol, is of technical importance, since the resulting *m*-toluidine and 1:3:5-xylydine are not readily obtained by successive nitration and reduction from toluene and *m*-xylene. In these aminations of phenolic homologues, the effect of orientation in the aromatic nucleus is plainly discernible. In the diphenyl series the ammonium chloride reaction on 2-hydroxydiphenyl and 2:2'-dihydroxydiphenyl leads respectively to *o*-xenyamine and carbazole, another important colour intermediate.

At the conclusion of the meeting, the visitors were conducted through the laboratories, in which exhibits and demonstrations had been arranged illustrating the following researches:—

Synthetic production of methyl and other alcohols from carbon monoxide and hydrogen, and the synthesis of acetic acid from methyl alcohol and carbon monoxide. For the characterisation of higher aldehydes and alcohols, it is necessary to have authentic specimens of well-crystallised derivatives, and a collection of these products was on view.

In the tar section there were demonstrations of shirlacrol, a new wetting agent used in mercerising cotton, and of the extraction of catechol and resorcinol from industrial liquors. The identification of tar constituents involves the synthesis of higher phenols and complex aromatic hydrocarbons. Distinctive specimens of such products were exhibited together with fuel oils derived from the hydrogenation of tars. In the road tar section a large-scale plant for the separation of the crystalloid and resinoid constituents of tars was in actual operation.

The allied sections of chemotherapy and synthetic resins were illustrated by comprehensive collections.

Inorganic chemistry was represented by researches on the aerial and immersed corrosion of metals, the production of base exchange materials from English clays and the isolation of rarer metals, such as germanium and rhenium, from British minerals. The exhibits arranged by the microbiological and dental investigation sections were also greatly appreciated by the visitors, who numbered about 260.

## New Regulations for the Natural Sciences Tripos

THE Committee of the Natural Sciences Tripos at Cambridge has issued a report on the regulations for that Tripos. The changes suggested in Part I are consequential on the recommendations of the Syndicate on Medical Courses and Examinations. New half subjects are introduced in biochemistry, physical and inorganic chemistry, organic chemistry, pathology and zoology (mathematics is already a half subject). Every candidate must take at least three whole subjects or at least two whole subjects and two half subjects.

Anatomy (a whole subject) is to consist of approximately equal proportions of topographical anatomy and scientific anatomy (embryology and morphology). A broad, rather than a detailed, knowledge of topographical anatomy will be required. The questions will deal mainly with the general architecture of the body and will not require a detailed knowledge, except of the more important areas. In the papers on physiology there are to be some optional questions on pharmacology, but it will be possible to obtain full marks in physiology without attempting any questions in pharmacology.

The half subject pathology is to be treated from the point of view of abnormal biology and is to include the variations which may occur in the structure and functions of living tissues and organs, together with the biology of parasites, bacteria and viruses. In the half subject biochemistry, a knowledge of the chemical processes associated with the normal life and growth of animal and vegetable organisms including micro-organisms is required.

In Part II, one of the four papers in geology and

in mineralogy and petrology is to be common to both subjects. Candidates in geology may substitute one of the papers in mineralogy for one of the papers in geology and vice versa. Candidates in physiology may substitute for a specified paper in physiology a paper in pharmacology or for two specified papers in physiology two papers in experimental psychology.

In Part II (chemistry), the first two papers will be of such a nature as to test the candidates' knowledge of general chemical science. The third and fourth papers will be set so as to enable candidates to show a specialised knowledge of some of the subdivisions of chemistry. They will include questions in inorganic, organic, theoretical and physical chemistry, colloid science, metallurgy, crystal chemistry; and candidates will be allowed complete freedom of choice in the questions which they attempt. A sufficient number of questions will be set in each of the subdivisions for a candidate to attain the standard of the first class by answering questions in one or more of them.

In Part II (physics), the first three papers will be of such a nature as to test the candidates' general knowledge of physics. The fourth paper will be of such a nature as to enable candidates to show a specialised knowledge of some branches of physics. This will contain a large choice of questions so that it will not be necessary for a candidate to have a specialised knowledge of all branches of the subject. This paper will include a sufficient number of questions on crystallography and crystal physics for a candidate to be able to gain full marks on the paper by answering questions on those branches only.

## Russian Studies of the Stratosphere\*

PLANS for the ascent into the stratosphere in the U.S.S.R. were first made in December 1932, and after various preparations the actual ascent was made on September 30, 1933, by G. A. Prokofiev, K. D. Godunov and Birnbaum. A height of nearly 19,000 metres was reached. The Central Geophysical Observatory has now issued a report in Russian of the ascent.

The original intention was to take measurements of the pressure and temperature of air, intensity and hardness of cosmic rays, intensity of electric field, conductivity of atmosphere, intensity of solar radiations, and analyses of the air, at various heights. It was, however, decided that in order not to overburden the balloon with the weight of all the necessary apparatus, the measurements of the intensity of electric field and solar radiation, as well as the observations on the conductivity of air, were to be postponed to the subsequent ascents.

The intensity of cosmic rays was measured by means of a Kollhörster electrometer, made of iron, volume 4,200 cm.<sup>3</sup> and electrostatic capacity 0.35 cm. During the ascent, the electrometer was charged by means of an ebonite rod. Measurements were made between the heights of 9,600 metres and 15,900 metres; the maximum possible error was estimated

as 5 per cent. The results obtained show fair agreement with Prof. Piccard's observations but there is a discrepancy of more than 30 per cent with the results of Prof. Regener.

Prof. Regener's observations		Prof. Piccard's observations		Russian observations	
Pressure in mm. Hg.	Intensity of cosmic rays	Pressure in mm. Hg.	Intensity of cosmic rays	Pressure in mm. Hg.	Intensity of cosmic rays
	ions/cm. <sup>2</sup> /sec.		ions/cm. <sup>2</sup> /sec.		ions/cm. <sup>2</sup> /sec.
150	153	142	215	137	221
100	224	127	248	86	345.3
75	243	88.5	305		
		83	313		

In order to measure the hardness of cosmic rays, a specially adapted Hesse electrometer was used, volume 1,100 cm.<sup>3</sup>, electrostatic capacity 1.2 cm. The electrometer was charged again by an ebonite rod, and was placed in a lead filter, with a wall thickness of 30 mm. The first set of measurements was taken at the height of 17,500–17,900 metres, when the electrometer was covered by the lead filter on all sides. The ionisation found was 338 ions per c.c. per sec., with a possible maximum error estimated at 8 per cent. A second set of measurements was taken at the height of 17,400–17,900

\* The Central Geophysical Observatory and the Ascent into the Stratosphere on September 30, 1933. A collection of articles (in Russian) by various authors. Pp. 26. Leningrad, 1934. 1 rub.

metres, but with the lead lid of the filter taken off. The ionisation found in this case was 415 ions per c.c. per sec., within a possible error of 5 per cent.

This series of results differs considerably from the results obtained by means of the Kolhörster electrometer (height 15,460 metres), and with the results obtained by Prof. Piccard. Unfortunately, no measurements were made with the Hesse electrometer completely out of the lead filter. The excess of ionisation is considered by the author (A. B. Verigo) to be due to the secondary radiations arising in the zinc walls of the electrometer under the action of cosmic rays.

Samples of air in the stratosphere were taken by means of specially constructed glass balloons suspended outside. Precautions were made to prevent possible contamination by air or gases which might arise from the balloon itself. The sample-taking balloons were originally at high vacuum and were opened and sealed electrically. Full descriptions of these small balloons are given.

In order to prevent contamination, samples of air were only taken during descent or when the balloon was floating. Analyses of the air samples were made independently by A. V. Moskvín in the Electrophysical Institute and by A. A. Tcherepennikov in the Gas Analysis Laboratory of the Central Geological Institute. The following results were obtained:

(1) Pressure inside the balloon after reducing to the original volume (1,120 c.c.) and to a temperature of  $-55^{\circ}\text{C}$ . was  $47.5 \pm 2$  mm. mercury.

(2) No hydrogen was found.

(3) The percentage volume of oxygen was 20.95 at a height of 18,500 metres.

(4) The contents of nitrogen and the sum of inert gases scarcely differ from the contents of air at the earth's surface.

The results obtained were so unexpected that a suggestion had to be considered that, owing to some unforeseen circumstances, the sample-taking balloons were filled by air somewhere near the surface of earth. This suggestion was disproved by measuring the humidity of air in the sampling balloons. A mirror hygrometer was used. At the temperature of liquid air no traces of moisture were found. Parallel experiments on specially dried air from the earth's surface with water vapour contents estimated at 0.5, 0.1 and 0.02 mm. mercury gave positive results on the same mirror. This ruled out the possibility that the air in the glass sampling balloons was taken on the earth's surface, and the author (M. I. Goltzman) suggests that there can be no doubt that the air in the sample balloons was taken in the stratosphere.

The lowest temperature observed during the ascent was  $-57^{\circ}\text{C}$ . Measurements were made by a platinum thermometer and Wheatstone bridge.

The rest of the pamphlet gives descriptions of the various pieces of apparatus that were used during the ascent, the way in which they were arranged inside the balloon, and also of other equipment which was prepared but not used in order to avoid overburdening the balloon.

### Archæology of the Caucasus

THE late Prof. Reginald W. Fessenden, author of "The Deluged Civilization of the Caucasus" (see NATURE, 113, 317, March 1, 1924), who had devoted forty years to the study of the prehistory of the Caucasus and had collected hundreds of thousands of references to the area, left much material still unpublished at the time of his death. Additional chapters of his book and a number of collected papers have now been privately printed—unfortunately for purposes of reference, under the same title. In these the author had put forward further applications of his theories which were based upon an intensive study of the mythology of ancient Egypt, Mesopotamia and Greece, of names, both personal and place-names, and of ancient geography. He again aimed at showing that there is evidence to support his view that not only was the Caucasus the land of the Book of the Dead, the original home of the Egyptians, the scene of ancient stories such as that of the labours of Hercules and the place of origin of Abraham; but also that it is the centre from which sprang all the great civilisations of antiquity, as well as the place of differentiation of the white and black races from a negro stock.

Prof. Fessenden here also attacked the question of Atlantis and the Platonic numerical cipher of the "Critias", as well as the Egyptian origin of masonry. The author was neither an archæologist nor a philologist; and in working out the identification of names of places and the interpretation of references in the traditions, he used material of very unequal value indiscriminately. Yet his suggestions at times were remarkably acute. His theories attached a significance to the Caucasian area which archæo-

logical research may well confirm, at least, in part.

There has been a number of indications recently pointing to the importance of the Caucasus as an area for exploration in relation to the early prehistory of adjacent countries; while the richness of the country on the eastern side of the Caspian in evidences of antiquity has to be seen to be believed. This must not be taken to endorse Prof. Fessenden's belief that exploration with oil-boring apparatus would bring to light the contemporary records of the pre-diluvial period which he held, according to tradition, had been buried in subterranean chambers. Reference at the moment is opportune, as the time is ripe for action. The Soviet Governments are willing, and indeed anxious, to co-operate with outside bodies in the work of anthropological research. They have already approached the United States, and one joint expedition has been at work on an ancient Gothic site in the Crimea on behalf of the Academy of the History of Ancient Culture and the University of Pennsylvania Museum. This expedition has enriched the latter institution to the extent of 3,600 objects, ranging in date from the historic period to 1500 B.C. The matter is not without urgency, as in certain areas the exploitation by the Government of material resources is a source of danger to the antiquities.

In the northern Caucasus the construction of an immense hydro-electric station will inundate a large area in which, it is estimated, in a year's time, some hundreds of burial mounds and tombs of the early bronze age and other archæological monuments of later date, belonging to the Scythic, Gothic or Tartar

civilisations, will have been irreparably damaged or entirely destroyed. In order that something at least may be saved, the Soviet Academy for the History of Early Culture has again asked for the co-operation of the University of Pennsylvania Museum. As the level of the water has already been raised 19 ft. in the past year, it will be possible to save only a limited amount by excavation before next autumn, when the work is to be completed. Yet the value of the material which is thus being lost to archaeological science is incalculable. Not merely has the north Caucasus been examined only very imperfectly, but also the implications of the discoveries already made in this area are very little appreciated. On this point it is worth while to glance at a communication by Prof. V. L. Avdief of Moscow on the relations of the Caucasus and early Egypt, which appears in *Ancient Egypt and the East*, Pts. 1-2; 1933. Prof. Avdief points out that the most valuable evidence on the cultural relations of the Caucasus and the countries of the ancient East is to be expected from the monuments of the chalcolithic and bronze age cultures of the Koban type in the Euxine region. In the Ossetian and Kabarda-Balkaria Autonomous Region of the North Caucasus, where the author conducted excavations in 1931-32, the bronze and

chalcolithic cultures are well developed. Here there were extensive deposits of copper ore, which indeed are not yet exhausted. In prehistoric times the tribes constantly extracted and worked these ores. The numerous bronze objects recently discovered in that area present close resemblances to those found at Koban. For example, a small stone hatchet, possibly ceremonial, found near Nalchik, fairly polished, with a central bored hole and partly bent downward, resembles one found at Koban. The pottery with incised line decoration painted white, the representation of animals in bronze akin to the Koban 'animal style' and finally the mode of burial in stone cists exemplify the same relation.

Certain objects found at Balkaria show relationship with ancient Egyptian culture. One of the most striking is an anthropomorphic deity standing in the middle of a circle which may symbolise the sun. It is comparable to a representation of the god Bes or Pateka. Late Egyptian (Hellenistic or Roman) objects found in Balkaria prove cultural or commercial relations in the first millennium B.C., and these relations are shown by a number of objects of domestic purpose to have extended to Assyria and Babylonia, although the actual trade routes are difficult to establish.

### Energy Relationships in Chemical Reactions

IN opening a discussion at the Royal Society on May 10 on the "Energy Distribution in Molecules in Relation to Chemical Reactions", Mr. C. N. Hinshelwood referred to some unimolecular reactions in which the velocity curve seems to be composed of several curves superposed, and suggested an interpretation in which several virtually independent reactions are taking place at the same time, all unimolecular and differing only in the values of the various characteristic constants. It is supposed that once a molecule has received its activation energy, the internal rearrangement of this is relatively difficult, and according to the original way in which the energy was placed in the molecule, there will be a different probability of chemical decomposition.

Investigations show that, with certain substances, molecules with activation energy differently located or distributed seem to behave as virtually independent entities for kinetic purposes, that there is a limited number of types of such molecules, and that

the chance that activation energy is communicated to a molecule in such a way as to cause rapid decomposition is relatively much greater in substituted molecules such as  $C_2H_5CHO$  as compared with  $HCHO$ . Investigations in liquid systems seem to suggest that there are two extreme cases, in one of which the rate of reaction is primarily determined by the acquisition of the necessary activation energy, and in the second a probability factor independent of temperature is of equal or greater importance and the reaction velocity is many powers of ten smaller than the activation rate.

There is a suggestive connexion between this and the remarkable catalytic effect of solvents, often roughly parallel with their polarity, on one hand, and on the other hand with the fact that, in reactions where one of the reactants is an ion, the rate is usually nearly equal to the activation rate, as though the great electrostatic forces contributed a perturbation powerful enough to increase the transformation probability to nearly unity.

### Barking Power Station

THE new generating station of the County of London Electric Supply Co., Ltd., is situated at Barking on the bank of the River Thames, about half a mile below Barking Creek. Its output is now 390,000 kilowatts, the largest in Britain, and when completed it will be about 600,000 kilowatts and will probably be the largest in Europe. It plays the leading part for the south-east England area in the Central Electricity Board's scheme. Ten circuits converge on Barking, six at 132 kilovolts and four at 66 kv. The Board's transforming station is situated on the opposite side of the road to the power station and is equipped with several very large high-tension transformers.

The Company with its associated companies supply power over an area of about 3,000 square miles. It supplies four London boroughs and a large number of the inner suburbs. In addition, it supplies various districts in Surrey and Essex. The associated companies feed large parts of Kent and Sussex. It is also developing outer areas under various electrification schemes. According to *Distribution of Electricity* of February, published by Messrs. W. T. Henley's Telegraph Works, it is intended ultimately to provide a supply for each village or township in the area having a population of 500 or more persons. In addition, transmission lines along the route will in due course be tapped at any point where a demand

exists. There are now more than seventy towns and villages where electric supply is available. There are several large poultry farms where electric hatcheries are in operation. Farms also use the electric supply for fruit and vegetable canning, and there are flour mills, small water and sewerage schemes, gravel and sand pits, brick-making and timber yards and sawing mills where it is employed. In addition to supplying electricity in bulk to many supply undertakings, it also supplies for traction purposes the London, Midland and Scottish Railway and the London Passenger Transport Board (Morden Tube).

The new extensions of the Barking power station work with a boiler pressure of 600 lb. per sq. inch. The temperature of the steam is therefore about 800° F. A few years ago it looked as if a still higher pressure would become the standard. In America, steam pressures of 1,200 lb. per sq. inch were first used; later, pressures above 3,000 lb. per sq. inch were used in Europe. Seeing that the new Battersea power station works at between 600 lb. and 650 lb. pressure and that the new Fulham station is being designed for this pressure, it looks as if 650 lb. would become the standard pressure. It is interesting to remember that early steam boilers worked with pressures of about 8 lb.

### University and Educational Intelligence

CAMBRIDGE.—The following appointments have been made:—J. H. Driberg, University lecturer in anthropology, Dr. S. Dickinson, University lecturer in mycology in the Department of Agriculture, W. J. Dowson (Christ's College), University lecturer in mycology in the Department of Botany and Dr. H. Godwin (Clare College), University lecturer in botany.

The degree of M.A. *honoris causa* has been conferred on Sir Charles Martin, formerly director of the Lister Institute of Preventive Medicine and professor of experimental pathology in the University of London.

At Girton College Dr. O. Taussky and Dr. C. Leubuscher have been elected to research fellowships.

On June 6, the following honorary degrees, among others, were conferred: Sc.D., Prof. Alfred Fowler, Yarrow research professor of the Royal Society and professor of astrophysics in the Imperial College of Science; Litt.D., Prof. Samuel Alexander, honorary professor of philosophy in the University of Manchester.

LIVERPOOL.—The Council of the University has accepted with regret the resignation of Mr. R. O. Street, senior lecturer in applied mathematics, on his appointment to the chair of mathematics in the Royal Technical College, Glasgow.

The University of Berne has conferred the honorary degree of D.Sc. on Prof. Share Jones, director of veterinary studies and professor of veterinary anatomy in the University, in recognition of his services to veterinary education and his distinction in his own branch of research.

SHEFFIELD.—The title of emeritus professor has been conferred on Prof. Edward Mellanby, formerly professor of pharmacology in the University.

### Science News a Century Ago

#### The Royal Society

At the meeting held on June 19, 1834, fourteen papers were taken; amongst these, a paper submitted on borings and ravages in timber, by William Thompson, vice-president of the Natural History Society of Belfast, was widely reported at the time. The opinion advanced that the *Teredo navalis* had ceased to be found on the British coast was shown by the author to be erroneous, since numerous specimens had been collected from the piles used in the formation of the pier at Portpatrick, in Ayrshire.

The subjoined letter from Mr. J. G. Children, Sec. R.S., addressed to Mr. Francis Baily, vice-president, was read: "British Museum, June 19, 1934. . . . His Royal Highness the President requests that, when you adjourn the meeting this evening to the 20th of November, you will have the goodness to express his great regret, that unfortunately, the state of his health and sight has lately been such as to render it impossible for him to preside at the ordinary meetings of the Society so regularly as it was his anxious wish to have done. His Royal Highness begs you will assure the Society that his absence has been occasioned by the cause alluded to alone, and from no feeling of diminished interest in the prosperity of the Royal Society, or of regard and respect for the Fellows; on the contrary His Royal Highness hopes that by the blessing of Providence, his health will soon be in all respects so far re-established as to enable him, on the reassembling of the Society, to resume the chair and fill it with that uninterrupted regularity which it is His Royal Highness's most anxious wish to observe, in whatever duty he undertakes. PS. His Royal Highness requests you will in his name bid the Fellows heartily farewell till he meets them again in November. (*Proc. Roy. Soc.*, vol. 3.)

#### Cause of the Aurora Borealis

A paper "On the Nature and Origin of the Aurora Borealis" by the Rev. George Fisher, read before the Royal Society on June 19, forms an excellent illustration of the state of geophysics in 1834. Arguing from "the general fact that the Aurora Borealis is developed chiefly on the edge of the Frozen Sea, or wherever there is a vast accumulation of ice", the author concludes that it "is an electrical phenomenon, arising from the positive electricity of the atmosphere, developed by the rapid condensation of the atmosphere in the act of freezing, and the induced negative electricity of the surrounding portions of the atmosphere; and that it is the immediate consequence of the restoration of the equilibrium by the intervention of the frozen particles, which being imperfect conductors, become luminous while transmitting this electricity. In tropical and temperate climates this phenomenon does not occur, because the electric equilibrium is restored by means of aqueous vapours, a process which often gives rise to thunder and lightning. . . ."

#### Lardner on Babbage's Calculating Machine

A century ago, few men of science were more widely known than Dr. Dionysius Lardner (1793–1859), who from 1827 until 1840 held the chair of natural philosophy and astronomy in University College, London. The writer of many textbooks, he projected the "Cabinet Cyclopaedia" and secured for it the

co-operation of Herschel, Brewster, Powell and other distinguished men. He was also well known as a lecturer, and on June 21, 1834, he lectured to a crowded audience in the theatre of the Mechanics' Institution on Babbage's calculating machine, to the cost of which the Government had contributed largely, but the construction of which was then at a standstill. Lardner dealt with the history and the principles of calculating machines and referred to their importance for the construction of correct mathematical tables. In its report of the lecture, the *Times* said that it would be considered a matter of national concern if means were withheld for the completion of Babbage's machine. The occasion was rendered notable by the presence in the chair of Lord Brougham and the attendance of M. A. Dupin, the president of the French Chamber of Deputies, whom the Committee of Management elected an honorary member of the Institution. M. Dupin was the brother of Baron Charles Dupin (1784-1873), the mathematician who had written on the manufactures and industries of England. In announcing M. Dupin's election, Dr. Birkbeck said he trusted, after what M. Dupin had heard that evening, that he would be induced to continue to lend his powerful aid and assistance to his brother in promoting the establishment of similar institutions to their own in France.

#### McCormick patents his Reaping Machine

There were many pioneers of the reaping machine but the outstanding inventor was Cyrus Hall McCormick (1809-84). His machine was exhibited at the Great Exhibition of 1837 and the *Times* said of it that "if it fulfilled its promise, [it] was worth the whole cost of the Exhibition". McCormick was the son of Robert McCormick (1780-1846) of "Walnut Grove" Farm, Virginia, a man of many interests who himself attempted but abandoned the task of constructing a reaping machine. At the age of twenty-two years, young McCormick, undaunted by his father's failures, took up the problem and in a year or two produced a machine which was tried with considerable success. "The fundamental principles in this reaper," a recent writer has said, "the divider, reel, straight reciprocating knife, fingers or guard, main wheel and gearing, and front-side draft traction, together with their peculiar combination, have proved essential to reaping machinery down to the present time." McCormick, faced with a rival in Obed Hussey, patented his important invention on June 21, 1834. He spent several years in perfecting it, but finding difficulty in getting his machines constructed, in 1847 founded a works at Chicago, then a small lake-side port. By 1851 he was building 1,000 machines a year and in 1857 constructed 23,000. The firm he founded is now the International Harvester Company. McCormick became very wealthy and many honours came to him, the Paris Academy of Sciences in 1879 electing him a foreign member "as having done more for agriculture than any other living man".

#### Magnetic Survey of the British Isles

In 1834 Capt. (afterwards Sir Edward) Sabine commenced, in conjunction with the Rev. Humphrey Lloyd and Capt. (afterwards Sir James) Ross, the first systematic magnetic survey ever made of the British Islands. The results were published in a series of reports to the British Association, commencing 1835, and the first observations (apart from

some preliminary tests of instruments) appear to have been made by Sabine at Limerick on June 21, 1834. The British Association report for 1835 contains a "Magnetic Chart of Ireland A.D. 1835". In 1836 Sabine, almost single-handed, extended the survey to Scotland and in 1837, with Lloyd, Ross and other collaborators, to England. The recording, plotting and combining of the observations to obtain the most probable mean results represent a very large undertaking.

#### The Overland Route to India

At a meeting of the Royal Geographical Society held on June 23, 1834, presided over by John Barrow, a paper was read "On the Manners of the Inhabitants of the Southern Coast of Arabia and Shores of the Red Sea, with Remarks on the Ancient and Modern Geography of that Quarter, and the Road through the Desert from Kosir to Kenah". This paper was communicated by James Bird, who had lately returned by that route from India. Bird had made the passage from Bombay to Aden, and thence to Jeddah and Kosir by a steam packet, and the interest in his account was heightened by the project of steam navigation to India having just been made the subject for a public inquiry.

#### Societies and Academies

##### LONDON

Royal Society, June 7. G. I. TAYLOR: (1) The mechanism of plastic deformation of crystals. Plastic strain is chiefly due to the sliding of one plane of atoms over its immediate neighbour in such a way that the perfect crystal structure is re-formed after each atomic jump. Slipping occurs over limited lengths of the slip plane, and this type of plastic strain necessarily gives rise to elastic stresses near the two dislocations which occur at the two ends of each of these lengths. The assumption that such dislocations will migrate through the crystal, owing perhaps to temperature agitation, under the influence of even the smallest shear stress, leads to a definite picture of the mechanics of plastic distortion. (2) The strength of rock salt. Experiment shows that plastic strain in rock salt is the main factor determining the strength of well annealed crystals. A recent theory of the strength of metals is applied to rock salt and shown to lead to a parabolic relationship between tensile stress and plastic strain. It is concluded that the strain in rock salt occurs in the crystalline parts of the structure where the crystal order is perfect, and that the strength is determined by the mean free path of the centres of dislocation. The latter, which is of the order of  $10^{-4}$  cm., is determined by the distance apart of the faults and by the temperature. The theory therefore assigns a definite function to the faults in determining the strength of crystals irrespective of their actual crystallographic or atomic nature. C. A. BEEVERS and H. LIPSON: The crystal structure of copper sulphate pentahydrate,  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ . The copper atoms lie on the special positions (000) and  $(\frac{1}{2}\frac{1}{2}0)$  and the sulphur upon the general position (0.01 0.29 0.64). Four of the waters are arranged in squares around the coppers, and two oxygens make with these approximate octahedra. The fifth water is not co-ordinated, but is in contact with two oxygens and two waters. All the waters show two oxygen bonds each, in accordance with recent ideas.

## PARIS

Academy of Sciences, April 23 (*C.R.*, 198, 1465–1556).  
 LOUIS ROY: Remarks on the construction of a standard of self-inductance. J. HAAG: The hypothesis of fibres. The elementary theory of elasticity supposes the elastic body to be composed of small independent parallel cylinders to each of which the formula of extension is applied. In general, this is inexact. The present paper discusses all the cases for which this hypothesis is rigorously correct. S. IKENO: Heredity of gynodioecia in *Petasites japonicus*. SYLVAIN WACHS: Linear systems of unilateral quaternion equations. W. MARGOULIS: The minimum of power consumed by flying machines. JULES GÉHÉNIAU: The tensor of polarisation. ADRIEN JAQUEROD: Classification of atomic masses. JEAN SAVARD: Compensation of the electronic energy and the energy of repulsion in the hydrogen molecule. TH. V. IONESCU and Mlle. IONICA CERKEZ: A new method for amplifying and producing low-frequency oscillations. The apparatus described gives oscillating currents of 0.5–1 amp., with frequencies between 2 and 15,000 cycles a second. ION I. AGARBICEANU: The mean life of a spectroscopic term and width of the lines of the spectrum. GUILLEN: The existence of the dimer  $O_4$  in liquid oxygen. From evidence based on the ultra-violet absorption spectrum, the author concludes that liquid oxygen is a mixture of molecules of  $O_2$  and  $O_4$ . RENÉ AUDUBERT and JEAN ROULLEAU: The mechanism of the action of light on selenium electrolytic photocells. F. BOURION and E. ROUYER: Determination of the total hydration of lithium chloride ions. R. TREHIN: Complementary researches on the absorption spectra of sodium chloride in the ultra-violet. The absorption spectra show that there is a distinct difference between the nature of the absorbing particles in crystallised salt and in aqueous solution. Salt solutions in glycerol were also studied. MARCEL BALLAY: The electrolytic deposition of nickel in media with pH higher than 7.0. LÉON PIAUX: The Raman spectra of cyclopentanol, of some alcohols derived from cyclopentene and of 1-cyano-1-cyclopentene. A. MICHEL-LÉVY and H. MURAUOUR: Experiments in micropyrotechny. The luminous phenomena produced by the detonation of a priming explosive (lead azide) are due to the wave of shock and not to the expansion of gas which succeeds it. M. LEMARCHANDS and Mlle. D. SAUNIER: The combinations of the metalloids and basic oxides. Description of the properties of the compound  $Ag_2OI_2$ , prepared by the action of iodine in carbon tetrachloride solution on anhydrous silver oxide. PIERRE DUBOIS: The thermal decomposition of manganous salts in a current of air. H. PIED and Mlle. M. FALINSKI. Neutral zirconium nitrate. Crystallised zirconium nitrate could not be prepared free from nitric acid, but the application of the method of Schreinemakers gave results which left no doubt as to the existence of the compound  $Zr(NO_3)_4 \cdot 5H_2O$ . Mlle. SUZANNE HÉMAR: The blue basic carbonates of copper. GEORGES ARRAGON: The acetylation of sorbose in the presence of pyridine. The substitution of pyridine for zinc chloride in the acetylation of sorbose gives higher yields of the tetracetate. A. COLANI: The combinations of uranyl oxalate with oxalates of the alkaline earths. SÉBASTIEN SABETAY and LÉON PALFRAY: The extension of Cannizzaro's reaction to fatty and aryl fatty aldehydes. A comparison of the authors' application of the Cannizzaro

reaction with the hydroxylamine method of determining aldehydes. MARIUS BADOCHÉ: Researches on the dissociable organic oxides. Ethyl 1.1'.3'.triphenylrubene carboxylate,  $C_{36}H_{23}.CO_2C_2H_5$ : its dissociable oxide. EDMOND URION: Some reduction products of cyclopentenylformaldehyde. MME. GUAISNET-PILAUD: A third hydrate of phenylmethylethylbetaine and its conditions of formation. HENRI ERHART: The white earths of Lorraine, their origin, nature and natural use. G. LUCAS: Tectonic study of the north region of Medjana (Algeria). J. COULOMB: The beginning of Love waves. ROBERT LAMI: The heterogeneity of some physical characters of coastal basins. A. MÉTRAL: Clouds in bands. BOGDAN VARITCHAK: The formation of organs of sexual reproduction in a species of the genus *Saprolegnia* in cultures *in vitro*. The formation of the organs of sexual reproduction depends on the composition of the nutritive medium, its hydrogen ion concentration and temperature. FERNAND MOREAU and Mlle. C. MORUZI: The sexual reactions between Ascomycetes of different species. H. S. REED and J. DUFRENOY: The histochemical detection of iron and zinc in the leaves of *Citrus*. The disease known as mottle leaf in *Citrus* is amenable to treatment of the soil with zinc salts. Micro-incineration of the leaves according to Policard's method, followed by microchemical analysis, shows the distribution of the zinc in the tissues. A. MAIGE: The physicochemical conditions of formation of the amylogen vacuoles in the plants. RAOUL LECOQ and JEAN SAVARE: The rôle of the food equilibrium in the utilisation of castor oil by the organism. H. BIERRY: The preparation of protein sugar. MME. YVONNE KHOUVINE: The synthesis of cellulose by *Acetobacter xylinum* starting with polyalcohols containing  $C_3$ ,  $C_4$ ,  $C_5$ ,  $C_6$  and  $C_7$ . G. WARCOLLIER, AUG. LE MOAL and J. TAVERNIER: The accidental presence of acrolein in cider brandy and pear brandy: its formation at the expense of the glycerol. N. STENDAL: The presence of a glycol in the wax of the tubercle bacillus. Description of the method of separation of a glycol, phytoglycol,  $C_{26}H_{54}O_2$ , the physical and chemical properties of which are given. MAURICE PIETTRE: Physicochemical phenomena accompanying the physiological stimulation of the breast in females before the first parturition. P. LÉPINE and Mlle. F. BILFINGER: The experimental infection of the louse by murin virus of the exanthematic type.

## LENINGRAD

Academy of Sciences (*Comptes rendus*, n.s., No. 4).  
 V. D. KUPRADZE: Integral equations for electromagnetic waves. V. GOGOLADZE: Cauchy's problem for a 'generalised' wave equation. A solution of Cauchy's problem is offered. V. KONDRATJEV and D. EROPKIN: Atmospheric band of water vapour 6324 Å. in the solar spectrum. In the interval 170 Å. of the solar spectrum, 235 new lines were found, 109 of them being of considerable intensity. As regards Rowland's lines, many of them proved to belong to water vapour. S. ARZYBYSHEV and A. TOPOREZ: A new method for the determination of mobility of metallic ions in alkali haloid crystals. N. DOBROTIN: Angular distribution of protons ejected by neutrons. A calculation made for  $F(\psi) = \cos \psi$  shows that the data obtained are nearer to Curie's results (*Phys. Rev.*, 44; 1933) than to those of Auger and Monod-Herzen (*C.R. Acad. Sci. Paris*, 196; 1933). P. LAZAREV, N. PODZOROV, E. JAKOVLEV and L. KUSMINITCH: Researches on

adaptations in peripheral vision during different stages of pregnancy. The visual sensibility becomes depressed a few days before the end of pregnancy, and the depression reaches its maximum during labour. After labour, the sensibility rises considerably. I. TCHERNIAEV and A. RUBINSTEIN: The reaction of pyridine with Cleve's and Gerard's salts. When pyridine reacts with Cleve's salt, a replacement of the molecules of ammonia by pyridine takes place, and  $(\text{PyCl})_2\text{Cl}_2\text{Pt}$  is formed. In the reaction with Gerard's salt, pyridine replaces two ions of chlorine, with the formation of  $(\text{NH}_3)_2(\text{PyCl})_2\text{PtCl}_2$ . The reaction with pyridine may serve as a qualitative test for these salts. N. HELD and V. DJACHKOV: Studies in the adsorption of organic substances on crystal surfaces. The adsorption of nonylic acid on barium sulphate proved to belong to the type of ionic adsorption. A. STUDIISKII: The interaction of cartilaginous tissue and the periosteum and its rôle in the endochondrial process according to data obtained from grafts transplanted on to the allantois. V. NOVIKOV, A. GRECHUSHNIKOV and J. BARMENKOV: The accumulation of rubber in the roots of *tau-sagyz* as a result of its disappearance from the leaves. B. LICHAREV: New genera of Upper Palaeozoic Brachiopoda. A. P. VINOGRADOV: Origin of iodine and bromine in oil-bearing waters. D. KOSTOV: Polygeneric hybrids experimentally produced. Experiments showed the possibility of obtaining trigeneric and tetrageneric hybrids of several species of *Nicotiana*.

*Comptes rendus*, n.s., No. 5.—I. VINOGRADOV: Trigonometrical polynomials for complicated moduli. S. BERNSTEIN: Diffusion with absorption. V. KUPRADZE: The proofs of existence and of unity in the diffraction theory. V. A. FOCK: Approximate representation of wave functions of penetrating orbits. V. KUZNETSOV and D. SARATOVKIN: Contribution to the problem of the primary crystallisation of metals. The orientation of monocystals is accidental, and the probable orientation is characterised by the angles  $\chi = 0^\circ$  and  $\chi = 30^\circ$ . P. BUDNIKOV: Activation of the slags of blast furnaces and the preparation of clinkerless cement. N. HELD and K. SAMOCHVALOV: Studies in the adsorption of organic substances on crystal surfaces (2). Influence of electrolytes on the adsorption of the octylalcohol by  $\text{Ag}_2\text{S}$ ,  $\text{HgS}$ ,  $\text{BaSO}_4$ , and of the nonylic acid by  $\text{Ag}_2\text{S}$ . A. STUDIISKII: Conditions for the differentiation of the osseous tissue of a human embryo in grafts on the allantois. I. KOLOMIEZ: On 'critical period' in the development of wheat. There is a connexion between the greatest sensitivity of wheat to a lack of moisture, and the time at which the formation of the generative organs begins. L. DOBRUNOV: Growth peculiarities of hemp as a result of a lack of nutritive substances in the soil.

## Forthcoming Events

Wednesday, June 20

ROYAL METEOROLOGICAL SOCIETY, at 5.—Sir Napier Shaw: "The Natural History of Weather".

I. S. Astapowitsch: "The Air-Waves caused by the Fall of the Meteorite on June 30, 1908, in Central Siberia". Dr. F. J. W. Whipple: "Phenomena related to the great Siberian Meteor".

INSTITUTION OF HEATING AND VENTILATING ENGINEERS, June 18–20. Summer meeting to be held at Hastings.

## Official Publications Received

### GREAT BRITAIN AND IRELAND

Air Ministry: Aeronautical Research Committee: Reports and Memoranda. No. 1557 (I.C.E. 823; T.V.C. 58): Effects of Friction in Aircraft Drives in Damping Torsional Vibration. By B. C. Carter. Pp. 25+3 plates. 1s. 3d. net. No. 1567 (Strut. 122, 127): Flexural and Shear Deflections of Metal Spars (Part 1). By I. J. Gerard and H. Boden. Pp. 11+20 plates. 1s. 6d. net. (London: H.M. Stationery Office.)

Proceedings of the Royal Irish Academy. Vol. 42, Section C, No. 3: A Wooden Cauldron from Altartate, Co. Monaghan. By A. Mahr. Pp. 11–29+plates 7–10. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 1s.

Seale-Hayne Agricultural College, Newton Abbot, Devon: Department of Plant Pathology, Tenth Annual Report for the Year ending September 30th, 1933. (Pamphlet No. 42.) Pp. 39. (Newton Abbot.)

A List of Official Chemical Appointments. Compiled by direction of the Council of the Institute of Chemistry and under the supervision of the Publications Committee. Eighth edition, revised and enlarged. Pp. 389. (London: Institute of Chemistry.) 5s.

The Scientific Journal of the Royal College of Science. Vol. 4: Containing Papers read during the Session 1933–1934 before the Imperial College Chemical Society, the Royal College of Science Natural History Society, the Royal College of Science Mathematical and Physical Society. Pp. 172. (London: Edward Arnold and Co.) 7s. 6d.

Annals of the Royal Statistical Society, 1834–1934. Pp. xii+308+8 plates. (London: Royal Statistical Society.)

A List of International Fellowships for Research. Second edition (revised and amplified). Pp. 187. (London: International Federation of University Women.) 2s.

Economic Advisory Council. Committee on Cattle Diseases: Report. (Cmd. 4591.) Pp. 161. (London: H.M. Stationery Office.) 2s. 6d. net.

### OTHER COUNTRIES

Mysore Geological Department. Bulletin No. 14: The Origin and Correlation of the Metamorphic Rocks of the Sakarsanahalli Area, Kolar District. By M. B. Ramachandra Rao and K. Sripada Rao. Pp. iv+33+8 plates. (Bangalore: Government Press.) 1 rupee.

Dominion of Canada: Department of Marine: Radio Branch. Supplement "A" to Bulletin No. 2: Radio Inductive Interference. By H. O. Merriman. Pp. 41. (Ottawa: King's Printer.) 15 cents.

U.S. Department of the Interior: Geological Survey. Bulletin 846-D: Some Lode Deposits in the Northwestern Part of the Boise Basin, Idaho. By Clyde P. Ross. (Contributions to Economic Geology, 1933.) Pp. iv+239–285+plates 39–48. 35 cents. Bulletin 848: The Microscopic Determination of the Nonopaque Minerals. By Esper S. Larsen and Harry Berman. Second edition. Pp. vi+266. 20 cents. Water-Supply Paper 726: Surface Water Supply of the United States, 1932. Part 1: North Atlantic Slope Basins. Pp. x+378. 25 cents. (Washington, D.C.: Government Printing Office.)

Forest Bulletin No. 82: The Measurement of Standing Sample Trees. By H. G. Champion. Pp. iii+17+5 plates. (Delhi: Manager of Publications.) 1.2 rupees; 2s.

Koninklijk Verensing "Koloniale Instituut", Amsterdam. Drie en twintigste Jaarverslag, 1933. Pp. 96. (Amsterdam.)

Smithsonian Miscellaneous Collections. Vol. 89, No. 13: A Systematic Classification for the Birds of the World. Revised and Amended. By Alexander Wetmore. (Publication 3242.) Pp. 11. Vol. 91, No. 9: Reports on the Collections obtained by the first Johnson-Smithsonian Deep-Sea Expedition to the Puerto Rican Deep—Three New Deep-water Fishes from the West Indies. By George S. Myers. (Publication 3238.) Pp. 12+1 plate. Vol. 91, No. 10: Reports on the Collections obtained by the first Johnson-Smithsonian Deep-Sea Expedition to the Puerto Rican Deep—New Brachiopods. By G. Arthur Cooper. (Publication 3241.) Pp. 5+2 plates. Vol. 91, No. 11: Reports on the Collections obtained by the first Johnson-Smithsonian Deep-Sea Expedition to the Puerto Rican Deep—Two New Nematodes. By B. G. Chitwood. (Publication 3243.) Pp. 4+1 plate. (Washington, D.C.: Smithsonian Institution.)

Chamber of Commerce of the State of New York. A Report of the Special Committee on Immigration and Alien Insane, submitting a Study on Immigration-Control. By Harry H. Laughlin. Pp. 51. (New York City.)

Bulletin of the Earthquake Research Institute, Tokyo Imperial University. Supplementary Vol. 1: Papers and Reports on the Tsunami of 1933 on the Sanriku Coast, Japan. Pp. xii+271+250+251 plates. (Tokyo: Iwanami Shoten.) 12.50 yen.

The Upper Winds of Hong Kong: from Observations made with Pilot Balloons, 1921–1932. By G. S. P. Heywood, under the direction of C. W. Jeffries. Pp. 13+18 plates. (Hong Kong: Royal Observatory.) 2 dollars.

Research Activities of the National Research Council, 1933–34. Pp. 59. (Ottawa.)

Department of Agriculture, Mauritius: Sugarcane Research Station. Bulletin No. 3: Some Preliminary Data concerning the Best Shape and Size of Plot for Field Experiments with Sugarcane. By Dr. H. Evans. Pp. 11+2 plates. (Port Louis: Government Printer.)

Publications of the Dominion Astrophysical Observatory, Victoria, B.C. Vol. 6, No. 9: Spectrophotometric Studies of Wolf Rayet Stars and Nova. By C. S. Beals. Pp. 95–148. Vol. 6, No. 10: The Radial Velocities of 477 Stars. By W. E. Harper. Pp. 151–202. Vol. 6, No. 11: The Spectroscopic Orbit of H.R. 8584. By W. E. Harper. Pp. 203–206. (Ottawa: King's Printer.)

The Indian Forest Records. Vol. 19, Part 9: Entomological Investigations on the Spike Disease of Sandal (19): On the Life-History and Morphology of *Petaloccephala nigritinea* Walk., (*Jasside*, Hompt.) By N. C. Chatterjee. Pp. iii+30+2 plates. (Delhi: Manager of Publications.) 12 annas; 1s. 3d.

The Tea Research Institute of Ceylon. Bulletin No. 11: Annual Report for the Year 1933. Pp. 75+2 plates. (Kandy.)