

# NATURE

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Vol. 158, No. 4026

SATURDAY, DECEMBER 28, 1946

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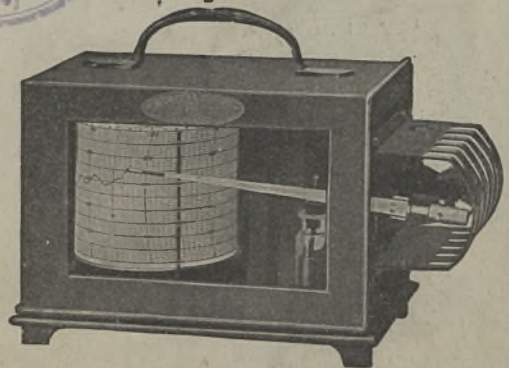
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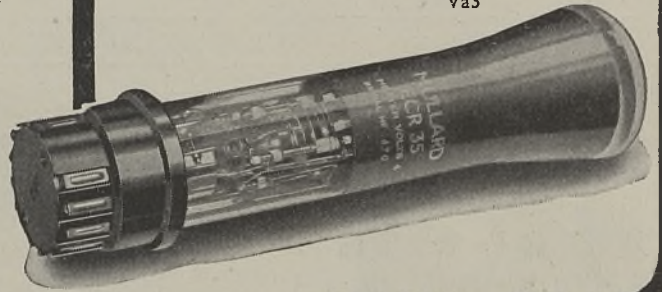
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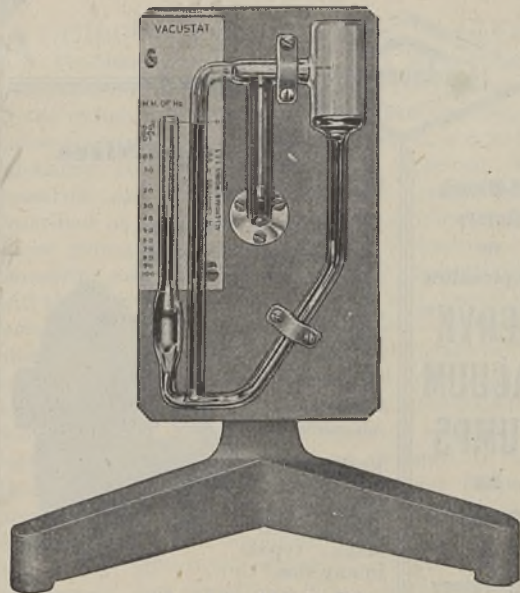
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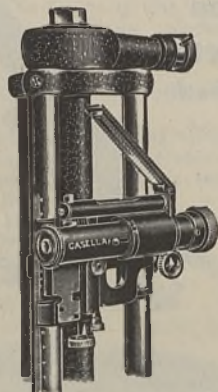


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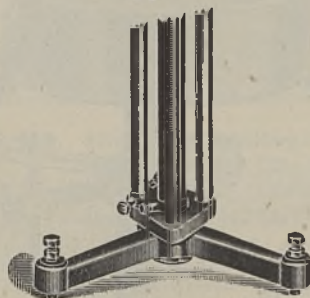
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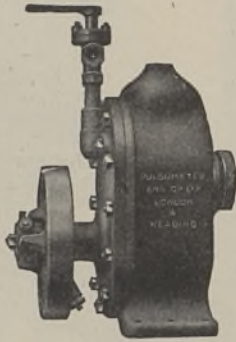
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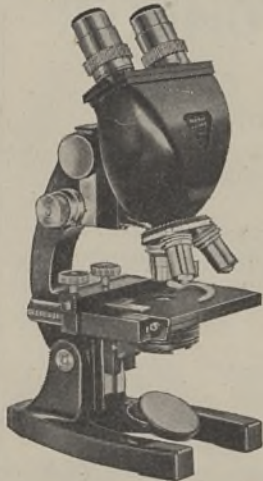
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## SCIENTIFIC AND TECHNICAL BOOKS

ALTHOUGH in his pamphlet, "Newsprint—a Problem for Democracy", Sir Walter Layton was concerned more specifically with the consequences of the reduction in size and freedom of circulation of newspapers, the position he discloses is not without relevance to the scientific and technical Press. Scientific and technical periodicals may also be described as imported articles, being like the newspaper printed either on imported newsprint or on newsprint made in British mills from imported pulp, and they are equally vulnerable to any factor interfering with imports. Similarly, scientific work and interests, as much as knowledge of public affairs, have suffered from the compression and also from the selection that are inevitable when newspapers are confined to four pages. Matters of scientific and technical importance raised or debated in either House of Parliament, for example, are frequently unreported or at best receive bare mention in the daily Press; the scientific and technical Press can rarely afford the space to discuss the topic adequately, and sometimes it is overlooked entirely. Some attempt is made by the Parliamentary and Scientific Committee in *Science in Parliament* to remedy this position, but the summaries thus published are usually too belated for any effective action to be taken.

Sir Walter Layton's pamphlet makes it abundantly plain that the critical importance of an adequate supply of newsprint is not adequately appreciated by the Government, and scientific workers on their side have the painful experience of the war years to impress on them the failure of either the Ministry of Supply or the Board of Trade to realize that books and periodicals are tools of research as essential as apparatus and laboratories. To a Government department a first-class scientific monograph or work of reference is equated with the latest novel or a bag of chalk, and most technical or scientific librarians could testify to their inability to secure any acceleration of the import of the text-books which research workers were urgently demanding. It is understandable that the output of British scientific and technical books should in war-time have dwindled to negligible proportions, and it was inevitable that the supply of such books from European sources should be interrupted. That no Government department should have appreciated that this situation accentuated the need to import American books is another question, and such departmental short-sightedness was at times a direct handicap to research and to our war effort.

What is discouraging is to find so slight an improvement in the position eighteen months after the termination of hostilities in Europe. The output of British scientific and technical books is still slight, due in large part to the shortage of man-power. Dollar stringencies are still allowed to curtail our imports of American books. American publishers are to be congratulated on the energy with which they have faced the situation and for their enterprise in

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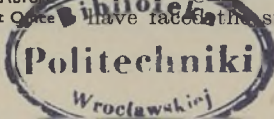
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the reproduction of important German scientific and technical books; nevertheless, we are entitled to ask whether it is likely to be in the interest of Britain or of its scientific workers to leave such developments exclusively in other hands.

The shortage is particularly acute as regards publications of the text-book class. Correspondence in the columns of *The Times* on the shortage of books and the difficulties which university students experience in consequence is corroborated in the annual reports of important public libraries, one of which states that twenty students may be waiting at the same time to use the sole copy of a particular book which the students themselves are unable to buy or to borrow elsewhere. Moreover, the abnormal demands at present made on the universities, and the shortage of teachers increase the importance of text-books in university education. Without books, as Sir Charles Grant Robertson observed in this connexion, a real university education is impossible; nor in such conditions is it possible to explore in the newer universities the possibilities of the tutorial system as opposed to the lecture system on lines, for example, such as Dr. C. H. Waddington has suggested.

The repercussions of this shortage of books are in fact not felt solely in the universities, or in research, in industry, or in Great Britain alone. They affect the Colonial Service courses and also, as Sir Stanley Unwin has pointed out, there is an acute and unsatisfied demand for British books on the Continent of Europe and elsewhere. One function of the British Council is to make known British culture and achievements; but the actual production of scientific and technical text-books certainly does not come within its competence. It is doubtful whether much success can be expected to attend the establishment of an emergency pool of text-books, for example, by the University and Research Section of the Library Association; such copies as exist are unlikely to be idle and available for pooling. Moreover, such measures are at best palliatives and should not be allowed to deflect attention from the main objective—the increase of production.

As Mr. H. M. Cashmore, president of the Library Association, urges in his letter to *The Times*, the production of books, including the reprinting of standard texts, is a matter of vital importance. Scientific men may well be expected to take whatever steps are in their power to facilitate and co-ordinate supplies of materials, and to renew their representations to the Government on the importance of books not only in the training of students, in the formation of opinion and the promotion of international understanding and the exchange of knowledge, but also as essential tools in research and production. Nor should they forget that in the present situation it behoves them to see that the most effective use is made of available supplies of material for book production. There is no room for books or for periodicals which will not bear searching objective scrutiny, and the present shortage of labour makes it the more imperative that scientific workers should not only set their own house in order by the elimination of redundant books and period-

icals; but also, by the rigorousness of their criticism and the impartiality and objectiveness with which they review scientific and technical publications, they can ensure that the highest possible standards of production and content are attained. This much being done, however, the central problem is the manpower situation. Until the various industries concerned in the production of books can employ the requisite number of workers and also make full use of their material equipment, the supply of all types of books is bound to continue seriously to lag behind the demand.

## DEVELOPMENTS IN RUBBER SCIENCE

### Advances in Colloid Science

Initiated by the late Elmer O. Kraemer. Vol. 2: Scientific Progress in the Field of Rubber and Synthetic Elastomers. Edited by H. Mark and G. S. Whitby. Pp. xl + 453. (New York: Interscience Publishers, Inc., 1946.) 7 dollars.

THE appearance of a comparatively comprehensive book on rubber science is an event of some importance. The last publication of the kind was Davis and Blake's "Chemistry and Technology of Rubber" (1937), and a comparison of this with the volume under review makes one immediately aware not only of the considerable advances which have taken place in almost every aspect of the subject, but even more strikingly of the shift of emphasis away from organic chemistry and towards physics and physical chemistry. This is not due to any reduction in the significance or importance of the organic chemical aspect, but rather to an efflorescence of new concepts and ideas of a somewhat revolutionary character in the physical realm which have combined to make rubber science one of the most fascinating of present-day studies.

In the second volume in the series appearing under the title "Advances in Colloid Science" the editors have succeeded in choosing recognized authorities to write on their particular branches in such a way that the whole subject is fully covered, without introducing any undesirable repetition. Of the nine principal chapters, five deal mainly with physics, two with physical chemistry, and two with organic chemistry. In addition there are an excellent short introductory chapter by G. S. Whitby on the structure of synthetic elastomers, and an appreciative review of the work of the late Elmer O. Kraemer, by whom this series of volumes was initiated.

The rubber-like state, characterized by long-range elasticity, is associated with an amorphous or disordered arrangement of long-chain molecules in a state of micro-Brownian motion. If the regularity of structure along the molecular chain is sufficient, the amorphous state may, under suitable conditions, transform to a partially crystalline state, while at low temperatures both crystalline and amorphous states give place to the glass-hard condition. The transition to the glassy state—the so-called second-order transition—is discussed by R. F. Boyer and R. S. Spencer, of the Dow Chemical Company, while the phenomena of crystallization are treated by L. A. Wood of the U.S. Bureau of Standards. Another

aspect of crystallization, the determination of the exact structure of crystalline polymers by X-ray methods, is dealt with by C. W. Bunn of I.C.I. (Alkali) Ltd., while the phenomena of elasticity are interpreted from the theoretical point of view by E. Guth of the University of Notre Dame, H. M. James of Purdue University, and H. Mark of Brooklyn Polytechnic.

Boyer and Spencer give a careful summary of the existing information on changes in physical properties associated with the second-order transition, including some of their own recent investigations. In a subject bristling with apparent anomalies and difficulties of interpretation, they have made a courageous attempt to produce some sort of order, and although final agreement on many of the issues cannot be expected, the attempt should provide a welcome stimulus to further work in this hitherto somewhat neglected field.

Wood's chapter on crystallization is concerned mainly with experimental methods of studying crystallization, and the principal phenomena observed. From the work of Bekkedahl and others it is shown that crystallization phenomena in rubbers show certain similarities to, but also striking differences from, crystallization in ordinary low-molecular systems. In particular the crystalline state does not attain real thermodynamic equilibrium with the amorphous state at any temperature. For example, the temperature of melting depends on the temperature of crystallization, but not on the time of crystallization or on the degree of vulcanization. It is concluded that none of the theories yet proposed is adequate to explain this and other remarkable but well-established observations.

Though very much a specialist's province, the subject of X-ray crystallography is presented by Bunn in a very lucid and readable manner. Exceptional difficulties arise in this particular application, due to the small size and imperfect ordering of the crystallites; it is impossible to obtain a single crystal, hence the usual optical methods for the preliminary examination of crystal symmetry are not available, and the number of measurable reflexions is relatively small. But by ingenious arguments of a general character it is often possible to make a plausible estimate of the type of structure; the diffraction pattern of the postulated structure is then calculated and compared with experiment. It is difficult at present to assess the accuracy of this procedure. Some of the structures proposed by the author have been challenged, and may have to be revised.

The section on the theory of rubber elasticity by Guth, James and Mark is based on the conception of vulcanized rubber as a network of long-chain molecules subject to statistical fluctuations of form. The mathematical treatment of the problem leads to quantitative stress-strain relations which show a close agreement with experimental curves, and it is apparent that we are now in possession of a fairly accurate quantitative theory of the mechanical properties of amorphous rubber. The chapter might have been improved by a more general consideration of theories of rubber elasticity other than that of James and Guth. The critical references to the work of Wall, of Flory and Rehner, and of Kuhn scarcely do justice to the extensive and stimulating contributions to the subject which these authors have made.

Dealing with reinforcement and the physical effects of compounding ingredients on the properties of vulcanized rubbers, D. Parkinson, of the Dunlop

Rubber Co., gives an excellent summary of the effect of various carbons and other fillers on tensile strength and elastic modulus, resistance to abrasion and tearing, rebound resilience, etc. There appears to be no generally accepted criterion of reinforcement, though it is normally taken to include enhancement of tensile strength and abrasion resistance. Most of the effects discussed have not yet received a satisfactory theoretical explanation.

The two sections on physical chemistry are contributed by G. Gee, of the British Rubber Producers' Research Association, who deals with the application of thermodynamics to problems of solution and swelling, and by R. H. Ewart, of the U.S. Rubber Co., who discusses the significance of viscosity measurements in dilute solutions of high polymers. Gee examines experimental methods of deriving the fundamental thermodynamic properties of solutions, namely, the free energy and heat of dilution (or mixing), from which also the entropy of dilution may be deduced. The statistical calculation of the entropy of dilution of a polymer by a low-molecular solvent is a difficult problem, approximate solutions to which by Flory and by Huggins agree rather well with experimental data.

The phenomena of the swelling and solubility of a rubber in various liquids can be satisfactorily interpreted on the basis of these thermodynamic concepts. It is clear that this type of approach is likely to be of considerable practical as well as theoretical importance.

Ewart considers in some detail the rather closely related topic of the viscosity of dilute polymer solutions, which is of special importance for the measurement of molecular weights, in which connexion it has an empirical rather than an absolute significance, and must be applied with caution. Various proposed relations between solution viscosity and polymer concentration are discussed. In general, the relation between intrinsic viscosity and molecular weight is a non-linear one, involving the use of two constants, as is shown particularly well by Flory's work on poly-isobutylenes. The chapter includes also a consideration of the conclusions which may be drawn from viscosity, light-scattering and other measurements on the form of molecules in solution, and a review of the theoretical background to the subject.

On the organic side E. H. Farmer, of the British Rubber Producers' Research Association, deals with the chemistry of vulcanization, while the somewhat analogous problem of the formation of photogels and photovulcanizates is discussed by H. P. Stevens. Farmer's comprehensive treatment includes a consideration of the various possible reactions of rubber and olefinic systems generally with sulphur and other reagents which are known to produce insolubilization. Recent investigations have established that sulphur reacts with simple olefins to produce intermolecular linkages containing one or more sulphur atoms. There is little doubt that a similar reaction occurs between poly-isoprene rubber and sulphur, but in this case there is the complication of ring-formation by linkages between two points of the same molecule. The chemical evidence for the existence of a cross-linked structure in vulcanized rubber provides a welcome confirmation of a theory which has been extensively postulated in purely physical investigations relating to swelling and elasticity.

Photo-gelation, a form of vulcanization produced by the action of light on either dry rubber or rubber solutions, is a phenomenon which appears still to be

imperfectly understood in terms of detailed reaction mechanisms. From Stevens's review of the subject there is seen to be much conflicting evidence on the effects of illumination, and further work designed with the object of providing more reliable experimental data is clearly called for.

Taken as a whole, this volume provides a much-needed co-ordination of recent developments, and will be eagerly studied by all whose work is associated with rubber and polymers, and, it is to be hoped, by others as well.

L. R. G. TRELOAR

## ELECTRIC FILTERS AND CRYSTAL LATTICES

### Wave Propagation in Periodic Structures

Electric Filters and Crystal Lattices. By Prof. Léon Brillouin. (International Series in Pure and Applied Physics.) Pp. xii+247. (New York and London: McGraw-Hill Book Co., Inc., 1946.) 20s.

THIS book deals not with a special branch of physical science but with a general method and its applications to different problems. Its striking feature is the number and variety of subjects which are accessible to the same mathematical treatment: on one side problems of pure physics, like scattering of X-rays by crystals, thermal vibrations in crystal lattices, electronic motion in metals, and on the other side problems of electric engineering, namely, propagation of electro-magnetic waves along periodic circuits and filtering properties of such systems.

In a very attractive introduction the history of the problem is described. The work on periodical structures is as old as modern mechanics itself, since Newton's derivation of the velocity of sound in his "Principia" is based on the consideration of a linear lattice. Many distinguished mathematicians of the eighteenth and nineteenth centuries have written about this subject: the Bernoullis, Taylor, Euler, Lagrange, Cauchy, Baden-Powell and others. Lord Kelvin gave a detailed discussion of the wave propagation in a one-dimensional lattice and discovered all its main properties: the non-linear relation between wave-number and frequency, the existence of a maximum frequency of propagation for systems of equal particles and of several frequency branches for systems of different particles; in modern terminology, he found the 'filtering' properties of a periodic structure. These results were re-discovered when Einstein's theory of the specific heat of solids demanded a detailed study of crystal lattices.

The succeeding chapters of the book are devoted to a careful presentation of the facts indicated in the introduction. First a mechanical model of particles coupled by elastic springs is used, but soon (Chapter 3) electric structures are considered. Already here, in the linear case, the idea of the reciprocal lattice is introduced. A whole chapter (5) is devoted to the discussion of the velocity and the flow of energy, and the results are expressed in the language of electro-technics by regarding the vibrating system as a transmitter of signals, or as a filter for waves. This way of thinking, familiar to the electrical engineer, is somewhat strange to the physicist. I confess that I have never looked on a lattice as a frequency filter. But this aspect is most interesting, and it is not difficult and most useful to express the results in terms of "passing bands" and "stopping

bands", impedance and other such technical expressions.

The propagation of waves in two- and three-dimensional lattices is discussed with the help of the reciprocal lattice and of the 'Brillouin zones'. This conception was the main contribution of the author to lattice theory; he has published it in several papers and in a book, "Quantenstatistik" (Springer), and it has been used with great advantage in many investigations. The boundaries of the zones in reciprocal space are the locus of possible discontinuities of the energy distribution. Special cases of this general theorem are Bragg reflexions of X-rays, the energy distribution of electrons in metals and so on. The author applies it also to the theory of specific heat and other thermal properties of solids. This is the only point in the book with which I cannot fully agree. Brillouin derives the distribution law of frequencies of lattice vibrations and shows that each branch contains as many frequencies as the number of cells of the lattice, and he continues (p. 161): "This is a very important and general result of the zone theory". In fact, it follows simply from the existence of the branches and has nothing to do with the zones. This is evident from the fact that it was found many years before the zones were discovered. The generalization of Debye's theory of specific heat based on this theorem (where a separate characteristic temperature is attributed to each branch) dates also from the pre-zone period.

While all the considerations so far are based on approximations (perturbation theory), Chapter 8 is devoted to a study of rigorous solutions in simple cases (Mathieu's and Hill's equation). The last two chapters are the most interesting ones as they give a full account of the author's own work on the propagation of waves along an electric line. Here matrix calculus is applied, and most interesting relations to Pauli's and Dirac's matrices, used in the theory of the spinning electron, are revealed.

The book is delightfully written. The author does not shrink from repeating a formula which has been derived before, so as to save the reader turning over pages. He never says "It is easy to prove" as many writers do (meaning, you have to work hard and spend a considerable time); but he gives the proof clear and simple. It is a work not only for instruction but also for enjoyment.

MAX BORN

## MAMMALS OF NEVADA

### Mammals of Nevada

By E. Raymond Hall. Pp. xi+710+11 plates. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1946.) 42s. net.

THIS is a work by an enthusiast who lives for his subject and makes his subject live. Such is the thoroughness of the groundwork on which it is based and the completeness of the treatment that it is unlikely to be superseded. Dr. Hall's knowledge is based on the examination of some eighteen thousand specimens, most of which were collected by expeditions led by him between 1930 and 1936, during which he covered the whole State of Nevada.

The first part of the book is devoted to an explanation of his methods and to a discussion of general considerations of taxonomic and allied questions:



the factors responsible for geographic distribution (ecological factors), fluctuations, clines, speciation, etc. There is a most interesting section on the characteristics of desert animals and their mode of life, with particular reference to the conservation of moisture in the body.

The treatment of sub-species is sensible. The routine habit of regarding a geographically isolated form as a sub-species because it does not intergrade with any other forms has led to many absurdities such as the numerous 'species' of rodents from the isles of western Scotland. Dr. Hall found that pikas (*Ochotona*) occur in three widely separated mountain ranges in Nevada. Many rule-of-thumb systematists would treat them automatically as species. The author's criterion is this. If the variation between these isolated forms does not exceed the variation found between forms which have a continuous distribution, then he treats them as sub-species; and this is what he does with the Nevadan pikas.

Dr. Hall's way with common names is an example which should be universally followed. He gives the same common name to all sub-species of a given species instead of straining to invent so-called common names for each local race. He argues that the differences between sub-species are not usually apparent to the layman, and that for practical purposes when dealing with non-migratory kinds of mammals (in which no more than one sub-species occurs in one place) common names of species almost everywhere suffice if the locality concerned is stated.

The geographical data are excellent. There is a general discussion of the topography of Nevada and its climate. At the end of the book is a gazetteer giving the latitude and longitude of each place mentioned in the text and particulars of the maps used by the author. There is also a map on which are marked the Nevadan type localities, and in the body of the work are many distribution maps of individual forms.

The treatment of each form is very complete, and full field data are given. The author distinguishes between juvenile, young, sub-adult and adult, in that order of ascending age. Most authors seem to use 'juvenile' and 'young' indifferently. There is a glossary of technical terms which includes some clear diagrams explaining the conventional skull measurements of the different orders.

The check-list is supplemented by a 'hypothetical' list of mammals which have not been recorded from Nevada but which the author thinks might occur there. There is a key to the mammals of Nevada which has good illustrations and no doubt works very well, but it is a pity that the layout of the key is so old-fashioned. The alternative halves of the main dichotomies are widely separated, which necessitates turning over several pages to find the second alternative and compare it with the first, and the minor dichotomies are indented progressively farther and farther, which is tiring to the eye. Much better is the type of key with the two alternatives of each dichotomy adjacent to each other and with no marginal indentations, thus:

- (1) Four toes on hind foot (16)  
Three toes on hind foot (2)
- (2) No tail (4)  
Tail (3)
- (3) Black ears—*Mirabile dictu*.  
White ears—*Monstrum horrendum*.  
etc., etc.

However, that is the only criticism I would make of this book.

Dr. Hall has not only written an excellent textbook on Nevadan mammals—he has written a book much of which will be of interest to all students of mammalogy.  
T. C. S. MORRISON-SCOTT

## CORROSION OF METALS

**Metallic Corrosion, Passivity and Protection**  
By Dr. Ulick R. Evans. Second Edition, with an Appendix by A. B. Winterbottom. Pp. xxxiv + 863. (London: Edward Arnold and Co., 1946.) 50s. net.

THE first edition of Dr. Ulick R. Evans's "Metallic Corrosion, Passivity and Protection" appeared in 1937 and was reprinted in 1938, but has for some years been out of print. The second edition will be welcomed enthusiastically by all those interested in, and concerned with, the corrosion of metals. While the war years probably did not yield such a flow of new knowledge and information on corrosion as those just before the War, substantial advances have been made between 1938 and the present time. The author has striven effectively to avoid undue lengthening of the text in spite of his finding it desirable to refer to the work of some thousand additional contributors to knowledge on corrosion beyond those mentioned in the first edition. The new volume seems, in spite of some expansion of the text, to be of a very convenient and easily handled size. An important addition is an appendix on optical methods for the determination of films on metals by A. B. Winterbottom, who has made a special study of this subject.

The general arrangement and presentation are on the lines of the earlier edition, each chapter being divided into three sections which deal respectively with the scientific, technical and mathematical aspects of the part of the subject under discussion. Dr. Evans mentions that this arrangement seems to have made some appeal to the younger generation, but it cannot fail to have advantages also for research workers and technologists.

The text has been improved by some rearrangement, such as the collecting together of information on statistical approach into one section of the chapter on testing. The author has a unique knowledge and experience of corrosion studies and gives a masterly survey of the present position. Each in its proper place and in fitting sequence, the various contributions to knowledge of the subject are explained. The views of other workers are represented with admirable fairness, and the numerous contributions to fundamental knowledge of corrosion by the Cambridge school are mentioned with the author's usual modesty.

His own flair for recognizing the more obscure features of corrosion and for devising and using methods of gaining enlightenment on them, to which the Cambridge school of corrosion research owes so much of its success, has obviously assisted the author greatly in presenting this matchless store of information.

A remarkable feature of the work is the wide range of technical processes and products that are discussed in the light of modern knowledge and experience.

The book opens very appropriately with an introduction on the principles of electrochemistry in which the author deals with electrode potentials, polarization, over-potential and the effect of surface films.

Each of the fourteen chapters which follow is introduced by a section dealing with the fundamental aspects, which are linked up very usefully with technical matters and practical problems in the further sections. Technologists concerned with the fight against corrosion and all students of the subject will find this book invaluable.

H. SUTTON

## A NATURE DIARY

The Country Diary of a Cheshire Man

By A. W. Boyd. Pp. 320+15 plates. (London: Wm. Collins, Sons and Co., Ltd., 1946.) 12s. 6d. net.

A NATURE diary, even the baldest, is ever fascinating, not only to keep but also to read. It is undoubtedly the diary-like form of Gilbert White's letters that helps them to hold their place as the great classic of country and Nature writing. The present book inevitably draws upon itself comparison with that masterpiece, a comparison from which it emerges with all credit, for it is of the authentic Selborne school, detailing the daily happenings of the countryside with a gusto that communicates itself to the reader, touching on this item and that item with an enthusiasm and insight that brings illumination to the most everyday subject. Take, for example, the following remarks on the grey squirrel and the red squirrel: "One of the alien grey squirrels, now so securely established in England, was killed in Cheshire and given me a few days ago, and it is easy to see how the belief arose that it inter-breeds with our native red squirrel, although no authentic evidence whatever of hybridization between the two species has ever come to light. The one given to me was just changing its coat, and possibly that accentuated the redness of its fur in certain parts of the body; there was a russet streak along each flank and the same colour on the face, the hind legs, and to a less extent on the back."

We agree with the author regarding supposed hybrids between these two species, having so far failed to obtain any evidence of fraternization of these animals in a wild state.

Mr. Boyd's notes of his home county happenings are interspersed with short accounts of trips abroad in search of birds, such as a visit to Finland and another to Spain, and very interesting are his descriptions; yet not, in the reviewer's opinion, half so fascinating as his day-to-day reports of little homely things. He ranges over a wide field: birds may be his chief interest but he does not forget to mention that April 27, 1942, saw "green-veined white butterflies flying in the sunshine, and the beautiful pale lilac purple-streaked marsh violet has come into flower"; he adds, "although red campions were out eleven days ago, most of them still remain in bud".

Mr. Boyd makes an interesting observation with regard to birds on an experimental seed farm. "Gulls do harm in a remarkable way. They regurgitate some of the grain they have swallowed, and these pellets fall among the carefully numbered lines of wheat and oats and produce 'rogue' plants. The activities of the short-tailed field-mice have the same result, for they collect grain from several rows and heap it in the wrong place; one vole had carried 350 grains of rye and planted them thirty-five yards away."

It would be interesting to know if the culprits were identified for certain, as it sounds more like the work of that indefatigable little rodent the bank vole,

*Evotomys glareolus*, than of the grass-eating, short-tailed, or meadow vole, *Microtus agrestis*.

A word of praise must be given to the excellent photographs—landscape, birds, insects and flowers—that illustrate this volume, the picture of that curious plant herb Paris and the study of white water lilies being particularly good.

FRANCES PITT

## GRAMME AND THE INVENTION OF THE DYNAMO

Zénobe Gramme

Notice bio-bibliographique suivie de la description de la dynamo par son inventeur et d'autres documents. Par Jean Pelseener. (Collection Nationale No. 6.) Deuxième édition. Pp. 80. (Bruxelles: J. Lebègue et Cie., 1944.) 15 francs.

THIS booklet falls into three main parts—a bibliographical note on Zénobe Gramme by the author, the reprint of four papers by Gramme, his only published work, and a bibliographical list concerning Gramme and his invention, three items of which are reprinted in full, being difficult to obtain in the original.

Zénobe Gramme was born in 1826, into a large family of a Belgian minor Civil Servant. His education was most elementary, as he had not shown much aptitude for routine school work. He was skilful with his hands from early childhood and took carpentry as his profession. Through a Belgian acquaintance he obtained a job as a model-maker to a firm of instrument manufacturers in Paris, where he became interested in electricity. Soon he had inventive ideas and began to construct in his home an electromagnetic machine capable of delivering uni-directional currents and thus suitable for replacing galvanic batteries, the only commercial source of electric power at the time. He was granted a patent for his invention in 1867, and founded a company for its exploitation in 1870. A description of his machine was first given in the *Comptes Rendus* in 1871.

Gramme's career from a carpenter's apprentice to a very successful company director differs from the more common fate of many self-taught inventors. He showed remarkable intuitive skill in concept, design and construction of his machine. A new source of power was gained by the rapidly developing industrial society, of which it was in great need.

The author devotes much space to the discussion of the priority dispute between Gramme and Pacinotti (1841-1912). Pacinotti, a professor of the University of Pisa, built an experimental model of an electromagnetic machine in 1860 and described it in detail in 1863 in an Italian journal. Pacinotti's machine shows several remarkably modern design features and is close to Gramme's in its main idea. But he was a little too early with his invention, so that he did not succeed in finding sufficient financial backing. Gramme's machine was conceived quite independently and at once proved commercially successful. M. Pelseener is inclined to give Gramme the olive branch for the invention, and uses arguments against Pacinotti which do not always carry conviction. It is interesting to note that Gramme did not take sides in the priority quarrel, which in the main raged after his death in France in 1901. Gramme's photograph is used as a frontispiece to the booklet, which is tidy if not very attractive in appearance.

**Bibliography of Indonesian Peoples and Cultures**  
By Raymond Kennedy. (Yale Anthropological Studies, Vol. 4.) Pp. 212. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1945.) 16s. 6d. net.

THIS bibliography aims at giving a complete list of works relating to the islands of the Indian Archipelago from the point of view of anthropology and sociology, including archæology, linguistics, and studies of acculturation, but not omitting those works on geography, history, and economics which are pertinent to anthropological studies in general. The bibliography is set out on a geographical basis—general works first, then works dealing with particular areas, the list being divided in each case into works in Dutch and those in other languages. Eight main divisions are used—Indonesia in general, Sumatra, Java, Borneo, Celebes, the Lesser Sundas, the Moluccas, and Netherlands New Guinea. There are seven maps which show the location of the places and peoples appearing in the list. The mainland of the Malayan Peninsula and also the Philippine Islands are omitted from this volume, which is published in photolitho.

The list has taken some sixteen years to compile and must be very nearly complete; nevertheless, one or two omissions are to be found, and the very paucity of these is a testimony to the completeness of the whole.

Marsden's "Memoirs of a Malayan Family" (London, 1830) should have found a place under Sumatra, and Favre's "An Account of the Wild Tribes inhabiting the Malayan Peninsula, Sumatra and a Few Neighbouring Islands, etc." (Paris, 1865) might have justifiably been included in the general Indonesian list, though it is true that Favre deals primarily with the Golden Chersonese. Where there are several editions of a book there seems to be some inconsistency as to citation—thus, only an early (1783) edition of Marsden's "History of Sumatra" is given, but only the latest (1930) edition of Hamilton's "New Account of the East Indies". It is, however, obvious that in a work of this kind perfect completeness is almost impossible of achievement, and an occasional omission does little to impair the value of such a thorough and meticulous bibliography.

J. H. HUTTON

### Organic Chemistry for Students of Agriculture (and Allied Subjects)

By Dr. Cyril Tyler. Pp. viii+341. (London: George Allen and Unwin, Ltd., 1946.) 15s. net.

AS the author points out in his preface to this book, there are many excellent text-books on organic chemistry. This particular book, however, has been written specially for the agricultural student. It has been designed to cover those parts of elementary theoretical organic chemistry which the student must master before passing on to a study of the carbohydrates, fats, proteins, etc., a sound knowledge of which is essential to an understanding of plant biochemistry, animal nutrition and dairy chemistry.

Dr. Tyler's simple and direct style will appeal to the student, and the excellent way in which he illustrates his text will prove a great help toward that appreciation of organic chemistry which can only come from a knowledge of structure. From the agricultural student's point of view his treatment of the carbohydrates, fats and proteins calls for especial praise, while the chapters towards the end of the book

which concern vitamins, hormones, essential oils and other substances with which the agricultural student must have acquaintance are treated adequately.

The author's approach to his subject is essentially factual, and his book contains no mention of the history which lies behind our knowledge of the subject. It might be argued that the inclusion of matter of historical interest would have meant the excision of certain parts of the existing text if the book was to be sold at its present reasonable price. It is, however, difficult to make theoretical organic chemistry 'live' without some reference to its history. No doubt those whose students use this book will cover this aspect in their lectures.

R. G. B.

### The B.D.H. Book of Organic Reagents for Analytical Use

Ninth and enlarged edition. Pp. x+196. (London: British Drug Houses, Ltd., 1946.) 4s. 6d. net.

THE appearance of a new edition of this well-known book will be welcome to all analytical and other chemists. Three reagents, dihydroxy-tartaric acid osazone for calcium, phenylthiohydantoic acid for cobalt, and phenylaminobenzene-azo-benzene sulphonic acid for magnesium, have been omitted as a result of experience obtained since the last edition. Four new reagents are included for the first time: triketohydrindene hydrate for the determination of free amino-acids, 8-hydroxyquinoline for the estimation of zinc, benzylisothiourea hydrochloride for the characterization of sulphonic acids, and *p*-nitrobenzene-azo-oreinol for the determination of beryllium. In addition, the whole text has been thoroughly revised and the general level of excellence and accuracy of the previous editions well maintained.

F. B. KIPPING

### Rapid Tomato Ripening

For Nurseryman and Amateur, with Notes on Possible Application to other Fruit. By L. D. Hills and E. H. Haywood. Pp. 143+12 plates. (London: Faber and Faber, Ltd., 1946.) 8s. 6d. net.

THE English climate is far from ideal for the production of outdoor tomatoes. The amount of ripe fruit harvested is almost always less than the total crop, even when this has been limited, as is the general practice, by pinching out the growing points of the plants.

Growers will therefore welcome this book, which describes in detail the use of ethylene or coal gas to ripen the green fruit after picking. This is the first practical manual on the subject, and as such deserves wide circulation among tomato growers. It describes the construction and operation of ripening boxes and chambers suitable for handling a few pounds or several tons of fruit. The book, which is based upon the authors' own experience, is written in a free-and-easy style, and though the frequent parentheses occasionally obscure the sense, the practical directions will be easily followed by the non-scientific reader. The authors are less fortunate in their attempts at scientific explanations; thus on p. 41 we read "The thermometer, by the expanding of the mercury molecules in which temperatures are measured . . .", and on p. 131 we are told that "The formula of ethylene is  $C_2H_4$ ; that of acetone or amyl acetate . . . is  $C_5H_8O$ ". The book is not, however, written for men of science, and these extraordinary statements do not detract from its undoubted value to the tomato grower. It is attractively produced and illustrated.

W. E. BERRY

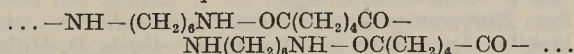
## CHEMISTRY OF 'TERYLENE'

By J. R. WHINFIELD

A RECENT announcement by the Calico Printers' Association, Ltd., and Imperial Chemical Industries, Ltd., relates to a new fibre-forming polymer derived from terephthalic acid and ethylene glycol, to which the name 'Terylene' has been provisionally assigned.

Polymeric ethylene phthalate was among the first of the condensation polymers to be described by W. H. Carothers in his well-known series of papers entitled "Studies on Polymerization and Ring Formation"<sup>1</sup>. He later reported the preparation of *p*-xylylene carbonate and, incidental to the problem of effecting ring-closure through the meta- and para-positions of the benzene nucleus, of a number of polyesters derived from the acids *m*- and *p*-C<sub>6</sub>H<sub>4</sub>(OCH<sub>2</sub>-COOH)<sub>2</sub>. With these exceptions, however, the published work of Carothers in this field is founded exclusively on the reactions of aliphatic bifunctional compounds, more especially of those in which the reactive terminal groups are separated by an unsubstituted polymethylene chain. What indeed lends so much distinction to this work is the range and depth of the conclusions drawn from the study of the reactions of such comparatively simple compounds. It is now well known that these investigations laid the foundations for the subsequent development of nylon, the first representative of a class of purely synthetic fibres.

A typical nylon is poly-hexamethylene adipamide, obtained by the inter-molecular condensation of hexamethylene diamine and adipic acid, the conditions of the reaction being so adjusted as to yield a polymer having a molecular weight in excess of 8,000. Its structure is represented as follows:



Poly-hexamethylene adipamide is a microcrystalline substance. In the massive state the crystals are randomly orientated, as may be shown by means of X-rays. It melts rather sharply around 270° C., and the molten polymer, which is very viscous, may readily be extruded into fibres. These fibres can then be extended to some four to five times their original length by the process of cold-drawing, and thereby acquire great strength and pliability. X-ray examination of the cold-drawn fibres shows that the crystals have become orientated in a direction parallel to the fibre axis.

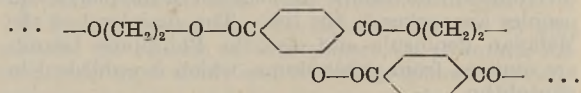
Microcrystallinity and a capacity to yield strong and pliable fibres are properties by no means confined to the linear poly-amides; they are exhibited in varying degree by the analogous poly-esters and the poly-anhydrides of the component acids as well as by other types of polymers such as those of ethylene and vinylidene chloride. The particular importance and value of the poly-amides from the fibre point of view resides very largely in their high melting points, which are much in excess of those of the polymers enumerated above. Microcrystallinity and high molecular weight are apparently the essential attributes of fibre-forming polymers; high melting point and a certain degree of chemical stability are practical necessities.

The work resulting in the discovery of 'Terylene' had as its starting point the general problem of the relation between crystallinity and the molecular architecture of high polymers, and was pursued in a

number of directions. It was commenced at a time (1939) when there was already available a good deal of information on this question, most of which pointed to the view that molecular symmetry was the dominant factor determining microcrystallinity<sup>2</sup>. From this point of view, therefore, isomerism in the benzene nucleus, resulting in both symmetrical and unsymmetrical distributions, presented some interesting possibilities.

The polymeric poly-methylene phthalates first described by Carothers were all devoid of crystallinity; the corresponding isophthalates and terephthalates were unknown. Of these the former should be amorphous and the latter crystalline.

These expectations were experimentally confirmed. Polymeric ethylene isophthalate proved to be an amorphous resin, while polymeric ethylene terephthalate was found to be highly crystalline. The structure of polymeric ethylene terephthalate is represented thus:



It is of incidental interest to note that Bucher and Slade<sup>3</sup> reported so long ago as 1909 the preparation of the anhydrides of both isophthalic and terephthalic acids. They state: "The properties of these anhydrides indicate that they have a high molecular weight and that they may be represented by the formula [C<sub>6</sub>H<sub>4</sub>(CO)<sub>2</sub>O]<sub>x</sub>".

A few minor difficulties were encountered in the preparation of polymeric ethylene terephthalate, but in most respects this follows the usual procedure appropriate to this class of reaction. It may conveniently be obtained by direct esterification of the glycol or by catalysed ester-interchange between the glycol and dimethyl terephthalate. The solubility of the poly-ester in organic liquids is very restricted, and in order to follow the progress of the reaction it was found necessary to determine the intrinsic viscosity in nitrobenzene at 150° C. This did not provide a reliable basis for the calculation of molecular weight.

Polymeric ethylene terephthalate—or 'Terylene'—as obtained by the solidification of the viscous reaction melt is a hard, porcelain-like substance, melting slightly above 250° C., and displaying random crystalline orientation. It is also obtainable in a condition of random crystalline orientation as a powder, by recrystallization from nitrobenzene and a few other solvents in which it is sparingly soluble at high temperatures.

If, however, the molten polymer is cooled very rapidly by quenching with water, it solidifies to a colourless, transparent and completely amorphous glass. In this form it is physically unstable, and on gently warming reverts suddenly to the crystalline state in a rather striking manner. These two forms of the material are distinguished by some difference in chemical reactivity.

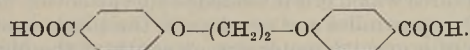
Fibres are obtained by extrusion from the melt and subsequent cold drawing, and are highly orientated (see *Nature*, Dec. 14, p. 871). A knowledge of their full range of properties must await the results of the more detailed evaluation now in progress. At an early stage of the work, however, it seemed evident that these properties were of a promising order from a textile point of view.

'Terylene' was first prepared in the expectation that it would prove to be a fibre-forming polymer,

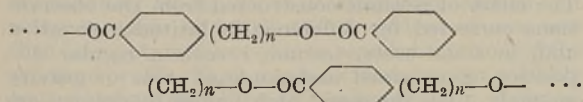
but the influence on the properties of the material as a whole of the symmetrically disposed, recurring benzene nuclei in the linear chain could not be predicted with any degree of certainty. All that could be inferred was that, in comparison with the purely aliphatic fibre-forming polymers, the chains would be less flexible, since there are fewer points of rotation in a given length. Nevertheless, they apparently retain sufficient suppleness to permit cold-drawing. That the poly-ester would have a high melting point appeared probable but by no means certain.

The possible effect of the ester linkages on the general chemical stability of the fibres was a very speculative matter. On one hand, unlike the amide linkages in the poly-amides (and in natural silk) the ester linkage should not induce instability to heat and light, and it has now been reported that 'Terylene' is notably resistant towards these agencies. On the other hand, the normal susceptibility of the ester linkage to hydrolysis at first gave rise to some misgivings. It was therefore rather surprising to find that 'Terylene' fibres remained apparently unaffected when subjected to quite severe hydrolytic treatments. This behaviour must be accounted for by the high degree of orientation and the close molecular packing—the density of 'Terylene' approximates to 1.4—whereby access of hydrolytic agents is rendered difficult, if not altogether prevented. In this connexion it is of interest to remark that undrawn 'Terylene' fibres are readily dyed by many dyestuffs commonly used for the dyeing of cellulose acetate rayon, but after cold-drawing the dye affinity of the fibres is very much reduced.

The higher polymeric polymethylene terephthalates show diminishing melting points with increasing length of the polymethylene chain separating the ester linkages; trimethylene terephthalate melted at 221° C. and the decamethylene ester at 123° C. These higher esters, however, all yielded orientated fibres when in a condition of sufficiently high molecular weight. On the other hand, esterification of diethylene glycol with terephthalic acid gave only amorphous, rubber-like poly-esters from which useful fibres could not be obtained. It is known that similar products result from the esterification of diethylene glycol and its homologues with the acids  $\text{HOOC}(\text{CH}_2)_n\text{COOH}$ . The effect of the ether linkage is, however, variable. The higher polymers of ethylene oxide are crystalline, and Dr. J. T. Dickson, while engaged on the present studies, obtained microcrystalline fibre-forming polymers by esterifying the glycols  $\text{HO}(\text{CH}_2)_n\text{OH}$  with the acid



From acids of the series  $p\text{-HOOC}-\text{C}_6\text{H}_4(\text{CH}_2)_n\text{OH}$ , microcrystalline fibre-forming poly-esters were obtained by self-condensation. These are of the type:



The poly-ester derived from  $p$ -hydroxymethyl benzoic acid is in many respects not dissimilar from 'Terylene', but shows a greater tendency to persist in the amorphous condition—behaviour perhaps

attributable to its rather lower degree of molecular symmetry.

The investigations which have now been briefly outlined were pursued by my colleagues (in particular, Dr. J. T. Dickson, Mr. W. K. Birtwistle and Dr. G. G. Ritchie) and me in the laboratories of the Calico Printers' Association, Ltd., during the period 1939–41, and met with many difficulties on account of the War. The preparation of 'Terylene' on a somewhat larger scale ultimately became necessary, and this was undertaken at a later period by Dr. D. V. N. Hardy of the Chemical Research Laboratory (Department of Scientific and Industrial Research), at the request of the Ministry of Supply. A sample of 'Terylene' prepared by Dr. Hardy was eventually submitted to Imperial Chemical Industries, Ltd., for preliminary evaluation.

I would like to conclude this short account by an acknowledgment of my indebtedness first to the work of Carothers, of which the present investigations are a logical extension; secondly, to my early association with the late C. F. Cross, the discoverer of the viscose reaction, from whom I first acquired an interest in the chemistry and structure of fibres that has endured for many years.

<sup>1</sup> See Part 1 of the collected papers of W. H. Carothers in Vol. 1 of "High Polymers" (Interscience Publishers, Inc., New York, 1940).

<sup>2</sup> For a more detailed discussion of this question see Whinfield, *Chem. and Ind.*, 62, 354 (1943).

<sup>3</sup> *J. Amer. Chem. Soc.*, 31, 1919 (1909).

## GEOPHYSICAL PROSPECTING AND ENGLISH OILFIELDS

AT a Geophysical Discussion on English oilfields, held at the rooms of the Royal Astronomical Society on November 22, a large attendance demonstrated the interest aroused by the geophysical methods which have been widely applied in the intensive search for oil in Britain over the past ten years.

Dr. J. Phemister, in opening the discussion, gave a general account of the types of structure in which oil may be found, of the distribution of such structures in England, and of the geophysical methods employed in their detection. The types of structure possible in England include the stratigraphic trap, the closed anticline or dome, and the traps against an unconformity or a fault. In each case the porous stratum which is a potential oil reservoir must be sealed off by impermeable rock against both vertical and lateral dissipation of fluid, and the seal must have remained effective. In considering the distribution of structures which might act as oil-traps, the field of inquiry may be limited to those geological formations which provide some indication of the presence of oil. Such indications include seepages, gas-escapes, oil-impregnations, elaterite veins, and bituminous coatings in fractures and joints. The formations suggested by such signs as worthy of consideration are the Wealden and Corallian of the south of England, the Coal Measures, Millstone Grit and Carboniferous Limestone of the Midlands, and in Scotland the Calciferous Sandstone Series. From a well at Hardstoft in the Carboniferous Limestone, more than 3,600 tons of oil had been obtained in the years 1919–38. To these possibilities the Magnesian Limestone of northern Yorkshire has recently been added,

as a considerable gas-field in it has been proved by boring.

Closed anticlines in the Corallian and Wealden of southern England have now been extensively tested but no oil-field has been found. The main purpose of geophysical survey in this region would be to locate structural crests in Mesozoic strata below a cover of Tertiaries, and to determine the depths to the Palaeozoic platform against which the Mesozoic strata overlap unconformably.

Structures in Carboniferous strata west of the Pennine Chain have so far proved non-productive, but east of this line four small oil-fields have since 1939 produced more than 300,000 tons of oil. They occur in closed anticlines in Millstone Grit which are concealed from surface observation by a thick unconformable cover of Jurassic, Triassic and Permian sediments. The structures were located principally by seismic survey, and this discovery represents a great achievement in the application of quantitative methods of refraction surveying on the part of the geophysical staff of the Anglo-Iranian Oil Co. In the search for similar oil-bearing structures, geophysical surveys have been extended over wide areas of Lincolnshire, Nottinghamshire and Norfolk. Many structures have been found, which although they have not been productive, are thought to indicate possibilities which should not be neglected.

In prospecting for concealed structures of the kind in question, two classes of geophysical survey—the gravitational and the seismic—are of particular value. Gravitational survey may be carried out by the Eötvös balance or by the gravity meter (gravimeter). The latter, being more rapid in operation and requiring less laborious corrections, is more suited to reconnaissance survey and has been extensively used in England by the oil companies. This instrument measures the amount by which  $g$  changes between a base station and other stations distributed over the area to be surveyed. Corrections for latitude, altitude and, when necessary, terrain are applied, and from the corrected observations a chart showing contours of equal difference in  $g$  (isogams) is prepared. The isogam chart shows the positions of local gravity maxima. These may be rendered less apparent but cannot be obliterated by regional changes.

Interpretation of gravitational surveys is based on the fact of experience that, close above the crest of a dome formed in a normal series of sediments, the force of gravity reaches a local maximum value. Similarly, above the position where an unconformable platform of old rocks comes nearest to the surface, gravity attains a maximum. Between these two structures, fundamentally different geologically, gravitational survey may not be able to discriminate, but it will supply the information necessary to decide the position for a boring which will prove the nature of the rocks in the concealed structure at least expense.

Seismic surveys also may be carried out by two methods. In the reflexion methods, depth to a bed which is accepted as an areal marker is deduced from the time elapsing between the firing of a shot at the surface and the arrival of the wave reflected from the bed. The method has not proved reliable in investigating the presence and depth of the Carboniferous Limestone in England. The refraction method, on the contrary, has proved capable of contouring the top of this formation with considerable precision, and its predictions have been checked by boring. Refraction survey may be carried out by

the procedure of arc-shooting in which the seismographs are stationed on the arc of a circle of about two to three miles radius and centred on the shot-point. Anomalously short travel-time signifies the approach towards the surface, along the radius concerned, of a high-velocity medium. By shooting a number of arcs, the interesting area can be delimited. In straight-line shooting the seismographs are set out on a line through the shot-point, and the time-distance graphs constructed from the observations yield data for calculating the depth to the refracting interface and the average velocity of the waves in the overlying and underlying rocks. The velocity is to a considerable degree diagnostic of the rocks, as the following figures, provided by Mr. R. Davies, chief geophysicist, Anglo-Iranian Oil Co., show: Keuper Marl, 7,600–9,000 ft. per sec.; Coal Measures strata, 12,000–14,000 ft. per sec.; Carboniferous Limestone, 18,500–19,500 ft. per sec.

A gravitational survey at present in progress in the region between Bristol and London, and the results achieved up to date, were then described by Mr. L. H. Tarrant, of the geophysical staff of the Anglo-Iranian Oil Co., Ltd. The instrument in use is the Frost gravity meter, which consists of an air-damped box-beam carrying at one end a gold weight and at the other a drum to compensate air-buoyancy. A frictionless pivot is effected by a ligature device. The beam is suspended by a mainspring which is attached to the framework vertically above the axis of rotation of the beam and is in an almost astatic condition. By raising or lowering the point of attachment of the mainspring, the beam is set for the average value of gravity of the region which is to be surveyed. Observations are made by reading on a divided dial the rotation required to increase or decrease the tension on a reading spring required to return the beam to the null position corresponding to an arbitrary zero of gravity anomaly at a station accepted as the base station of the survey. The divisions of the dial are calibrated by reading at stations between which there is a known difference of gravity. An instrumental correction must be applied to the observations for drift of the zero; this is determined empirically by re-occupying an earlier station at two-hour intervals, and applied on the assumption of a linear change with time. Temperature correction is eliminated by thermostatic control of the instrument. The sensitivity of this gravity meter is rather better than 1/50 milligal (0.000,02 cm./sec.<sup>2</sup>), and the probable error of an observation estimated from a number of observations at individual stations is 1/30 milligal.

The area which it is intended to survey covers about 5,000 square miles and overlaps in the south-west the locus of a gravity meter survey south of the Mendip Hills carried out earlier by the Gulf Exploration Co., Ltd. About 2,000 square miles have been covered and nearly four thousand stations occupied. A magnetic survey has been run concurrently but not with such detail, 850 observations having been made. The chart of isogams constructed from the observations corrected for difference in latitude, elevation and, in some cases, terrain, reveals a regular disposition of maximal and minimal areas of gravity anomaly. On the west, high values of gravity are conspicuous and are readily correlated with the Mendip anticline and the partly concealed outcrop of the Carboniferous Limestone along the eastern flank of the Bristol basin. The Mendip axis can be traced under cover of the Mesozoic strata as a long

spur of diminishing gravity anomaly, and low maximal ridges indicate its continuation as a line of minor importance which curves east and then east-south-east beneath the north margin of Salisbury Plain.

The most remarkable and unexpected feature of the isogam chart is a deep trough of low-gravity values extending in a south-north direction approximately through Cirencester. From this axis gravity increases steadily and rapidly eastwards, and the chart shows a plateau of high gravity with two broad maximal areas between Oxford and Swindon and north-west of Oxford. Magnetic anomalies show a similar areal disposition of high and low values, but the maxima are considerably displaced from the gravity 'highs'. No geological interpretation of these significant gravity anomalies is being put forward at present by the Company's scientific workers, who hope to obtain complementary data by the application of seismic refraction methods of survey. It is, however, of interest and importance to recall that a boring at Burford reached Coal Measures at 1,200 ft. from surface. The difference found by the gravity meter between the values of  $g$  at Bristol and Oxford is 8.5 milligals, the difference by pendulum measurement being 10 milligals.

The rate of survey by gravity meter is high in a country so well provided as England with good roads and with bench-marks, spot-levels and contours. The instrument can then be transported rapidly from station to station in a motor-car, and little time need be spent in surveying station sites for exact position and elevation. The average area covered each day in the survey described by Mr. Tarrant was 10 square miles, and the average number of stations occupied was nineteen. In countries poorly provided with topographic maps progress is very much slower; and where the ground conditions are difficult, it is estimated that to keep the gravity meter fully employed the services of three topographic surveyors are required. The instrument itself is easily portable, being of small bulk, moderate weight (35 lb.) and possessing a reliable system of clamps.

Mr. Tarrant was followed by Mr. J. E. R. Wood, also of the Anglo-Iranian geophysical staff, who described, in illustration of seismic refraction survey, an investigation which has just been carried out in north-east Yorkshire. The object of the survey was to study the Magnesian Limestone, which was already known to occur at 2,400 ft. in a boring one mile south of Redcar. To obtain basic information, the seismic survey was begun by carrying out a line-shoot as near as possible to this boring and orientated parallel to the probable underground strike of the limestone. It was found that the limestone acted as a refracting medium transmitting waves with a velocity of 19,500 ft. per sec. and that the average velocity in the overlying strata was 11,800 ft. per sec. From inspection of the time-distance graph and the amplitudes of the pulses, which were becoming weak at 15,000 ft., it was decided that the main survey by arc-shooting would be most effectively carried out using a radius of 14,000 ft. A system of arcs was then laid out, and in order to avoid distortion of the arc-time profile the shot-points were located suitably to the inclination of the refracting medium, so far as this may be indicated by the contours of the base of the Rhætic series.

From the results of arc-shooting, time-contours of interval 1/100 sec. were constructed over the area from the sea to Upleatham Hills in the south and

between Marske and Grangetown. The contours revealed a dome in the Magnesian Limestone below the southern outskirts of Redcar, and a bore has since been drilled. The difference in depth of the limestone in the two borings differed from that calculated from the seismic results by only 40 ft., a length representing 3/1000 sec. It is of interest to note that the system of arcs and lines shot over the area contained three closed polygons, around which the sum of the time differences was small and less than the limit of accuracy of measurement. This fact indicates that the pulses employed came from the same stratum throughout the survey, and that there are no significant changes of velocity in either the refracting medium or the overlying strata. In extending the survey southwards, difficulties in interpreting the results were encountered, and are ascribed to (a) distortion of arc-time profiles when shot across troughs and, possibly, faults in the limestone; (b) the possibility of change in the true velocity in the refracting stratum; and (c) the possibility that the pulses did not arrive from the same bed on reversal of the direction of shooting.

In opening the general discussion which followed the formal contributions, Prof. V. C. Illing stressed the distinction between finding structure and finding oil. Suitable structure is necessary, but of as great importance to the main issue is the geological history of the strata in which oil is sought; and in assessing the oil-bearing potentialities of a region, as great consideration must be devoted to this aspect of the problem as to the discovery of structure. While there can be no question that certain British rocks had contained oil, is it to be expected in the light of their past geological history of severe folding and rupture that they now retain sufficient to repay the expense of intensive search? Prof. Illing said he had some years ago expressed his dubiety, and he continued to be dubious of an affirmative answer to this question. Regarding the purely geophysical aspect of the search for oil, one marvelled at the precision of predictions based on the results of seismic refraction survey. He was puzzled, however, by the failure of the reflexion method to yield reliable evidence of the Carboniferous Limestone, and would be greatly interested to know what explanation might be adduced.

The production of considerably more than 300,000 tons of crude oil which has already been attained was mentioned by Prof. A. O. Rankine, who emphasized the importance of the part played by geophysical survey in this achievement. While the evidence from borings and mining for coal had indicated the possibility of a fold near Eakring, it was by geophysical survey by the seismic refraction method that the existence of a closed structure in the Carboniferous Limestone had definitely been proved. He left it to Mr. Wyrobek to discuss the failure of the reflexion method. Referring to the interesting nature of the gravitational anomalies between Bristol and Oxford, he hoped that it would be possible for the geophysicists of the Anglo-Iranian Oil Company to investigate by seismic refraction tests the buried structures which had been indicated by the gravity meter surveys. Mr. Wyrobek then put forward his view that reflexion of compressional waves is most efficiently effected when the high-velocity medium is comparatively thin and is, so to speak, suspended in low-velocity strata. He believed the lack of success in detecting the Carboniferous Limestone by seismic

reflexion survey was due to the massive character of the limestone, which absorbed a high proportion of the energy. He pointed out also that it is covered by strata of Millstone Grit and Coal Measures age, which have fairly high velocity characteristics. In contrast to this purely physical explanation, the suggestion was made by Prof. W. G. Fearnside and supported by Prof. O. T. Jones that the existence of a transition zone of interbedded limestones and shales between the Millstone Grit strata and the massive limestone may be responsible for the confusing and baffling reflexions.

In reply to a question by Mr. Wyrobek whether the accuracy of prediction of depth of the Magnesian Limestone from refraction shooting had been tested in the Redcar area, Mr. Wood said that the discrepancy between prediction and boring data was 50 ft. at 2,120 ft. depth.

Dr. E. C. Bullard, in closing the discussion, directed attention to the fundamental advances which are being achieved alike in the study of the concealed geological structure of England and of the correlated magnetic and gravitational anomalies, and in the development of precise instruments of physical research, as a consequence of the quest for oil. The honours in the contribution of data fundamental to the elucidation of structure in England were evenly divided between the American and British oil companies. He would himself be interested to know whether Kater's pendulum station at Arbury Hill had been occupied in the gravity meter survey in the Oxford district, and Mr. Tarrant stated in reply that while this station lay considerably beyond his survey, the desirability that the gravity meter survey should be linked with absolute measurements of gravity was being constantly borne in mind by his Company's geophysical staff.

## SYNCARIDA IN RELATION TO THE INTERSTITIAL HABITAT

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THE Syncarida occupy an important position among the Crustacea, and are of considerable interest to carcinologists by virtue of certain primitive features which they show. The more typical forms, *Anaspides* and *Paranaspides*, are familiar to all zoologists, but it is possible that the less well-known Bathynellidæ may have an even greater interest. On account of their small size, these have tended to be overlooked, but no one has devoted more attention to them than has Dr. P. A. Chappuis, of the Speleological Institute at Cluj, in Transylvania. His work, extended over many years, has been carried on through the difficult times of the War, and the accounts of it have recently reached us in a series of papers dealing with subterranean fauna in general. As much of the more interesting results have been published in some of the less readily accessible journals of central and south-eastern Europe, a review of these may be of interest to zoologists.

An account of the history of *Bathynella*, and the related genus *Parabathynella*, was given by Chappuis<sup>1</sup> in 1939, the main points of which may be briefly recapitulated. *Bathynella* was discovered by Vedjovsky

in 1880, from a well in Prague. His description, published two years later, was based on two specimens one of which was later lost, the other being a poor preparation mounted in Canada balsam. Vedjovsky, at that time, did not attempt to classify this crustacean, regarding it as of uncertain position, but he believed that it was of common occurrence and had previously been overlooked owing to its small size (1.5 mm.). In 1899 Calman<sup>2</sup>, on a re-examination of Vedjovsky's preparation, was able to place it in the Syncarida. It then receded into the background—if not into oblivion—since no one was able to find more specimens until Chappuis, in 1913, rediscovered it in an abandoned well near Basle. Shortly after his discovery the well was filled in and the new source thus lost, but not before Chappuis had collected a number of specimens, three of which he sent to the British Museum (Natural History). These enabled Calman to give a thorough description of *Bathynella*<sup>3</sup>. Three years later, Chappuis again found *Bathynella* in the Swiss Jura Mountains, and sent specimens to Delachaux, who described these as a second species which he named after Dr. Chappuis.

Since then, owing to the intensification of interest in the fauna of underground waters, it has been found in many places in Europe, as shown on the chart given by Chappuis<sup>1</sup>. Its discovery in England by Lowndes<sup>4</sup> was by chance, but is none the less interesting on that account.

The related genus *Parabathynella* was first described by Chappuis<sup>5</sup> in 1926, his specimens having been obtained from a stream flowing from the Sveta Voda Cave in Jugoslavia. A second species was described by Sars<sup>6</sup> in 1929, from the Batu Cave, Kuala Lumpur, and Karaman<sup>7</sup> extended our knowledge of the European species by finding more mature specimens at Skoplje. These were regarded by Chappuis<sup>1</sup> as belonging to a distinct species, but there would not appear to be adequate grounds for this view.

It is a characteristic feature of the Bathynellidæ that, up to 1939, they had always been found in wells, in springs, or in streams in caves; that is to say, they are associated with water of subterranean origin. Because of the isolated nature of the localities where Bathynellidæ had been found, Chappuis<sup>8</sup> considered the possibility of their having been transported from one body of water to another over the surface. He concluded that this was most improbable, and it has been generally assumed that they inhabited the water of crevices (*Spaltengewässer*) which were in general intercommunication, a hypothesis which it is difficult to accept in view of their occurrence at points so far removed from the apparent centre of distribution as in the Pyrenees and in England.

Chappuis's more recent work, however, has shed new light on this problem, and has opened a new field of investigation. Largely as the result of the work of the late Dr. C. B. Wilson<sup>9</sup>, it has been known for some time that the interstitial spaces of sandy beaches are inhabited by a varied and extensive fauna in which copepods are abundant. This fauna is not restricted to the marine environment, but is also to be found around the shores of lakes, and this environment has also received much attention of recent years<sup>10</sup>. Chappuis<sup>11</sup> has now extended these investigations to yet another type of habitat. He has found that by digging holes in the sand and rubble within a few yards of swiftly flowing streams, and by collecting and filtering the water which accumulates in such pools, he has been able to collect a considerable and varied fauna.



In one such pool in the Körös Valley, from about 60 litres of water, he collected a new isopod, eight species of copepods, an ostracod, three species of mites, nematodes, oligochaetes, *Hydra*, a quantity of insect larvæ, and *Bathynella*. In another place he found yet another new isopod (representing a new genus), an amphipod, and a varied assortment of other forms similar to the first.

He extended this work during the years which followed, and found places where he could collect *Bathynella* by the hundred, in all stages of development<sup>12</sup>. He later identified these as *B. chappuisi*, and gave additional notes on their biology<sup>13</sup>. Thus he has established *Bathynella* as an inhabitant of the permanent water of the water-table (*Grundwasser*), in suitable soil conditions, which indicates that its presence in wells, springs, and streams has been accidental. This fact, together with its small size, accounts for its having been overlooked and for the difficulty in finding it again subsequent to its first discovery.

Chappuis's discovery of the true habitat of *Bathynella*, and the abundant supply of material thus made available, has made possible for the first time a full account of its developmental stages. This work was undertaken by Bartok<sup>14</sup> who, though writing in Hungarian, has given a four-page summary of his work in German and a useful table showing the course of development of the body and its appendages through the seven stages. This account is well illustrated with clear text-figures. A point of considerable interest is that in the youngest stage, although the thoracic region is fully segmented, the abdomen consists of only three segments; one segment is added at each stage up to the fourth, in which the full number of six first appears. Of the appendages, the first and second antennæ show a progressive development from the first stage onwards, attaining their full development in the fifth stage. The second antenna in the youngest stage resembles the thoracic legs in structure.

Of the thoracic legs, only the first four pairs are present in the first stage, the fifth and sixth appearing in the second and third stages respectively. A peculiarity is shown in the order of appearance of the last two pairs: the eighth pair appears first, in the fifth stage, while the seventh pair does not appear until the sixth stage. Although the pleon is only three-segmented at first, the single pair of pleopods characteristic of *Bathynella* is present at that stage, though not fully developed.

In the caudal region the anterior pair of appendages first appears in the fourth stage, simultaneously with the appearance of the sixth abdominal segment, whereas the posterior appendages, interpreted as furcæ, are present throughout.

When *Bathynella* is referred to in a general textbook of zoology, it is usually dismissed as a degenerate Syncarid which has taken to an underground existence. However, while at first sight it might be expected that such a form, which has left the normal environment for a subterranean existence, should rightly be regarded as degenerate, *Bathynella* nevertheless shows certain very interesting features which can only be regarded as primitive. Its habitat, as Chappuis has shown, is analogous to that of the interstitial harpacticoid copepods. In conformity with their adoption of this peculiar habitat, both forms show a number of common features, such as the slender, elongate, very flexible body, and the loss of eyes. Although the interstitial copepods are thus

specialized for this existence, they are far from being degenerate; and there would not appear to be any primary reason for assuming that the Bathynellidæ are degenerate because they share the same type of habitat.

The chief primitive characters shown by the Bathynellidæ are first, the retention of a free first thoracic somite; secondly, the presence on this somite of appendages (maxillipeds), which are practically undifferentiated from the other thoracic legs; and, thirdly, the possession of two pairs of appendages on the terminal segment of the abdomen. So far as the thoracic appendages are concerned, *Parabathynella* shows a greater number of segments in the exopods, thus indicating that it is more primitive than *Bathynella* in this respect.

The interpretation of the appendages of the caudal region has been the subject of divergent views and some controversy. In no other groups of Crustacea are there examples of the terminal abdominal segment bearing two pairs of appendages; even the other Syncarida show a tail-fan similar to that of the Decapoda. There is no doubt that the anterior pair are uropods, but the posterior pair, which are composed of single segments each armed with spines and setæ, are not so easily identified. Vedjovsky contented himself with calling them *Schwanzplatten*; Calman<sup>2</sup> interpreted them as probably furcal rami, though possibly the halves of a divided telson such as is found in many amphipods and some other Crustacea. Chappuis<sup>9</sup> gave preference to the theory of the divided telson, and Calman<sup>3</sup> concurred. But Sars<sup>6</sup> regarded them as a second pair of uropods, homologous with the third pair of the amphipods. It is possible that in drawing this homology he was misled by an inaccuracy in one of his figures to which Nicholls<sup>15</sup> later directed attention. The latter showed that they could not be homologous with the third pair in amphipods, and accepted the divided telson as an explanation. However, in 1939 Chappuis<sup>1</sup> reverted to Calman's original interpretation and gave new reasons for regarding them as furcal rami, explaining that the caudal segment was probably composed of the sixth abdominal segment with which the telson had become fused, and thus these appendages must be telsonic. Bartok<sup>14</sup> suggests that the presence of these appendages in the first young stage, while the abdomen is still not fully segmented, proves that Chappuis's latest interpretation is correct, since the telson could not be completely divided into two parts and still give rise to additional segments. However, this does not close the controversy, because there are reasons for believing that the two pairs of caudal appendages in the Bathynellidæ may represent those of the fused sixth and seventh abdominal somites, and may thus both be interpreted as uropods.

Chappuis<sup>12</sup>, after discussing the habitat and distribution of certain forms which he obtained from the interstitial spaces of sand and rubble in the valleys of Transylvanian rivers, concluded that they are of marine origin, relics from the tertiary period when a great part of central Europe was covered by the Sarmatian Sea. It is a fact that some of the copepods isopods, and amphipods found in that habitat have marine forms as their nearest relatives. He suggested that as this sea became increasingly fresh and later diminished in extent, many of its inhabitants remained behind in the sand and rubble masses of the emptying valleys, and are known to-day in the extensive variety of forms which inhabit such an environment. He concludes:

"Eines der ältesten Elemente der Subterranafauna ist wohl *Bathynella*. Wit können zwar nicht sagen, seit wann das Tier unterirdisch leben muss, das einzige was wir überhaupt wissen ist, dass ihre nächsten lebenden Verwandten in Ost-Indien, Australien und Tasmanien zu finden sind und dass die fossilen Verwandten im Perm und Carbon lebten. Seit dem Palaeozoikum sind weder in Marinen- noch in Süßwasser-Ablagerungen Überreste von Syncariden gefunden worden. *Bathynella* ist daher eines der ältesten Elemente unserer Süßwasserfauna, denn schon ihre fossilen Vorfahren lebten in solichem. Das eigenartige ist, dass sich die verschiedenen Bevölkerungen nicht artlich differenziert haben. *Bathynella* aus Südengland ist von den Tieren aus Siebenbürgen (Transylvanien) kaum zu unterscheiden."

If Chappuis's theory be correct, here is good evidence for the antiquity of the Bathynellidæ, and the fact that they have retained certain primitive characters supports this opinion of their great age. At the same time, in association with their subterranean habits, they have doubtless undergone some specialization, which has led to their being regarded as degenerate.

The recent discovery by Chappuis of the true habitat of *Bathynella* may have important results when similar situations in other parts of the world are studied in the same way. It would not seem unduly optimistic to suggest that an extension of his methods to other localities will not only widen the present known distribution of the Bathynellidæ, but may also bring to light hitherto unsuspected forms. Among these may be expected new Syncarida, which may throw further light on crustacean affinities. The discovery by Pennak and Zinn<sup>16</sup> of a new crustacean belonging to a new order (*Derocheilocaris*, *Mystacocarida*) was the result of further investigation of the sand environment of marine habitat. The alluvium of mountain streams is as yet practically unexplored, and may be expected to provide valuable information. *Bathynella* itself, although possibly related to the ancient Sarmatian Sea, is clearly not restricted to the area covered by that sea. *Parabathynella*, although represented by one species within that region, is also known from Malaya. The other Syncarida are Australian, and this region may well yield new subterranean forms.

*Koonunga* and *Micraspides* would appear to be intermediate forms between the true surface dwellers (*Anaspides* and *Paranaspides*) and the subterranean Bathynellidæ. Sayce<sup>17</sup> found *Koonunga* in "reedy pools beside a tiny runnel" under conditions where the water dries up for varying periods, and although it possesses small eyes, it "shuns strong light". *Micraspides*, which is without eyes, was found in water "drained from sphagnum", in detritus on the floor of pools in the bed of a creek and from the water which filled holes dug near a lake, in ground inhabited by the burrowing "land-crab", *Engæus*<sup>18</sup>. The size of these forms (nearly 10 mm.) precludes the possibility of their being interstitial in habitat, but it is possible that *Micraspides* may inhabit the burrows of *Engæus*.

These two forms thus link the surface dwellers with the subterranean, not only on account of their morphology<sup>18</sup>, but also by reason of their habitat. While it cannot be disputed that the Anaspididæ-Koonungidæ-Bathynellidæ form a series showing reduction in complexity of structure, the possession by the Bathynellidæ of primitive features not seen in the other forms suggests not so much that they are degenerate

as that they are primitive forms which have undergone simplification in relation to their underground existence. They have not been subjected to the same modifying influences as have the higher forms, which show clear evolutionary trends leading towards the condition of the higher Malacostraca.

<sup>1</sup> Chappuis, *Věst. Cs. Zool. Spolek. Praha*, 8/7, 120 (1939).

<sup>2</sup> Calman, *J. Linn. Soc.*, 27, 338 (1899).

<sup>3</sup> Calman, *Quart. J. Mic. Soc.*, 62, 489 (1917).

<sup>4</sup> Lowndes and Calman, *Nature*, 130, 61 (1932).

<sup>5</sup> Chappuis, *Bull. Soc. Sci. Cluj*, 3, 7 (1926).

<sup>6</sup> Sars, *J. Fed. Malay States Mus.*, 14, 339 (1929).

<sup>7</sup> Karaman, *Mitt. Höhlen. Karstf.*, 26 (1934).

<sup>8</sup> Chappuis, *Zool. Jahrb. Syst.*, 40, 147 (1915).

<sup>9</sup> Wilson, *Bull. U.S. Nat. Mus.*, 158 (1932).

<sup>10</sup> Pennak, *Ecol. Mon.*, 10, 537 (1940).

<sup>11</sup> Chappuis, *Acta Sci. Math. Nat. Kolozsvár*, No. 6 (1942).

<sup>12</sup> Chappuis, *Allattani Közlemények*, 40, 225 (1943).

<sup>13</sup> Chappuis, *Mat. Termés. Közlemények, Budapest*, 40, 1 (1944).

<sup>14</sup> Bartok, *Acta Sci. Math. Nat., Kolozsvár*, No. 21 (1944).

<sup>15</sup> Nicholls, *J. Linn. Soc.*, 57, 473 (1931).

<sup>16</sup> Pennak and Zinn, *Smithsonian Misc. Coll.*, 193, No. 9 (1943).

<sup>17</sup> Sayce, *Ann. Mag. Nat. Hist.*, (8), 1, 350 (1908).

## RADAR DETECTION OF METEOR TRAILS

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Radio Division, National Physical Laboratory

IN the course of ionospheric observations made during the International Polar Year 1932-33, a transient type of radio echo was observed from levels in the upper atmosphere about 100 km. above the ground. Such echoes were found to last only a second or two and were noted to be equally frequent both by day and by night. A solar origin in terms of ultra-violet radiation could thus be excluded, and it was pointed out that, possibly, the ionization trails of meteors were responsible, since Skellet had already noted major increases of abnormal *E* layer ionization to occur at night when meteors were observed to pass overhead.

Since 1932, many studies of these transient echoes have been made as part of the programme of the Radio Research Board of the Department of Scientific and Industrial Research, and evidence has gradually been accumulated supporting the view that their persistent occurrence throughout the day is due to the general incidence of sporadic meteors. Most valuable studies of echoes from scattering centres in the *E*-layer of the ionosphere have been made by Eckersley and his co-workers, though, in their latest study of the direction of arrival and polarization of these scatter echoes, it was concluded that the results did not conform with the hypothesis of meteoric origin. Quite recently, however, Hey and Stewart, working with 5-metre waves, have shown a definite correlation between ionization bursts and meteor showers, and, using the results of more than one observing station, have in certain cases been able to determine the approximate position of the meteor radiant.

Since January 1944, daily observations have been made at the Research Station, Slough, of the diurnal and seasonal variation of these transient echoes. On October 10, 1946, however, an exceptional obser-

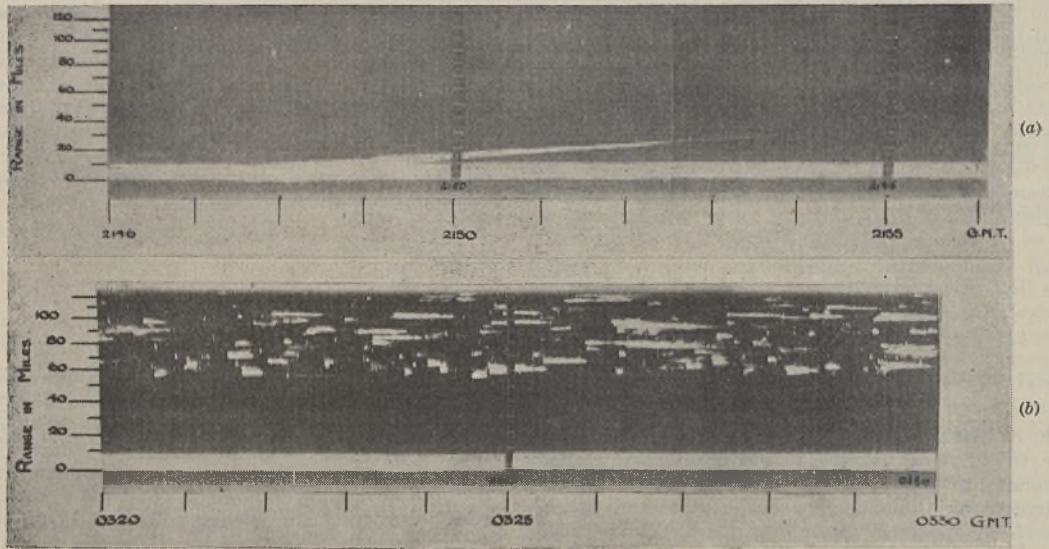


FIG. 1. (a) TRANSIENT ECHOES RECORDED ON 27 Mc./SEC. ON OCTOBER 9, 1946. (b) IONIZATION TRAILS RECORDED AT SLOUGH DURING THE GIACOBINID METEOR SHOWER ON OCTOBER 10, 1946

tunity occurred for testing the meteoric hypothesis of their origin during the Giacobinid shower. For that purpose a radar sender and receiver operating on a frequency of 27 Mc./s. was used. The aerial system, designed to radiate principally in an upward direction, had been erected for us by 60 Group of the Royal Air Force. Pulses of 15 microsec. duration and of a repetition rate of 50 per sec. were used, and the usual cathode-ray oscillograph display of ground- and echo-pulses was employed. For photographic recording the whole of the tube except the time base was masked off, and a strip of photographic paper moved slowly in a direction at right angles to the time base, so that the breaks in the time base, due to the ground pulse and the echoes, formed traces on the paper.

In Fig. 1a is shown a record of this type in which the range marks are also indicated automatically. The record, which was made before midnight on October 9, 1946, is of ten minutes duration. Three transient echoes were recorded as occurring at 2148, 2151 and 2155 G.M.T. (The continuous rising trace in the middle of the record is due to the echo from a single aircraft flying away from the observing station.) In Fig. 1b is shown, for comparison, the type of record obtained at the height of the meteor shower on October 10, 1946, which illustrates the very numerous echoes

registered during a similar ten-minute interval. The duration and ranges of the transient reflecting meteor trails can be clearly measured. It is also interesting to note that the reflecting trails did not reach levels substantially below 90 km. above the ground.

A comparison of the rate of transient echo occurrence during the shower and at other times is shown in Fig. 2. For example, on the night of October 2/3, 1946, which is taken as illustrating normal conditions, the rate of occurrence is low, though it is noted that the rate is higher after midnight than before. This is in keeping with the hypothesis that sporadic meteors are responsible for the transient echoes, for in the morning hours the point of observation on the earth is running into such meteors and in the evening it is running away from them. On the same figure is shown the result for the Giacobinid meteor shower which occurred between 0000 and 0600 G.M.T. on October 10, 1946, with a maximum of activity between 0300 and 0400 G.M.T. No visual observations on this particular shower, which occurred when the weather was cloudy over almost the whole of Great Britain, are yet available to us for comparison. It is, however, of interest that the shape of the curve in Fig. 2, which was obtained by radio methods, bears a striking resemblance to that shown in Fig. 3 which

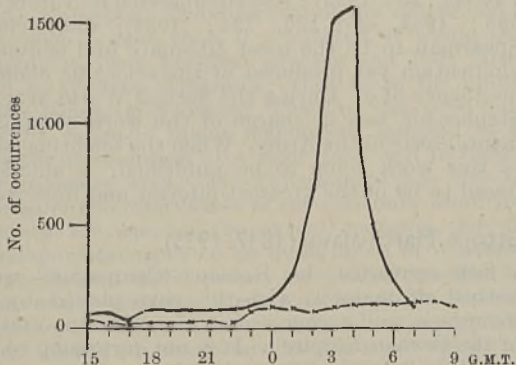


FIG. 2. NUMBER OF IONIZATION TRAILS OBSERVED AT SLOUGH: —, DURING THE GIACOBINID METEOR SHOWER OF OCTOBER 10, 1946; x—x, DURING A NORMAL NIGHT

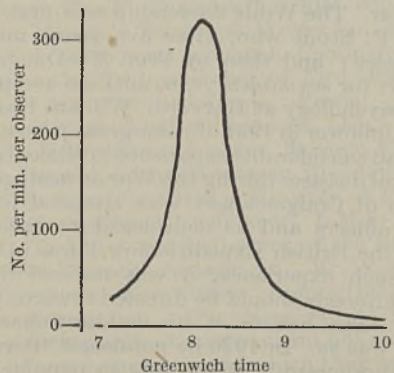


FIG. 3. METEOR SHOWER OF OCTOBER 9, 1933\*

is due to F. G. Watson\*, and shows the results of visual measurements made in the United States on the last occasion when an intense meteor shower, associated with the same comet, was observed.

This complete confirmation of the theory of the meteoric origin of short-period ionospheric echoes is most satisfactory, for we can now count our radio

\* "Between the Planets", by F. G. Watson, p. 129 (Blakiston Company, Philadelphia).

methods of ionospheric sounding as providing a reliable technique of meteor exploration which is applicable in all weathers and also during daylight. Moreover, since it is found that the effective reflecting power of meteor trails is increased as the exploring radio-frequency is reduced, we have been able to show that, using pulses of lower radio-frequency, many meteor trails may be detected and examined which escape even telescopic visual recognition.

## NEWS and VIEWS

### Physics at the Royal Holloway College, London Prof. S. Tolansky

DR. S. TOLANSKY, who has been appointed to the chair of physics at the Royal Holloway College, University of London, was born in 1907. He went to Armstrong College, Newcastle, where he started research in spectroscopy under Prof. W. E. Curtis. After a period in London with Prof. A. Fowler and another in Berlin with Prof. F. Paschen, he joined the Physics Department of the University of Manchester in 1934. Dr. Tolansky has become a leading expert on hyperfine structure of spectral lines. He has made a number of important contributions and has elucidated the nuclear spins for a number of elements: As, Sb, Sn, Pt and Br I. He has also studied the nuclear magnetic isotope and quadrupole effects for various atoms. Recently, Dr. Tolansky has developed new and powerful methods of interferometry, applying them particularly to the detailed investigation of surfaces of crystals, films, etc. These methods, which combine the properties of multiple-beam interferometry with those of wedge fringes, have proved a valuable means of investigating the structure of surfaces in a way that was not possible before. With it he has found it possible to measure differences of level of a few atomic diameters.

### Institute of Experimental Psychology, Oxford Dr. William Brown

THOSE interested in psychology will be sorry to hear of the retirement under the age limit of Dr. William Brown from the Wilde readership in mental philosophy at Oxford. Dr. Brown retired from the directorship of the Oxford University Institute of Experimental Psychology last year. It was through Dr. Brown that the laboratory of experimental psychology was re-established—it had been started by Prof. W. MacDougall but disrupted by the First World War. The Wilde readership was first held by Prof. G. F. Stout who, after five years, moved to St. Andrews; and then by Prof. MacDougall, who retained it for seventeen years until he accepted the chair of psychology at Harvard. William Brown was a worthy follower in 1921 of these great psychologists. He had had considerable experience in clinical nervous and mental diseases during the War as medical officer in charge of Craiglockhart War Hospital for neuroathenic officers and as neurologist to the Fourth Army in the British Expeditionary Force in France.

With such experience, it was natural that Dr. Brown's interests should be directed towards psychotherapy. The nature of his publications showed that this was so. In 1920 he published "Psychology and Psychotherapy", which was so popular that it passed through four editions. In 1924 he edited and

contributed to "Psychology and the Sciences", and in 1926 he published "Mind and Personality", and "Science and Personality" in 1929. In 1938 he wrote "Mind, Medicine and Metaphysics" and "Psychological Methods of Healing". These books were meant to popularize psychological treatment rather than contribute fresh knowledge to the subject, but were very valuable because of Dr. Brown's clear thinking and wide knowledge. Brown is also interested in social psychology, and in 1939 published "War and Peace: Essays in Psychological Analysis". In 1940, jointly with Prof. Godfrey H. Thomson, he wrote "The Essentials of Mental Measurement". Oxford will miss Dr. Brown's genial personality; he is continuing in full-time work in medical psychology in London.

### Dr. William Stephenson

DR. WILLIAM STEPHENSON, who has succeeded Dr. William Brown as director of the Institute of Experimental Psychology at Oxford, was appointed assistant director on its foundation in 1936. He had previously held the position of tutor and supervisor of post-graduate students in psychology at University College, London, and had specialized in mental testing and in the correlations of mental aptitudes with one another, having before that worked under the late Prof. Charles Spearman, who regarded him as his most outstanding pupil. Dr. Stephenson's researches in statistical psychology proved, among other things, the existence of a verbal factor, distinct from general intelligence, which needed to be 'partialled out' before correlation coefficients between mental tests could give mathematical support to Spearman's theory of a central intellectual factor, *g*. Indeed, his joint research with Dr. William Brown, entitled "A Test of the Theory of Two Factors" (*Brit. J. Psychol.*, 23; 1933); and summarized in *Nature* (130, 588; 1932, and 133, 724; 1934), was held by Spearman to be the most adequate and convincing vindication yet produced of the scientific claims of his theory of *g*. During the Second World War, Dr. Stephenson was in charge of the work of applying mental tests in the Army. When the scientific results of this work come to be published, it should be found to be of the greatest interest and importance.

### Ettore Marchiafava (1847-1935)

FOR centuries the Roman "Campagna" was a hotbed of malaria, and the part played by this scourge is well recognized in the "Decline and Fall of the Roman Empire". It is not surprising to find, therefore, that Italian malariologists have enriched our knowledge of its etiology and prevention. Before 1880, medical men and patients attributed the

'shivering ague' to an enigmatic nocturnal 'miasm'. In that year Laveran described the malaria parasite. His discovery was confirmed and amplified by Marchiafava and Celli of Rome, who observed amoeboid movements of the plasmodium within the red blood corpuscles and recorded an instance of the experimental transmission of malaria in man. A translation of Marchiafava and Bignami's researches on "Summer-autumn malarial fevers" was published by the New Sydenham Society in 1894. Born in Rome on January 3, 1847, Ettore Marchiafava in 1883 became professor of morbid anatomy and in 1916 of clinical medicine, remaining actively interested in medical research until his death on October 22, 1935, at the age of eighty-eight. He was the grand old man of Italian medicine, a leader of international science, and founder of the first Italian anti-tuberculosis sanatorium at Rome. Marchiafava was elected an honorary fellow of the Royal Society of Medicine in the year of its centenary, and one of his last publications was a communication in 1933 to its Section of Neurology on degeneration of the brain in chronic alcoholism. Distinguished in appearance and most approachable, he was a fascinating lecturer who made the dead live again as he recounted their clinical story and correlated it with the post-mortem findings.

### Australian Guided Projectiles Range

SUBJECT to a satisfactory agreement between the two Governments on the financial and other aspects of the undertaking, the Australian Government has accepted the British Government's proposal that a firing range and associated technical facilities should be set up in Australia for experiments with guided projectiles and other long-range weapons. Lieut.-General J. F. Evetts, formerly senior military adviser to the Ministry of Supply, has left for Australia to collaborate with the authorities there in the detailed planning and execution of the project. In view of the numerous representations received, the Australian Guided Projectiles Committee and the director of Native Affairs will report to the Australian Cabinet to ensure the safety and welfare of aborigines in the proposed range area.

The Hon. J. J. Dedman, Australian Minister for Defence, made a statement in the House of Representatives on November 22 on the project for a guided missiles range and technical establishment in Australia. He emphasized that the scheme is a joint venture of Great Britain and Australia. The firing point will be in the vicinity of Mount Eda in South Australia, between the Transcontinental and North-South Railways. The direction of the centre line of the range is such that, if prolonged, it would pass roughly midway between Broome and Port Headland in Western Australia; that is, in the middle of the Ninety Mile Beach. The first step is to build a short range of about 300 miles, designed to be capable of extension at a later date, and to reserve the necessary area. The Government has also approved of the reservation of the Salisbury Munitions Factory for use, to the extent required, for the developmental work to be undertaken in Australia. Research and development on guided missiles has been under way for some time in Great Britain, whereas, so far, Australia has done no work in this field. Hence for some considerable time, by far the greater portion of the scientific staff required for the trials or research and development associated with them must be drawn from Britain. The capital

cost of the range head and the first 300 miles of the range is £3,000,000, and the eventual annual maintenance cost of the range project is £3,000,000. If the development work is expanded, considerable additional capital and maintenance expenditure will be involved.

Except for a few pastoral leases at the firing point and in South Australia, the Central Aboriginal Reserves and a few more pastoral leases adjacent to the Ninety Mile Beach in Western Australia, the area of the range and that which it is proposed to reserve for eventual extensions is largely uninhabited. For some years the range will come short of the Central Australian Aboriginal Reserves. During this period, it is expected that accuracy of control will be largely perfected; hence the risk to the aborigines, when the range is extended, will be negligible, for the average density of population is probably about only one native in every 50-100 square miles. Until the control is perfected, none but non-explosive missiles will be fired, possibly at the rate of one a week. A very limited number of observation posts may have to be established along the line of fire in the aboriginal reserve; in this connexion the director of native affairs and other authorities concerned in aborigine welfare are to be consulted.

### Fire Research in Great Britain

H.M. GOVERNMENT, through the Department of Scientific and Industrial Research, has decided to establish a comprehensive Fire Research Organisation, jointly with the Fire Offices' Committee. A Fire Research Board has been appointed jointly by the Department of Scientific and Industrial Research and the Fire Offices' Committee. The members of the Board are: Lord Falmouth (chairman), head of Fire Research ("F") Division, formerly Ministry of Home Security, now D.S.I.R., past member of the Advisory Council and Executive Committee of the National Physical Laboratory, and of the Fuel Research Board; Dr. S. F. Barclay, head of the Research Department of Mather and Platt, Ltd., manufacturers of fire-fighting equipment; Mr. J. W. Berry, general manager, Royal Insurance Co., Ltd., member of the Fire Offices' Committee; Mr. E. L. Bird, editor of the *Journal of the Royal Institution of British Architects*, member of the Joint Committee of the Building Research Station and the Fire Offices' Committee on the Fire Grading of Buildings; Sir George Burt, chairman, John Mowlem and Co., Ltd., chairman of the Building Research Board and of the Interdepartmental Committee on House Construction; Dr. S. F. Dorey, chief engineer surveyor, Lloyd's Register of Shipping; Dr. P. Dunsheath, chief engineer and director, Henley's Telegraph Works Co., Ltd.; Mr. A. J. Makins, general manager, Commercial Union Assurance Co., Ltd., member of Fire Offices' Committee; Air Commodore G. Powell, managing director, British Aviation Services, Ltd.; Mr. A. S. Pratten, chief officer, London Salvage Corps; Sir William Stanier, scientific adviser, Ministry of Supply, and lately scientific adviser, Ministry of Production, and chief mechanical engineer, L.M.S. Railway; Prof. D. T. A. Townend, director of the British Coal Utilisation Research Association; Mr. W. H. Tuckey, director of the Fire Offices' Committee Fire Protection Association. The members of the Board serve in their personal capacity and not as representatives of any organisation to which they may happen to belong.

### Organisation of Fire Research

THE Fire Research Organisation is a joint scheme in which an industry and the Government are partners, sharing the cost equally. It will be responsible for the conduct of research on all aspects of the prevention and extinction of fires, on the safety of life in fires and the mitigation of damage, except that on the fire resistance of buildings the Organisation will collaborate with the building research organisation of the Department of Scientific and Industrial Research, where much research on this subject has already been done. A Fire Research Station will be jointly established. The capital cost is likely to be of the order of £75,000-£100,000, and the ultimate annual running cost up to £50,000, both shared equally between the Department and the Fire Offices' Committee. As part of its contribution to the capital cost, the latter will transfer its Fire Testing Station at Elstree to the Government. The following are the broad subjects on which research will clearly have to be undertaken, although it will be for the Fire Research Board to make a selection and allot priority of work: (1) methods of preventing the occurrence of fires; (2) methods of extinguishing fires and equipment; (3) fire protection of buildings, that is, on the fire resistance of buildings, properties of building materials, and elements of structure, safety of life in fires, the prevention of the spread of fire within buildings and from building to building; (4) other fire hazards, for example, ships, aircraft, special industrial hazards.

### Textile Machinery Production in Britain

THE crucial importance of the relations between the textile industry and the textile machinery industry was emphasized in the report of the Working Party for the Cotton Industry, which recorded the broad impression that there is a clear need for more effort in Great Britain in regard to the perfection of the design of the machinery and the development of new methods of processing. This report has now been followed by a broadsheet (No. 252), in which Political and Economic Planning sets forth the facts and findings of a preliminary survey of the textile industry. The War has given rise to a very large accumulated demand for textile machinery from all textile manufacturing countries, since they have been unable to obtain new machinery for six years. Normal obsolescence requirements have been accelerated by production at high pressure with a minimum of maintenance, and total demand for textile machinery is likely to remain at a high level for years. Moreover, Germany and Japan are for the moment almost completely out of the picture, and the United States, the only other country with a large potential capacity, is at present preoccupied with its domestic market and was never a large exporter of textile machinery. For the time being, the task of satisfying world demand will in the main fall upon the British industry, and in view of the need to encourage exports with favourable long-term prospects, P.E.P. suggests that textile machinery should be given a high priority, in respect both of the allocation of labour and raw materials and the proportion of output devoted to export.

The capacity of the industry must be increased well beyond its pre-war limits. In the spinning, weaving and finishing sections, this could be facilitated by making use of the engineering resources of other areas. In all sections of the industry shortage of

labour is the limiting factor to increased capacity, and the productivity of the present labour force is low in comparison with other mechanical engineering industries. Among the most important measures of reorganisation and modernization recommended are mechanization of machine shops and foundries, which should increase productivity, and, by creating better conditions of work and pay, help to attract new recruits; an increase in the average size of producing unit, particularly at the foundry-level; and standardization of product. At present, too many different types of machinery are manufactured for work on identical fibres, with heavy demands on skilled labour and restricted possibilities of using automatic machine tools.

### Insect Control in Australia

THE use of D.D.T. as an agricultural insecticide has been investigated by G. A. H. Helson and T. Greaves (*J. Coun. Sci. and Ind. Res.*, 18, No. 4, Canberra, Australia, November 1945). They find that it is effective against a variety of lepidopterous pests and also certain aphids, including *Myzus persicae* and *Macrosiphum gaei*, which can act as vectors for virus diseases. D.D.T. was ineffective against the cabbage aphid *Brevicoryne brassicae*, woolly aphis and red spider. On the debit side, bees were seriously affected by this insecticide when visiting the flowers of sprayed bean plants. The experiments were on varied scales, from laboratory tests to field trials, and several methods of application were used. D.D.T. dusts were also found by T. Greaves (*ibid.*, 18, No. 2, May 1945) to provide the best control for a number of cabbage pests in north Queensland. Lead arsenate and calcium arsenate were also effective, but it would seem necessary to apply all three substances only to the early stages of growth of the crop, as they are toxic to man and higher animals. R. F. Powning (*ibid.*, 18, No. 2, May 1945) has evolved a method for the analysis of D.D.T. and pyrethrins in kerosene-based sprays. The two insecticidal components are separated by passage through a column of alumina. D.D.T. passes through, and is then boiled with alcoholic caustic potash to liberate hydrochloric acid, which can be titrated with standard silver nitrate solution. Pyrethrins are liberated from the alumina and estimated by the usual methods. Wheat stored in bulk is sometimes attacked by *Rhizopertha dominica* and other insect pests. F. Wilson (*ibid.*, 18, No. 2, May 1945) has shown that such outbreaks can be largely controlled by applying finely ground magnesite or dolomite to the surface of the mound. Smaller infestations can be dealt with by fumigation with carbon disulphide or ethylene dichloride.

### Indexing and Filing Unpublished Material

THE report of the meeting on February 15, 1946, of the Association of Special Libraries and Information Bureaux to discuss the "Indexing and Filing of Unpublished Material" (see *Nature*, 157, 259; 1946) has now been published. It includes the papers by Miss L. G. Thomerson on "Filing and Indexing Systems of Patra", Mr. W. Ashworth on "Correspondence Filing Problems of the British Cast Iron Research Association", Mr. A. E. Dodd on "The Filing of Unpublished Material in the British Refractories Research Association", and by Miss D. Knight, "Unpublished Material in the Library of the National Institute for Research in Dairying", which have not already appeared in the *Journal of Docu-*

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mentation. The discussion includes contributions from Dr. F. Steggerda, director of the Nederlandsch Instituut voor Documentatie en Registratuur, and Dr. C. Groeneveld, of the Royal Dutch Shell Laboratory, and indicates the wide variety of practice. Two points which might be noted in passing are: first, the importance of relating the filing system to the quantity of material it is called upon to handle; and secondly, that notably in regard to correspondence, the papers and discussion collected in this report indicate a number of factors in efficient registry service which should be impressed firmly on all those using correspondence files, whether they bear any responsibility or not for the filing system itself.

### Delinquency among Young People in Colombia

IN *Revista de la Universidad del Cauca* (No. 9, June 1946), Luis Carlos Pérez deals with factors responsible for crime among young people in Colombia. The author provides statistics based upon the results of certain investigations, in particular of the cases where there has been death of one or both parents, and these present some interesting features. When the mother survives, the number of delinquents increases, but when the father survives it decreases; the greatest number comes from cases where both parents are alive. Offences against property are by far the most numerous, and next to these, but very much less numerically, are offences against persons and cases of vagrancy. Cases of lapses after reformatory treatment are numerous; they suggest that it has no effect or that the teaching is practically the negation of correctional. Other matters are discussed, such as the larger number of male than of female criminals, the criminality of women in Colombia (in 1944, out of a total of 5,217 people condemned for offences, only a little more than 6 per cent were women), the problem of crime among the Indians, the Indian in relation to the law in Colombia, etc. In connexion with the last point, there is no general legislation; the protectors and judges of the Indians are usually the missionaries. They are authorized to exercise civil, penal and judicial jurisdiction over them, in accordance with a law passed in 1890. Difficulties arise in those cases where it is not very easy to differentiate between Indians who are civilized and those who are not. The methods for obviating this difficulty are by no means ideal, and alterations in the system are matters of great importance.

### Fruit Production and Propagation

THE war-time concentration on food production and the turning over of many fruit-tree nurseries to short-term crops has resulted in an acute shortage of young trees to meet the needs of the expanding industry and the private garden alike. In addition, much experienced labour has been lost to the industry in general, so there is real need to make known in a practical form the most up-to-date methods of propagation and the accumulated experience of orchard management. These objects are admirably achieved by two recent pamphlets issued by the Ministry of Agriculture and Fisheries ("Apples and Pears". Bull. 133. Pp. 119+18 plates. 2s. 6d. net; and "Fruit Tree Raising: Rootstocks and Propagation". Bull. 135. Pp. 46+2 plates. 1s. 3d. net. London: H.M. Stationery Office). The arts of budding and grafting can only be fully acquired by

observing the green-fingered dexterity of the experienced propagator, and proficiency and speed are only achieved after long practice (100 buds or 70 grafts an hour are said to be good averages); nevertheless, Bulletin No. 135 does as much as can be done by precept. It includes, *inter alia*, chapters on the classification and uses of rootstocks; propagation from seed, cuttings, stools and layers; tree shaping; control of pests and diseases, and a useful calendar of nursery operations.

Bulletin No. 133 is a well-illustrated text-book of commercial apple and pear production, and covers all aspects of the subject from planning and planting to storing and marketing. There is a particularly good chapter on top-working and frame-working, but that on pruning might have been improved by reference to the results of pruning and shaping trials at the research stations. In the chapter on soil management, on the other hand, the section on cover crops does not distinguish very clearly between established commercial practice and recent experimental results which have not been tested commercially. Both bulletins provide the orchardist with authoritative manuals at negligible cost.

### Diseases of Cereals in Scotland

THE high atmospheric humidity in Scotland favours the rapid development of eyespot (*Cercospora herpotrichoides*) on wheat and barley, but the severity of the disease is offset by the relatively long rotations employed. A survey carried out in 1944 (Mary D. Glynn, *Ann. Appl. Biol.*, 33, 1, 35; 1945) showed 75 per cent of the autumn-sown wheat crops to be affected, and some 9 per cent showed obvious loss. Nearly all spring-sown crops of barley were affected; but damage appeared to be less than on wheat. Sharp eyespot (*Corticium Solani*) was widespread and was particularly common in Aberdeenshire; loss is apparently slight, but deep lesions may cause some straggling. Take-all disease (*Ophiobolus graminis*) was seen on less than half the wheat crops, and in only one case was 10 per cent of the straws affected. Except in Dumfriesshire and Aberdeenshire, it was much less common than eyespot, a conclusion similar to that reached by R. W. G. Dennis (*Ann. Appl. Biol.*, 31, 370; 1944).

### Coryndon Memorial Museum, Nairobi

THE annual report for 1945 of the Museums Trustees of Kenya announces the appointment of Dr. L. S. B. Leakey (upon his release from war duties) to the full-time curatorship of the Coryndon Memorial Museum. Dr. Leakey, well known for his work in East African prehistory, has already carried out a great deal of work for this Museum in his capacity first as honorary curator and then as part-time curator. The Curator's report for the same year reports the holding of a Conference of Curators of East African Museums under the chairmanship of Dr. Leakey, and it is hoped that in future this will be an annual event. It was decided that a Federation of East and Central African Museums should be formed and linked with the Museums Association of England and the Empire. The same report makes reference to the possible development of the Museum as Kenya's War Memorial. During the year, the Governor called for suggestions as to what form the Kenya War Memorial should take, and a special committee was appointed to consider schemes sent in. Out of the ninety-eight

received, two were selected for a final choice. Of these, one was a scheme for a "Technical College for All Races", and the other a "Museums Service Extension Scheme", which was submitted by the curator and by the Executive Committee of the Natural History Society. It will be remembered that Dr. Leakey referred to these proposals in a broadcast on the needs of the East African peoples which he made during a recent visit to Great Britain. He made it clear that so far as the East African native is concerned, the scheme envisaging a technical college is overwhelmingly favoured.

#### South African Association for the Advancement of Science

THE *South African Journal of Science* of June 1946 (volume 42; from the Association, Johannesburg) contains the report of the Johannesburg meeting in 1945 of the South African Association for the Advancement of Science, including the presidential address of E. C. Chubb, director of the Durban Museum, on "Museums and the Advancement of Science", the sectional addresses and the papers read or presented to the sections. The president, after indicating the services which the British Museum had rendered to the advancement of science, gave an interesting review of the activities of the museums of South Africa. Dr. H. van Gent's presidential address to Section A dealt with the contribution of variable star research to the progress of astronomy, while Mr. H. Wilson's presidential address to Section B, "Methane: a Neglected National Asset", discussed the potentialities of methane and urged the serious co-ordinated exploration of the country's resources of natural gas containing methane. Prof. C. J. van der Horst's presidential address to Section D, "Revolution in Evolution", reviewing the influence of Hugo de Vries' conclusion regarding evolution by sudden mutations, discussed more particularly the nature and origin of the trophoblast or feeding layer surrounding the mammalian embryo, and Prof. C. P. Lestrade, addressing Section E, dealt with "Some Problems of Bantu Language Development". Prof. Lestrade was concerned mainly with whether all or any of the South African Bantu languages should survive, and if so, with the part they should play in the life of the Bantu-speaking peoples, and secondly, how we could best ensure that the languages deemed worthy of survival could play the part desired, and he referred in conclusion to the lessons to be learned from the language situation in the Philippines. Of equal practical interest is A. J. Limebeer's presidential address to Section F on "The Employment of the Partially Disabled considered as a Social Policy".

#### Congress on Colonial Agriculture

THE Institut National pour l'Étude Agronomique du Congo Belge (INEAC), 12 rue aux Laines, Brussels, is organising at Yangambi, in the Belgian Congo, an 'agricultural week' during February 27-March 5. There will be visits to the Yangambi laboratories and gardens and to the neighbouring experimental stations. Papers will be read concerning Colonial agricultural questions, including particularly agricultural methods of promoting soil conservation. A report will be published in due course. Papers (two typewritten copies) should be sent to the Institute at Brussels by January 15 or to Yangambi (Belgian Congo) by February 1.

#### University of Sheffield: Appointments

THE Council of the University of Sheffield has made the following appointments: Dr. Arthur G. Walker, special lecturer in differential geometry in the University of Liverpool, to the chair of mathematics, in succession to the late Prof. P. J. Daniell; Dr. T. S. Stevens to be senior lecturer in organic chemistry; Dr. Quentin H. Gibson to be lecturer in physiology; H. J. V. Tyrrell to be assistant lecturer in chemistry; Dr. W. J. P. Neish to be cancer research assistant in the Department of Pathology.

#### University of Cambridge: Appointments

THE following appointments have been made in the University of Cambridge: W. L. S. Fleming to be director of the Scott Polar Research Institute in succession to Prof. F. Debenham, who has resigned; Dr. L. E. R. Picken, Dr. R. J. Pumphrey and H. W. Lissmann to be assistant directors of research in zoology. Prof. Carl Sörmer, of the University of Oslo, will deliver the Rouse Ball Lecture for 1946-47.

#### Announcements

PROF. W. V. MAYNEORD, professor of physics applied to medicine at the Royal Cancer Hospital, London, will deliver a series of six lectures at the British Institute of Radiology on "The Applications of Atomic Physics in Medicine" on Wednesdays beginning January 1 at 5 p.m.

THE Rector and Fellows of Lincoln College, Oxford, propose to elect an official fellow in chemistry, the appointment to commence on October 1, 1947. Particulars may be obtained from the Rector, to whom application, including a personal record and the names of three referees (but no testimonials), should be made before February 8, 1947.

AN election to the Pinsent-Darwin Studentship in mental pathology will be made at Cambridge in March. It is of the annual value of not less than £225 and is tenable for three years. The student must engage in original research into any problem having a bearing on mental defects, but may carry on educational or other work concurrently. Applications should be sent before February 28 to the Secretary, Pinsent-Darwin Studentship, Psychological Laboratory, Cambridge. Applicants should state their age and qualifications and the general nature of the research that they wish to undertake. No testimonials are required, but applicants should give the names of not more than three referees.

FOURTEEN member firms of the Scientific Instrument Manufacturers' Association of Great Britain, Ltd., have formed an Electronics Section. The first chairman is Capt. A. G. D. West, director of Cinema-Television, Ltd. One of the main objects of the Electronics Section will be to further and improve the manufacture of British electronic instruments and apparatus, an industry which has experienced a rapid growth during the last few years.

MR. ROBERT D. POTTER, former science editor of the *New York Herald Tribune* and staff physics writer on Science Service, Washington, D.C., is resigning after six years as science editor of the *American Weekly* to found his own science writing organisation. His firm will be known as "The Word-hop" with headquarters at Scarborough-on-Hudson, N.Y., U.S.A. Mr. Potter was a founder-member and twice president of the National Association of Science Writers.

## LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

## Millimetre Wave Propagation

INFORMATION has recently been disclosed about the absorption band in the oxygen molecule for electromagnetic radiation of wave-length in the region of 5 mm.<sup>1</sup>. This communication gives preliminary details of an experimental investigation on propagation over sea of waves in this wave-length region.

The tests were carried out at Weymouth, where a transmitter was set up on a site on the northern breakwater of Portland Harbour. In the course of the experiments two transmitter positions were used, one at a height of 15 ft., the other at 48 ft. above mean sea-level. The receiver was mounted at the masthead of one of H.M. ships, at a height of 63 ft. Two wave-lengths were used, one of 5.81 mm., which is in the oxygen absorption band; the other of 6.35 mm., which is just outside the absorption band.

The transmitter was a klystron oscillator operating at a wave-length of twice the required value. Its output was fed into a crystal distorter which gave a second-harmonic output power of some 10  $\mu$ W. The aerial system was a 16-in. paraboloid fed by a wave guide, giving a gain of about 40 db., with vertical polarization. A superheterodyne receiver with crystal mixer and a similar aerial were used for reception. Because of the narrow beam-width consequent upon its high gain, the aerial on board ship was fitted on a radar mounting stabilized against ship movement. The received signal was recorded continuously on a recording milliammeter.

Over a period of a week, twenty-five runs were made, moving on a straight course to or from the transmitter, covering a range from less than a kilometre up to some 12 kilometres.

Figs. 1 and 2 are representative curves of signal strength plotted against distance, curves *A* and *B* taken for the high transmitter site at the two wave-lengths, and *C* and *D* corresponding curves for the low transmitter site. For unattenuated free-space propagation, the signal strength should vary inversely as the distance  $d$ , and reference curves proportional to  $1/d$  have been included in each figure. Ignoring for the moment the oscillatory nature of the curves, it will be seen that for the 6.35 mm. wave-length curves, *A* and *C*, the mean level closely follows the  $1/d$  curve; this indicates that absorption is small. For *B* and *D*, however, taken at 5.81 mm. wave-length, the mean curves fall progressively below the  $1/d$  line, showing the existence of atmospheric absorption. The nature of the curves and some uncertainty in the range figures make it impossible to state a precise value for the attenuation constant; but a figure of about 1.5 db./km. is indicated. This is considerably higher than the value of about 0.5 db./km. given by Beringer<sup>1</sup>, even allowing for additional water vapour attenuation in the present measurements, which for the prevailing relative humidity of about 90 per cent will not amount to more than about 0.1 db./km. Beringer's measurements were made in the laboratory on oxygen mixtures contained in a short length of wave guide.

The other striking feature of the curves is the interference pattern shown. It might have been

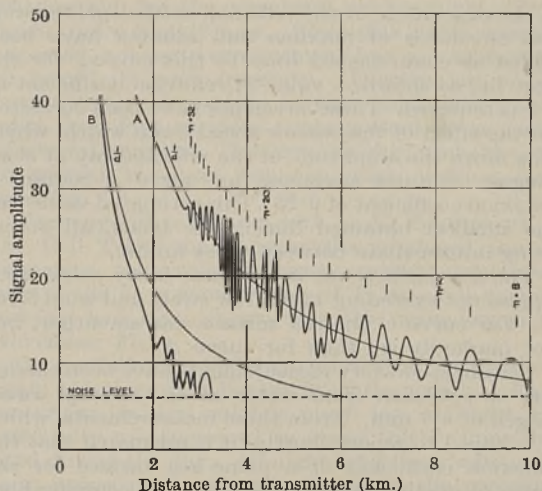


Fig. 1. SIGNAL STRENGTH/DISTANCE CURVES  
A:  $\lambda = 6.35$  mm. } High transmitter site  
B:  $\lambda = 5.81$  mm. }

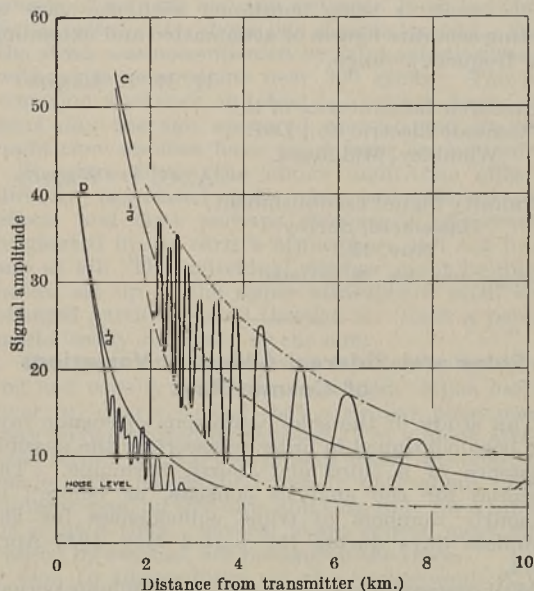


Fig. 2. SIGNAL STRENGTH/DISTANCE CURVES  
C:  $\lambda = 6.35$  mm. } Low transmitter site  
D:  $\lambda = 5.81$  mm. }

considered improbable, except possibly for very calm seas, that any considerable amount of specular reflexion from the sea surface would occur at wave-lengths so small compared with normal sea wave-heights. However, the figures show a regular pattern of interference between the direct and reflected rays. This explanation is confirmed by the close correlation between the observed maxima of the curves and their positions as calculated theoretically and shown for curve *A* by the short vertical lines. The positions of the maxima are calculated simply from those values of the phase difference angle  $\psi$  between the direct and reflected rays which make  $\psi = (2n + 1)\pi$ . The effect of the difference in transmitter height is clearly shown in the difference in spacing of the maxima between curve *A* and curve *C*.

Curve *C* shows the greatest amplitude of interference recorded during the trials. To give some idea

of the magnitude of the reflexion coefficient, theoretical envelopes of maxima and minima have been added as chain-dashed lines to this curve; for the best fit, as shown, a value of reflexion coefficient of 0.8 is required. These envelopes have been corrected for the effect of the narrow aerial beam width, which cuts down the amplitude of the reflected ray at close ranges. Similar envelopes for curve A require a reflexion coefficient of 0.25. This estimated value was the smallest obtained during the trials, all others being intermediate between these limits.

The sea surface was in all cases fairly calm, with ripples not exceeding 12 in., low swell, and wind force 2. For curve C the sea surface was smoother, but not markedly so, than for curve A.

Certain laboratory measurements have been carried out on reflexion from water at the nearby wavelength of 8.7 mm. From these measurements, which it is hoped to report shortly, it is estimated that the reflexion coefficient of a plane sea surface for the range of grazing angles (less than 1°) occurring here would lie between 0.88 and 0.97. Thus for an actual sea surface the values obtained approach this upper limit.

The work is being continued with the view of getting accurate figures of attenuation and extending the frequency range.

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A. G. D. WATSON

Admiralty Signal Establishment,  
Haslemere, Surrey.  
Nov. 15.

<sup>1</sup> Beringer, *Phys. Rev.*, 70, 53 (1946).

### Solar and Sidereal 6-Hourly Variations of Cosmic Rays

THE study of the solar variations of cosmic rays has been continued in order to ascertain the possible existence of a third and fourth harmonic. The material for the analysis consists, as before<sup>1</sup>, of bi-hourly numbers of triple coincidences for 860 complete days during the period May 1941–April 1944.

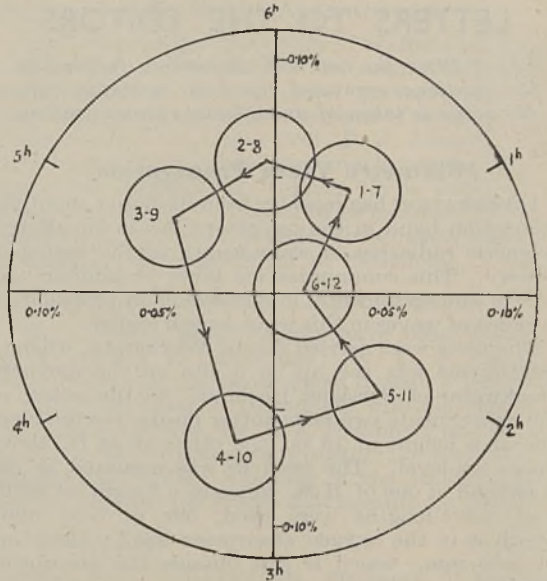
With regard to the harmonic of the 6-hour period, it is found that when all the data are taken together, no appreciable variation is apparent. But the result is entirely different if the data are arranged in 12 monthly groups and each one analysed separately. The following table gives the amplitude and phase for each group after correcting for non-cyclic variation and for pressure by using the barometric coefficient 0.345 per cent per mm. The first group refers to January for all three years, the second to February, and so on.

TABLE 1

Group	Ampl.	Phase	Group	Ampl.	Phase
1	0.117%	2°	7	0.098%	122°
2	0.034	37°	8	0.100	112°
3	0.032	190°	9	0.089	128°
4	0.102	270°	10	0.040	218°
5	0.087	321°	11	0.040	308°
6	0.028	42°	12	0.014	294°

Probable error: ± 0.030%

As shown by the table, the phase increases regularly in chronological order, suggesting that a sidereal effect is present. The existence of this effect is better



SOLAR TIME DIAL. THE RADIUS OF EACH CIRCLE REPRESENTS THE PROBABLE ERROR

shown, however, if the importance of the probable error is diminished by taking groups of pairs of months. In the harmonic dial of the accompanying figure, the mean amplitudes and phases for these bi-monthly groups have been plotted. January has been combined with July, February with August, and so on, in order to avoid increasing the smoothing effect. The orderly progression of the points in an anti-clockwise direction is beyond doubt.

But the possible existence of a superimposed solar variation cannot be excluded. To separate the two effects, if they actually exist, we can eliminate the sidereal one by taking the mean values of the groups of three or multiples of three successive months. Table 2 gives the mean amplitude and phase for cosmic rays of the 6-monthly groups November–April and May–October, together with, for comparison, the corresponding amplitude and phase for pressure.

TABLE 2

	Cosmic rays		Pressure	
	Ampl.	Phase	Ampl.	Phase
Nov.–April	(0.032 ± 0.012)%	318°	0.035 mm.	173°
May–Oct.	(0.034 ± 0.012)%	115°	0.024	341°

As the table shows, the wave in cosmic rays is in the two cases opposite in phase to the pressure wave. The amplitude for cosmic rays is somewhat less than three times the probable error; but the fact that the means of any other pair of groups of six successive months appear to be always in a similar correspondence with those of the pressure wave seems to indicate that a real solar variation does exist, and that it is controlled by the barometric oscillation of the 6-hour period—a similar result to that obtained for the semi-diurnal variation<sup>2</sup>.

As the variation of pressure for each monthly group is known from barograph readings, the ratio of the cosmic ray wave to the pressure wave, the value of which is roughly –1 per cent per mm., enables us to obtain and eventually to remove the real solar variation. By doing so we obtain for the amplitude of the sidereal variation the value 0.057 per cent, which is six times greater than the probable error ± 0.009. The times of maxima are 4, 10, 16,

22 hr. sidereal time. The fourth maximum appears to occur at about the same time as that of the maximum of the 24-hourly sidereal variation previously obtained<sup>1</sup>.

Ehmer<sup>2</sup>, by a totally different method, has also deduced the existence of a 6-hourly sidereal variation, though its amplitude is not given.

It may be noteworthy that in the studies of radio-frequency energy from the stars, several maxima have been recorded which, according to Reber<sup>4</sup>, may be associated with projections from the Milky Way analogous to the arms of other spiral nebulae. If cosmic rays are generated, as previously suggested<sup>1</sup>, in the stars, a similar cause might account for the sidereal fourth harmonic.

With regard to the third harmonic, no variation for cosmic rays appears which could be regarded as real.

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<sup>1</sup> Duperier, *Nature*, **158**, 196 (1946).

<sup>2</sup> Duperier, *Proc. Phys. Soc.*, **57**, 464 (1945).

<sup>3</sup> Ehmer, *Z. Phys.*, **111**, 260 (1936).

<sup>4</sup> Reber, *Astrophys. J.*, **100**, 279 (1944).

### Solar Radiation at 480 Mc./sec.

FOR several months past, daily measurements of radio waves from the sun at 480 Mc./sec. have been made here at true noon. The normal observed intensity is about  $5 \times 10^{-19}$  watt/sq. cm. per Mc./sec., corresponding to an apparent solar temperature of about a million degrees. Superimposed on this are slow day-to-day variations of about 15 per cent which are quite closely correlated with the apparent area of sunspots. This variation is no doubt the same phenomenon on a greatly reduced scale which was observed by Pawsey<sup>1</sup>. The apparent solar diameter is about  $\frac{1}{2}^\circ$ , and no observable variation (less than  $0.1^\circ$ ) has been found from day to day.

On November 23 a partial solar eclipse occurred here. On that day the observed solar intensity dropped about 25 per cent compared to the observed intensity on November 22 and 24. This is approximately the amount of the sun's disk obscured by the moon at noon. No change in solar width was observed.

On November 21 a great radio storm was observed similar in type to that described by Hey<sup>2</sup>. It started about 1630 G.M.T., increased in severity to about 1800 G.M.T. and then died down. A second smaller outbreak occurred about 1930 G.M.T. The storm manifested itself as greatly increased apparent radio intensity. The sounds coming from the amplifier were typical hissing or rushing noises quite similar to thermal agitation noise. However, instead of being steady as is the normal solar noise, this storm noise varied from second to second in amplitude. Thus the output meter showed an erratic reading, and the audible effect in headphones was much like wind whistling through the trees when no leaves are on the limbs. Occasionally great swishes occurred above the rapidly varying background. No snaps or crackling sounds could be heard which might be interpreted as lightning or sparking discharges of any kind.

At the peak of the disturbance the antenna was turned to declination  $57^\circ$  N., which is practically at right angles to the sun. All the solar background

disappeared, but the occasional swishes could still be heard, quite weakly now. Since this storm was not expected, adequate arrangement had not been made to record its peak intensity. Observation of the output meters showed the background intensity to be more than four hundred times normal for a period of several minutes. The great swishes probably rose to several thousand times normal, judging from listening.

Exchange of telegrams with G. C. Southworth of the Bell Telephone Laboratories produced the information that solar intensity measurements had been made at a wave-length of  $1\frac{1}{2}$  cm., but nothing unusual had been observed at this wave-length on November 21.

On the following night the apparatus was operated again to measure radiation from the galaxy. Since motor-car ignition noise is much less at night, the sensitivity was increased to about thirty times that used during the day. All night long there were quite faint noises similar to those heard at the preceding noon, but perhaps  $10^5$  times fainter. Due to faintness only individual swishes could be heard. These occurred at irregular intervals of from a second to a couple of minutes between swishes. Each individual swish lasted only about one quarter second. Often the swish was accompanied by faint grinding sounds with noise components near 300 cycles. The phenomenon weakened and died out toward dawn. The next day the sun appeared normal, and no more night-time swishes have since been encountered.

It seems likely the above night-time effect is directly associated with the previous noon-day effect, and that perhaps the whole phenomenon originated in the earth's atmosphere and not in the sun at all. The individual swishes might be due to noises set up in the upper atmosphere when some charged particle passed through it. Such a particle might easily originate in the sun.

The apparatus used here is automatically recording and usually operates unattended. Upon looking over my charts, I find that a similar phenomenon may have occurred on October 17 in a much attenuated form. No one was present when this chart was made. The background rose to only about twenty times normal on this day, and then only for a minute or so at a time. Several sharp spikes, most likely caused by swishes, are present on the trace.

Due to unsteadiness of the background, it was impossible to measure accurately the solar width on November 21. However, estimates show it to be not more than a few degrees and probably less at the half-intensity points.

GROTE REBER

212 W. Seminary Ave.,  
Wheaton, Illinois.  
Nov. 24.

<sup>1</sup> Pawsey, *Nature*, **157**, 158 (1946).

<sup>2</sup> Hey, *Nature*, **157**, 47 (1946).

### Demodulation by Superconductivity

WE have examined further the anomalous fluctuations in the superconducting bolometers previously reported by Andrews, Milton and Desorbo<sup>1</sup>, and find that, in part, such fluctuations are due to the absorption by the superconductor of modulated broadcast radio waves and the conversion of the modulation wave, by the superconductor, to simple audio-frequency. Our experiments were carried out

with superconducting bolometers using small ribbons of columbium nitride mounted in cryostats, and employing circuits as described in the preceding reference. Following the discovery on December 2, 1946, of demodulation of broadcast waves at 1,090 kilocycles, we generated waves in the laboratory at frequencies ranging from 200 to 30,000 kilocycles, and found that demodulation occurred only in four bands centred approximately at 1, 3, 5 and 16 megacycles. We have found this demodulation to occur only within a narrow temperature zone corresponding to a part of the transition interval between the normal and the superconducting state. The temperature for maximum demodulation was not affected by changing the radio-frequency. Quality of reception was comparable with good standard radio reception. Although no tuned radio-frequency circuit or antenna was used, the signal generated was estimated to be of the order of ten to one hundred microvolts at the terminals of the ribbon. Demodulation could be reduced or eliminated by passing small direct currents through the superconductor.

Superconductors may be useful for generating or receiving waves in frequency ranges where the use of present methods is difficult, or for improving present methods.

This research was carried out under a basic research contract with the Physics Division, Office of Naval Research, United States Navy, at the Chemistry Department, Johns Hopkins University, Baltimore, Maryland.

DONALD H. ANDREWS  
CHESTER W. CLARK

Dec. 10 (by cable).

<sup>1</sup> *J. Opt. Soc. Amer.*, **36**, 518 (1946).

### Determination of the Variation of Composition of Airborne Crystalline Materials with Particle Size

THE 'cascade impactor'<sup>1</sup> is a four-plate sampling instrument so designed that particles in successive size ranges are deposited in turn on the corresponding plate. While some overlapping of sizes occurs, the cut-off of the second, third and fourth plates is comparatively sharp (v. ref. 1), and this can be utilized in the following manner.

The microscope slides normally used in the instrument are covered on one side by a thin sheet of 'Cellophane' or aluminium foil, the foil being held in position on the slide by a small amount of cellulose acetate cement at either end. The foil is then coated with a thin film of Canada balsam in xylene. This must be done immediately prior to use, or alternatively the slides must be stored in xylene vapour. The slides are inserted in the usual way, and a sample much denser than for normal counting is taken. It is necessary to avoid continuing the sample to a point where the greater part of the sticky surface has been covered by dust. The slides are removed and a small amount of a thin solution of Canada balsam applied over the trace by means of a wire. The slides are located in their former position and re-exposed: in this manner a dense linear trace is built up. The slides are then removed and covered with a coverslip supported on a spacing ring. Should one plate become heavily coated compared with the other three, it is removed, and replaced by an ordinary slide made adhesive with balsam, and the sampling continued until the rest have reached the desired density.

Immediately after the dense sample has been taken, another sample for counting is obtained, and this enables the size range on each plate to be determined.

To obtain the X-ray diffraction pattern, the coverslip and glass slide are removed, and the linear trace on the foil treated by the usual powder methods.

This method would seem to have the following advantages over previous methods for determining the variation in composition with particle size:

(1) The sample undergoes no treatment before the diffraction pattern is obtained. Even low-temperature ashing of filter samples may alter the crystal structure, while the possibility of chemical reaction when aqueous media are used in size separations is always an uncertain factor. (2) Coagulae are deposited in the range appropriate to their Stokes law size—in the same manner as they would be in the breathing passages. Elutriation methods of size separation redisperse coagulae into their ultimate particles, thereby producing erroneous results. (3) The sample obtained is representative of the dust in a considerable volume of air (5 cu. ft. in the samples so far taken). (4) There is no question of selective coating of the sample placed in the diffraction camera. This is of importance when flaky materials such as micas are present.

This method compares favourably on a time per sample basis with elutriation methods, and seems suitable for the study of aerosols consisting of mixed silicates and silica.

Thanks are expressed to Dr. A. Woods of the National Physical Laboratory for help and advice.

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Nov. 16.

<sup>1</sup> May, K. R., *J. Sci. Instr.*, **22**, No. 10 (1945).

### Response Curve of the Yellow Receptors of the Human Fovea

THE micro-stimulation apparatus<sup>1</sup> has been used recently for studying the shapes of the response curves of some of the receptors which take part in human foveal colour vision. It will be remembered that Granit found evidence for seven kinds of 'modulator' in the retinae of such animals as frogs, snakes and rats, which had maximum responses at the following approximate wave-lengths: 6000, 5800, 5400, 5200, 5000, 4600 and 4400 angströms. All these had narrow response curves. In the cat, on the other hand, the response curves appeared to be wider, having legs which were farther apart. Particularly was this the case with the 'modulators' produced from 'dominators' after the retina had been exposed to red, to green, or to blue lights.

Now the three-colour theory of Thomas Young postulates three kinds of modulator in the human fovea: red, green and blue (or violet), and supposes, moreover, that these have very wide response curves indeed, which spread in each case over, roughly, half the visible spectrum. The question that arises, therefore, is: Does man resemble the frog, in having receptors with very sharp response curves? Or does he resemble the cat, in having receptors with somewhat broader response curves? Or, is he unique in possessing three types of receptor only, having exceptionally broad response curves?

I have found two methods of obtaining the response curve of one of the receptors of the human fovea, both depending on a study of the antichromatic responses.



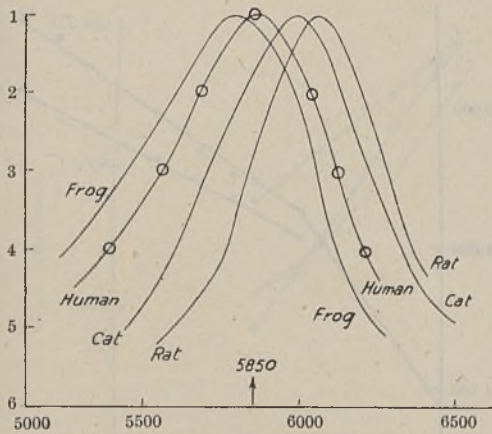


Fig. 1

THE CURVES FOR THE RECEPTORS OF THE FROG, THE RAT AND THE CAT WERE OBTAINED BY PROF. GRANIT. THE HUMAN CURVE WAS OBTAINED BY THE AUTHOR

(1) It was found that when a yellow test-object has been sufficiently reduced either in intensity or in visual angle, it is replaced by white. But if a second yellow object is placed near the first, in the visual field, the latter is seen to become yellow again. If the second conditioning object is not yellow, but some other colour, then it facilitates the reversion of the first to yellow if it reflects yellow rays, but not otherwise. This effect was employed for obtaining the shape of the response curve of the yellow human foveal receptor, in the following way. Two point sources of light of about the same brightness were presented to an observer by means of the micro-stimulation apparatus. One of these was a yellow test light of fixed intensity, produced by suitable colour filters. The other was a conditioning light, produced by a monochromator, which could be altered in both wave-length and intensity. It would have been better for both sources to have been produced by monochromators, but unfortunately only one was available. The intensity of the conditioning source having been adjusted, the wave-lengths were determined, first in the orange, and then in the yellow-green, at which the test-source underwent a transition from yellow to white. When the conditioning source had a high intensity, a considerable difference in wave-length was necessary; but as the intensity was reduced, the wave-lengths approximated more and more to one another, until finally they

became identical. When the wave-lengths were plotted against the log of the intensity, the curve shown in Fig. 1 was obtained. In the same diagram are also plotted three typical response curves, as found by Granit for the retinae of animals. Granit's method of obtaining response curves differs radically from that used by me, so also do the data on which the curves are based; none the less, the similarity between the two kinds of curve is striking.

(2) When either the visual angle or the light intensity, or both, are made small, normal foveal colour vision is replaced by reduced foveal colour vision, which is a form of dichromatism in which orange-red is one primary and greenish-blue is the other. During this change, yellow is replaced by white, and blue by dark grey or black. Consequently, since the luminosity curves indicate the total effect at different parts of the visible spectrum of all the photo-receptors which are in operation, the luminosity curve for reduced foveal vision should differ from that for full foveal vision, at two spectral regions, namely, yellow and blue. In both these regions the curve for reduced vision should fall below that for full vision. But further, a study of these curves should give an indication of the magnitude of the changes which have taken place. In Fig. 2 are given three curves: (a) for the light-adapted fovea, as shown in Fig. 50, on page 83, of Wright's book, "Researches on Normal and Defective Colour Vision"; (b) for the fovea for a 20-min. test-object at a low intensity of illumination, as shown by Wright in *Nature*, 151, 726 (1943); (c) the differences of the ordinates of (a) and (b) at different wave-lengths. The latter curve should indicate the shapes of the response curves for the yellow and the blue receptors. The former is shown clearly, but the latter is too near the base line for any definite conclusions to be reached about it.

If the response curves for the yellow receptor given by methods (1) and (2) be compared, it will be seen that, while they are of the same general form, they are not identical. Both are alike in one important respect, namely, in reaching maxima at about 5850 angstroms; also both indicate the presence of a modulator with the very narrow type of response curve, similar to those found by Granit in the retinae of many lower animals. The differences between the response curves given by the two methods may be due to several factors. Thus in the first method, the retinal area under investigation was many times smaller than that used for the second method.

In spite of these differences in detail, the following conclusions appear to be justified: (1) there is present, in the human fovea, a receptor with a sharp response curve in the yellow region of the spectrum; (2) that this has a peak at, or near, 5850 angstroms; (3) this receptor takes part in the antichromatic responses, being responsible for one of the changes which affects colour vision when the intensity or the visual angle is reduced.

Method (1) has been used for investigating the other receptors present in the human fovea. There is a receptor having a response curve in the red and another in the green. Both these resemble the one in the yellow, in having narrow response curves. Lastly, these three appear to be too sharp for the light-adapted luminosity curve to be produced by their summation, thus indicating the presence of other receptors in the long-wave region of the visible spectrum. This conclusion is in agreement with that

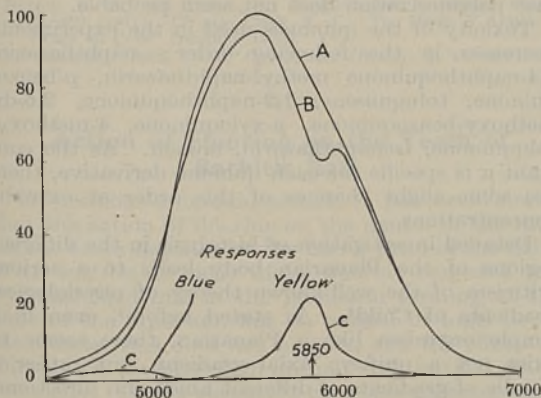


Fig. 2

recently arrived at as the result of employing other methods of micro-stimulation.

The evidence so far available seems to point to the receptors responsible for human colour vision being very like those found by Granit in lower animals. The response curves are narrower than those found in the cat. The position with regard to dominators having broad response curves is far from clear. The evidence seems to be that all modulators become dominators when the light intensity or area of stimulation is sufficiently reduced. The details of this change, if indeed it takes place at all, and the means by which it is brought about, will require further investigation.

*Note added in proof.*—Since the above letter was written, Prof. Granit has sent me some curves showing the responses obtained after selective adaptation in cats. These occupy the red, yellow and green parts of the spectrum, with maximum sensitivities at 6000, 5800 and 5400 Å. respectively. The response curve for the yellow receptor is very similar in shape, and reaches a maximum at almost the same point as that obtained by me for the human fovea, which is shown in Fig. 1.

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Nov. 12.

<sup>1</sup> To be described in *Phil. Trans. Roy. Soc.*

## A Quantitative Study of the Toxic Action of Quinones on *Planaria gonocephala*

THE purpose of the experiments to be described in this paper have been: (1) to continue studies on the mechanism of the antibiotic and toxic effects of certain quinone derivatives<sup>1</sup>; and (2) to extend earlier investigations<sup>2</sup> and to study the so-called axial gradients in a quantitative way. *Planaria gonocephala* was chosen as a suitable model organism for both purposes. Eleven different quinone derivatives have been tested.

Where solubility allows a sufficiently high concentration (*p*-benzoquinone and toluquinone), progressing from higher to lower concentrations of quinones, a marked change from a fixation-like effect to a histolytic one is found in Planarians.

As log-log plotting of mean values of death-times shows, the effect of concentration follows the equation

$$\log t = \log b + a \log \frac{1}{c}, \text{ or } tc^a = b,$$

where *t* is time, *c* is concentration, *a* and *b* are constants.

There is a break in the curve at about 1/1,000 molar concentration, corresponding to the transition from fixation to histolysis, where *a* > 1 for the former, *a* < 1 for the latter effect. Where solubility does not allow a sufficiently high concentration, of course, the second (histolytic) part of the curve is the only one present. Examples of these curves are given in Fig. 1; the other substances give similar curves. Two naphthoquinone derivatives behave differently; *a* > 1 in the histolytic curves of lawson (2-hydroxy-1,4-naphthoquinone) and *iso*-naphthazarin (2,3-dihydroxy-1,4-naphthoquinone). A pos-

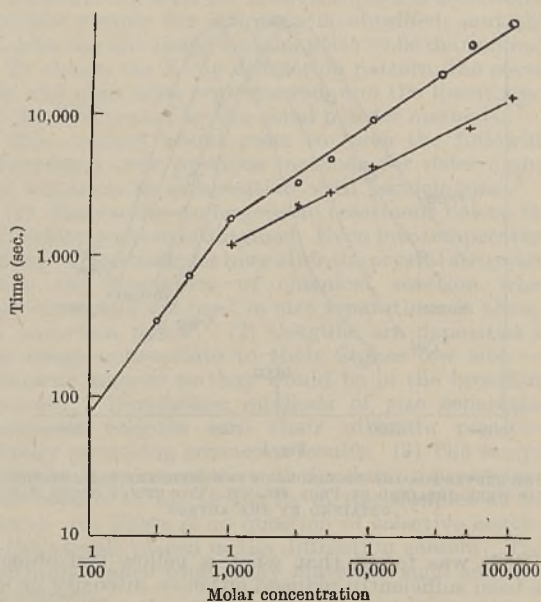


Fig. 1. Curves of death-times; —○—, *p*-benzoquinone; —×—, *p*-naphthoquinone

sible explanation for this exceptional behaviour is that these two substances can react in two tautomeric forms (as *ortho*- and *para*-quinone derivatives), and that the effect described is due to a change in the adsorption equilibrium of these two forms, corresponding to the change of concentration.

No investigations, as yet, have been made of the action of quinones on lower animals, but there are many records of the antibacterial effects of these substances<sup>3</sup>. Two theories of the mechanism of these effects have been published. E. A. Cooper<sup>3</sup> explains the antibacterial action of the quinones as a kind of tanning reaction between bacterial proteins and quinones; K. Wallenfels<sup>4</sup>, on the other hand, believes that the antibiotic effect is due to an inhibition of certain enzymes necessary in bacterial metabolism. In Planarians, the break in the curve obviously indicates a change from one predominant mechanism to another. The fixation-like effect is, doubtless, due to a protein reaction; whereas for the histolytic one no satisfactory chemical explanation can be given. Similar effects have been described by Herzog and Betzel<sup>5</sup> in disinfection and interpreted as polymerization and adsorption respectively, but in our case polymerization does not seem probable.

Toxicity of the quinones used in the experiments decreases in the following order: naphthazarin, 1,4-naphthoquinone methyl-naphthazarin, *p*-benzoquinone, toluquinone, 1,2-naphthoquinone, 2,6-dimethoxy-benzoquinone, *p*-xyloquinone, 4-methoxy-toluquinone, *ison*naphthazarin, lawson. As the constant *a* is specific for each quinone derivative, there are some slight changes of this order at extreme concentrations.

Detailed investigation of histolysis in the different regions of the Planarian body leads to a serious criticism of the well-known theory of physiological gradients of Child<sup>6</sup>. As stated before<sup>2</sup>, even in a simple organism like a Planarian, there seems to exist not a uniform axial gradient, but rather a bundle of gradients of different kinds and directions. This is confirmed by the present experiments in a

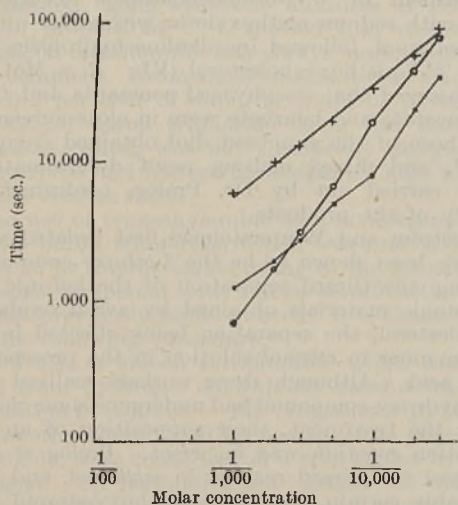


Fig. 2. —x—, curve of death times; —●—, curve of decay beginning at anterior region; —○—, curve of decay beginning at posterior region. Toxic agent: 4-methoxy-toluquinone

very striking manner. In higher concentrations of quinones, decay begins at the anterior region, in lower concentrations at the posterior region; so there is a certain concentration where an inversion of gradient occurs. An example is shown in Fig. 2. This indicates that at least two complexes of factors are involved in the histolytic process, the first being primarily effected by higher, the second by lower, concentrations.

Full details of the results obtained will be published elsewhere.

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Oct. 11.

<sup>1</sup> Hoffmann-Ostenhof, O., and Lee, W. H., *Monatsh. Chem.* (Vienna), **76**, 180 (1946). Hoffmann-Ostenhof, O., and Blach, E., *Monatsh. Chem.* (in the press). *Experientia* (Basle) (in the press).

<sup>2</sup> v. Bertalanffy, L., *Biologia Generalis* (Vienna), **15**, 295 (1942). Cf. also v. Bertalanffy, L., "Theoretische Biologie", **2** (Berlin, 1942).

<sup>3</sup> Cooper, E. A., *Biochem. J.*, **7**, 186 (1913). Cooper, E. A., and Nicholas, S. D., *J. Soc. Chem. Ind.*, **46**, T69 (1927). Oxford, A. E., and Raistrick, H., *Chem. Ind.*, **61**, 128 (1942). Oxford, A. E., *Chem. Ind.*, **61**, 189 (1942).

<sup>4</sup> Wallenfels, K., *Chemie* (Berlin), **58**, 1 (1945).

<sup>5</sup> Herzog, R. O., and Betzel, R., *Hoppe-Seyler's Z. physiol. Chem.*, **74**, 221 (1911). Cf. also Clark, A. J., "The Mode of Action of Drugs on Cells" (London, 1933).

<sup>6</sup> For example, Child, C. M., *Protoplasma* (Berlin), **5**, 447 (1929).

### Action of Fluorine on the Teeth of Rachitic Rats

In previous communications, it has been shown that the action of fluorine on the dentin of the rat's incisor tooth depends on the Ca : P ratio of the diet<sup>1</sup>. With low Ca : P ratio diets, fluorine causes a fine hypercalcified line in the pre-dentin forming at the time of the injection, but on normal or high Ca : P ratio diets, this does not happen, and the effects of fluorine on the pre-dentin are not seen until it starts to calcify. It was suggested that this difference was due to the differences in the blood calcium level, as

this is low with low Ca : P ratio diets and normal or high with the other diets. This supposition has been tested in two ways : by raising the blood calcium of animals on the low Ca : P ratio diet, and by lowering the blood calcium of animals on the high Ca : P ratio diet, and observing the effects of fluorine after this has been done.

Four litters of young rats were placed on a diet of low Ca : P ratio (0.25 : 1), similar to that previously used, for 28 days. Three different procedures were then adopted : some were dosed with 27 i.u. of vitamin D by mouth and given an injection of sodium fluoride solution two days later ; some were given only an injection of sodium fluoride solution, and some were only dosed with vitamin D. The rats were killed at intervals up to eight days after the sodium fluoride injection. Whereas the incisors of the rats given sodium fluoride alone all had the usual line in the pre-dentin, the teeth of those previously given vitamin D showed either nothing at all or else an extremely faint line in the most proximal pre-dentin. One litter was given a rather larger dose of sodium fluoride than usual ; all the rats getting sodium fluoride alone died in tetany, but those given vitamin D before injection had no tetany and survived. It has been shown<sup>2</sup> that vitamin D dosage in rats on this diet causes a transient rise in blood calcium lasting 4-6 days.

Young rats from three litters were placed on the Steenbock and Black rachitogenic diet (Ca : P ratio, 4 : 1) for 28 days, and were then starved for 1, 1½, 1¾, 2 or 3 days. At the end of this time some were killed as controls and the rest given injections of sodium fluoride and returned to the diet. Many of the rats had violent tetany after the period of starvation, accentuated by the injection of fluoride, and two died. The rest were killed at intervals and examined. The four rats starved for one day showed no changes in their teeth due to the injection of fluoride. Of the other injected rats, two starved for 1½ days, and all the other rats, fifteen altogether, had the same hypercalcified line in the pre-dentin as had previously been found in rats on the low Ca : P ratio diet given an injection of fluoride. Measurements showed that the line was laid down at the time of injection, and that the average incremental rate of pre-dentin formation after that was 6 μ per day. As is well known<sup>3</sup>, starvation causes a fall in the blood calcium of rats on high Ca : P ratio diets, often to tetanic levels.

Thus under conditions when the blood calcium is raised, the action of fluorine on the pre-dentin is greatly lessened or prevented, while when the blood calcium is lowered, this effect of fluorine is caused in rats previously found not to show it. These observations strengthen the theory previously put forward that the action of fluorine on the teeth is related to the level of the blood calcium.

The expenses of this work were defrayed by grants from the Council for Scientific and Industrial Research, and from the Staff Research Fund, University of Cape Town.

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Nov. 9.

<sup>1</sup> Irving, J. T., *Nature*, **151**, 363 (1943); *J. Dent. Res.*, **22**, 447 (1943).

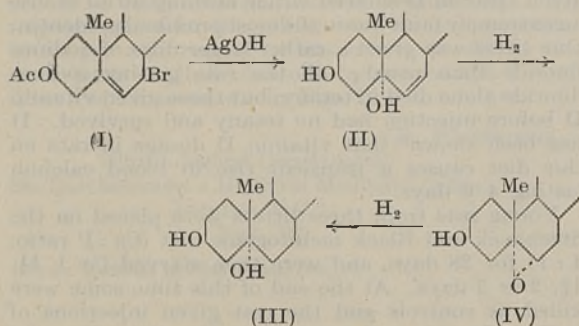
<sup>2</sup> Irving, J. T., *J. Physiol.*, **105**, 16 (1946).

<sup>3</sup> Cavins, A. W., *J. Biol. Chem.*, **59**, 237 (1924). Wilder, T. S., *J. Biol. Chem.*, **81**, 65 (1929). Kramer, B., Shear, M. J., and Siegel, J., *J. Biol. Chem.*, **81**, 271 (1931).

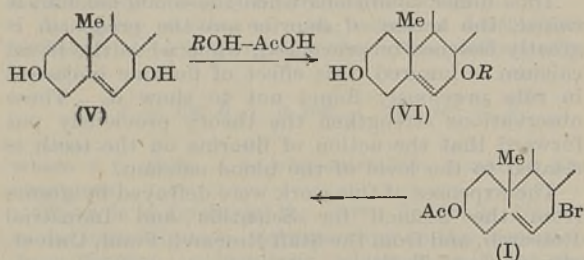
## Etherifications Accompanying Girard Treatment for the Separation of Ketonic Substances

THE reagents devised by Girard and Sandulesco<sup>1</sup> for the separation of ketonic substances are widely employed in a variety of fields, especially for the isolation of ketonic steroids. Although the conditions under which these reagents are normally employed are comparatively mild, it has now been shown that, in certain cases, etherification of reactive alcohols can occur.

During the investigation of the reactions of 'β'-7-bromocholesteryl acetate<sup>2</sup> (I), we have discovered that one of the products obtained by alkaline hydrolysis is Δ<sup>6</sup>-cholestene-3-(β):5(α)-diol (II). This compound, m.p. 181°, is readily hydrogenated to cholestane-3(β):5(α)-diol (III), previously prepared<sup>3</sup> by hydrogenation of α-cholesterol-oxide (IV).



Only two Δ<sup>6</sup>-cholestene-3(β):5-diols, differing in configuration at C<sub>5</sub>, can possibly exist, and two such 'diols' had already been tentatively assigned this structure. Bergström and Wintersteiner<sup>4</sup> obtained a compound, m.p. 138°, from 'β'-7-hydroxycholesterol (V) by refluxing in ethanol containing 10 per cent of acetic acid. Prelog, Ruzicka and Stein<sup>5</sup> isolated a compound, m.p. 155.5–156°, from the non-saponifiable portion of extracts of pig spleen, which they suggested might be an isomer of the Bergström and Wintersteiner diol. The reactions of these two substances were consistent with the formulations suggested, but in neither case was any rigorous structural proof obtained, for example, by hydrogenation, etc.



We have now shown that the former compound is actually 'β'-7-ethoxycholesterol (VI; R = Et), formed by a facile acid-catalysed etherification reaction; substitution of methanol for ethanol in this reaction gives 'β'-7-methoxycholesterol (VI; R = Me), m.p. 158°. These formulations are supported by analytical data, including methoxyl and ethoxyl determinations.

Treatment of 'β'-7-bromocholesteryl acetate (I) either with sodium methoxide or with silver nitrate and methanol, followed by alkaline hydrolysis, also yields 'β'-7-methoxycholesterol (VI; R = Me). It was observed that its physical constants and those of its acetate and benzoate were in close agreement with those of the supposed diol obtained from pig spleen<sup>5</sup>, and mixed melting point determinations, kindly carried out by Dr. Prelog, confirmed the identity of the products.

Bergström and Wintersteiner<sup>4</sup> first isolated what has now been shown to be the 7-ethoxy-compound, following the Girard separation of the ketonic and non-ketonic materials obtained by aerial oxidation of cholesterol, the separation being effected in the usual manner in ethanol solution in the presence of acetic acid. Although these workers realized that the 7-hydroxy-compound had undergone some change during the treatment, their supposition of an isomerization reaction was incorrect. Prelog *et al.*<sup>5,6</sup> employed the Girard reagent in methanol, and it is reasonably certain that the 7-methoxy-steroid does not occur in the natural material, but that it is formed during the Girard separation from 'β'-7-hydroxycholesterol originally present in the extract.

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E. R. H. JONES

Imperial College of Science and Technology,  
London, S.W.7.  
Nov. 18.

<sup>1</sup> Girard, A., and Sandulesco, G., *Helv. Chim. Acta*, **19**, 1095 (1936).

<sup>2</sup> Henbest, H. B., Jones, E. R. H., Bide, A. E., Peever, R. W., and Wilkinson, P. A., *Nature*, **158**, 169 (1946).

<sup>3</sup> Plattner, Pl. A., Petzlik, Th., and Lang, W., *Helv. Chim. Acta*, **27**, 513 (1944). Plattner, Pl. A., and Lang, W., *Helv. Chim. Acta*, **27**, 1872 (1944).

<sup>4</sup> Bergström, S., and Wintersteiner, O., *J. Biol. Chem.*, **143**, 503 (1942); **141**, 597 (1941).

<sup>5</sup> Prelog, V., Ruzicka, L., and Stein, P., *Helv. Chim. Acta*, **26**, 2222 (1943).

<sup>6</sup> Prelog, V., and Ruzicka, L., *Helv. Chim. Acta*, **26**, 936 (1943).

## Analysis of Boron Trifluoride: a Double Compound of Silicon Tetrafluoride and Trimethylamine

IN connexion with nuclear cross-section studies in which boron trifluoride was used as a reference gas, a method of analysis of this gas was devised based on the condensation of boron trifluoride with acetyl fluoride to form acetyl fluoborate. This material is involatile at -120° C., and volatile impurities from the boron trifluoride can easily be pumped off and their volume determined<sup>1</sup>.

During these studies, particular attention was paid to silicon tetrafluoride as the most likely volatile impurity remaining in the gas after two fractional distillations *in vacuo* at -160° C.

The volume of the sample of boron trifluoride to be analysed was determined in a calibrated bulb attached to the vacuum apparatus, in which mercury cut-offs were used throughout in place of stopcocks. It was then frozen out in liquid nitrogen in a bulb attached to a 300-c.c. reaction vessel, and an excess of acetyl fluoride prepared by the method of Nemesjaow and Kahn<sup>2</sup> afterwards condensed in the same trap. On warming, the gases volatilized and reacted. The contents of the vessel were pumped out slowly through an efficient liquid-nitrogen trap, the temperature of the condensate was raised to -120°, and the silicon tetrafluoride collected and

its volume determined. Tests of the efficiency of the method, using synthetic mixtures of  $\text{BF}_3$  and  $\text{SiF}_4$  in proportions 2:1, showed that recovery of the silicon tetrafluoride was always more than 99 per cent complete. From these results it was estimated that 0.2 per cent of impurity could be detected in 200 c.c. of boron trifluoride using this particular apparatus, which was not specifically designed for this purpose and had an unnecessarily high internal surface volume ratio.

The use of trimethylamine as a condensing agent for the boron trifluoride, which was first tried, was found to be impracticable owing to the formation of a double compound with silicon tetrafluoride which has not previously been reported. It is characterized by the following procedure.

30.3 c.c. of silicon tetrafluoride which had been freed from hydrogen chloride by careful fractional distillation *in vacuo* at  $-150^\circ$ , together with 80.8 c.c. of trimethylamine dried by passage over phosphorus pentoxide, were condensed in a trap cooled by liquid nitrogen. On permitting the mixture to warm up and volatilize, a cloud of white solid was produced, and analysis of the gas remaining revealed that this consisted of 49.1 c.c. excess trimethylamine. The gaseous reactants had thus combined in the volume ratio  $\text{NMe}_3/\text{SiF}_4 = 1.04$ . A later experiment using an excess of silicon tetrafluoride gave a volume ratio  $\text{NMe}_3/\text{SiF}_4 = 1.01$ . It therefore appeared that these two gases had formed an equimolecular double compound, which proved to have a dissociation pressure of about 45 mm. at room temperature, and 0.1 mm. at  $-78^\circ\text{C}$ .

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Late of National Research Council,  
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Oct. 25.

<sup>1</sup> Seel, *Z. anorg. Chem.*, **250**, 331 (1943).

<sup>2</sup> Nesmejaow and Kahn, *Ber.*, **67**, 372 (1934).

abandoned if the assumed extension of the sun is untenable.

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### 'Velsicol 1068'

Kearns, Ingle and Metcalf<sup>1</sup> have recently commented on the properties of a chlorinated hydrocarbon of empirical formula  $\text{C}_{10}\text{H}_8\text{Cl}_8$  which was described as "possibly a mixture of isomers which as yet have not been resolved and evaluated individually". In a note<sup>2</sup> on this new insecticide it has been stated that in solubility the compound, to which the trade name 'Velsicol 1068' has been assigned, resembles D.D.T. and benzenehexachloride. It seems desirable to direct attention to the fact that unlike the two latter compounds, we have confirmed the observation of Kearns and co-workers<sup>1</sup> that the new compound is soluble in all proportions in most organic solvents, including deodorized kerosene. This property is of considerable importance in formulating products for test purposes. It appears that apart from the results of Kearns and co-workers<sup>1</sup> little has been published on the insecticidal efficacy of 1068, but these workers presented results to support their statement that "(1068) was found to be more toxic than D.D.T. and to compare favourably in toxicity to the pure  $\gamma$  isomer of benzenehexachloride"<sup>3</sup>.

T. F. WEST

Hygienic Chemical Co., Ltd.,  
600 Commercial Road,  
London, E.14.  
Nov. 19.

<sup>1</sup> Kearns, C. W., Ingle, L., and Metcalf, R. L., *J. Econ. Ent.*, **38**, 661 (1945).

<sup>2</sup> *Nature*, **158**, 701 (1946).

<sup>3</sup> Taylor, E. L., *Nature*, **155**, 85 (1945).

### Checking of Sir James Jeans' Numerical Calculations

In the preface to his "Introduction to the Kinetic Theory of Gases", 1940, the late Sir James Jeans intimates that I had checked "all the numerical calculations" in the fourth edition (1925) of his "Dynamical Theory of Gases". It should, however, be stated that as a rule I only checked one or two of the items in the tables. As regards these and the numerical results given in the text, I did indeed as a rule agree, at least approximately, with Jeans' figures; but in a few cases, some of which are to be mentioned in a forthcoming note in the *Philosophical Magazine*, my results differed substantially.

Another quite distinct point is that, in the third edition (1933) of his book "The Universe Around Us", Sir James Jeans credits me on page 254 with a theory of the tidal origin of the planets which may seem to adumbrate his own theory. But whereas I did in effect suggest that the outermost planet might have been produced by the tidal action of a passing star on the nebulous sun, assumed to extend to the planet's orbit, I supposed that the remaining planets were each produced in succession by the tidal action of the nearest existing planet on the contracting solar body. This supposition must, however, be

### A Revival of Natural Oyster Beds

IN *Nature* of October 26, p. 586, Dr. P. Korringa has discussed the problem of reviving natural oyster beds. In general, I agree with his views; but I should like to add some comments on the origin of the oysters used when trying to revive a depleted bed.

In the south-eastern part of Norway, we often have great mortality among oysters reared in netting trays. This mortality, however, only affects oysters taken as spat from districts with different hydrographical conditions. Oysters from spat spawned in the same waters have never failed. When we first noticed this, we believed that the spat from other districts might have been damaged during transport. But if this was the case, the mortality should be greatest shortly after arrival. Heavy mortality can, however, take place a year or two after transplantation; although in the same locality the native oysters flourish.

We are inclined to believe that oysters from the western coast of Norway are not able to stand the rather large variations in salinity occurring on the Skagerrack coast.

ALF DANNEVIG

Flødevig Sea-fish Hatchery,  
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## ABSORPTION SPECTRUM OF HÆMOGLOBIN IN RED CELLS

By D. L. RUBINSTEIN and H. M. RAVIKOVICH

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Moscow

SOME years ago Macallum, Bradley and Adams<sup>1,2</sup> discovered that the absorption spectrum of red corpuscles is entirely devoid of the  $\gamma$ - or Soret-band—the broad absorption band of hæmoglobin located between 400 and 430  $m\mu$ —whereas the  $\alpha$ - and  $\beta$ -bands in the visible part of the spectrum remain unaltered. This band appears only after hæmolysis, when intraglobular hæmoglobin becomes free and passes into solution. This phenomenon has since been confirmed by Keilin and Hartree<sup>3</sup>.

These authors, however, do not support Adams's<sup>4</sup> contention that the disappearance of the  $\gamma$ -band is due to intraglobular hæmoglobin being chemically bound to stromatin. Especially convincing were experiments in which they had obtained a similar obliteration of the  $\gamma$ -band by emulsifying minute droplets of a hæmoglobin solution in paraffin or castor oil. It has been inferred that the disappearance of the  $\gamma$ -band—both in intact red cells and in the hæmoglobin-oil emulsion—is a purely optical phenomenon. However, no plausible explanation of this peculiar phenomenon could be suggested.

In a previous investigation carried out in collaboration with Iljina and Shpolsky<sup>5</sup>, we managed to detect the vanished  $\gamma$ -band in intact red cells by means of a spectro-photo-electric technique. The important point was to adjust the cuvette with the red cells quite close to the photocell, thus gathering on its surface the major part of rays scattered by the suspension. This can be easily achieved by means of a selenium photocell because of its flat surface, the absorption curve scarcely differing in this case before and after hæmolysis (Fig. 1). If an antimony-cæsium photocell is used, a considerable part of the scattered light is prevented by its spherical bulb from reaching the photosensitive layer. As a result, the  $\gamma$ -band in the spectrum of intact red cells, although still distinct, is obviously dimmed (Fig. 2).

In the same investigation a spectrographic technique for detecting the vanished  $\gamma$ -band has also

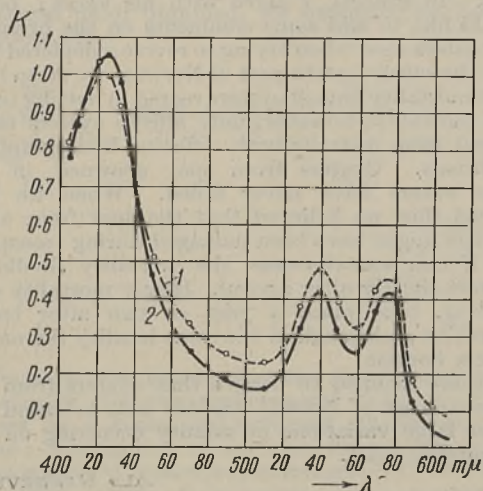


Fig. 1. (1) Absorption spectrum of a red-cell suspension; (2) the same after hæmolysis. Selenium photocell

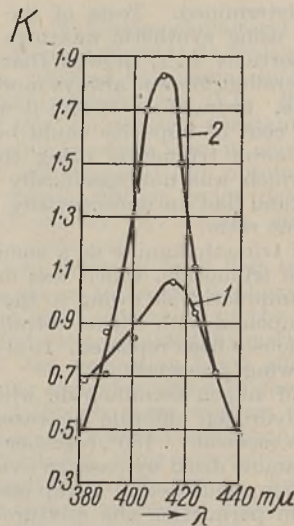


Fig. 2.  $\gamma$ -Band in absorption spectrum of a red-cell suspension (1) before (2) after hæmolysis. Antimony-cæsium photocell

been devised. Instead of the usual set-up, a light beam was directed on the cuvette with the red-cell suspension at a small angle (not greater than  $40-45^\circ$ ) to the optical axis of the spectrograph. Only the light that is scattered in a backward direction was thus allowed to reach the collimator: it displayed the  $\gamma$ -band specific for hæmoglobin.

In the present investigation a further analysis of the Macallum-Bradley-Adams phenomenon has been attempted. It is obvious that the obliteration of the  $\gamma$ -band thus far observed is a phenomenon of light scattering. But the scattering of light in a turbid disperse system depends upon a large difference in the refractive indices of both its phases. This provides a means of experimentally controlling the phenomenon under investigation.

The experiments of Keilin and Hartree mentioned above have been repeated and their results wholly confirmed. Indeed, the  $\gamma$ -band disappears completely even if the hæmoglobin solution is emulsified in oil in a much greater proportion than in these authors' experiments (for example, 1 part of a 1.6 per cent hæmoglobin solution dispersed in droplets of  $1-7\mu$  in diameter per 4 parts of 'Vaseline' oil). However, the  $\gamma$ -band in the spectrum of the hæmoglobin emulsion could be detected by a simple procedure.

This could be achieved by adding concentrated sucrose to the hæmoglobin solution before emulsifying it in oil. A syrup containing 70 gm. sucrose per 100 gm. solution has approximately the same refractive index as our 'Vaseline' oil, namely, 1.49. It has been shown by photometric measurements that the addition of such a high sucrose concentration reduces the turbidity of a water-in-oil emulsion to a small per cent of its initial value. The  $\gamma$ -band, that was entirely obliterated in the hæmoglobin-oil emulsion, becomes perfectly distinct if the hæmoglobin droplets have been saturated with sucrose (Fig. 3).

An attempt has been made to apply a similar technique to red-cell suspensions. This was not easy, since most of the substances that could raise the refractive index of the solution would, at the same time, hæmolysed the red cells. The best results were finally obtained by means of a dextrin preparation, a refractive index  $n_D^{20} = 1.40$  corresponding to a

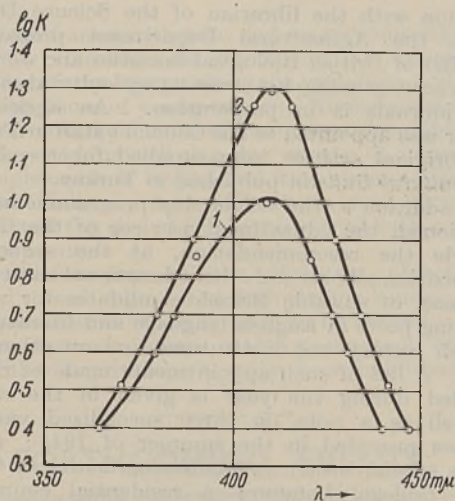


Fig. 3. (1)  $\gamma$ -Band in absorption spectrum of a sucrose-haemoglobin solution (68 per cent sucrose) emulsified in 'Vaseline' oil; (2)  $\gamma$ -band of oxyhaemoglobin. Hydrogen tube, Zeiss quartz spectrograph "für Chemiker", Hilger microcell

concentration of 70 gm. dextrin in 100 c.c. solution. This is, of course, far from reaching the refractive index-level of the red cells (which would have resulted in producing 'laked blood' without haemolysis). But the discrepancy between the two refractive indices is smoothed sufficiently, thereby considerably increasing the transparency of the suspension and distinctly revealing the  $\gamma$ -band (Fig. 4). This effect is certainly not due to haemolysis, since the  $\gamma$ -band disappeared again upon diluting the suspension tenfold with physiological saline.

The experiments described throw some light on the mechanism of the obliteration of the  $\gamma$ -band in the absorption spectrum of red corpuscles. A tentative explanation of this phenomenon follows.

In a red-cell suspension we must distinguish between two kinds of scattered rays corresponding to the two interfaces on which light scattering occurs. Light rays may be scattered on passing from the medium into the haemoglobin-carrying particle, and are in this case evidently devoid of any specific

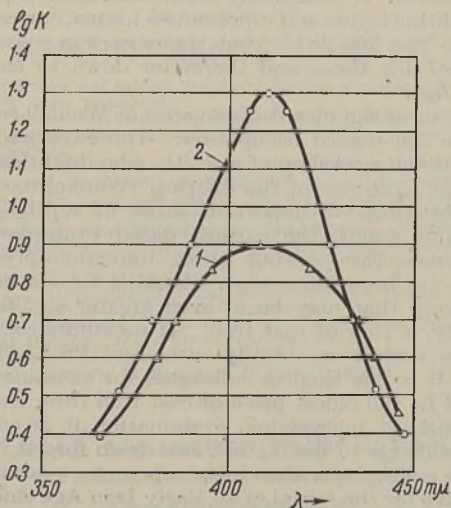


Fig. 4. (1)  $\gamma$ -Band in absorption spectrum of a red-cell suspension in a dextrin-saline solution (70 per cent dextrin dissolved in physiological saline); (2)  $\gamma$ -band of oxyhaemoglobin. Hydrogen tube, Zeiss quartz spectrograph "für Chemiker", Hilger microcell

absorption bands. Rays of the second type enter the disperse particle and are scattered on passing from it back to the dispersion medium. If the latter has a smaller optical density than the particle (for example, a corpuscle suspension in physiological saline), a part of the rays undergoes thereby a complete interior reflexion. The scattered rays of the second type naturally possess all the spectral bands specific for the dispersed substance.

The proportion of scattered rays of these two types depends upon the angle at which the light beam is scattered by the suspension. Rays of the first type are scattered mostly forward in the direction of the entering beam. They prevail, therefore, in the narrow light beam passing through the red-cell suspension when the usual spectrographic technique is applied—leading, in this case, to the disappearance of the  $\gamma$ -band. As the angle at which light is scattered becomes larger, there appears an increasing proportion of scattered rays of the second type, namely, of such rays as have traversed the interior of the red corpuscles, undergoing selective absorption in them. As has been previously described, their investigation reveals in the absorption spectrum of red corpuscles the  $\gamma$ -band otherwise lacking.

The effect depends largely upon the wave-length of scattered light. Being of no importance in the visible part of the spectrum (bands  $\alpha$  and  $\beta$ ), its role becomes prominent in the ultra-violet.

<sup>1</sup> Macallum, A. B., and Bradley, R., *Science*, **71**, 341 (1930).

<sup>2</sup> Adams, G., Bradley, R., and Macallum, A. B., *Biochem. J.*, **28**, 482 (1934).

<sup>3</sup> Keilin, D., and Hartree, E. F., *Nature*, **148**, 75 (1941).

<sup>4</sup> Adams, G., *Biochem. J.*, **32**, 646 (1938).

<sup>5</sup> Iljina, A. A., Ravikovitch, H. M., Rubinstein, D. L., and Shpolsky E. V., *C. R. Acad. Sci., U.S.S.R.*, **48**, No. 5, 325 (1945).

## THE BRITISH COUNCIL

### ANNUAL REPORT

ALTHOUGH it is not easy in the absence of any financial statement to judge from the report of the British Council for the year ended March 31 as to how far the activities of the Council are now in balance either geographically or functionally, the report gives a convincing answer to some of the more captious criticisms, and in particular it is possible to assess from it how large a contribution the Council is making to the interchange of knowledge. Geographically, the most interesting feature of the report is the account of the activities of the Council in liberated Europe and the intense demand for British books and for information regarding Britain in Austria, Czechoslovakia, France, Hungary, Greece, Italy, Holland, Belgium, Poland, Sweden and Yugoslavia. Work in Latin America has also gone ahead, but in the colonies, protectorates and mandated territories there has been consolidation rather than expansion. With the withdrawal from the United Kingdom of large numbers of Allied troops and civilians, the work of the Council at home changed considerably. Leave courses gradually diminished, but the scholarship programme was considerably extended, 405 being offered as against 115 in 1944, and some 307 holders of British Council scholarships arrived in the United Kingdom during the year. A Students' Welfare Department was established to supervise the general welfare of such students and certain other students from overseas and to offer

them facilities for study, travel and recreation. Lecture courses for such students and other overseas visitors, an information services department, exhibitions and a series of informative pamphlets are among the ways in which the Council has sought to help overseas visitors to understand the British way of life.

Turning to the functional activities, the greater part of the book grant has been concentrated on building up British Council libraries, especially in liberated Europe. The book review scheme was extended to cover many new countries, and circulation of *British Books to Come* was doubled, the periodical now reaching sixty-three countries. Forty-one brochures in twelve languages were published. Although the Book Export Scheme introduced in 1941 largely as a war-time measure has been withdrawn, the Council's book copyright work has largely increased. The Council was also instrumental in allocating and distributing to numerous learned institutions back sets of periodicals given by individuals, learned societies and publishers, and as a further step towards overcoming the shortage of back sets of periodicals and filling the gap in information caused by the War, it has arranged for the indexes and contents list of sixty specialist journals for the years 1939-45 to be microfilmed. One set of these microfilms will be lodged in each of fourteen European countries and in China, either in the principal library where a microfilm reader is available, or in the Council's library. Much information about publications now available in Europe has been obtained for British organisations, and 533 new exchanges between British and foreign periodicals, involving thirty-nine different countries, were arranged during the year.

The total distribution of *Monthly Science News* was about 70,000 at the end of March, and the distribution of articles on engineering and technology was continued, 113 sets going to thirty-nine countries. The Information Section was fully occupied, chiefly with bibliographical inquiries, and requests from Moscow for books, papers, and other scientific information considerably increased. An exhibition of British medical books published during the War was held in Moscow, and articles sent to Moscow for publication included a series on the work of the Department of Industrial and Scientific Research. Scientific supplies to China considerably increased during the year, and the report refers to the lasting impression on the Chinese people made by the Council's staff during the last three and a half years under Dr. Needham's direction.

The *British Medical Bulletin* has now reached its fourth volume, and sets of volumes 2 and 3 were sent to liberated Europe as soon as possible. A selection of articles from the *Bulletin* made by members of the Medical Faculty of Leyden was published in January 1946 as a book under the title "Recent Medical Science, 1940-5". About five hundred foreign and Empire medical journals are now received in exchange for the *Bulletin*, in addition to others received for the Medical Library, while fifty medical films were reviewed for distribution overseas.

The engineering consultant, Prof. S. J. Davies, visited Greece in the autumn of 1945 to investigate questions affecting engineering and scientific education, particularly the arrangement of courses, the equipment and libraries available, and the distribution of British technical books and periodicals. In con-

junction with the librarian of the Science Department, the Agricultural Department prepared a handlist of British Biological Societies and Journals, and a corresponding list covering agricultural societies and journals is in preparation. An agricultural officer was appointed to the Council's staff in Turkey, and original articles were supplied for the *British Agricultural Bulletin* published in Turkey.

In addition to the scholarship programme already mentioned, the educational services of the Council include the recommendation, at the request of universities, schools and other educational institutions overseas, of suitable British candidates for vacant teaching posts in English language and literature, in British history and institutions and on other subjects. A list of such appointments made or recommended during the year is given in the report, as well as a note on three specialized vacation courses provided in the summer of 1945: a two weeks special electrical engineering course at Queen Mary College, London; a residential course on "Britain, its System of Government, of Education and of Life, and its Ideals of Empire" at the University of St. Andrews; and a residential course, at Wadham College, Oxford, in conjunction with the Oxford University Delegacy for Extra-Mural Studies.

## IRON AGE DISCOVERIES IN CZECHOSLOVAKIA

IN the *Illustrated London News* of October 19 and November 3, Prof. K. Absalon, of Brno, describes the remarkable discoveries made by his grandfather, Dr. Wankel, in the cave of Byči Skala. Wankel's excavations in 1876 have only been described in a popular tourist guide, "Bilder aus der mährischen Schweiz", published in 1882, but have now been supplemented by Prof. Absalon's own operations between 1922 and 1939.

The cave was inhabited in the Upper Palæolithic age and has left stratified relics of a 'primitive Aurignacian', a Gravettian and a long Magdalenian occupation. A completely sterile travertine seals the palæolithic layers and represents a hiatus, corresponding to the Mesolithic, but the cave was reoccupied in Neolithic times and thereafter down to the first Iron Age.

The most significant discoveries of Wankel referred to the last-named occupation. The cave had been used as the workshop of a smith, who doubtless used the rich iron ores of the district. Wankel recovered and described an important series of smiths' tools, including tongs, the earliest dated examples from temperate Europe, but these unfortunately have never yet been illustrated. Absalon figures another discovery that may be of even greater significance, namely, a ring of cast iron. If metallurgical study proves that it was really cast—and Prof. Absalon offers it to his English colleagues for examination—it will be the oldest piece of cast iron from Europe; but without microscopic examination it is actually very difficult to distinguish cast from forged iron.

The smithy was abandoned when use was made of the cave for the burial of an Early Iron Age chieftain, with rites more Oriental than European. Like the occupants of the 'Royal Tombs' of Ur, this Hallstatt chief was conveyed to the tomb on a wheeled wagon



which was buried with him, and was accompanied by numerous retainers slaughtered at his obsequies. More than forty human skeletons were found, all but five being those of young women. Numerous animals and enormous quantities of grain were also deposited with the dead, as well as a fine variety of ornaments and implements in bronze and iron, characteristic of the late Hallstatt Age. The body was, however, burned and the site of the pyre covered with a layer of large stones.

The illustrations of the Hallstatt objects in Wankel's book reproduced here are inadequate, and a full publication of the relics is to be desired. Prof. Absalon, however, states that a monograph on the Palaeolithic excavations has just been published.

## FORTHCOMING EVENTS

(Meetings marked with an asterisk \* are open to the public)

### Tuesday, December 31

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 3 p.m.—Prof. H. Hartridge, F.R.S.: "Colours and How we See Them" (Christmas Juvenile Lectures, 2).\*

### Wednesday, January 1

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. Derek McCulloch: "The Children's Hour" (Dr. Mann Juvenile Lecture).

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 5 p.m.—Prof. W. V. Mayneord: "The Applications of Atomic Physics in Medicine" (succeeding lectures on January 8, 15, 22, 29 and February 5).

### Thursday, January 2

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 3 p.m.—Prof. H. Hartridge, F.R.S.: "Colours and How we See Them" (Christmas Juvenile Lectures, 3).\*

ROYAL SOCIETY OF MEDICINE, NEUROLOGY SECTION (at 1 Wimpole Street, London, W.1), at 8 p.m.—Prof. E. D. Adrian, F.R.S.: "General Principles Governing Nervous Activity" (Hughlings Jackson Memorial Lecture).

### Friday, January 3

INSTITUTE OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. H. G. Conway, Mr. S. M. Parker and Mr. D. A. L. Robson: "The Development of Aircraft Hydraulic Machinery" (Discussion).

### Saturday, January 4

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 3 p.m.—Prof. H. Hartridge, F.R.S.: "Colours and How we See Them" (Christmas Juvenile Lectures, 4).\*

## APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments to which the dates mentioned:

EDUCATIONAL PSYCHOLOGIST for the City of Portsmouth—The Chief Education Officer, Education Offices, 1 Western Parade, Southsea (January 4).

PRINCIPAL OFFICER (temporary) to take charge of development of electrical and mechanical earth-moving and road-making plant required by the Army, and SENIOR OFFICERS (temporary) with high qualifications in Civil, Structural or Mechanical Engineering, at the Military Engineering Experimental Establishment, Christchurch, Hants.—The Director of Scientific and Technical Administration (D), Room 27, Ivybridge House, Adam Street, Strand, London, W.C.2, quoting No. D. 2246 (January 6).

CLINICAL BACTERIOLOGIST—The House Governor, Royal Victoria Infirmary, Newcastle-upon-Tyne (January 18).

SENIOR LECTURER IN PHYSICS—The Principal, Sir John Cass Technical Institute, Jewry Street, London, E.C.3.

LECTURER IN ZOOLOGY, and a LECTURER IN MATHEMATICS—The Registrar, University of Tasmania, Hobart, Tasmania.

## REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

### Great Britain and Ireland

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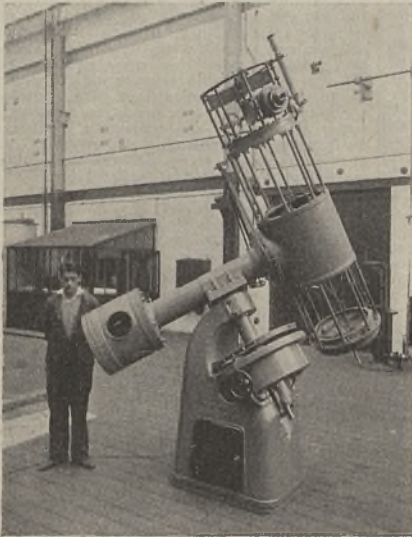
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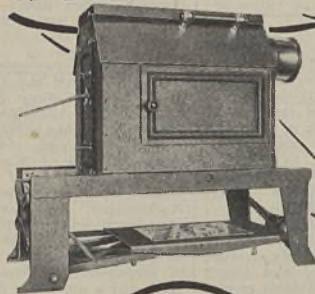
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For the BENEFIT OF INDIGENT BACHELORS and WIDOWERS of good character, over 55 years of age, who have done "something" in the way of promoting or helping some branch of Science.

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For particulars, apply to MESSRS. SHEPHERD & WEDDERBURN, W.S., 16, Charlotte Square, Edinburgh, 2.

**MINISTRY OF LABOUR AND NATIONAL SERVICE  
VACANCIES FOR H.M. INSPECTORS OF FACTORIES**

The Minister of Labour and National Service invites applications from suitably qualified men and women between the ages of 23 and 36 for permanent, pensionable appointments as H.M. Inspectors of Factories. Successful candidates will enter in the grade of Inspector Class II, the salary scale for which is £325 by £25 to £500 in London, plus consolidation addition at the minimum of the scale of £78 a year for men and £63 for women. Starting pay will be £325 at the age of 26, plus or minus £25 for every year above or below that age at the date of appointment, subject to an upper limit of £375 and a lower limit of £275. This scale is subject to deduction varying from £10 to £20 in the case of officers appointed outside London. The higher posts in the Factory Inspectorate are filled by promotion from Class II. The duties of Factory Inspectors include the enforcement of the provisions of the Factories Acts and Regulations affecting the safety, health, and welfare of work-people, and extend to all manufacturing industries and to certain other places, including docks, works of engineering construction, and building operations.

Candidates should either have passed an examination qualifying for a university degree or should possess an equivalent qualification in engineering, industry, or science, although this requirement may be dispensed with in the case of a candidate who is exceptionally well qualified by reason of suitable works or other practical experience.

Forms of application, with further particulars of the appointments, may be obtained from the Secretary, Ministry of Labour and National Service (O.E.11), 15, Portman Square, London, W.1, or from the Chief Officer, Civil Service Commission, at the following addresses: (India), 10, Underhill Lane, Delhi; (Egypt), 8, Sharia Tolumbat, Garden City, Cairo; (Italy), c/o G.H.O., C.M.F.; (Germany), c/o 2nd Erhelon, G.H.O., B.A.O.R. The last date for receipt of completed application forms is March 31, 1947, but applications from candidates now serving in H.M. Forces will be accepted up to June 30, 1947.

**ROYAL NAVY****SHORT SERVICE COMMISSIONS IN THE EDUCATION BRANCH**

Applications are invited from university graduates and qualified teachers under thirty-six years of age for short service commissions of three, four, or five years in the Education Branch of the R.N. Officers with scientific qualifications are particularly required at the present time to serve as instructors in Radar, W/T, etc., and for Meteorology. Opportunities will be afforded for officers to be selected for permanent commissions.

Entry will be in two grades. Selected candidates with first- and second-class honours degrees receive approximately £328 in their first year's service, £347 in second year, £438 in third and fourth years, £474 in fifth year. Other candidates receive £237 in first year, £310 in second and third years, £347 in fourth and fifth years. Married men, if aged 25 or over, receive marriage allowance of £228 per annum. Accommodation and rations are provided or allowances in lieu. An outfit allowance is paid. Tax-free gratuities are payable at the end of third, fourth, or fifth years respectively. Teachers who enter from contributory service under the Teachers' (Superannuation) Acts will continue in contributory service, superannuation contributions being deducted from the above gratuities.

Instructor Officers serve both ashore and afloat and are responsible for all educational work; officers with suitable qualifications may also be employed on general meteorological and forecasting duties. They are borne in the larger ships and in the Naval Colleges, Training Establishments, and Naval Air Stations.

Apply to Director, Education Department, Admiralty, London, for further information and application forms.

**ASSISTANT INFORMATION OFFICER** Required. Metallurgical knowledge essential. Age preferably 25-35. Languages an advantage. Salary according to qualifications. Apply as soon as possible to Information Officer, The Iron and Steel Institute, 4, Grosvenor Gardens, London, S.W.1.

**NEW ZEALAND GOVERNMENT****VACANCIES FOR PROFESSIONAL FORESTERS in the New Zealand State Forest Service**

Applications from Professional Foresters are invited for vacancies in the New Zealand State Forest Service. Salaries range from £(N.Z.)435 to £(N.Z.)710 per annum, according to previous experience and qualifications.

Applicants are required to be graduated in forestry or possess equivalent qualifications. The applications should include full details of the age, nationality, marital status, academic career, and practical experience of the applicant, and be supported by copies only of recent testimonials.

The State Forest Service is expanding and requires additional qualified staff immediately, not only for general forestry duties and research, but also to fill tutorial vacancies at Staff Training Centres. There will be prospects of further advancement for officers of courage, initiative, and administrative ability.

Fees of successful applicants and their families will be paid from country of residence to New Zealand provided an undertaking is given to remain in the service of the New Zealand Government for a period of three years. Salary will commence from the date of taking up duty in New Zealand, and accommodation allowance will be paid for a short period to meet excessive expenditure before permanent accommodation is secured.

Applications, accompanied by testimonials, are to be addressed to the High Commissioner for New Zealand, 415, Strand, London, W.C.2, and should be lodged not later than January 12, 1947.

**UNIVERSITY OF SHEFFIELD**

Vice-Chancellor:

J. I. O. Masson, M.B.E., D.Sc., F.R.S.  
DEPARTMENT OF BACTERIOLOGY

Professor:

C. P. Beattie, M.A., M.B., Ch.B., D.P.H.

Applications are invited for a post as Lecturer in Bacteriology. Salary £550, rising by £25 every year to £650, and then if the appointment is renewed £700. In the case of a medically qualified candidate of outstanding attainment, consideration may be given to making the appointment as a Senior Lecturer, at a salary of £750, rising by £50 every two years to £1,000. In either case there will be superannuation provision under the Federated Superannuation Scheme for Universities, and family allowance.

Applications (three copies), including the names and addresses of referees and, if desired, copies of testimonials, should be sent to the undersigned (from whom further particulars may be obtained) by February 15, 1947.

If a referee named by a candidate is abroad, the candidate may ask the referee to send a confidential report direct to the Professor without waiting for an inquiry from the university.

A. W. CHAPMAN,  
Registrar.

**UNIVERSITY OF DURHAM**

King's College, Newcastle-upon-Tyne  
**RESEARCH ASSISTANT IN THE DEPARTMENT OF MARINE ENGINEERING AND NAVAL ARCHITECTURE**

The Council of King's College invite applications for the post of Research Assistant in the Departments of Marine Engineering and Naval Architecture. Candidates should be qualified in electronics and capable of undertaking experimental research work using electrical resistance strain-gauge equipment and other electric methods of measurements. Experience with similar equipment and a university degree in electrical engineering or physics desirable, but not essential. Commencing salary not less than £600 per annum.

Six copies of application, which should include the names and addresses of three persons to whom reference may be made, should be addressed as soon as possible, and in any case not later than January 31, 1947, to the undersigned, from whom further particulars may be obtained.

G. R. HANSON,  
Registrar of King's College.

**ROYAL INSTITUTION****AWARD OF GRADUATE MEMBERSHIPS**

Notice is given that the Managers of the Royal Institution will shortly proceed to award three Graduate Memberships of the Institution for the year 1947. Graduates of either sex, of any university of the British Empire, who have graduated during 1946 with first- or second-class honours in any scientific subject, are eligible for these awards. The Memberships entitle the holders to the full privileges of the Institution for a period of three years, except that of voting at meetings of the Members.

Full particulars and forms of application, can be obtained from the General Secretary, Royal Institution, 21, Albemarle Street, London, W.1. Completed applications must be received by January 15, 1947.

**UNIVERSITY OF CAPE TOWN**

Applications are invited for the post of Lecturer in Applied and Industrial Chemistry. A degree in chemical engineering or some special qualification in industrial chemistry will be a recommendation. Salary scale £450 by £25 to £500 by £50 to £675 per annum, plus a temporary cost-of-living allowance (at present £75 per annum for a married man and £40 per annum for a single man). A higher commencing salary may be given on the grounds of experience. Applications from candidates who have been on military or other national service will be given special consideration; applicants are advised to give particulars of such service.

Applications should be made in duplicate, together with copies of testimonials, stating age, qualifications and experience, and giving the names of three referees to whom the university may refer, to Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting F.1450 A.O. for application form, which must be completed by February 8, 1947.

**COUNTY BOROUGH OF WEST HAM**

West Ham Municipal College, Romford Road, Stratford, E.15

Principal: E. A. Rudge,

Ph.D., M.Sc., F.R.I.C., A.M.I.Chem.E.

Applications are invited for the post of Assistant Curator at the Essex Museum of Natural History, Romford Road, West Ham, E.15. Applicants should have some museum experience, and a university degree is desirable, but not essential. A good knowledge of photography is essential. The successful applicant would occasionally be required to act as Guide Lecturer.

Salary £285, rising by annual increments of £15 to £330, plus bonus, at present £59 16s. per annum.

Application forms, with full particulars, can be obtained on application to the Principal, West Ham Municipal College, and should be returned to him not later than January 31, 1947.

IRVINE G. JARDINE.

Education Department, Education Officer.  
95, The Grove, E.15.

**WEST OF SCOTLAND AGRICULTURAL COLLEGE  
POST OF PRINCIPAL**

The Governors invite applications for the post of Principal, which has been vacant since the retirement of Principal W. G. R. Paterson on September 30, 1944.

Applicants, who should be graduates of a university within the British Empire, should possess a sound knowledge of agriculture and have had wide experience in the organization of agricultural education, research and advisory work.

The salary offered is £1,650 per annum. Conditions of the appointment are obtainable from the undersigned, with whom applications should be lodged not later than February 28, 1947.

N. B. BAIN,

6, Blythwood Square, Glasgow, Secretary.

**NATIONAL MILK TESTING SERVICE**

Applications are invited for the following post, in a temporary capacity, in the West Midland Province, under the Ministry of Agriculture and Fisheries:

Provincial Supervisor, to exercise general supervision of the service in the province. Applicants should possess a degree in science or the equivalent, and should have had sound training in dairy bacteriology and experience in dairying.

The salary scales are as follows: Men, £300-£400 per annum; women, £275-£320 per annum. A consolidated addition is also payable.

Further particulars may be obtained from the Advisory Bacteriologist, Provincial Laboratory, Bank House, Newport, Shropshire. Applications should be sent to the Advisory Bacteriologist before January 11, 1947.

**UNIVERSITY OF OTAGO**

Dunedin, New Zealand

**DIRECTOR OF THE SCHOOL OF PHYSICAL EDUCATION**

Applicants are informed that the opening of the School of Physical Education has been postponed until 1948 and the appointee would be expected to report in New Zealand about August 1, 1947. Further applications will therefore be accepted up to January 16, 1947, but re-application is not necessary. Salary £875 per annum (N.Z. currency). Full particulars and forms of application may be obtained from the High Commissioner for New Zealand, 415, Strand, London, W.C.2.

**CITY OF NOTTINGHAM**

City Hospital, Hucknall Road

Applications are invited for the position of a qualified Biochemist in the Ministry of Health Area Laboratory at the above hospital. Applicants must be university graduates with experience in clinical biochemistry and familiar with optical method of analysis.

Salary from £400 to £600, according to experience. The position is permanent, but terminable by one month's notice on either side, and the successful applicant will be required to pass a medical examination and to contribute to the Local Government Superannuation Act, 1937.

Apply direct to the undermentioned, such applications to be forwarded as soon as possible.

The Medical Superintendent,  
City Hospital, Hucknall Road, Nottingham.

**LEEDS COLLEGE OF TECHNOLOGY**Principal: C. Chew, M.Sc.Tech., F.R.I.C.  
Department of Chemistry

Applications are invited for two posts as full-time Lecturers in the above department, duties to commence as soon as possible. One post is concerned with the teaching of organic chemistry and the other mainly with inorganic chemistry. Candidates should possess a good honours degree of a British university, together with teaching and industrial or research experience. Salary according to the Burnham scale.

Further particulars and form of application, to be returned within three weeks of the appearance of this advertisement, will be forwarded on receipt of a stamped addressed foolscap envelope.

GEORGE GUEST,

Director of Education.  
Education Office,  
Leeds, 1.**UNIVERSITY OF OXFORD****LECTURER IN COLONIAL AGRICULTURE**

Applications are invited for the post of Lecturer in Colonial Agriculture in the University of Oxford. The appointment will begin on October 1, 1947, and be tenable for three years in the first instance. Salary £540 to £900, according to age and experience, plus children's allowances and membership of the F.S.S.U.

Duties will be to lecture and give instruction in tropical agriculture, with special reference to native agriculture and colonial development, and to assist generally in the work of the Department of Agriculture.

Applications, giving the names of three referees must be submitted in quadruplicate before April 20, 1947, to the Registrar, University Registry. Further particulars can be obtained from Professor Blackman, Department of Agriculture, Parks Road, Oxford.

**UNIVERSITY OF ADELAIDE****CHAIR OF MINING AND METALLURGY**

Applications are invited for the Chair of Mining and Metallurgy in the Faculty of Engineering (the Professor will also be Director of the Bonython Laboratories of the South Australian School of Mines and Industries). Salary £1,500 (Australian) per annum. Further particulars may be obtained from the Secretary, Universities Bureau of the British Empire, 24, Gordon Square, London, W.C.1. Closing date for the receipt of applications is March 1, 1947.

**UNIVERSITY OF DURHAM**

Applications are invited for the post of Reader in Marine Engineering at King's College, Newcastle-upon-Tyne. Salary £900 to £1,100 per annum, with superannuation (F.S.S.U.). Further particulars may be obtained from the undermentioned, with whom applications (twelve copies) must be lodged by March 1, 1947.

W. S. ANGUS,

Registrar,  
University Office,  
23, St. Thomas Street, Newcastle-upon-Tyne, 1.**UNIVERSITY OF READING**

Faculty of Agriculture and Horticulture

The Council of the University will shortly appoint a Professor of Agricultural Chemistry to succeed Professor H. A. D. Neville, who retires on September 29, 1947. Salary £1,450 per annum. Applications should be received by the Vice-Chancellor not later than Monday, March 17, 1947. Further particulars may be obtained from the Registrar.

**UNIVERSITY COLLEGE OF SWANSEA**

The Council of the College invites applications for the post of Professor of Engineering. Salary £1,350 per annum. Further particulars may be obtained from the Registrar, University College, Singleton Park, Swansea, by whom applications must be received on or before February 8, 1947.

**DIRECTOR OF RESEARCH REQUIRED**

immediately for recently established research laboratory in London. Primary qualification a wide experience in bacteriology. Applicant should also have interest in, and some knowledge of, cognate subjects, especially chemistry. Adequate equipment and assistance are provided and duties will involve short- and long-term investigation in Bacteriological Department and the planning and direction of biochemistry and chemistry sections of the laboratory. Minimum salary £1,200. Pension scheme is in operation. Applications, with full details of qualifications, experience, age, and the names of three referees to whom confidential enquiries can be addressed, should be sent to Managing Director, Milton Antiseptic, Ltd., 12, Brewery Road, London, N.7.

**FIRM IN N.W. LONDON SPECIALIZING**

in the manufacture of industrial instruments and controls requires Assistants for its engineering and hydraulic laboratories. Candidates for either laboratory should have a degree in physics or engineering or equivalent qualification, and applicants for a position in the hydraulic laboratory should have sound knowledge of hydraulics and flow measurement. Applications, stating age, experience, and salary required, should be addressed to Box 775, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

**SWISS FIRM OF INTERNATIONAL REPUTE** seeks Editorial Assistant for the translation of articles on the history of art, ethnology, science, and medicine from German into English. Qualifications required: Mother tongue English, good literary style. Knowledge of German sufficient for the rendering of even subtle shades of meaning. Broad cultural background, some experience in translation, and a liking for editorial work.

The position is interesting, well-paid, and offers good prospects of development. The successful applicant will be required to reside in Switzerland for at least two years.

Applications, including education and experience, photograph, references, and specimens of previous work, should be sent to Box 789, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

**CHEMIST REQUIRED FOR RUBBER LATEX**

research, preferably with colloid experience. Position initially in London at commencing salary of up to £600 per annum, with prospects of periodical tours in Malaya at a salary consisting of European salary plus tropical allowance of £150 per annum, cost-of-living allowance (at present about £300 per annum), and free house. Box 790, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

**APPLICATIONS ARE INVITED BY ENGLISH**

Clays Lovering Pochin and Co., Ltd., St. Austell, Cornwall, from Scientists with university first-class honours degree to take charge and direction of their Research Laboratories. Applications should be addressed to the Managing Director of the Company at St. Austell, giving age, full particulars of qualifications and career. Applications will be treated confidentially, and further particulars of the position will be given at interviews arranged after application has been received.

**THE MEDICAL COLLEGE OF ST. BARTHOLOMEW'S HOSPITAL**, in the City of London, West Smithfield, E.C.1. Applications are invited for the following posts:

Lecturer in Physiology. Salary £500-£700 per annum.

Demonstrator of Physiology. Salary £400-£500 per annum.

Required to commence duties as soon as possible. Applications should be addressed to the Dean of the Medical College, from whom further particulars may be obtained.

**SENIOR EXECUTIVE CHEMIST. A LARGE**

firm of international reputation manufacturing ethical pharmaceutical products, requires a first-class Chemist to take control of the development and production section of the business. The position offers exceptional opportunities and will be well remunerated. It calls for a man with first-class qualifications, a wide knowledge of organic chemistry, executive and organizing ability, and some experience in a similar capacity would be an advantage. Replies, which will be treated in strict confidence, should give fullest details and be addressed to "The Director," Box 788, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.

**APPLICATIONS ARE INVITED FOR AN ASSISTANT** in the Chemical Laboratory of the Fine Spinners' and Doublers', Limited. Candidates should have a university degree. Salary according to qualifications. Apply to **Politechniki**, Rock Bank, Bollington, Cheshire.

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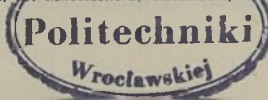
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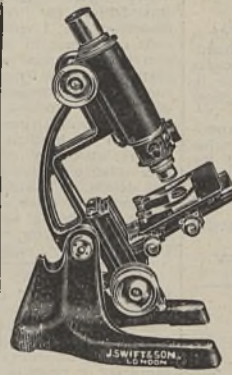
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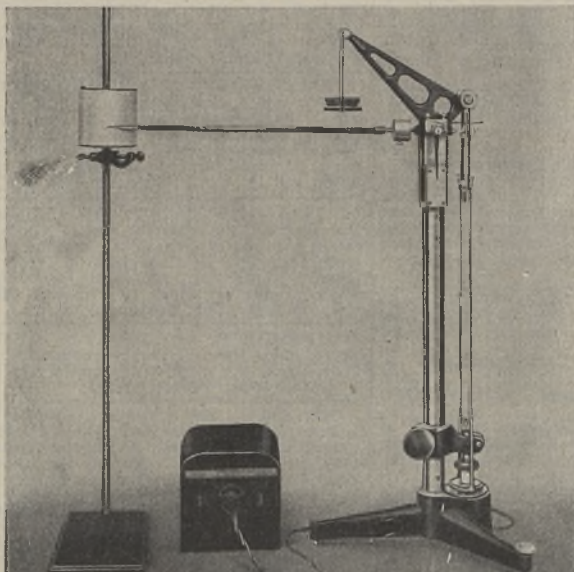
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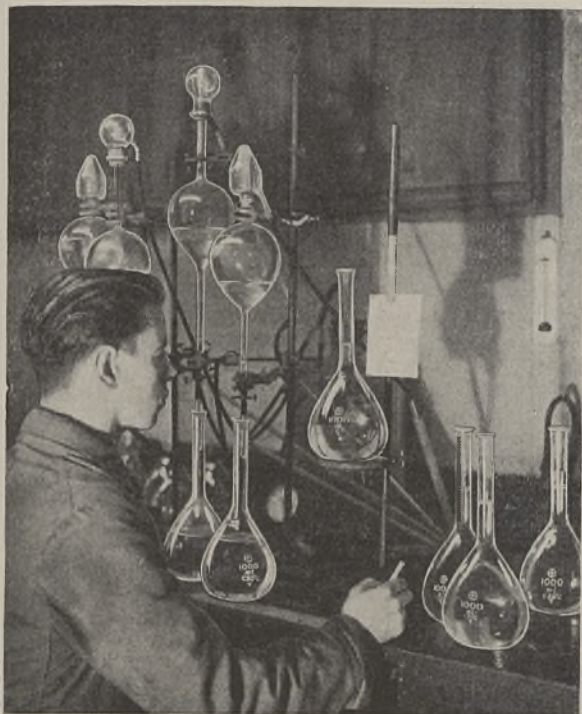


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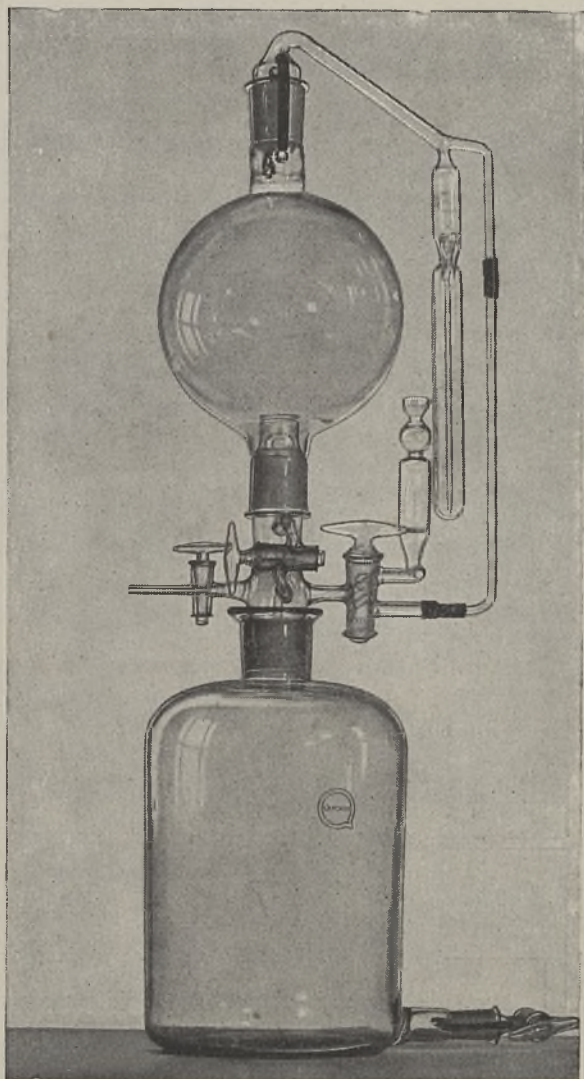
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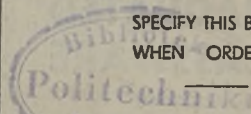
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