

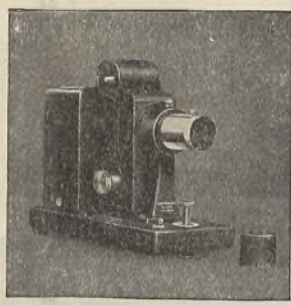
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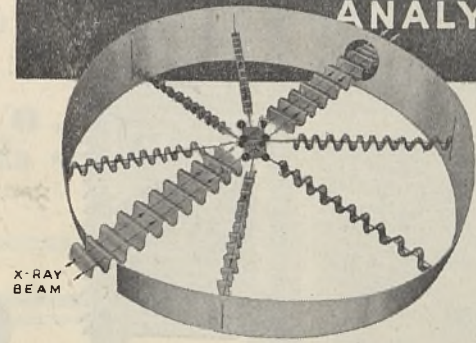
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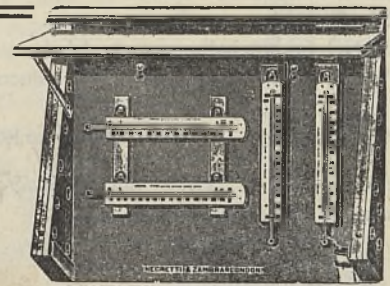
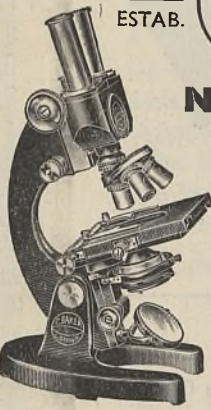
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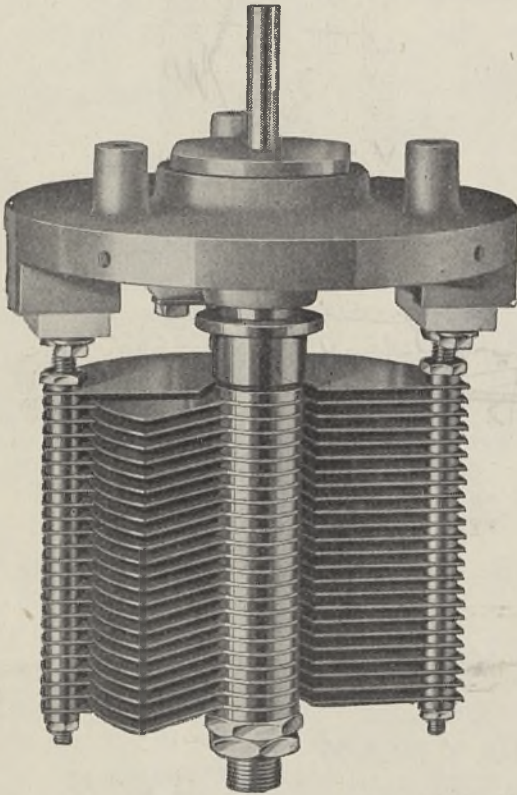


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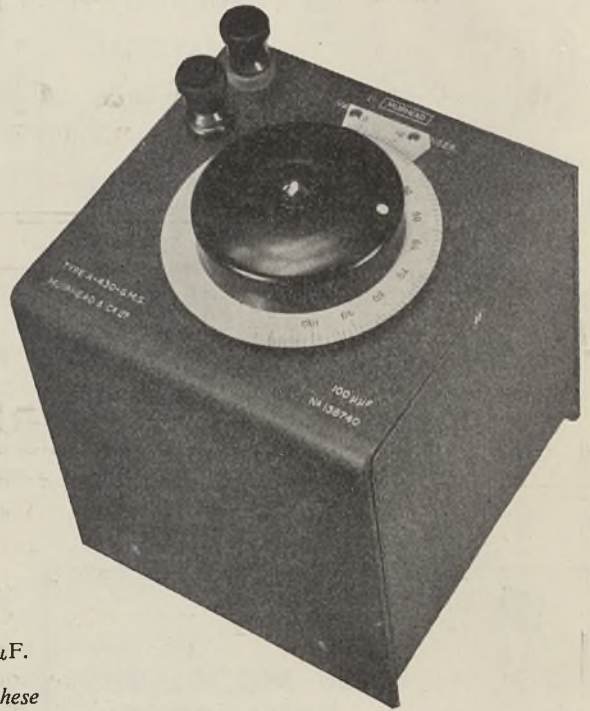
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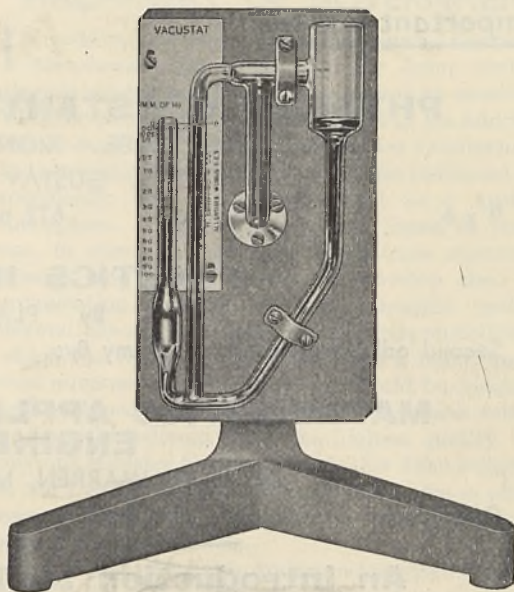
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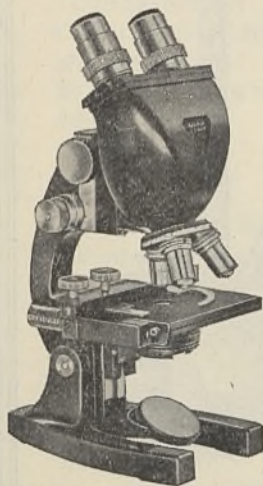
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# NATURE

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## MACHINERY OF GOVERNMENT

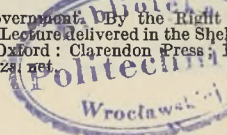
IN addressing the Joint Research Council in Manchester last December, Sir John Anderson dissociated himself from the proposal to establish a Minister or Ministry of Science, and in his address at the Federation of British Industries Conference on Industry and Research last March, he indicated more specifically why he regarded that as a mistaken conception. Most departments of State, he pointed out, in some part of their work have recourse to science, and should be free to develop their own organisation. There are also scientific problems beyond the scope of departmental responsibilities in which the Government should take a hand, and for that purpose some one Minister should be designated and equipped with the necessary staff, which need not be large but should be of the highest quality. The obvious Minister for this purpose, Sir John suggested, is the Lord President of the Council, who is already responsible for the three main extra-departmental scientific organisations.

These ideas Sir John Anderson has since developed more fully in his Romanes Lecture at Oxford on May 14, "The Machinery of Government". In this lecture\*, Sir John begins with some discussion of our system of Cabinet government and the way in which developing responsibilities of the central government have led to a steady growth in the size of the Cabinet and in the machinery of the central government becoming unwieldy. Rejecting the idea of supervising ministers co-ordinating the work of departments, he advocates the development of a series of Cabinet committees, the functions of which he proceeds to illustrate more particularly by reference to the fields of economics and of science.

It is somewhat surprising to find that Sir John, in discussing the changes which took place during the First World War and afterwards, and which Lord Hankey discussed more particularly in the Lees Knowles Lectures "Government Control in War", makes no reference to the Haldane Report, though that is presumably what he had in mind in rejecting the idea of a supervising minister as likely to break down in practice, and as inconsistent with the parliamentary responsibilities of departmental ministers and with departmental control. Authority over departments, he rightly says, must be undivided and unquestionable, and a supervising minister would mean, in practice, a supervising staff with endless possibilities of friction and clash.

What the Haldane Report recommended, however, was, not placing responsible ministers under a super-minister, but the consolidation or grouping of departments into a small number of super-ministries with one responsible minister for each. The obvious danger here is not friction, as Sir John suggests, but that of creating a bottleneck at the top, which might outweigh the advantage of the effective co-ordination of the work of ministers and departments handling different aspects of the same subject, and the lighter

\* The Machinery of Government, by the Right Hon. Sir John Anderson. (The Romanes Lecture delivered in the Sheldonian Theatre, May 14, 1946.) Pp. 32. (Oxford: Clarendon Press; London: Oxford University Press, 1946.) 2s. net.



burden on the Prime Minister and the central organ of government thereby secured. The great merit of the alternative system of standing Cabinet committees which Sir John suggests is its flexibility. While the number and scope of the committees might vary from time to time to suit the actual situation, he visualizes some six committees which in effect would be subsidiary cabinets, covering, for example, defence, economic relations, external affairs, social services, with two others reviewing all proposals for legislation and questions of national economic development, respectively.

The chairman of each committee, Sir John suggests, might be either a non-departmental minister or a departmental minister with a dominant interest in the matters comprised within the particular group, but it should be clear that the chairman of such a committee would have no supervisory powers. Further, as a consequence, only the more important and difficult matters would be remitted to the full Cabinet; and in addition to reducing the Cabinet burden in this way, the necessity for a Cabinet of unwieldy size would be avoided. Such a system, however, requires for its successful functioning two conditions: the doctrine of the collective responsibility of the Cabinet as a whole must be fully maintained; and, secondly, the Cabinet committees must have available the services of a highly competent central staff.

The most important part of Sir John Anderson's lecture is that in which he deals more specifically with the functions of the Cabinet secretariat as an instrument for providing the Cabinet with the expert research and intelligence service which is an indispensable element in government to-day. Sir John may have done something less than justice to the proposals of the Haldane Committee, but what he says about the necessity of providing each department, within its own organisation, with the expert advice required for the efficient discharge of its day-to-day business, and also of providing the central government as a whole with more authoritative guidance in technical matters than any individual department could provide, is endorsed by every recent study of this subject, including the reports of the Select Committee on National Expenditure and two P.E.P. broadsheets. He is primarily concerned, however, to avoid in this connexion infringement of the principle of ministerial doctrine by even the appearance of setting up any independent source of authority, such as is implied by conceptions like an economic general staff or a scientific general staff.

Sir John Anderson points out that the functions of the recently created Economic Section of the Cabinet secretariat were settled after a careful review of the experience of the past. There has been, he said, a substantial measure of agreement that the main contribution to be made by economists to the work of the Government should continue to be made in the departments themselves. The functions of the Central Economic Section are conceived as the reception of all economic intelligence collected by various government agencies, covering by its own researches any gaps in that intelligence; making or procuring specific studies in spheres not covered by

any one department; appraising economic intelligence, and presenting co-ordinated and objective pictures of the economic situation as a whole and the economic aspects of projected government policies. It should also be open to the Section to commission, where appropriate, special studies from universities or other institutions. Economic advice would be provided to particular departments, as well as to the Cabinet or Cabinet committees, on departmental matters on broader lines than are possible for the departments themselves; and in working closely with the departments, it is considered that the Section would facilitate contacts with, and exchange of views among, all economists in the Government service.

Similarly, Sir John conceives of the functions of a Central Statistical Office, organised as part of the Cabinet secretariat, as producing and maintaining a body of statistical information general in character, and presented in a form which would be regarded as authoritative by all departments, and with which the more detailed statistics provided by the departments themselves would comply. The same general model is advocated for scientific services. While the idea of a joint scientific staff on the lines of the Joint Planning Staff is rejected, Sir John hopes that a section of the Cabinet secretariat will be organised to assist the Lord President of the Council as the minister responsible for the general aspects of scientific investigation, and that thereby provision will be made, without prejudice to the work of departmental scientific staffs, for enlisting scientific advice on the highest level for the guidance of ministers.

Sir John Anderson did not pursue this matter further on the ground that the whole subject is at present under the consideration of a Government committee, though whether this is the Cabinet Committee on the Machinery of Government which was set up under the Coalition Government is not clear. At least it is to be hoped that the report and findings of any such committee will be published in full, for as Sir Ernest Barker has emphasized, this general problem of relating the expert's knowledge to the function of government is a key difficulty in democratic government. No more fruitful subject for research and study could well be conceived, for example, either for the British Institute of Management or the Administrative Staff College, both of which include research among their aims and functions.

That is well brought out in the final part of Sir John Anderson's lecture, when he passes to the consideration of the problems of administration which will arise in the phase of government ownership or control to which Great Britain is being increasingly committed by the present policy of nationalization. It is generally agreed that we here require organisation essentially different from the normal departmental organisation governed by Civil Service traditions. Whether we are being asked to move too rapidly in this matter is, as Sir John rightly indicates, a matter of personal opinion, but there is much to be said for his view that the problem is unlikely to be solved satisfactorily except by a process of experiment. Caution and a gradual approach as well as clear

thinking are required, and it is not unreasonable to suggest that only the gravest urgency from other points of view should lead to the tempo of the programme of nationalization being such as to give inadequate opportunity for such study, experiment and thought.

The special feature of the problem is that of devising organisation which can be relied upon under changing conditions to act with vigour, to exhibit in a high degree initiative and enterprise, to accept freely such risks as are taken every day by private enterprise, and to engage wherever necessary in competitive activity. In all this the public interest must be safeguarded to the satisfaction of Parliament as the ultimate authority, and having thus defined the problem, Sir John indicates certain guiding principles which must be served. For the constitution of the responsible authority, some form of council, committee or board will usually be indicated, and he strongly advocates a part-time rather than a whole-time basis as the most likely way to find people with the necessary breadth of experience, freshness of outlook and a reasonable measure of independence. While due regard should be had to the inclusion of different types of experience, representation of interests as such should be avoided. What may be termed the 'consumers' interest' should be left to the care of ministers and Parliament, and it is to the vigilance of Parliament and an alert public opinion that we must look to avoid undue political influence in the appointment of personnel.

As regards the relations of ministers and Parliament to this type of organisation, Parliament, as the ultimate authority, must have adequate opportunity for inquiry, for debate, and for passing judgment. Sir John suggests that the extent of ministerial control should be defined as clearly as possible in the instrument constituting the authority; but while he recognizes that within the field so defined the minister would be liable to be questioned in Parliament in the usual way, he does not really face the initial issue of the bearing of the Parliamentary question on the problem of ensuring initiative and enterprise. That may well be one of the matters in which much experience has yet to be gained before Parliament can be convinced that a satisfactory technique has been evolved.

What needs to be remembered, moreover, is that the problem is something more than one of devising machinery which serves the principles of departmental and collective responsibility. In a real sense, as Dr. J. T. MacCurdy and Dr. K. E. Barlow have pointed out, it is a complex biological problem, especially on the intelligence side. It is this biological aspect and the consequent need to give time for the evolution of the appropriate intelligence system which is probably one of the strongest reasons for 'hastening slowly' in matters involving a drastic change of policy. Sir John Anderson's lecture should stimulate further thought on a problem which has its bearing on almost every aspect of national life. On the more mechanical side of organisation with which

he is chiefly concerned, he gives as clear warning as Sir Ernest Barker of the need for experiment, for a scientific approach and for critical and impartial examination of the alternatives. That can only be possible if time is allowed; and this plea for caution and for time for the accumulation and examination of experience is reinforced by all those biological and sociological considerations which Dr. MacCurdy and Dr. Barlow have emphasized in their writings. Disregard of these factors constitutes in reality one of the gravest threats to the stability and indeed existence of civilization.

## THE UNDERGRADUATE'S FIRST YEAR

### First Year at the University

A Freshman's Guide. By Bruce Truscot. Pp. 111. (London: Faber and Faber Ltd., 1946.) 4s. 6d. net.

THIS book is not ephemeral: it is in the perennial class. It will appeal to many in every generation of students and should be included in every 'sixth form' library. It puts first things last, but perhaps that is no disadvantage, for the less important matters dealt with in the earlier chapters are of primary concern to the university student in the 'professional' sense and will have for him the most immediate appeal. The fact that the advice given about them is sound and acceptable will give weight to that offered later on more fundamental aspects of life. To each individual reader, especially to those who are older and look back across the years, different portions of the book will appeal according to his experience, his limitations and his tastes. The appeal for "unobtrusive courtesy founded on a sense of mutual obligation" is perhaps the book's most valuable phrase, and might be directed as much, in these distracting days, to the more senior half of university society. The essay on concentration has the same universal appeal, but, to us seniors, with more than a suspicion of regret for opportunities missed. So many things that matter in university administration are not tied to an obvious time limit and are thus in danger of neglect.

The stressing of the importance of the 'society' for the amateur in all branches of university study is one of the author's more constructive contributions. This is one of the thoughts it is particularly to be hoped will be translated into action by undergraduates of the future who are readers of the book. There are few things more necessary for the full development of undergraduate society and few things more difficult to bring about. Such a development must come from students themselves, and the student of to-day is more obsessed with the professional or specialist aspect of his studies than his predecessors were in more leisurely days.

The only concept with which I take issue is not essential to the purpose of the book. It needs comment, however, because it is placed in the forefront of the argument. In my view, teaching is an essential function of the university to-day. It is foolish to contend that, because of the origin of universities, it is not. It necessarily became an *essential* function before the end of the working lives of the first generation of the Socii to whom the author refers in his opening chapter. If we do not recognize this develop-

ment, we fail to appreciate the essence of the university to-day. This view in no way conflicts with the idea that the pursuit of new knowledge was the original university objective and is to-day an equally essential element of university work. Indeed, the pursuit of new knowledge is not only an essential end in itself: participation in this search by all members of the teaching staff without exception is necessary for the maintenance of high quality in teaching. It is, however, neither necessary nor right to degrade the teaching either of undergraduates or graduates from its correct status as one primary and essential element of a university in order to establish this truth. If the view that teaching is only incidental to the real work of universities were generally held, university teaching would suffer; just as university research would suffer if research were held—as in places and at times it has been—to be a secondary component of university life. R. E. PRIESTLEY

## APPLIED GYROSCOPY

### The Gyroscope and its Applications

Edited by Dr. Martin Davidson. Section 1: General Theory, by Dr. M. Davidson; Section 2: Marine Applications, by G. C. Saul; Section 3: Aeronautical Applications, by J. A. Wells and A. P. Glenny. Pp. 256. (London: Hutchinson's Scientific and Technical Publications, 1946.) 21s. net.

THE applications of the gyroscope to marine and aeronautical problems during the Second World War have been so many that pre-war treatises have become out of date. This book is an endeavour to bring the subject up to date, with a minimum amount of mathematics. The subject is considered in three sections, each by a different author. The first section deals with the simple theory of the gyroscope, and with its main properties; appendixes are concerned, chiefly, with the errors of the gyroscopic compass. The second and third sections treat of the marine and aeronautical applications respectively, and each is self-complete. Since much of the material of these two sections is new and practical, they are of more interest than the first; they contain scarcely any mathematics; they are illustrated by excellent diagrams and photographs, and make exceedingly interesting, though very technical and at times difficult, reading.

The marine applications fall into three groups, the gyro compass, the gyro pilot and the gyro stabilizer. The idea of a gyro compass began when Sang in 1836 suggested, and Foucault in 1852 showed, that a gyroscope could demonstrate the rotation of the earth. The Anschütz gyro compass was patented in 1908, the Sperry in 1911 and the Brown in 1916. The latest forms of these three types, (a) the Sperry Mark XIV gyro compass, with one heavy rotor of mass 52 pounds spinning at 6,000 revolutions a minute, (b) the Brown gyro compass, with one rotor weighing  $4\frac{1}{2}$  pounds and spinning at 14,000 revolutions a minute, and (c) the Anschütz gyro compass, originally having one rotor, later three rotors, and now having two rotors each of about  $4\frac{3}{4}$  pounds spinning at 20,000 revolutions a minute, are described in full with excellent illustrations, and are compared and contrasted.

Successful relaying of the compass reading to repeater compasses led naturally to automatic steering. The gyro pilot is much more sensitive to

slight changes in the direction of the ship's head than the human helmsman, and does not find the job monotonous, so that when properly designed it steers a straighter course, and saves time, fuel and man-hours. The actions of the Sperry gyro pilot and the Brown automatic helmsman are described, with photographs of the gear.

A chapter follows on the Sperry gyro ship-stabilizer, in which each gyro rotor weighs 100 tons and spins at 800 revolutions a minute, and in which the precessional action of these massive rotors damps out the roll. This is followed by a chapter on the Denny-Brown ship-stabilizer, in which a comparatively small gyro spinning at 6,000 revolutions a minute controls the means of damping out the roll; the stabilization is obtained by the use of fins projecting from the hull and oscillated in a similar manner to the ailerons of an aeroplane. The control gyro acts not merely when the ship is rolling, but even anticipates a roll. The fins are extended from, and retracted into, their housing in the hull by the same electrohydraulic machinery that angles the fins during stabilization.

Section 3 deals with aeronautical applications of the gyroscope. In many ways these contrast with marine applications. The speed of the aeroplane prevents the use of the gyro compass; nevertheless the gyro can be used, for local flights, as a direction indicator, much as the torpedo gyro controls the direction of the torpedo. Two examples are described, the Sperry directional gyro and the Brown static compass. When the directional gyro is monitored by a magnetic compass, the arrangement is called a gyromagnetic compass; examples given in detail are the R.A.F., the Sperry 'slave', and the Askania (German) gyromagnetic compasses. The Brown pitch-azimuth indicator, showing any divergence of an aircraft from a pre-set glide path, was produced for use in blind approach and landing. A chapter follows on rate-of-turn indicators; several types of these are detailed, including the Reid and Sigrist instrument, standard in the R.A.F.

The need for an accurate indication, to the pilot, of the vertical (or the horizontal) has led to the development of a large number of instruments, in which erection of a gyro, that is, adjustment of the gyro until its axis of spin is vertical, is carried out automatically by some device that applies the right couple, when required, to hurry the precession of the gyro about the vertical axis: such a gyro is called a gyro vertical. The Sperry artificial horizon provides a horizon bar on a dial, on which also is a miniature aircraft silhouette; the horizon bar is controlled in pitch and roll by a gyro vertical; thus the pilot can see at all times his flight attitude, even when flying in fog or heavy cloud. Erection of the gyro is carried out by air jets. The Gyrorector, of German design, though it does not use a gyro vertical, is a form of artificial horizon; in it the rotor is mounted with its axis horizontal and athwartships. In the O.M.I. artificial horizon, of Italian make, bank and pitch are indicated on a dial, as in the Sperry artificial horizon, by the relative movements of a horizon bar and a miniature aeroplane; erection is by the Gray method, in which when the rotor axis is not vertical; steel balls roll to positions where they exert the correct erecting couple. Paragraphs follow on the Sperry electrical artificial horizon, with automatic electrical erection, and on the Horn (German) artificial horizon, in which the erection is electrical, and in which a turn-indicator gyro, with axis fore-



and-aft, is also incorporated. A description is given of the Pioneer Bendix Fluxgate Gyro, an interesting instrument which is basically a magnetic compass maintained on an even keel by a gyro vertical. The compass, called a Fluxgate, is an inductive device responsive to the earth's horizontal magnetic field, and capable of providing remote magnetic compass readings on a repeater system; the erector system of the gyro is of the Gray type.

The book closes with a chapter on automatic pilots, of which there have been many types since the first Sperry gyroscopic stabilizer was successfully tried out in 1909. The modern Sperry A3 gyropilot has a gyro vertical to control pitch and roll, and a directional gyro to detect yawing; the system is pneumatic-hydraulic. The Pollock Brown automatic pilot is entirely hydraulic; one gyro, with its axis fore-and-aft, is used for rudder and elevator control, while a second gyro controls the ailerons. The R.A.E. Mark I and Mark VIII automatic pilots are described and contrasted. The Mark I had a single gyro, and the arrangement was intended primarily as a stabilizing control in bombing; it had only rudder and elevator control. The latest Mark VIII has a single inclined gyro, and is monitored by a magnetic compass. A 1942 example of a German automatic pilot of the three-axis type is described. This elaborate instrument was all electric, and contained five gyros, respectively a directional gyro, a gyro vertical, and a gyro for each of the three axes. In the Minneapolis Honeywell automatic pilot, control is by a directional gyro with axis athwartships, and a gyro vertical with frictional erection. The V1 flying bomb of 1944 had three gyros; one gyro, monitored by a compass against random azimuth precession, controlled rudder and elevators; the other two were rate gyros, responsive one to rate of yaw and the other to rate of pitch.

There are many war-time applications of the gyroscope, for example, to gun sights and bomb sights, that cannot yet be published; the principles involved must be generally the same as those employed in the many devices described in this book, which, despite the unfortunate absence of an index, forms an excellent book of reference on modern applied gyroscopy.

ROBERT C. GRAY

## INDUSTRIAL CHEMISTRY AND CHEMICAL ENGINEERING

### The Chemical Process Industries

By Prof. R. Norris Shreve. (Chemical Engineering Series.) Pp. xiii + 957. (New York and London: McGraw-Hill Book Co., Inc., 1945.) 25s.

THERE has always been something intellectually unsatisfying about manuals, dictionaries and encyclopaedias of industrial chemistry. To the works chemist, intimately acquainted with the details of a particular industry, they often appear superficial and elementary; to the student of chemistry they lack the imaginative appeal which is found in works on the pure sciences; to the chemical engineer, concerned primarily with the quantitative aspects of physical and chemical processes, they usually offer a qualitative and unbalanced *olla podrida* of engineering, chemistry and economics which is peculiarly irritating.

The disfavour into which such works have fallen can only be regarded as temporary, for there is a constant need for more information upon industrial procedures; they form a necessary link between text-books on chemistry and physics and the more specialized treatises on the principles and practice of chemical engineering. The aim of such a book, therefore, should be to correlate individual operations and reactions, and the complete processes which are built up from them, in such a manner as to emphasize the quantitative engineering aspect of large-scale work and the costs and other economic factors which have a bearing upon market values.

To form such a link, Prof. R. N. Shreve has contributed a new work on the chemical process industries of America. In compiling this volume, the author has followed established procedure to the extent of allocating separate chapters to individual or connected groups of industries; thereafter he has followed a well-defined plan, whereby, with the aid of energy and material flow sheets, the logical sequence of operations required to transform raw materials into saleable products is clearly demonstrated. By this means the interest of the reader is sustained and the descriptions of industrial procedures, however condensed, are not devoid of reality.

The book contains thirty-nine chapters, of which all but three are devoted to process industries. The accounts are based upon American practice and the statistics relate almost entirely to the home market. The English reader has, therefore, constantly to bear in mind the difference in economic conditions in respect of availability of raw materials, and energy and labour costs, between the two countries. The wide field embraced by the title and the limitations of space have necessarily involved a degree of arbitrary selection of subject-matter, and in some instances, an inadequate treatment.

At the present time, particular interest is attached to those comparatively new industries which, through the incidence of war, have undergone an accelerated growth. Of these the synthetic fibre and rubber industries have profoundly affected American economy and have not been without repercussions on British markets. The plastics and petroleum industries have also developed new techniques and have made available ranges of new products which are now finding widespread applications. The account given by Prof. Shreve of these war-time advances is both stimulating and informative.

The chapter on pesticides, on the other hand, fails to do justice to what is perhaps one of the most significant developments in technology in recent years. Elementary insecticidal and fungicidal agents have long been known and employed with success in the wine, fruit- and vegetable-growing industries; but a need has arisen for more refined products possessing lethal and toxic properties greater than those commonly in use to-day. In this connexion the discovery of D.D.T., 'Gammexane', neonicotine and other substances having selective toxic properties has opened up possibilities of scientific pest control of immense importance. There are, however, some formidable technical and engineering problems associated with applications in the field, which are at present engaging the attention of agriculturists and which must be solved before full advantage can be reaped from these new discoveries. It is to be regretted that the author has not given a more comprehensive treatment of this aspect of the subject.

In several instances, reference is made to new undertakings based upon the recovery of minerals from sea-water. The problems involved in this branch of technology are full of interest to the chemical engineer. The low concentration of salts, the large quantities of raw material to be handled, and the narrow margin of costs available for processing, are factors which necessitate the most rigid scientific control of processes and exceptionally high plant efficiency.

The remaining chapters deal with the major heavy and fine chemical industries according to the usual classification. It would appear that while few changes in the fundamental methods of manufacture have occurred in recent years in America, increasing attention has been given to improving the efficiencies of the unit operations upon which they are based. Transportation, phase separation and energy conservation have been extensively studied, and a better understanding has been obtained of the principles of plant lay-out.

Prof. Shreve has added short historical notes to the accounts of the various industries, and has appended to each chapter an adequate bibliography.

D. M. NEWITT

## EMOTION AND ILLNESS

### Emotions and Bodily Changes

A Survey of Literature on Psychosomatic Interrelationships, 1910-1945. By Dr. Flanders Dunbar. Third edition. Pp. lix + 604. (New York: Columbia University Press; London: Oxford University Press, 1946.) 50s. net.

AFTER the First World War it was generally agreed that symptoms such as paralysis, tremors and morbid anxiety might be the expression of mental experiences rather than the result of ultra-microscopic lesions in the central nervous system, but a sharp line was drawn between the organic and the psychogenic. For most of us the psychogenic was something that could, if necessary, be consciously simulated. This clear-cut idea was challenged in 1935 when Flanders Dunbar collected a wealth of data suggesting that physical disease might be initiated or at any rate accelerated by emotional events. The idea was not new. It is, and always has been, the belief of lay people, and a generation ago it was expressed and practised with conviction by the physician Groddeck. The hostility of the majority of the medical profession to the acceptance of psychological interpretations of organic disease is not because this is a new idea, but because it is a very old one, and because the advance of medicine since the time of Hippocrates has been largely due to a prejudice against the belief that disease could be explained by demoniac possession, emotional experiences or mental influences.

One picks up the third edition of Dr. Dunbar's treatise in the expectation of discovering how far the psychosomatic attitude to illness has advanced from suggestion to demonstration, and one is frankly disappointed, for this is just a reprint of the 1935 work with a new introduction. Now the first edition may have been a significant event, but it was not in the same category as William James' "Varieties of Religious Experience". In other words, it was a bibliography of an uncritical literature and not a classic, and no very useful purpose will be served by rattling these old bones again. Great things have

happened in orthodox medicine in the last ten years, and it would be helpful to know whether corresponding progress has been made on the psychosomatic side. In so far as it has ensured a greater respect for human personality and an increased interest in the life-history of patients, the psychosomatic theory has done good. It has also the merit of being less dangerous to those on whom it is practised than other theories of disease, such as phlogiston, intestinal intoxication or focal sepsis; but like these previous theories it tends to be used as a facile explanation of conditions we do not understand. The Zola-esque writing of case-histories and the description of disease temperaments have been mistaken for a causal analysis of illness, and it sometimes seems that all that has happened is that whereas in the old days we said a man was passionate because he had red hair, nowadays we say he has red hair because he is passionate.

All this is unfortunate at a time when a lot of young men are coming out of the medical services with the idea that there is something in psychosomatic medicine. Of course there is, as anyone knows who has had much to do with the treatment of asthma or eczema. It is high time we began to try to find out what this is instead of mouthing big phrases such as 'psychobiologic unit'. A collection of the 'gilt-edged' work that has been done in this field, as by Wolf and Wolff on the stomach or Sir Thomas Lewis on urticaria, is overdue and, *pace* Dr. Dunbar, it would not be very large. We might find that whereas mental experiences, being part of the environment, influence all disease processes; their effect is most obvious in conditions in which muscular tone and glandular secretion play a predominant part. In the second edition Flanders Dunbar made the astonishing statement that it was not worth while to bring the book up to date as "nothing in the general point of view would be altered". Until that point of view is altered, professors of medicine will find it difficult to recommend text-books on psychosomatic medicine to their students, and will wish to see them well disciplined in psychiatry, genetics and statistics before they penetrate into this ill-defined field.

L. J. WITTS

## BIBLIOGRAPHY OF MATHEMATICAL TABLES

### An Index of Mathematical Tables

By Dr. A. Fletcher, Dr. J. C. P. Miller and Prof. L. Rosenhead. Pp. viii + 451. (London: Scientific Computing Service, Ltd., 1946.) 75s.

IT is common knowledge now that the tabulation of mathematical functions, and the whole approach to numerical mathematics, have been revolutionized within the present century by the increased use and improvement of calculating machines. In Britain we have seen the effects of this in the productions of Dr. L. J. Comrie and of the British Association Tables Committee; in Germany in the work of Dr. J. Peters; in the United States in the tables produced by Prof. H. T. Davis and his collaborators and, most recently and strikingly, by the New York Work Projects Administration. The old classical tables, beginning in the late sixteenth and early seventeenth centuries with Rheticus, Pitiscus and Briggs, revised, corrected, re-edited from time to time, already formed a literature in themselves; the modern and contemporary tables form an enorm-

ous and ever-increasing supplement. Descriptions of extant tables had been given in the past, for example, by De Morgan in his articles written for various encyclopædias and by the numerous reports of the British Association Tables Committee, beginning with Glaisher's extensive report of 1873, of 175 pages; but latterly the need of a comprehensive index of tables had begun to be felt. The authors of the present book set to work in 1939 to supply this need. In the United States the same need was independently experienced, the result being the publication in 1943, by a Committee of Mathematical Tables and Aids to Computation, of the quarterly journal, *Mathematical Tables and Aids to Computation*, which has very quickly justified its existence.

The "Index of Mathematical Tables", which we here review, is of outstanding value. Its price is not at all excessive, when the wealth of its contents and the beauty of its printing are considered. It is not a complete index, the compilation of which would be a task of prohibitive difficulty, but with its aid, and particularly through the bibliography, one should be able to trace and appraise all mathematical tables of genuine importance over an extraordinarily wide range of tabulated functions. Of special value is the running commentary on the subjects treated and on the accuracy of the tables.

The book falls into two parts, Part 1 being an index of tables, of 372 pages, in twenty-four sections according to the functions tabulated, Part 2 being a bibliography of seventy-two pages. In addition, there is a long introduction of great interest and instructiveness, describing in detail the arrangement of the work, the general principles and the abbreviations used.

As to the functions tabulated, we may exemplify by choosing two sections: Section 5, Mathematical Constants; Multiples and Powers; Roots of Algebraic and Transcendental Equations; Miscellaneous Constants; Conversion Tables: Section 14, Factorial or Gamma Function, Psi Function, Polygamma Functions, Beta Function, Incomplete Gamma and Beta Functions. Should one want, to thirty or more digits, the authoritative values of all the familiar constants, and a host of unfamiliar ones, their powers, their logarithms, here they all are, in elegant black type. Or if one is interested in the binary quadratic forms of integers and in the remarkable numbers  $\exp(\pi\sqrt{D})$  of Hermite, here are the values for  $D = 22, 37, 43, 58, 67, 163$ , as calculated by Peter Gray, Ramanujan and D. H. Lehmer. The last is worth record here, its value to 39 digits being 262 537 412 640 768 743-999 999 999 250 072 597.

As to the thoroughness with which the authors have checked the tables, a single partial quotation, one of hundreds of the same kind, will serve. It concerns the value  $x_0$  giving the main minimum of  $\Gamma(1+x)$ .

"It has been stated in Legendre 1814 (71) and 1826 (436), and quoted by various authors, that the main minimum occurs at  $x_0 = 0.46163\ 21451\ 105$ , and that  $\log_{10}(x_0)! = \bar{1}.94723\ 91743\ 9340$ . Davis 1933 (278), however, gives  $x_0 = 0.46163\ 21450$ . Calculations to about 25 decimals by J. C. P. Miller give (retaining 15 decimals)

$$x_0 = 0.46163\ 21449\ 68362, \dots \\ (x_0)! = 0.88560\ 31944\ 10889$$

The natural value of  $(x_0)!$  is wrongly given as 0.88560 24 in Gauss 1813 (at any rate as reproduced

in *Werke*, 3, 147, 1866). The correct 7-decimal value is given in Bertrand 1870 (284), Carr 1886 (364) and Hayashi 1926 (273), 1930b (53, 155)."

Such information in regard to errors in extant tables is visible on almost every page and is of the greatest value.

Enough has been said to show that this "Index" will henceforth be indispensable to all self-respecting centres of computation. The highest praise must be given not only to the industry, but even more to the resolution, of the authors, for completing their project during the most difficult years of the War, and amid a heavy pressure of war duties and anxieties. The book is published by the Scientific Computing Service under Dr. L. J. Comrie, and in the clearness of arrangement and the beauty of typography is in all respects up to the standard associated with this name.

A. C. AITKEN

## PHILOSOPHY AND ÆSTHETIC CRITICISM

The Basis of Criticism in the Arts

By Prof. Stephen C. Pepper. Pp. xi+177. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1945.) 14s. net.

THIS book is of the nature of a philosophical experiment; an instructive one, well worked out, but like many experiments less simple than appears at first sight. Prof. Pepper selects (for reasons discussed in another book—"World Hypotheses", 1942) four types of philosophy as "relatively adequate world hypotheses", and uses them for the purpose of æsthetic criticism, arguing in terms of concrete examples.

The critical examination of a work of art and the interpretation of the judgments made about it bring one up against what is ultimately and irreducibly given in experience in such a way that issues cannot be dodged by selecting a few more manageable elements and ignoring the rest. The method should be valuable. The author's conclusion appears to be that each kind of world hypothesis brings out some special significant aspects and that from all of them together something like a synthetic view may emerge. The reviewer's conclusion is more one-sided. One theory comes out of the test badly: the one that, starting from the truism that beauty causes pleasure, refuses, ostensibly, to say more and is found borrowing its standards of judgment surreptitiously from other theories. What the author calls the formistic theory, the assertion of external, 'objective' standards, looks like several theories, not one. Two theories come out much better, as providing out of their own resources æsthetic criteria which are relevant and significant. But these are closely related philosophies, the fundamental distinctions of which are æsthetic, not moral, scientific or anything else. They are the type loosely called Hegelian idealism and the philosophy derived from Prof. Dewey, which the author calls contextualist. The conclusion would appear to be that the fourfold classification needs revising.

There are a number of excellent points in this stimulating discussion which cannot be dealt with in a short review, but it would be unfair not to mention the really admirable treatment of the subject of definition, a useful corrective to the distortions of some recent logicians.

A. D. RITCHIE

### Library Resources of the University of North Carolina

A Summary of Facilities for Study and Research. Edited with a Foreword by Charles E. Rush. (University of North Carolina Sesquicentennial Publications.) Pp. x+264. (Chapel Hill, N.C.: University of North Carolina Press; London: Oxford University Press, 1945.) 21s. 6d. net.

WITH the exception of a chapter on the role of the library in the advancement of scholarship, by L. R. Wilson, professor of library science and administration, and another on co-operative facilities in research and service, by C. E. Rush, director of libraries, this volume in the sesquicentennial celebration series of the University of North Carolina is a purely factual but well-written account of the library resources of the University and its facilities for study and research, as well as of the development of the library and of its more distinctive collections of material. The chief emphasis is placed on the role of the library in the promotion of culture and scholarship, and the contribution of the library in teaching, investigation and research is well displayed.

Although there are a score and a half of contributors, the volume does not lack unity; in style and content it is admirably designed for the purpose it seeks to serve, and the production is no less appropriate. British readers handling this well-printed book, with its good paper and binding, will envy a university able to devote so much material and labour to such a purpose. There is, indeed, room for such publications in Great Britain, even on a more modest scale. A new edition of Colonel Newcombe's "The University and College Libraries of Great Britain and Ireland", now twenty years old, would scarcely meet the need, but if each British university could put out some account of its library resources intermediate in scale between the present volume and, for example, the admirable "A Reader's Guide to the British Library of Political and Economic Science", a useful addition would be made to the bibliographic tools of research and a first step taken towards that survey of library resources which the Library Association suggested in a recent report. R. B.

### Report of the Michigan Academy of Science, Arts and Letters

Vol. XXVI, containing papers submitted at the Annual Meeting in 1940. Edited by Eugene S. McCartney and Mischa Titiev. Pp. xiii + 586 + 36 plates. (Ann Arbor, Mich.: University of Michigan Press; London: Oxford University Press, 1941.) 28s. net.

THIS volume contains papers covering a wide field in botany, zoology, geography, geology, anthropology, economics and non-scientific subjects. Most of the botanical papers are of taxonomic interest and deal with local flora in Michigan. The zoological section contains some papers of general interest, including one by M. G. Whitney on "The Hermaphrodite Gland and Germ Cells of *Vallonia Pulchella* Mull.". A second paper by Sister M. F. Xavier O'Reilly deals with "Leucocytic Reaction to Bacterial Infection in Animals". This is a contribution from the Department of Zoology and Institute for Medical Research of the University of Michigan and gives a detailed account of the injection of *Staphylococcus aureus* into earthworms, crayfish, yellow perch, goldfish, garter-snakes, turtles, pigeons, guinea pigs, rabbits and mice. Mice were also inoculated

with suspensions of lampblack and fibrin in order to compare the reactions of the leucocytes to an infecting organism, and to particulate matter (lampblack) and a foreign protein (fibrin). The reactions of leucocytes in a variety of animals to the presence of an infecting organism indicate that in each class of animals a particular set of reactions is induced to protect the animal against bacteria and their metabolic results. The features associated with phagocytosis are described in detail and fall into three categories: (1) phagocytosis and excretion; (2) phagocytosis and digestion; (3) basophilia of the granules of the polymorphonuclear neutrophils or their homologues, the pseudoeosinophils.

### Basic Mathematics for Radio Students

By F. M. Colebrook. Pp. x + 270. (London: Iliffe and Sons, Ltd., 1946.) 10s. 6d.

COMPETITION and diversity among text-books is surely to be desired, and it is time that the dominance of a few names in the field of educational mathematics and its applications should be challenged. The present author is correct in stating that in mathematics it is the first steps which count. Many students fail to achieve their proper stature in applied science because of the non-acquirement of facility of expression in mathematical terms, for, again quoting the author, mathematics is the generalization of experience. For such students mathematics was dull, and the present author seeks to obviate the possibility of such a defect.

His technique is to start at the very beginning and to develop a whole course of instruction based on concrete instances, titillated with engaging literary references, leading through series, limits, vectors, and some calculus, with a final application to electric circuits found in radio engineering. Not an entirely original conception; but the author manages to be rigorous at every step as far as he goes, and uses all ingenuity to induce the student to be rigorous also. There are ample examples, but no index. So we conclude that a substantial gap in the literature for teaching potential engineers has been filled.

L. E. C. HUGHES

### The Annual Register

A Review of Public Events at Home and Abroad for the Year 1945. Edited by Dr. M. Epstein. Pp. xvi + 470. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1946.) 42s. net.

THE arrangement and allocation of space in this annual volume remain unchanged. Rather more than half the space is devoted to the political history of the world for the year, with special reference to Great Britain and the United States both of which are treated with singular impartiality even in the record of the change of British Government in the summer of that year. It was a year of turbulence but hope. The international complications that now loom so large were only beginning to arise and the successful end of war was the dominant note. Yet the editor's task cannot have been easy; and his untimely death as this volume was being published will be widely regretted.

The second part of the book as usual gives a survey of literature, science and finance, etc., a chronicle of events and a number of obituary notices. Among the public documents printed in full is the text of the declaration of the defeat of Germany signed at Berlin on June 5, 1945, the Russo-Polish Treaty of April 1945 and the Russo-Chinese Treaty of August 1945.

## POWER PRODUCTION BY NUCLEAR ENERGY

A CONSIDERABLE measure of agreement was revealed at the discussion on power production by means of nuclear energy held in the hall of Jesus College, Oxford, on August 30 as part of the International Conference arranged by the Atomic Scientists Association.

Lord Cherwell, who opened the discussion, held that great harm has been done by the exaggerated stories which have appeared in the Press, suggesting that these new sources of energy would usher in the millennium. As only about one twentieth of the national effort in Great Britain is devoted to producing and distributing power, and the greater part of this is in costs of distribution, there would be only a small gain even if power could be produced at no cost at all by atomic energy, and of this there is at present no prospect whatever. To pretend, as has been suggested, that it would lead to a 4-hour day or 20-hour week is, therefore, manifestly absurd. On the other hand, these tales have provided an admirable opportunity for every country in the world to produce bombs under the guise of developing atomic energy. He doubted whether Governments would have provided the large sums of money which had been made available in various countries for nuclear research if this had been merely directed to civil use; it seemed to him that the military aspects were the driving force and the industrial applications were the excuse. Why otherwise should expenditure on purely peaceful research, that is on metallurgy, or on plastics or on getting power from sunlight, which would probably yield a bigger return than expenditure on nuclear energy, be on such a comparatively small scale if indeed it were incurred at all by many governments?

There would probably be valuable applications of atomic power production for special purposes, such as warships or even ordinary ships, or opening up desert countries; and great benefits would accrue from the use of tracer elements, and possibly there might be direct medical applications. For these reasons, research and development should, of course, proceed. But scientific workers should combine to decry the exaggerated tales which are going the rounds. They provide the excuse for any government minded to make bombs to insist on building large piles, and thus to make international inspection and control very much more difficult than would be the case if it were frankly recognized that such activities could be postponed without serious loss to the various nations. It is so vital to the survival of civilized life on the earth that some form of control be established, that anything which stands in the way of this should be avoided.

Prof. M. L. Oliphant, who was the first speaker in the ensuing general discussion, laid stress on the importance of finding a new source of power, particularly so far as Britain is concerned, now that there is so much reluctance to mine coal from the narrow seams prevalent in Great Britain. In certain other regions, for example, parts of Australia, a thousand miles or more from the nearest coal-field, some alternative source of power would be especially valuable, exposed as they are to such a variety of industrial vicissitudes. On the other hand, the uncertainty of being able to obtain the necessary amount of uranium to produce any notable addition

to world power supplies was mentioned, and it was emphasized by Prof. F. Simon that it may well be easier to derive energy from sunshine if a comparable effort in research and development were to be made. Indeed, he cast some doubt on the reality of the fuel shortage, observing how wastefully energy as a whole is used, not only in our inefficient domestic heating, but also in industrial processes. It seems to be generally agreed that the benefits to be expected from the use of nuclear energy would be in the main due to its special characteristics of great concentration per unit of weight and unit of volume, rather than to the total energy to be derived from fissionable elements.

Some of the foreign representatives (in particular Dr. L. Kowarski and Prof. F. Perrin from France) said that their countries were only interested in the power project and had no intention of making bombs; Prof. Oliphant thought it would be desirable to adopt this same line in Great Britain. Dr. H. L. Anderson told the Conference that atomic power was taken very seriously in the United States as being an important development the effects of which were likely to be felt quite soon, and that large industrial firms were pressing to have the whole matter thrown open to private enterprise to develop. A pile specially designed for production of useful power was being built, and it was expected that it would be possible to run a turbine within a year. But, of course, there was no promise that this would be an economic proposition.

Everybody agreed about the great importance of the use, for investigations and research, of radioactive tracer elements which may be obtained in abundance from piles. But many felt, as Dr. S. Devons pointed out, that fissionable elements might well prove more valuable to humanity on account of developments totally unforeseen than merely as substitutes for our present sources of power.

On the whole, the discussion proceeded on sober lines, and the balanced view prevailed that the world is not entering upon an 'atomic age' in which power would be plentiful and cost virtually nothing, but that atomic energy has great possibilities which should be explored and developed.

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## HUMAN ECOLOGY IN RELATION TO THE PHYSICO-CHEMICAL FACTORS

A DISCUSSION on "Human Ecology in Relation to the Physico-Chemical Factors" was held at the Royal Society on May 30.

Prof. J. B. S. Haldane, who opened the discussion, pointed out that a human environment may be specified by the time of exposure to it, and by its various constituents, which may be scalars (for example, partial pressure of a gas or temperature) or vectors (for example, acceleration). There are safety regions within which less than a certain fraction of those exposed are affected in a specified way. Human response to some variables is far less constant than to others. He instanced the wide differences in response in subjects exposed to high-pressure oxygen and the variability in response of the same subjects on different exposures. On the other hand, the response to low oxygen pressure is much more constant between individuals and on successive exposures.

Many factors, such as carbon dioxide and high-pressure oxygen, interact to increase the reaction for some values and decrease it for others. Thus carbon dioxide added to high-pressure oxygen increases the severity of reaction, but 3-5 per cent of an atmosphere of carbon dioxide will reduce the symptoms of moderate anoxia. Carbon monoxide and anoxia are additive in the reaction produced at moderate pressures, but at high pressure animals can survive high carbon monoxide concentration.

The difficulty of measuring the reaction produced in human subjects is considerable; in the response to high oxygen pressure, twitching of the lips often precedes generalized convulsions and has been used as a measurable end-point in many experiments, but is not reliable. In the case of anoxia, the conditions under which 50 per cent of subjects retain consciousness for a specified time can be used as a safe end-point.

Prof. D. Brunt then outlined the optimal conditions of climate for human comfort. He suggested that the ideal outdoor climate would permit a clothed man (a) to walk at 3 m.p.h. in bright sunshine without sweating appreciably, and (b) to rest in bright sunshine or to stand in the shade doing light work in air movement of 17 ft./minute without body cooling. This necessitates at 60 per cent relative humidity an air temperature not exceeding 68° F. for (a) and not less than 66° F. for (b); the optimum temperature is 67° F. A nude man should require a temperature 4° F. higher. The upper limits of tolerable conditions are set when the body is unable to prevent rise of rectal temperature, and heat stroke may occur.

Increasing air speed allows greater temperatures to be tolerated, but the highest wet-bulb temperature which can be tolerated falls with increasing dry-bulb temperature. When the comfort limits are surpassed, the rate of rise of body temperature is determined by the wet-bulb temperature almost independently of the dry-bulb temperature. But for comfort the dry-bulb temperature is important. He instanced the use in India of water-soaked curtains over doorways, the effect of which lowers the dry-bulb temperature without affecting the wet-bulb temperature. Very many years experience show that this method of cooling the air inside buildings is very effective in increasing comfort.

Prof. Brunt discussed equations relating heat loss to the physical factors involved in climate for both comfort and avoidance of heat stroke under various conditions. He pointed out that the 70° isotherm runs through many of the centres where early civilizations developed, and suggested that until man began to be able to control his indoor environment he was restricted to the neighbourhood of that isotherm.

The physiology of men working in a very hot environment was considered by Dr. E. A. Carmichael, who illustrated this from recent research at the National Hospital, Queen Square, London. The reaction of a man in a hot environment depends not only on immediate conditions but also on his previous experience. When a man from a temperate environment is suddenly exposed to heat, his heat-regulating mechanism at once reacts to the situation; but there is also a slower adapted process resulting from repeated exposure or when living in the tropics. This acclimatization raises the level for efficient physical or psychological work and for breakdown. The unacclimatized man shows great increase in

heart-rate, blood flow to the skin increases, and the rectal temperature rises. At 94° F. wet bulb, circulatory collapse may occur and the man faint. The heart-rate at successive exposures rises less and there is less liability to faint as adaptation of the cardiovascular system occurs. This may be partly due to an increased blood volume.

Sweating is the most important control of temperature in a hot environment. With acclimatization, sweating commences at a lower rectal temperature and the rate of sweating increases. Under severe conditions with subjects at work, sweating may reach 60 c.c. per minute for short periods. With longer exposure sweat loss decreases and the salt concentration of it rises. This is suggested as due to fatigue of the sweat glands, as less osmotic work has to be done in the production of sweat with increased salt content. This fatigue of the sweat glands during work becomes less after many days continuous exposure. This may be due to hypertrophy of the glands, an increase in the number functioning, redistribution of blood or endocrine activity. This stresses the need for adequate replacement of fluid and salt. If not made good, heat cramps following a fall in plasma chlorides may occur. Acclimatization appears to occur in the same way in subjects repeatedly exposed in a hot chamber and in those living in the tropics.

Limiting conditions for psychological efficiency are lower than those for physical efficiency. The effective temperature scale does not emphasize the very narrow limit at high wet-bulb temperatures between effective temperature allowing efficient work and that producing breakdown. Nor does it sufficiently emphasize the deleterious effect of still air on working men. The experiments and observations under desert conditions show that men left to themselves drank water insufficient to replace their fluid loss although satisfying their thirst. It is questioned whether thirst is an accurate index of water needed, and it is necessary to force water and salt intake; this should be done until the daily urine secretion exceeds 500 c.c.

Dr. B. H. C. Matthews then described human tolerance and reaction to low partial pressures of oxygen, both as seen on rapid ascent in aircraft, in low-pressure chambers and on mountains.

The tolerance limits of low oxygen pressure are very different in acclimatized men; thus climbers have reached 23,000 ft. on Mount Everest. This height produces unconsciousness in a few minutes and death in less than an hour in men acclimatized to sea-level. The symptoms seen in man due to low oxygen pressure are due primarily to the reactions of the central nervous system. Peripheral tissues are little affected at oxygen pressures producing unconsciousness. The abnormalities of increasing severity from 10,000 ft. to 20,000 ft. are those of the central nervous system, particularly the higher functions. Above 20,000 ft. unconsciousness may be expected in a large proportion of subjects after a short interval. Above 25,000 ft. there is considerable possibility of death if the exposure exceeds 15 minutes.

The oxygen saturation of the blood is not the only factor in producing symptoms. Subjects vary in the degree of hyper-ventilation in response to oxygen lack, and this leads to varying degrees of alkalosis caused by the lowering of carbon dioxide in the blood by hyper-ventilation. Following hyper-ventilation, convulsive movements are common. Subjects not exhibiting much hyper-ventilation

frequently become unconscious without exhibiting hyper-excitability of the nervous system. Subjects at 22,000 ft. breathing air may become unconscious for a minute or less when given pure oxygen; this may be a reaction to the change in acidity of the blood brought about by sudden oxygenation.

By acclimatization a man is able to live and work at altitudes up to 18,000 ft. for long periods. The ultimate tolerance of the acclimatized subject is at present unknown. The principal changes that are seen are an increase in the oxygen capacity of the blood and red cell count, increased pulmonary ventilation with a lowered carbon dioxide level in the blood, the alkalosis being compensated by the kidneys to restore the pH to normal with a lowered alkali reserve; this takes many days for full development. Finally, changes in tissue oxidase systems occur, so that the performance of a man with an oxygen saturation of, say, 60 per cent improves greatly if he is acclimatized. The relative sensitivity of the respiratory centre to low oxygen and to changes in carbon dioxide partial pressure shows wide individual variations.

Human tolerance of acceleration depends on the posture of the body and the axis along which acceleration acts. For accelerations acting from feet to head, unconsciousness is produced if the acceleration exceeds about seven times that of gravity for five seconds. This limit is determined by failure of the circulation to maintain blood supply to the head. It is preceded by failure of vision. For shorter durations, much higher accelerations can be tolerated. For 0.1 sec., twenty times gravity can be tolerated if the body is adequately supported. The limit here is set by the mechanical strength of the body, for at high values of acceleration the large forces accelerating the body may lead to disruption of its parts.

Dr. G. L. Brown considered human tolerance to oxygen, nitrogen and carbon dioxide at raised partial pressures. Any of these may poison the central nervous mechanism of man. He emphasized the wide variation in individual tolerance and the day-to-day fluctuation in a single subject even when living under strictly standardized conditions. The prevention of convulsions through high oxygen by the use of anti-convulsants has not been successful in man. High oxygen concentration poisons enzymes concerned in carbohydrate metabolism of the brain; protective agents effective in isolated brain slices have not yet been extended to man. The cerebral intoxicant action of high partial pressures of carbon dioxide have become a serious problem in some forms of diving. Experimental work shows that 15 per cent carbon dioxide causes unconsciousness in all subjects provided that sufficient oxygen is present. If the oxygen is also low, the experiment is terminated by a feeling of suffocation and inability to maintain the large tidal volume.

There appears to be an additive effect between carbon dioxide and nitrogen intoxication. Poisoning with carbon dioxide at high oxygen concentrations closely resembles the effect of very low oxygen pressure. Performance of skilled tasks deteriorates, but convulsion, the common result of high oxygen pressure alone, is never seen. The effect of nitrogen at 10 atmospheres pressure resembles that of a general anaesthetic. The intoxication produced prevents clear thinking or performance of skilled tasks. The initial symptoms are of short duration, but there remains mental impairment of which the subject is unaware.

After exposure to toxic levels of oxygen and carbon dioxide, however, symptoms develop after return to normal conditions. Acute intoxication with carbon dioxide (15 per cent) leaves little after-effect, whereas 6 per cent carbon dioxide, which can be tolerated for hours, evokes severe effects on return to air. Vomiting and severe headache are very common. Withdrawal of nitrogen associated with a fall of pressure may lead to bubble formation within the tissues, with serious consequences. There is little evidence of any adaptation as a result of repeated exposure, and little evidence of sensitizing effects.

Sir Joseph Barcroft summed up the discussion, stressing the similarities in human reaction to any large change in his normal environment. All appear to lead to failure of co-ordination of activity in the cerebral cortex, thus producing symptoms in patterns that are often closely related; he suggested that a common factor lies behind all the reactions described, namely, that the cells of the brain are unable to continue their normal carbohydrate oxidations when the physico-chemical state of the blood supplying them is displaced from normal in any direction.

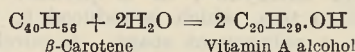
A quantitative human ecology must take into account the interaction of numerous environmental factors, and the variability of the response, as well as the influence of acclimatization or sensitization. Work done by various groups of physiologists in connexion with the War constitutes the beginning of such an ecology.

B. H. C. MATTHEWS

## THE CONVERSION OF CAROTENE INTO VITAMIN A

By DR. R. F. HUNTER

THE conversion of  $\beta$ -carotene into vitamin A which occurs *in vivo* is represented in many standard works by means of the hydrolysis equation:



Apart from the fact that we can trace no example of a hydrolytic fission of such a type in the literature, various *ad hoc* experiments on the hydrolysis of colloidal solutions of  $\beta$ -carotene with water, aqueous organic solvents in the presence of mild alkali and various emulsifying agents such as lecithin, sodium cholate, and polyglycerol esters, under pressure, have failed to furnish any evidence of the formation of vitamin A alcohol<sup>1</sup>. The mechanism of conversion is still obscure, but the 1:2-ratio for biological activity of  $\alpha$ - to  $\beta$ -carotene<sup>2,3</sup> and the similar 'half activity' of semi- $\beta$ -carotenone<sup>4</sup> and cryptoxanthin<sup>5</sup> indicate that this involves fission of the central double bond of  $\beta$ -carotene<sup>6</sup>.

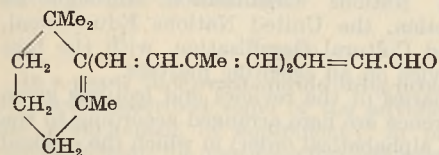
It is generally assumed that the site of the conversion is the liver. Moore<sup>7</sup> showed that when massive doses of carotene were fed to rats, it persisted apparently unchanged throughout the alimentary tract while high concentrations of vitamin A appeared in the liver. The storage of vitamin A in this organ, which plays an important part in regulating the concentration of the vitamin throughout the rest of the body, indicates that it is intimately connected with the process. Moreover, when the liver is poisoned or damaged<sup>8</sup>, there is a decrease in vitamin A forma-



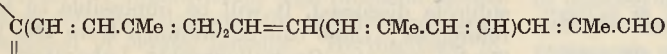


many trichloride reaction. This, however, differed from vitamin A<sub>2</sub> in that on 'cyclization' it gave a substance showing fine structure in the ultra-violet with absorption maxima displaced some 25 mμ into the region of longer wave-length from those of 'cyclized' vitamin A<sub>2</sub><sup>22</sup>.

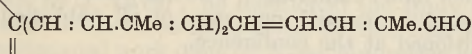
It is significant that oxidation of β-*apo*-2- and β-*apo*-4-carotenal by hydrogen peroxide in acetic acid under similar conditions to those used in the case of β-carotene failed to yield any detectable quantities of vitamin A aldehyde.



β-*apo*-5-CAROTENAL



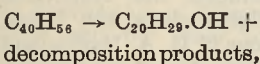
β-*apo*-2-CAROTENAL



β-*apo*-4-CAROTENAL

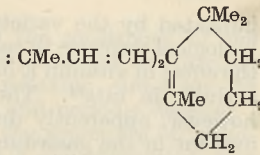
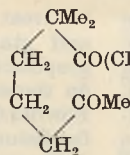
These *apo*-carotenals differ from vitamin A aldehyde (β-*apo*-6-carotenal) in possessing a methyl group on the carbon atom adjacent to the aldehyde group, but their failure to furnish vitamin A aldehyde is in agreement with the supposition that the latter is formed by direct fission of the β-carotene molecule.

As was pointed out some years ago<sup>8</sup>, any picture of the *in vivo* conversion involving attack of a double bond in β-carotene other than the central double bond with the production of two fragments, one of which is already too small to yield vitamin A



is open to objection from more than one point of view. Since it is the β-ionone ring which is preferentially attacked in the oxidation of α-carotene<sup>17</sup>, the latter would be expected to be biologically inactive on the basis

of such a mechanism of conversion of β-carotene into vitamin A. Furthermore, it would necessitate quantitative conversion of β-carotene into vitamin A in order to account for potencies in the neighbourhood of 3 million international units per gm. for the pure vitamin, which seems unlikely in a biological process in which basal diet plays such an important part. Kuhn and Brockmann's observations<sup>4</sup> that semi-β-carotenone shows growth-promoting activity in rats in daily doses of 5-10 μgm. is further evidence on the point, since oxidative degradation might be expected to proceed more readily from an already disrupted β-ionone ring.



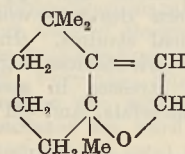
Semi-β-CAROTENONE

Further but more precise evidence of a similar type is provided by the quantitative biological assay of the pro-vitamin A activity of mutatochrome<sup>23</sup>, which Euler, Karrer and Walker<sup>24</sup> originally supposed to be β-carotene epoxide ('β-carotene oxide') (see below).

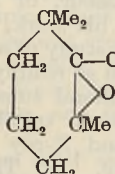
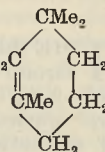
A four-point assay, involving 87 rats, designed and interpreted in accordance with modern statistical principles, indicates that mutatochrome has certainly less than 47 per cent, and probably less than 39 per cent of the activity of β-carotene<sup>25</sup>.

With regard to the general problem of oxidation of β-carotene, recent experiments<sup>26</sup> indicate that in both arachis oil and benzene solution, gaseous oxygen attacks the terminal double bond of the conjugated system yielding β-carotene epoxide, which isomerizes to mutatochrome which undergoes further oxidation to semi-β-carotenone. Further oxidation results in the attack of the second terminal double bond of the conjugated system with the production of aurochrome and β-carotenone (formulae as mutatochrome and semi-β-carotenone respectively with both ionone rings oxidized).

There is much evidence that the effective utilization of carotene in the animal body is intimately connected



MUTATOCHROME



β-CAROTENE EPOXIDE

with the presence of the glycerides of unsaturated fatty acids<sup>27</sup>, and it seems likely that the latter, in conjunction with an enzyme, play a significant part in rendering the central double bond prone to oxidation. The work of Sumner<sup>28</sup> on the relation between carotene oxidation and enzymatic peroxidation of unsaturated fats is of particular interest. Carotene is only slowly oxidized by peroxides of linseed oil, whereas its rapid oxidation in the presence of the enzyme from soya bean requires simultaneous peroxidation of the unsaturated fat.

The complexity of the problem of the mechanism of conversion of carotene into vitamin A *in vivo* is

indicated by the variety of factors which affect the biological response to carotene; such as, for example, the effect of vitamin E in increasing growth-promoting activity in rats<sup>20</sup>. The effect of the tocopherol is, however, apparently due to its function as an antioxidant in the gastro-intestinal tract, rather than as a vitamin regulating some phase of metabolism in the tissues.

- <sup>1</sup> Devine and Hunter, unpublished observations.  
<sup>2</sup> Kuhn and Brockmann, *Klin. Wschr.*, **12**, 972 (1933).  
<sup>3</sup> Wilkinson, *Biochem. J.*, **35**, 824 (1941).  
<sup>4</sup> Kuhn and Brockmann, *Ber.*, **66**, 1319 (1933).  
<sup>5</sup> Kuhn and Grundmann, *Ber.*, **67**, 593 (1934).  
<sup>6</sup> Hunter, *Chem. and Ind.*, **61**, 89 (1942).  
<sup>7</sup> Moore, *Biochem. J.*, **25**, 275 (1931).  
<sup>8</sup> Greaves and Schmidt, *Amer. J. Physiol.*, **111**, 492, 502 (1935).  
<sup>9</sup> With, *Nord. Med.*, **3**, 2901 (1939).  
<sup>10</sup> Sexton, Mehl and Deuel, *J. Nutrition*, **31**, 299 (1946).  
<sup>11</sup> Olcott and McCann, *J. Biol. Chem.*, **94**, 185 (1931).  
<sup>12</sup> Pariente and Ralli, *Proc. Soc. Exp. Biol. Med.*, **29**, 1209 (1932).  
<sup>13</sup> Woolf and Moore, *Lancet*, **223**, 13 (1932).  
<sup>14</sup> Drummond and Rea, *Z. Vitaminforsch.*, **1**, 177 (1932).  
<sup>15</sup> Drummond and MacWalter, *Biochem. J.*, **27**, 1342 (1933).  
<sup>16</sup> Wilson, Ahmad and Majumdar, *Indian J. Med. Res.*, **25**, 85 (1937).  
<sup>17</sup> Hawkins and Hunter, *J. Chem. Soc.*, 411 (1944).  
<sup>18</sup> Euler, Karrer and Solmssen, *Helv. Chim. Acta*, **21**, 211 (1938).  
<sup>19</sup> Hunter and Williams, *J. Chem. Soc.*, 554 (1945).  
<sup>20</sup> Hawkins and Hunter, *Biochem. J.*, **33**, 34 (1944).  
<sup>21</sup> Zechmeister, Le Rosen, Schroder, Polgar and Pauling, *J. Amer. Chem. Soc.*, **65**, 1940 (1943).  
<sup>22</sup> Embree and Shantz, *J. Biol. Chem.*, **132**, 619 (1940).  
<sup>23</sup> Karrer and Jucker, *Helv. Chim. Acta*, **28**, 27 (1945).  
<sup>24</sup> Euler, Karrer and Walker, *Helv. Chim. Acta*, **15**, 1507 (1932).  
<sup>25</sup> Zechmeister, Hunter and Williams, in the press.  
<sup>26</sup> Hunter and Krakenberger, in the press.  
<sup>27</sup> Sherman, *J. Nutrition*, **22**, 153 (1941).  
<sup>28</sup> Sumner, *J. Biol. Chem.*, **148**, 215 (1942).  
<sup>29</sup> Hickmann, Kaley and Harris, *J. Biol. Chem.*, **152**, 313 (1944).

## WAR-TIME PROGRESS IN X-RAY ANALYSIS

THE third annual conference of the X-ray Analysis Group of the Institute of Physics was held during July 9-11 at the Royal Institution. It provided the first opportunity since the War for crystallographers of all nationalities to re-establish contacts and to exchange information and ideas. The chairman, Sir Lawrence Bragg, was able to welcome among about 320 members of the conference no less than seventy-five foreign visitors representing fifteen different countries. In his opening address, Sir Lawrence emphasized the inadequacy of a three-day conference for a full interchange of crystallographic news and views, and he felt that the visits to laboratories arranged for the foreign visitors during the following week, as well as the intervals between official sittings of the conference, should provide additional opportunities for personal discussions. In this spirit, too, the official dinner which took place at Frascati's on the night of July 10 was an outstanding success.

At the general meeting of the X-ray Analysis Group, Sir Lawrence Bragg reported on the previous year's activities of the Group and on the forthcoming discussions about the possible inauguration of an international crystallographic journal. The conversion factor of 1.00202 from kX. units of X-ray wave-length to Å. (Ångströms) was agreed on in conformity with a similar decision by the American Society for X-ray and Electron Diffraction. Dr. W. H. Taylor reported on steps undertaken to make crystallographic X-ray tubes more readily available

in Great Britain and outlined plans for encouraging and standardizing the manufacture of crystallographic instruments. Dr. A. J. C. Wilson reported on the success of the first supplement to the X-ray Powder Index and appealed for further contributions for future supplements.

During the course of the first official session, Prof. P. P. Ewald extended a welcome to the meeting on behalf of the International Union of Pure and Applied Physics. He took the opportunity to outline the purpose of the Union in promoting the interests of physicists the world over, and emphasized its special task in co-operating with its sister unions to provide the United Nations Organisation, through its scientific section, the United Nations Educational, Scientific and Cultural Organisation, with the best available advice on all scientific matters.

The summaries of the reviews and lectures given at the conference are here arranged according to the countries (in alphabetical order) in which the original work had been carried out. Owing to the diverse subjects discussed, it will be impossible to include references; these can be obtained from Dr. W. H. Taylor (at the Crystallographic Laboratory, Free School Lane, Cambridge), who has asked contributors to supply him with one copy of all published work mentioned at the conference.

### Belgium

Prof. G. A. Homès described the work on X-ray diffraction carried out in Belgium during the War. The Engineering College at Liège opened a "Centre for the Internal Physics of Metals"; lectures held there had a marked influence on the application and development of X-ray methods for industrial purposes.

New methods and apparatus—including several new camera designs—were employed for use in metallurgical studies. Investigations were carried out on the orientation of grain boundaries, the effect of elastic stresses in steel, lattice distortions in welded materials, and on the sintering of metallic powders.

Work on non-metals included the systematic studies of P. Theys on Belgian clays and baked ceramics, and the investigations of G. A. Homès and S. Lefevre on the polymerization of phenolic plastics.

Prof. H. Brasseur, of Liège, himself elaborated some aspects of his work, which included: (a) The crystal structure study of a complex cyanide, crystals of which twinned so readily as to be flexible. (b) The study of the mineral substance of bones with particular reference to tricalcium phosphate hydrate, the structure and X-ray pattern of which closely resemble apatite. (c) The measurement of bond angles in some organic compounds containing two benzene rings joined by one or more intermediate atoms.

### Czechoslovakia

Prof. V. Petržílka gave a brief summary of work done in Czechoslovakia, which was concerned chiefly with the study of metals; but interest also lay in the determination of orientation of quartz crystals, and in foundry problems such as radiography (often employing radium or radon) of welds and castings.

Dr. Adéla Kochanovská described a new method for determining anisotropic deformations of polycrystalline cubic metals subjected to internal or external stresses.

## Finland

Dr. J. A. Wasastjerna described how he had shown by very accurate experimental determinations of atomic scattering factors in alkali halides that, in the pure substances, the values of the mean squares of the displacements of ions from their theoretical positions are almost completely accounted for by thermal vibrations. In mixed crystals, however, his results showed that there were additional mean displacements of ions due to both long- and short-range disturbances. The experimental values of these two kinds of displacements indicated the existence of a certain degree of local order.

## France

In a paper on French work during hostilities, Prof. J. Wyart described some of the advances made in the development of equipment; in particular of curved crystals for obtaining focused, monochromatic radiation, and of apparatus for high precision lattice parameter determination and for the determination of orientation of crystal lamellæ. He discussed in detail the important investigations on diffuse X-ray scattering by J. Laval; he mentioned the study by A. Guinier of the extra spots given by diamond, and the experimental work done on X-ray absorption and emission spectra by Kurylenko and Mlle. Cauchois, and went on to describe work done on reactions in solid phases, such as dissociation of oxides of cadmium, zinc and iron, and adsorption of hydrogen on palladium. He also mentioned structure determinations done on calcium, barium and strontium mixed carbonates, a Mn-As alloy and others.

Prof. J. J. Trillat, continuing the review of French work, described two new methods of electron micro-radiography, both of which depend upon the photographic effect of secondary photo-electrons rather than of X-rays. The first method, that of electron radiography by reflexion, enables micro-radiographs to be made on finished materials. Very thin films of the Lippmann type are applied to the surface under investigation, which is irradiated by hard X-rays. The photographs so obtained can be used to study the distribution of different metals on the surfaces of alloys and for other topographical investigations. The second method, electronic radiography by transmission, was used in order to obtain radiographs of very thin films, for example, plant tissues, paint films, etc. Here, the material was crossed by photo-electrons emitted from a metallic surface against which the film was pressed. Examples of application of both methods were shown, and further possible developments discussed.

Prof. Trillat also made a brief reference to the electron microscopes both with magnetic and electrostatic focusing which had been constructed in France.

Dr. A. Guinier gave an account of the work carried out in France during the War on the application of X-ray analysis in the fields of chemistry and metallography. He described the studies of M. Mathieu and Mlle. T. Petitpas on nitrocellulose, of Trillat and R. Tertian on the natural and synthetic rubbers, and his own work on measurement of particle size.

The metallographic work carried out may be divided into work on crystalline textures, and on the crystal structure of alloys. Under the former heading an extensive study was made by R. Jacquesson on the effect of torsion on a monocrystalline rod, and P. Lacombe and L. Beaujard studied the surfaces of single metal crystals. Under the second heading,

improvements were made in the sensitivity of the detection of crystalline phases, and the use of scattering outside the selective reflexion directions for studying lattice irregularities and periodic defects:

Dr. Mladen Paic explained the principles of 'radioanalysis', namely, analysis by X-ray absorption, and its application to the study of segregation and diffusion of heavy components in aluminium alloys.

## Germany and Austria

Dr. R. C. Evans, who had recently returned from an extensive tour of numerous crystallographic laboratories in Germany and Austria, was greatly impressed by the excellence of the equipment and by the generous scale on which it had been available in many diverse academic and industrial centres. It was the more disappointing that remarkably few advances in fundamental research had been achieved. A notable exception was the precision determination of electron density maps in simple structures, as for example that of oxalic acid dihydrate, where the parameter values obtained differ significantly from previously reported results. Dr. Evans painted a vivid picture of present conditions in the laboratories he had visited, where research is proceeding in the face of almost unimaginable difficulties.

## Great Britain

Dr. K. Lonsdale described the work done in Great Britain during 1939-46 on the modification of scattering power of crystals due to the thermal vibration of the atoms, the changes that take place during the progressive dissociation of an alloy into its final phases, the phenomena that accompany age-hardening at various temperatures, and the causes of line-broadening on powder photographs of cold-worked metals, and of cobalt and  $\text{AuCu}_3$ . She referred to the extra lines on photographs of graphite, known to be due to the presence of a second structure, and to the extra reflexions, as yet unexplained, given most strongly by diamonds, the perfection of which can be demonstrated by the divergent-beam method; and finally, she described the very small changes of structure that accompany the anomalous electrical properties found in certain temperature regions for Rochelle salt, potassium dihydrogen phosphate and arsenate, and barium titanate.

In discussion, Prof. M. Born expressed a doubt if there was such a thing as a perfect single crystal larger than a thousand units in each direction, since the unsymmetrical vibrations will cause the atoms to be quite out of step over larger intervals.

Prof. J. D. Bernal gave an account of crystal structure determinations made in Great Britain during the period 1939-46. Complete structure analyses of relatively simple organic molecules and of molecular complexes yielded valuable accurate information on intermolecular and intramolecular bond character (J. M. Robertson and co-workers, Cox and Jeffries, H. M. Powell and co-workers). With more complex compounds, it is the detailed stereochemical relations that have been determined, as for example in the work on the sugars and on cholesteryl iodide.

These determinations and others have depended upon notable advances in the technique and methods of crystal analysis developed at the same time. The elucidation of the structure of penicillin (Hodgkin and Rogers; Bunn and Turner-Jones) exploited many of these advances, especially the development

by Bunn of Sir Lawrence Bragg's 'fly's eye' method, and the use of the Hollerith technique for the calculation of three-dimensional Fourier series (L. J. Comrie).

Bunn and co-workers investigated the structures of some natural and synthetic polymers. Further work was done by Perutz and by Mrs. Hodgkin and her co-workers on the internal structure of the protein molecule.

Prof. W. T. Astbury, in the third British review, spoke on fibrous proteins of the keratin-myosin group which show reversible intermolecular elasticity. He stated that fibrin, fibrinogen and the muscle protein tropomyosin, discovered by Bailey, belong to the group. X-ray work has included an analysis of the complete fibre pattern of porcupine quill by MacArthur, and a study of living muscle at various stages. The X-ray interpretation of the denaturation of corpuscular proteins as an unfolding of specific configurations is now made use of in the production of fibrous from corpuscular proteins. He mentioned work done by R. D. Preston on the structure of the plant cell wall, by Rudall on the chitin-protein complex of the insect cuticle, and by Hanes on the preparation and structure of synthetic starch.

Dr. W. Hume-Rothery showed an elegant apparatus for the preparation, in an argon atmosphere, of filings suitable for very accurate lattice parameter determinations.

Sir Lawrence Bragg gave an entertaining evening lecture on the bubble model which he has devised as a two-dimensional representation of the arrangement of atoms in a metal. It illustrated clearly their behaviour under stress and on annealing, as well as the effects of an impurity and of a dislocation in the structure. A short film showing the model in operation was seen at the end of the lecture.

#### Holland

Prof. J. M. Bijvoet gave an account of the X-ray crystallographic work carried out in Holland during the War (Part III, Chemistry in Wartime in the Netherlands, published under the auspices of the Netherlands Chemical Society).

Structures determined by trial and error methods based on two-dimensional Patterson syntheses have included: (a) the investigation of allotropic modifications (example,  $P_2O_5$  ( $P_4O_{10}$ )); (b) order-disorder transitions and the structures of high- and low-temperature modifications (examples, sodium nitrite, sodium cyanide); (c) further inorganic structures including lithium and ammonium cyanides; and (d) the structures of organic compounds including hexabromoethane and adipic acid.

New methods of structure determinations and further refinements of existing methods were developed. They included the use of isomorphous structures, as in the work on Br-, Cl- and CN-camphor, the application of artificial temperature factors in the summation of incomplete Fourier series, and the use of the background blackening in fluorescent Weissenberg diagrams for the determination of absorption factors.

The lattice defects and diffuse Laue spots in crystals of tetragonal tin were investigated. Work was also done on recrystallization phenomena in metallic crystals.

Important mathematical-physical contributions were also made to the theory of order-disorder transitions.

#### India

Sir K. S. Krishnan gave an account of the theory of electrical resistivity of metals in terms of the scattering of electron waves passing through them. On the basis of the analogy between X-ray and electron scattering, calculations of specific resistances and of the temperature changes in resistance were made by Krishnan in collaboration with A. B. Bhatia for a number of special cases. Close agreement was found between the observed and calculated effects. The large resistance of polyvalent metals in the liquid state was accounted for, and results of some interest obtained for the electrical resistivities of order-disorder alloys of the  $\beta$ -brass type over a wide range of temperatures.

#### Norway

Prof. O. Hassel described electron diffraction work in Norway on glasses and liquids, using a rotating-sector to modify the background and hence to get more detail in the low-angle range.

#### Sweden

The diverse researches carried out in Sweden during the War years were described by Prof. I. Waller and Dr. L. G. Sillén. Besides developing a new type of electrical Fourier summation machine, Prof. Hägg and his co-workers at Uppsala have carried out comprehensive crystal structure studies on inorganic compounds. This and similar work reported from the Institute of Inorganic and General Chemistry of the University of Stockholm is too varied to be described even in summarized form within the space here available. At the latter laboratory some binary alloy phases had also been studied.

Prof. Waller also described the widespread use of focusing cameras in Sweden, his work on the breadth of powder lines and on diffuse, thermal reflexions. X-ray investigations on the kinetics of order-disorder transformations were carried out in the Department of Physics of the Technical University of Stockholm.

#### United States of America

Dr. R. W. G. Wyckoff presented a survey of the development of electron microscopes, which are now available commercially to suit both routine and research investigations, and of techniques for specimen preparation. High-speed microtomes permit the investigation of thin sections of rubber, polymers and biological tissues. The most striking advances, however, have been made in the methods of replica production, especially using oblique metal shadowing to enhance contrast. Dr. Wyckoff showed a wealth of photographs of macromolecules obtained in this way, in which the shapes and sizes of the molecules are clearly discernible. Using single crystals of virus proteins, it is possible to observe directly the molecular details of crystal formation. This constitutes a new direct method of crystal structure analysis, and Dr. Wyckoff looked forward to a fruitful co-operation between electron microscopists and X-ray crystallographers studying low-angle diffraction phenomena.

Prof. W. H. Zachariassen gave some account of the crystal chemistry of plutonium and neptunium. In the Manhattan Project he had carried out partial or complete crystal structure determinations on a large number of compounds of rare earth elements, thorium, uranium, neptunium and plutonium. The chemical identity of most of these compounds was

deduced from their X-ray diffraction patterns, and a knowledge of the method of preparation. The elements uranium, neptunium and plutonium are closely related crystal-chemically in all known valence states. They are closely related to thorium and particularly cerium in the tetravalent state, and to the elements lanthanum...samarium in the trivalent state. A formal valency of two is shown by cerium, thorium, uranium, neptunium and plutonium in some compounds, the structures of which are of the interstitial type.

In the discussion which followed, Mr. H. S. Peiser said that some work on uranium compounds had been done in England, and raised the question of the value to be taken for the atomic radius of uranium.

Dr. D. Harker began with an account of X-ray work on metals done in the United States. He gave a short description of the work of C. S. Barrett on X-ray topographs which show the variation of perfection over the surface of a crystal, and went on to mention investigations on the problem of age-hardening of aluminium-silver and gold-copper alloys. He concluded with some remarks about the mechanism of crystal orientation in iron-silicon sheet.

Prof. L. O. Brockway spoke about electron diffraction work. He described some commercial types of apparatus available in the United States, in two of which great space-saving has been achieved by using a high-frequency unit for the generation of high voltage. He gave examples of results achieved, first in the structure of organic liquids and then in the study of monomolecular layers on polished metal surfaces. He emphasized the fact that different patterns may be obtained from X-ray and electron diffraction studies of the same substance, but to get full information both techniques should be used.

Dr. D. MacLachlan described the principle of construction of a machine for the mechanical computation of two-dimensional Fourier series. It depends upon the spreading of layers of sand in sinusoidal waves over a scale plan of the unit cell, so that the height of the sand layer at any one point is proportional to its relative electron density.

AUDREY M. B. DOUGLAS (PARKER)

H. S. PEISER

BARBARA W. ROGERS (LOW)

## OBITUARIES

Prof. John Laird, F.B.A.

PROF. JOHN LAIRD, regius professor of moral philosophy in the University of Aberdeen since 1924, died on August 5 at the age of fifty-nine. He had been in bad health for some time, but a paper read for him at a conference in July showed no falling off in clarity and incisive wit.

Laird was born on Deeside, not far from the birth-place of Reid, also a son of the manse. He studied philosophy at Edinburgh under Pringle-Pattison and Seth, and then went on to Cambridge, where he was a scholar of Trinity College. The idealism of his Scottish teachers was less congenial to him than the critical, analytic temper of Moore and Russell at Cambridge, though it may have helped him to avoid the extreme, where that temper turns into a one-sided and rigid metaphysics expressed in negations.

Laird's own philosophical temper is well seen in his

book reviews, of which he wrote very many. He approaches each author prepared to examine his position on its merits and in its own terms, and as nearly as possible without prejudice, except a prejudice against anything sloppy, pretentious or obscure. The two volumes of his Gifford Lectures delivered in Glasgow ("Theism and Cosmology", 1940; "Mind and Deity", 1941) display that temper on the large scale. Laird set himself to examine the philosophical arguments that have been used to support theism. Carefully, systematically, relentlessly he winnows the chaff from the wheat; at the end, almost disappointed that his work is ended, and there is actually some wheat left. It seems unlikely that anybody will need to do this work again for a long time, and until that time nobody can consider himself a competent student of the subject without reading Laird. The only defect one can point to is a tendency to avoid any aspect of his subject which is not capable of clear statement in abstract terms. This kind of limitation is present, but is scarcely a defect, in his last book ("The Device of Government", 1944), an admirable elementary discussion of political theory. The work which is perhaps the most comprehensive and distinctive of any that Laird wrote is "The Idea of Value" (1929); a specially useful contribution to thought, constructive as well as critical, because so much recent philosophy is centred on the notion of value, and no previous writer has dealt with the subject as a whole.

There are few aspects of philosophy which Laird left untouched, though his main interest was in ethics; and he wrote a great deal. In these days when a reputation for profound scholarship can be earned by writing nothing or by making it unreadable, so prolific and easy a writer is suspected of being superficial. Such a judgment of Laird is entirely unwarranted. Moreover, it is hard to find any signs of carelessness or haste in his writing, and he repeated himself less than most. Four or five of his books have it in them to become classics, and it may well be that future generations will read them when contemporary works now more popular are quite forgotten.

A. D. RITCHIE

Prof. B. H. Bentley

THE death was announced on June 24 at the age of seventy-three of Prof. Bertram H. Bentley, emeritus professor of botany in the University of Sheffield. A scholar of Keble College, Oxford, Prof. Bentley secured a first class in natural sciences in 1896. Going to Sheffield as assistant lecturer in biology in Firth College, he helped to mould the fortunes of the young university and served it until his retirement in 1939. As the number of botany students under his care increased, he was appointed lecturer in botany in 1905 and eventually became head of a newly formed Department of Botany; but it was not until 1931 that the University appointed him to a full professorship.

Although of an inquiring mind and demanding a critical approach from his students, Prof. Bentley will be remembered for his teaching rather than his original work. Much influenced by A. H. Church, for whom he had the greatest respect, and by the distinguished contributions of Bower and others to the study of phylogenetic problems, his teaching was based always on a morphological approach, and he took pains to see that his students were well grounded

in this aspect of botany. The great advances in physiology and genetics which marked the later years of his life never seemed to capture his imagination in the same way.

Prof. Bentley was a real lover of plants, in the field and also in the garden and allotment which he tended with such care. He took pleasure in bringing in fresh material of all kinds for his students to examine, and was always anxious that they should not accept without question the text-book accounts of familiar plants. He showed great skill in Nature photography and illustrated his lectures with many slides of his own making. Before his retirement, a

good deal of his time was spent in the devoted care of his wife who, following overstrain in the First World War, was somewhat of an invalid. His own latter years in Cheltenham were clouded by her death and by the gradual loss of his eyesight.

WE regret to announce the following deaths :

Nikolai Morozov, honorary member of the Academy of Sciences of the U.S.S.R., known for his general writings on scientific topics, on July 13, aged ninety-two.

Mr. H. G. Wells, on August 13, aged seventy-nine.

## NEWS and VIEWS

### Mathematics at Edinburgh :

Sir Edmund Whittaker, F.R.S.

ON September 30, Sir Edmund Whittaker vacates the chair of mathematics in the University of Edinburgh, which he has held for a third of a century. Educated at Manchester Grammar School and Trinity College, Cambridge, he was second wrangler (equal with J. H. Grace), Bromwich being senior wrangler; afterwards, he was first Smith's Prizeman and he was elected to a fellowship at Trinity in 1896. Much of Sir Edmund's earlier scientific interest centred in theoretical astronomy, particularly in celestial mechanics; during 1901-7 he was secretary of the Royal Astronomical Society and in 1906 he was appointed Royal Astronomer of Ireland. Although his election to the chair of mathematics at Edinburgh in 1912 terminated his official astronomical career, Sir Edmund retains a lively interest in theoretical astronomy, particularly, in these latter days, in the problems of relativistic cosmogony to which he has made some notable contributions, among which may be mentioned his Riddell Lectures at Durham in 1941 on "The Beginning and End of the World". One of his achievements at Edinburgh was the institution of a Mathematical Laboratory in which students obtained a training in the science and practice of computing; the "Calculus of Observations" written by him in collaboration with G. Robinson (a member of his staff) is now the standard work in this field of mathematical discipline. Sir Edmund's other books are "Modern Analysis" (with G. N. Watson), "Treatise on Analytical Dynamics", "Theory of Optical Instruments" and the "History of the Theories of the Aether and Electricity". When Sir Arthur Eddington died in 1944, he left a nearly completed manuscript of a book on "The Fundamental Constants of Nature"; there could only be one choice of editor to see the book through the press, and Sir Edmund has given his time unsparingly in this cause, now nearing fruition.

Sir Edmund was elected to the Royal Society in 1905 and was awarded the Sylvester Medal in 1935. He was president of the Mathematical Association in 1920-1, president of Section A of the British Association in 1927 and president of the London Mathematical Society in 1928-29, being De Morgan Medallist in 1935. During 1939-44 he occupied with distinction the presidential chair of the Royal Society of Edinburgh; it is not too much to say that the

Society owes an immeasurable debt to him for maintaining its activities at the highest level during these difficult war years. He has received honorary degrees from several universities and his knighthood in 1945 came as a fitting reward for a life of devoted service and notable achievement.

Dr. A. C. Aitken, F.R.S.

DR. ALEXANDER CRAIG AITKEN has been appointed to succeed Sir Edmund Whittaker as professor of mathematics in the University of Edinburgh.

Dr. Aitken, who was born at Dunedin, New Zealand, in 1895, graduated at the University of Otago, and went in 1923 as a research student to Edinburgh, where his subsequent life has been spent. After two years he submitted a thesis of such quality that, on the recommendation of the examiners, the Senatus awarded him the degree of D.Sc. instead of the Ph.D. for which he had entered. He was then appointed to the staff, and in recent years has attracted a steady flow of research students from all over the world. An original impetus towards numerical mathematics doubtless came from his own extraordinary powers in mental arithmetic: for the benefit of those who are not gifted in this way, one of his earliest achievements was to devise methods by which most of the problems with which the practical mathematician is confronted can be reduced to repetitions of a process peculiarly suited to an arithmometer, namely, a cross-multiplication followed by a division. His original papers of the last twenty years have effected notable advances in the theory of matrices and determinants, and the mathematical theory of statistics; and there have been occasional irruptions into other branches of mathematics, such as his remarkable theorem which comprehends in one formula Taylor's theorem and the other expansion-theorems which involve derivatives, all 'single-line' difference interpolation formulæ, and a multitude of other possibilities.

### Physiology at Manchester : Prof. W. Schlapp

DR. WALTER SCHLAPP, who will succeed Prof. H. S. Raper (see *Nature* of August 17, p. 233) in the Brackenbury chair of physiology at the University of Manchester, received his early training in Edinburgh. He first studied chemistry under Sir James Walker and then physiology under Sir Edward Sharpey

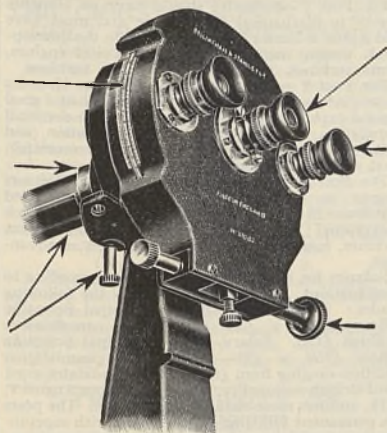
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**CIVIL SERVICE COMMISSION**

The Civil Service Commissioners invite applications for the posts of Superintendent at the Royal Aircraft Establishment, South Farnborough, Hants, under the Ministry of Supply.

Post 1. Superintendent of the Chemistry Division.

The successful candidate will be expected to supervise research and development on non-metallic materials used in aircraft and associated aircraft equipment. Applicants should have the following qualifications: (a) an established reputation for research in some branch of chemistry preferably with a slight bias towards its physical aspects. (b) A general acquaintance with the Universities and other United Kingdom Government or Industrial Research Laboratories or Associations. (c) D.Sc. or F.R.I.C. (d) Experience of the organization and administration of research. Some experience of Departmental procedure is preferable but not essential.

Post 2. Superintendent of a Division dealing with Flutter, Aero Elasticity and General Airframe Vibration.

The successful candidate will be expected to supervise research work in the subjects mentioned above and give guidance in the application of new principles to existing aircraft and to new designs. Applicants should have the following qualifications: (a) An honours degree in engineering, mathematics or physics. (b) Research experience supported by original scientific reports and patents. (c) Experience in flutter work. A general knowledge of aerodynamics and aircraft design is also desirable.

Post 3. Superintendent of the Metallurgy Division.

The successful candidate will be expected to supervise research and development of metals used in aircraft and associated aircraft equipment. Applicants should have the following qualifications: (a) An established reputation for research in aircraft metals with the qualification D.Sc., or alternatively an honours degree in physics and specialist experience in research on metals. (b) A general acquaintance with the Universities and other United Kingdom Government or Industrial Research Laboratories or Associations. (c) Experience of the organization and administration of research. Some experience of Departmental procedure is preferable but not essential.

These posts carry the rank of Senior Principal Scientific Officer, for which the London salary scale is £1,200 x £50-£1,400. This scale is subject to deduction in the case of appointments outside London. The deduction varies according to the location and salary, and for the posts advertised is £100 throughout the scale. The salary will be increased by a consolidated addition (in place of War Bonus) which on this scale is £120. The posts carry superannuation benefits under the Federated System for Universities. Candidates must be of British nationality and not more than 50 years of age. They must possess the stipulated qualifications and experience.

Further details, together with application forms, may be obtained from the Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1611, with whom completed applications must be lodged by September 30, 1946.

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Post 3. Principal Scientific Officers (Mechanical Design Engineers).

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For Post 2 candidates should have an Honours Degree in electrical engineering and have had a good general experience in the design of a large electrical installation, knowledge of design, installation, and maintenance of switchgear and circuits essential; good research background preferred.

For Post 3 candidates should have an Honours Degree in Mechanical Engineering, with good experience in development and design, and a research background; knowledge of diesel engines, steam turbines, marine engines, or gas turbines an advantage.

Salaries for these posts will be fixed according to qualifications, age and experience in the following grades: Salary (men)—Senior Principal Scientific Officer £1,100 x £50-£1,300, plus consolidation addition £120. Salary (men)—Principal Scientific Officer £750 x £30-£1,020, plus consolidation addition ranging from £90-£105. Candidates must be of British nationality, born on or before August 1, 1915, and not more than 50 years of age. The posts are permanent full time appointments with superannuation provisions under the Federated Superannuation Scheme for Universities.

Further particulars and forms of application are obtainable from the Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1613, to whom completed applications must be returned not later than September 15, 1946.

**CIVIL SERVICE COMMISSION**

The Civil Service Commissioners announce that a special competition will be held for appointments as Probationary Assistant Engineer (Male) in the Engineering Department of the Post Office. Approximately 50 vacancies will be filled by competitive interviews spread over a period of two or three years. Every candidate must normally have passed an examination qualifying for an honours degree in engineering or possess qualifications equivalent in the opinion of the Civil Service Commissioners, but exception to this rule will be made in special cases, for details of which candidates should consult the regulations governing the competition. Candidates must have been born on or after March 2, 1915, and have attained the age of 20 by January 1 of the year in which they compete. Allowances will be made for service in H.M. Forces prior to September 3, 1939, or as Assistant Traffic Superintendent in the Post Office, the latter allowance being subject to a maximum of five years. The starting pay for men in London will range from £353 to £541 per annum, according to age, rising to £685 per annum by annual increments. There will be prospects of promotion to higher grades. Candidates now serving in H.M. Forces must send in their application forms in time to reach the Civil Service Commission not later than four months after the completion of their service. All other candidates must send them in by October 1, 1946. (Service candidates may apply without regard to the date of their release in Class "A".)

Copies of the regulations and forms of application may be obtained from the Secretary, Civil Service Commission, Burlington Gardens, London, W.1, or from the Chief Officer, Civil Service Commission, at the following addresses, quoting No. 1501: (India) 10 Underhill Lane, Delhi; (Egypt) 9 Sharia El Birgas, Cairo; (Italy) c/o Headquarters, No. 3 District, C.M.F.; (Germany) c/o 2nd Echelon, G.H.Q., B.A.O.R.

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STANLEY DUMBELL,  
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A. A. MACIVER, C.A., F.H.A.,  
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Applications, giving details of age, qualifications and experience, together with copies of not more than three testimonials, and endorsed "Assistant to the City Analyst," must be delivered at my office not later than Monday, September 9, 1946.

O. A. RADLEY,  
Civic Hall, Leeds, 1. Town Clerk.

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Further information may be had from the Chief Education Officer, Nelson Square, Bolton, to whom applicants should send full particulars of training and experience, with dates, together with copies of not more than three recent testimonials as soon as possible.

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Persons desirous of being considered for the office are requested to lodge their names with the Secretary to the University on or before September 14, 1946.

The conditions of appointment and form of application may be obtained from the undersigned.

H. J. BUTCHART,  
Secretary.  
The University,  
Aberdeen.**UNIVERSITY OF ST. ANDREWS**

The University Court of the University of St. Andrews invites application for appointment as Professor of Natural Philosophy and Director of the Physics Research Laboratory in the United College, St. Andrews. The stipend at present attached to this appointment is £1,150 per annum together with F.S.S.U. benefits. Further particulars may be obtained from the undersigned, with whom one copy of the application, together with testimonials or names of referees, should be lodged not later than September 30, 1946.

DAVID J. B. RITCHIE,  
Secretary.  
The University,  
St. Andrews.**SOUTH-WEST ESSEX TECHNICAL  
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SESSION 1946-47

Full-time Courses are provided for the University of London (External) Degrees in Science, Engineering, Economics and Commerce. Opportunities are available for full-time or part-time post-graduate research.

Next Session commences on Wednesday, September 11, 1946. All communications regarding these and other courses should be addressed to the Principal.

**BATTERSEA POLYTECHNIC**

LONDON, S.W.11

LECTURER IN PHYSICS

The Governing Body invite applications for the post of Lecturer in Physics. Candidates should have high academic qualifications and be capable of teaching the subject to Honours Degree standard. Salary in accordance with the London Burnham Scale for Technical Teachers. Further particulars may be obtained from the Clerk to the Governing Body, by whom applications should be received as soon as possible.

**THE CHRISTIE HOSPITAL AND  
HOLT RADIUM INSTITUTE**

WITHINGTON, MANCHESTER 20

Assistant Physicist required. Preference will be given to applicants having experience with Radium and high voltage X-ray and vacuum technique. Duties include research work. Salary in accordance with the Hospital Physicists' Association Scales. Applications stating age, qualifications, experience, and copies of two recent testimonials to be sent to the Superintendent not later than September 7.

**KING'S COLLEGE OF HOUSE-  
HOLD AND SOCIAL SCIENCE  
(UNIVERSITY OF LONDON)**

CAMDEN HILL ROAD, W.8.

Applications are invited for appointment as part-time Assistant Lecturer and Demonstrator in Physics for the Session 1946-47.

Applications, together with copies of testimonials, should reach the Secretary (from whom further details may be obtained) not later than September 13, 1946.

**THE UNIVERSITY OF  
MANCHESTER**

BEYER CHAIR OF ENGINEERING

Applications are invited for appointment to the above post in the Faculty of Science. Stipend: £1,300 to £1,600 per annum, according to qualifications. It is hoped that the successful candidate will enter upon his duties on September 29, 1947. Candidates should possess qualifications in Civil or Mechanical Engineering or in both.

Applications, which must be received on or before November 1, 1946, should be sent to the Registrar, the University, Manchester, 13, from whom further information may be obtained.

**CHELSEA POLYTECHNIC**

MANRESA ROAD, LONDON, S.W.3

Required, full-time Lecturer in Chemistry up to B.Sc. standard. Salary will be paid in accordance with the Burnham Scale for Technical Teachers. Full particulars together with application forms may be obtained by sending a stamped addressed foolscap envelope to the Principal of the Polytechnic, to whom applications must be returned not later than September 2.

F. J. HARLOW, M.B.E., Ph.D., B.Sc.,  
Principal.**UNIVERSITY OF READING**

FACULTY OF SCIENCE

Applications are invited for the post of Assistant Lecturer in Geology. Initial salary £350 to £400 per annum according to qualifications and experience. Applications should be submitted not later than September 16, 1946, to the Registrar, from whom further particulars may be obtained.

**UNIVERSITY OF TASMANIA**

Applications, closing September 30, 1946, are invited for appointment as Lecturer in Zoology. Salary according to qualifications within scale £500 to £675. Method of application and conditions are available from Universities and from the Agent-General for Tasmania, Australia House, Aldwych, London, W.C.2.

**THE WELSH NATIONAL SCHOOL  
OF MEDICINE**

Grade B III Laboratory Technician, Histological Technique essential, required in Pathological Department, commencing salary £300 per annum. Apply Secretary, 10 The Parade, Cardiff.

**CLIFTON COLLEGE**

BRISTOL, 8

Young man required for Physics laboratories, chiefly for maintenance and repair of instruments. Some knowledge of metal work necessary. Apply, Head of Science Department.

**Chief Chemist required by milling concern in Nairobi.** Consideration given only to qualified chemists experienced in the control of flour milling and rations for livestock. Applicants must be conversant with the latest developments in the field of cereal chemistry and capable of initiating research work. Salary in the region of £1,000 per annum. Reply to Box 668, T. G. Scott & Son, Ltd., 9, Arundel Street, London, W.C.2.**Applications are invited from Scientists**

qualified to fill the position of Director of the Department of Scientific and Technical Liaison, of the International Wool Secretariat. Qualifications must include a good University degree in Science with Honours, organizing and recent research experience, and the ability to operate as a link between pure and applied research workers, technicians and the public. Editorial experience will be valuable. This is not a research appointment. This Department, at the Headquarters in London, is now being constituted, and the Director will be able to assist in its creation and expansion. The liaison covers the full range of wool production, manufacture and treatment, and Assistants to supplement the range of the Director will be appointed subsequently. The Salary is £1,000 per annum. A good superannuation scheme operates.

Applications should be forwarded before August 31 to The Secretary, The International Wool Secretariat, Grand Buildings, Trafalgar Square, London.

**Consultant required by the Govern-**

ment of Iraq for the Irrigation Development Commission to study and advise on problems of reclamation and to undertake soil surveys. Appointment would be for two years in the first instance. Salary between Iraq Dinars 150 and Iraq Dinars 225 a month according to qualifications and experience, plus high cost of living allowance Iraq Dinars 24 a month (I.D. 1 = £1 sterling). Free passages. Candidates must hold a first or second class Honours Degree in Physical Chemistry or be Fellows or Associates of the Royal Institute of Chemistry. Knowledge and experience of agricultural chemistry and of the reclamation of saline and waterlogged lands are essential.

Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience to the Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M/N/16738.

**The Council of The Gas Research**

Board invites applications for the position of Joint Assistant Director. The applicant should be an Honours graduate in physics, with advanced research experience in such fields as thermodynamics, fluid flow and surface action. (Graduates in physical chemistry with research experience in the above fields will also be considered.) The candidate must be capable of taking administrative charge of a number of investigations. Commencing salary £1,250 per annum plus war bonus which is at present £62 per annum.

Apply in the first instance to the Secretary, The Gas Research Board, 1 Grosvenor Place, London, S.W.1.

**The Medical Research Council have**

a vacancy at their Department for Research in Industrial Medicine at the London Hospital, Whitechapel, E.1, for a Chemist to take responsibility for the environmental side of the Department's work. Applicants should have considerable experience in and knowledge of inorganic analytical chemistry. Starting date, as soon as possible. Salary according to qualifications and experience.

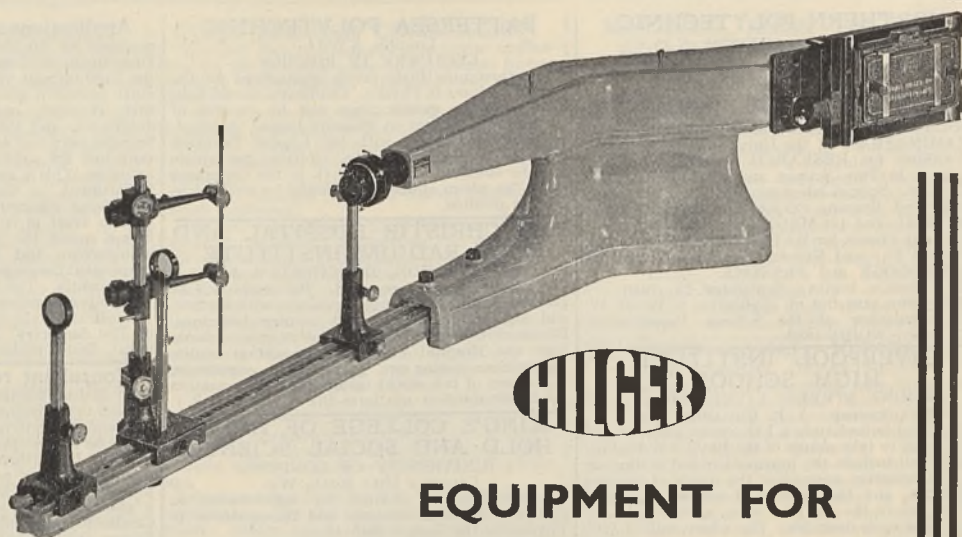
Applications giving the names and addresses of three referees to be sent to the Physician in Charge, Department for Research in Industrial Medicine, London Hospital, Whitechapel, E.1.

**May & Baker, Ltd., require one or two Organic Chemists for Research and Development work in the field of medicinal and fine chemicals.** The posts offer excellent opportunities for men of ability and originality to develop their ideas. Candidates must have a good Honours Degree in Chemistry and preferably a Research Degree, and in any case not less than five years post-graduate Research or Development experience. Age 26-32. Salary in accordance with qualifications and experience. Apply initially in writing, giving full details of qualifications and experience to: Personnel Officer, May and Baker, Ltd., Dagenham, Essex.**Two assistants, preferably with entomological interests, either sex, required to assist in research work and to look after insect cultures.** Applicants, who must have completed their national service, will be appointed to the Assistant Experimental Officer grade as applicable to the Scientific Civil Service. The commencing salary, including bonus, will be not less than £218 for men and £203 for women per annum.

Applications to: The Director, Agricultural Research Council, Unit of Insect Physiology, 34A Storey's Way, Cambridge.

**Production Chemist required to assist Departmental Manager in Chemical Manufacturing firm, East London.** Quals. A.R.I.C. or B.Sc. degree, with 3 years' experience of control and production in a Chemical Works. Salary £475. Position offers good prospects and is permanent. Box 669, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

(Continued on page lviii.)



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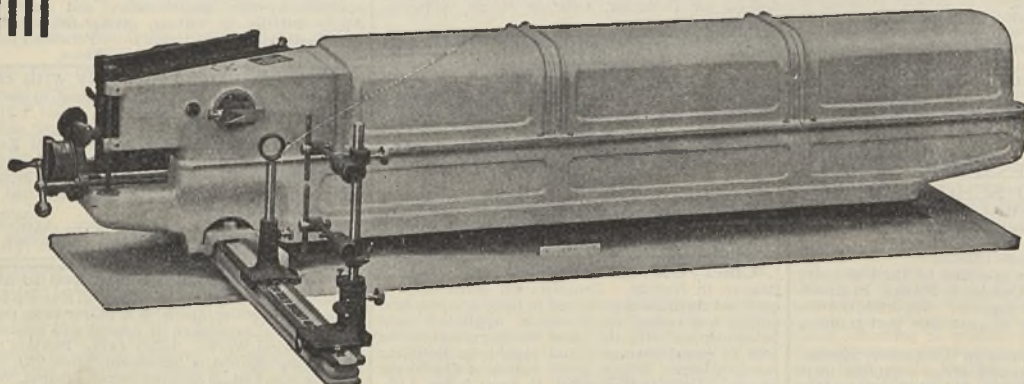
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Schafer, for whom he acted as assistant. After a year as Carnegie Research Fellow, at the end of which he obtained his Ph.D., he took up the study of medicine and graduated M.B., Ch.B. in 1929. In the following year he was appointed assistant lecturer in pharmacology in the University of Manchester. He was next transferred to the department of physiology as lecturer and afterwards appointed as reader in experimental physiology. For several years he has acted as assistant director of the Physiological Laboratories and as tutor and secretary to the Faculty of Medicine. Dr. Schlapp's early research work was concerned with the separation and physiological action of the active principles of the posterior lobe of the pituitary gland. More recently, among other things, he has carried out valuable work on ventricular fibrillation and, with Prof. Bentley, on the effects of pressure and anoxæmia on peripheral nerves. He is at present engaged in the study of pulse wave velocity making use of oscillographic records, and of experimental auricular fibrillation. He will bring to the chair a wide knowledge of teaching, research and administration which will be of great value.

#### Dr. Max Hartmann

DR. MAX HARTMANN, director of the Kaiser Wilhelm Institut für Biologie, spent his seventieth birthday on July 7 on his small farm in the Allgäu. One of the outstanding personalities among German biologists of his generation, he can look back upon a fine record of original research, particularly in the field of sexuality and fertilization in Protozoa and Algæ. His investigations of 'relative sexuality' have led to very important biochemical studies of the substances produced and released by gametes and essential for fertilization in Algæ, echinoderms, molluscs and fishes (cf. Lord Rothschild's article in *Nature* of June 1, p. 720). Realizing the great opportunities opened up by the transition from the morphological to the experimental approach to biological problems, he has been singularly successful in guiding a large number of young workers to new and fruitful fields of research, inspiring them with his own enthusiasm for every great discovery made, whether in protozoology, cytology, genetics, experimental embryology or physiology. His capacity for critically sifting and clarifying the progress made is well reflected in his "Allgemeine Biologie", of which the third edition is now in the press. Dr. Hartmann was a fearless and outspoken critic of Nazism.

#### Tercentenary of Flamsteed

THE Rev. John Flamsteed, who in 1675 became the first Astronomer Royal, was also from 1684 rector of Burstow, Surrey, and at his death in 1719 was buried in the chancel of this parish church. It was fitting, therefore, that the tercentenary of his birth should be commemorated there, and at the conclusion of the afternoon service on Sunday, August 18, the present Astronomer Royal, Sir Harold Spencer Jones, gave an impressive address on his illustrious predecessor. In academic dress the Astronomer Royal stood at the chancel steps of the singularly pleasing church. In the stalls on either side sat the present rector, the Rev. Arthur Hackblock, and the Rural Dean, Canon Godwin, and the choir of the Women's Institute. In the background could be seen the window and tablets erected to Flamsteed's memory in 1887 by the late J. J. Tustin. The whole setting was of quiet

beauty, and the occasion will be long remembered. In his address, Sir Harold Spencer Jones told of Flamsteed's perseverance amid many difficulties and his firm determination that nothing but the greatest possible accuracy should come from his labours. It was listened to by a large congregation, which included representatives of the Royal Astronomical Society, the British Astronomical Association, the Royal Observatory, the Clockmakers' Company and the Newcomen Society. Flamsteed's birthplace was Denby, near Derby, and a commemoration service was also held there.

#### Population Policy in Great Britain

A BROADSHEET, "Population—a Challenge and a Choice", No. 251, issued by Political and Economic Planning, attempts to re-state clearly and simply the arguments for and against a determined effort to alter the population trend in Great Britain, discussing the economic prospects in relation to that trend, the internal social effects which would flow from certain trends and the effects on our international position. There is no purely eugenic argument as to the effects of population trend on the average inherited qualities of the population as a whole; but the importance of quantity in relation to the distribution of age-groups and in relation to the best training and use of the raw materials of population is emphasized throughout. Now that our numbers are within our own control and the standard of living for women is a major interest in our national life, it is concluded that the choice of family size which would be made by parents, if they considered only their own personal and social development and reasonable standards of life for themselves, would strike too low a level to maintain our numbers. There are no reliable signs that this tendency will be arrested, and it is urged that to such factors as improved social services connected with parenthood there must be added a willing and confident acceptance of the demands which are made of us as a community if we are to play a worthy part in the world, and a new attitude to parenthood which will modify calculations of purely personal comfort or competition.

Action should be taken quickly; for the economic position of Great Britain enforces the need for a population policy. The rapid decline of population facing us in the last part of this century will involve waste of resources and endanger initiative and technical progress. Furthermore, the process of decline has serious social effects, such as an increasingly heavy proportion of old people, less flexibility in readjustment and an old people's influence in politics which tends to perpetuate a bias in their favour. The argument for an immediate population policy is decisive when the choice is related to the international field, but involves a decision as to the part Great Britain is to play in the world. Whether it is our work of training and education in East Africa, by our counsels and experience in helping the United Nations towards a peaceful and just solution of their difficulties, or in playing a leading part in the association of free British nations within the Commonwealth, the broadsheet suggests that Britain has yet a mission. In the coming era, Britain's influence will be maintained more by the economic adviser and the scientific worker than by the nineteenth-century methods of the armed soldier, and these young men cannot be provided in the numbers required from a population of thirty million.

### American Philosophical Society

THE Year Book, 1944, of the American Philosophical Society covers the year January 1, 1944–December 1, 1944. During the year a radical change was made in the policy of the Society's library towards exchange and distribution of the Society's publications, based on the conviction that acquisitions for the library and the distribution of the Society's publications can be more effectively promoted through subscriptions than by the system of exchange. Under the new policy, the library receives in exchange for the Society's publications relatively little, depending rather on subscription or direct purchase of materials vital to the development of its holdings. The Library Committee is also mindful of the possibilities of current trends in library and research disciplines like those started by Binkley and recently developed by Fremont Rider in his volume "The Scholar and the Future of the Research Library". The problem of bringing the rich resources of the library to the attention of scholars and making them available for study and research has been a major concern of the librarian. Two special committees were set up during the year to assist in this way, in the special fields of American linguistics and archæology and of Americana. Of exceptional interest in this Committee's report are the notes by C. Dan Doren on the Franklin–Mecon correspondence, by G. Chinard on the strange fortune of two volumes of the *Transactions* associated with Franklin, and on the Elihu Thomson collection. The report of the Committee on Research includes a list of grants made from the income of the Penrose Fund and a summary of the grants made during the period July 31, 1933–December 31, 1944, together with reports from recipients of grants, arranged alphabetically under the classification of subjects represented in the membership of the Society. Because of the participation of many scientific men in research connected with the war effort, particularly in certain fields, the request for grants during the past two years was not as large as previously, but the Committee has not lowered the standard set for making grants.

### National Foundation for Scientific Research, Brussels

THE seventeenth annual report of the National Foundation for Scientific Research, Brussels, for the year 1943–44, in addition to the report on the activities of the Foundation during the year, includes the statutes, a list of members of the scientific commission, and of publications during the year, which renders the report a most useful reference work. Reporting on eleven important projects in the field of industrial science, reference is made to research financed by the Foundation André van der Stricht on the mechanism of the degradation of nitrogenous substances contained in yeasts, malts and moulds of breweries. The *Établissements Hauzeur, Simonis and Peltzer* have financed a research on the physico-chemical affinity between the molecules of certain colouring matters and proteins, especially the keratins of wool. Further research is being assisted by the *Fabrique de Produits Chimiques de Grammont* on the preparation, improvement and stabilization of certain grades of animal black and of certain carbons and colloids constituting the active absorbents. The Belgian Institute for the Improvement of the Beet is supporting an experimental study of the causal factors of the phenomena of polyploidy in the beet, in view of its eventual systematic use

in industrial cultivation. The Belgian Association for the Testing and Use of Materials is supporting an investigation on the protection of ferrous metals against corrosion, and the Optical Society of Belgium an investigation leading to the development of a photometer for the trichromatic specification of colour.

### Cheshunt Research Station

THE glasshouse work of the Experimental and Research Station at Turner's Hill, Cheshunt, Herts, was interrupted by enemy action in July 1944; but a substantial amount of laboratory work was carried out during that year (Rep. Exp. Res. Sta., Cheshunt, 1944). Preliminary trials by W. H. Read show that 5 per cent D.D.T./kaolin dusts or 0.02 per cent D.D.T. sprays give good control of tomato moth caterpillars (*Polia oleracea*). Red spider mites are not, however, controlled by this new insecticide, but D.D.T. can be added to petroleum emulsion sprays and the mixture used for the control of both pests. E. R. Speyer and W. J. Parr suggest measures for the control of tomato leaf-miners (*Liriomyza* spp.). These involve steaming the soil of propagating houses before introduction of the staging, and growing plants with a harder kind of growth than normal. Magnesium deficiency of tomato has been studied by O. Owen, who finds that spraying the foliage with 2 per cent Epsom salts, plus a wetting agent, gives good control. I. W. Selman finds that Cheshunt Early Giant lettuce is most resistant to mosaic virus when grown with low nitrogen and low phosphate, with medium watering. It is unlikely, according to P. H. Williams, that *Verticillium* wilt can be controlled by altering the pH of the soil, as the fungus can grow well between pH 4.0 and 8.0. A severe loss of heliotrope cuttings, due to the fungus *Corticium solani*, is described by Mrs. E. Sheard. The report of the director (Dr. W. F. Bewley) shows that experiments on the growth of tomatoes in gravel cultures have been commenced. Trials of bulky composts were inconclusive because of damage by enemy action.

### London Scientific Film Society

THE London Scientific Film Society, 34 Soho Square, London, W.1, which has been re-organised and enlarged, starts its ninth season in September. It has booked the Scala Theatre in Charlotte Street, London, for ten Sundays in the next ten months, and will show programmes of scientific and documentary films afternoon and evening. In addition it hopes to arrange for lectures and showings of research films on weekday evenings in suitable halls. It also proposes activities to organise shows of scientific films for children and to publish a small quarterly journal to be called the *Scientific Film*. The Society is also to sponsor the production of experimental films by a group of its members. Membership is open to anyone more than sixteen years old.

### Size of Page in Technical Journals

A REPORT of the Technical and Trade Papers Committee of the Institute of Incorporated Practitioners in Advertising to the Trade and Technical Press, dated October 1943, was issued in May 1946 by the Institute under the title "Standardisation of Type Area Sizes for Trade and Technical Journals", with the note that the trade and technical Press has recommended its members to give serious consideration to the standardization of type-areas. The members of the Institute hope that British

periodicals which adopted reduced page-sizes as a war-time measure will as soon as possible revert to full size, but they direct attention to the opportunity for standardization that will occur when paper supplies permit this change. Out of 638 trade and technical periodicals examined by the Committee, the maximum number with any one type-area was 47; there were 242 different sizes, 144 of which were unique, and the type-areas also vary in shape. Standardization is pressed in this report from the point of view of the advertiser, who wishes to submit sketches, layouts and copy in as few sizes as possible; but the strong recommendation of the report in favour of the adoption of a single size, namely, 10 in. by 7 in., will be welcomed by librarians and others who have been seriously embarrassed at times by the apparent irrational changes in size of periodicals as well as by the extreme diversity. The Committee recommends adoption of this size as the one indicated by its analysis as the most generally suitable and that to which journals making a change are likely to conform. It is also to a much greater extent than any other the most approved size for American, Canadian and other periodicals published overseas. Two other sizes are also suggested for consideration: 11½ in. by 8 in. and 9 in. by 6½ in. The proposals of the report are now commended by the Institute for detailed consideration by all concerned.

#### Vibration Problems

In a paper read before the Institution of Electrical Engineers in London recently, Dr. A. J. King considers the various ways in which vibration manifests itself, namely, noise, vibration, stress and rotational oscillation. The available methods of measuring vibration are described and their relative merits and limitations discussed. Methods of calibrating measuring apparatus are given, with an indication of their limits. The suppression of vibration is considered from the points of view of what is desirable, how much can be obtained at the source and how much by resilient mountings, attention being given to the effect of ground and source impedance. Practical examples are given of the reductions in vibration which have been achieved in certain cases by improvements in the source and by resilient mountings. The second part of the paper is concerned with the determination of elastic design data on resilient materials and mountings for use as described earlier for reducing vibration transmission. The limitations of a previous moving-iron-drive resonance-type method are discussed, and the advantages of a moving-coil-drive co-ordinate-potentiometer method are pointed out. The apparatus is described in detail, and results of tests on typical materials and mountings are given and discussed.

#### Mites as Carriers of Typhus

THE British Museum (Natural History) has issued a useful pamphlet, in its Economic Series (No. 16), by Dr. Susan Finnegan entitled "Acari as Agents Transmitting Typhus in India, Australasia and the Far East" (from the Museum. 1s. 6d.). The typhus fever group of diseases, it may be added, includes a number of affections occurring under diverse climatic and biological conditions throughout the world. They are all due to the activities of minute, non-filterable, rod-like bodies of the genus *Rickettsia*. Excluding epidemic louse-borne typhus, these diseases are known, or suspected, to be carried by larval mites of the family Trombidiiidae or by ticks of the family

Ixodidae. The most important infections spread by Acari are 'rural' typhus, tsutsugamushi or 'scrub' typhus; tick typhus or 'Kumaon fever' of India; the so-called 'Q' fever of Queensland; Rocky Mountain spotted fever of North America and others. The carriers are definitely known in but few cases, though the available evidence points to Acari as being the main vectors. This naturally has led to the great importance of correct identification of any species suspected in this connexion. Dr. Finnegan in this pamphlet has provided an admirably clear and well-illustrated guide to the subject which can scarcely fail to be of real use to medical officers and others in lands where typhus occurs.

#### Varieties of Red and White Clover

WATKIN WILLIAMS (*Bull. Welsh Plant Breed. Stat.*, No. 16, 1945) has outlined the results of the recent work on clovers which has been carried out at the Welsh Plant Breeding Station, largely under the guidance of the late R. D. Williams. This painstaking work emphasizes the necessity of an analysis of the characteristics of the existing types, judicious selection of the characters desired and the practical production of suitable methods for the isolation of commercially desired forms. Both in red clover and in white clover, the Welsh Plant Breeding Station has been able to produce improved strains which are outstanding for commercial purposes.

#### University of London Appointments

The title of reader in civil engineering in the University has been conferred on Dr. L. A. Beaufoy in respect of the post held by him at King's College. The title of reader in chemistry in the University has been conferred on Dr. D. J. G. Ives, in respect of the post held by him at Birkbeck College. The title of reader in history and philosophy of science in the University has been conferred on Dr. Douglas McKie, in respect of the post held by him at University College. The title of professor of morbid anatomy and histology in the University has been conferred on Dr. R. W. Scarff, in respect of the post held by him at the Middlesex Hospital Medical School.

The title of professor emeritus of civil and mechanical engineering in the University has been conferred on Prof. E. H. Lamb, who held the chair of civil and mechanical engineering at East London College (now Queen Mary College) from 1913 until his retirement at the end of the session 1944-45 (see *Nature*, 156, 137; 1945). The title of professor emeritus of helminthology in the University has been conferred on Prof. R. T. Leiper, who retires in September 1946 from the William Julien Courtauld chair of helminthology at the London School of Hygiene and Tropical Medicine, which he has held since 1917. The title of professor emeritus of experimental pathology in the University has been conferred on Prof. E. L. Kennaway, who retires in September 1946 from the chair of experimental pathology at the Chester Beatty Research Institute of the Royal Cancer Hospital, which he has held since 1931 (see *Nature*, 158, 51; 1946).

ERRATUM. In the communication "Nutritional Value of High-Extraction Wheat Meals" by A. R. P. Walker, Prof. J. T. Irving and Dr. F. W. Fox in *Nature* of June 8, p. 769, the percentage of calcium absorbed during week 2 on usual diet (see table) should be 26, and not 36 as printed.

## LETTERS TO THE EDITORS

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

## Effect of X-Rays on the Rate of Turnover of Phosphatides

IONIZING radiation produces chemical effects on the irradiated tissue which often lead, after a very appreciable lag, to extensive morphological changes. It is of interest to investigate which chemical processes are involved in the immediate effect of the ionizing radiation.

At an earlier date<sup>1</sup> it was found that the rate of turnover of desoxyribonucleic acid is diminished under the influence of X-rays. This was shown by using radiophosphorus as an indicator. From the <sup>32</sup>P content of the desoxyribonucleic acid and that of the inorganic phosphorus isolated from Jensen sarcoma of the rat, it was calculated that of a hundred desoxyribonucleic acid molecules extracted from the sarcoma 2 hours after administration of labelled phosphate, about two had been built up in the course of the experiment. If irradiation with several hundred r. units preceded the administration of labelled phosphate, the corresponding figure was decreased to a half to a third of the above value. The effect of X-rays on the rate of turnover is temporary, disappearing with time. The phenomenon of recovery of the nucleic acid cycle from the effect of X-rays is of importance for the understanding of the different sensitivities of growing and full-grown tissue to the effect of X-rays. In the latter case the average cell is very much further from the mitotic stage than in the growing tissue, and thus has time to recover its normal nucleic acid cycle before any appreciable change in the nuclear structure takes place. This is not the case in the growing tissue where, in the absence of a normal nucleic acid cycle, an anomalous nuclear development takes place with all its far-reaching consequences.

It is not only the rate of turnover of desoxyribonucleic acid that is diminished under the action of X-rays. A similar behaviour is also shown by the phosphatide turnover, as seen from the accompanying table.

## EFFECT OF X-RAYS ON THE TURNOVER OF PHOSPHATIDES OF THE CELL NUCLEI AND ON THE TOTAL TISSUE OF THE JENSEN SARCOMA AND THE LIVER OF THE RAT. AVERAGE WEIGHT OF RATS, 150 GM.

Groups of 12 rats	Activity of 1 mgm. phosphatide phosphorus as a percentage of the activity of 1 mgm. inorganic tissue phosphorus			
	Sarcoma		Liver	
	Nuclei	Tissue	Nuclei	Tissue
Controls	2.86	3.75	10.34	20.44
Controls	2.38	2.37	8.15	11.25
Controls	2.75	2.67	11.33	14.25
Irradiated	2.56	2.32	3.29	12.30
Irradiated	1.02	1.52	4.08	8.91
Irradiated	1.44	1.41	4.83	8.20
Percentage decrease due to irradiation	37	38	59	36

To groups of twelve rats, after irradiation with 1,000 r., labelled phosphate is administered, and control groups are treated in a similar way. After the lapse of 2 hours, the sarcoma and livers are pooled separately. An aliquot is used in the determination of the specific activities of the inorganic and phosphatide phosphorus of the tissue, while from the bulk of the material cell nuclei are isolated by the method of Dounce<sup>2</sup>. The specific activities of the corresponding phosphorus fractions of the nuclei are also determined.

As seen from the table, the rate of turnover of the phosphatides in the nuclei is markedly diminished under the effect of X-rays and that in the cytoplasm is also diminished (the greater part of the phosphatides of the tissue is present in the cytoplasm).

No appreciable difference is found between the rates of renewal of phosphatides present in the nuclei and in the cytoplasm of the sarcoma. In the nuclei of the liver, however, the rate of renewal of phosphatides lags behind the rapid turnover of these compounds in the cytoplasm. The question of a possible interchange between the phosphatide molecules of the nuclei and those of the cytoplasm is under investigation.

While irradiation of the sarcoma diminishes the rate of turnover of the total phosphorus of the tissue by 10 per cent only, the corresponding value for the sarcoma nuclei is reduced to a third of its normal value. This result is partly to be explained by the comparatively high content and rate of turnover of the desoxyribonucleic acid phosphorus and phosphatide phosphorus of the nuclei of the sarcoma.

I wish to express my thanks to Prof. H. von Euler for numerous facilities kindly placed at my disposal, to Prof. M. Siegbahn for the radiophosphorus used, and to Miss Marianne Andersen for very efficient assistance.

G. HEVESY

Institute for Research in Organic Chemistry,  
University of Stockholm.  
June 23.

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## Sensitization of Muscle to Choline and Acetylcholine, and the Supposed Existence of Choline Acetylase

NACHMANSOHN and his colleagues<sup>1,2</sup> and Feldberg and Mann<sup>3</sup> have suggested the enzymatic synthesis of acetylcholine from choline and acetate in the presence of adenosine triphosphate. The alleged enzyme has been named choline acetylase. The authors used the m. rectus abdominis of frogs to test the quantity of synthesized acetylcholine.

Repeating their experiments, we found that the contraction of m. rectus abdominis of frogs and of the dorsal muscle of leeches in response to choline, concentration 1 : 10<sup>-2</sup> - 1 : 10<sup>-4</sup>, is greatly increased in the presence of adenosine triphosphate (1 : 10<sup>-4</sup> - 1 : 10<sup>-6</sup>), this increase depending on the concentration of adenosine triphosphate. In an earlier communication<sup>4</sup> we described the same effect of adenosine triphosphate upon muscle contractions produced by acetylcholine.

Since this effect of adenosine triphosphate was not taken into consideration by the authors mentioned above<sup>1,2,3</sup>, the increase of observed muscle contraction may possibly have been due not to the stimulation of acetylcholine synthesis by adenosine triphosphate, but to the sensitizing effect of this substance upon the test-muscles.

The sensitizing effect of adenosine triphosphate is also of interest in connexion with the observations of Binet and Minz<sup>5</sup>, Bergami<sup>6</sup>, Feldberg<sup>7</sup>, and others, concerning the sensitization of muscle to acetylcholine in the presence of extracts and emulsions of nerve tissue. It is possible that this sensitization is due to the adenosine triphosphate present in these extracts. Further data on this matter will be given in a separate communication.

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## The Pancreas and Alkaline Phosphatase

IN various accounts of histochemical studies on the presence of alkaline phosphatase (substrate : sodium-β-glycerophosphate, pH 9) in homologous organs, correspondences (for example, in kidney and intestine) have usually been stressed rather than differences. It seems, however, appropriate to direct attention to the latter in order to place the value of experiments on animals in its proper perspective. If the pancreas is selected for discussion, it is because of the confusion which seems to exist in the literature concerning the phosphatase content of this organ. It is often stated in a general way that the enzyme occurs or has been shown to be present in pancreatic tissue<sup>1,2</sup>. The fact is that Grosser and Husler<sup>3</sup>, who investigated the pancreas of cattle, sheep, cat and man biochemically, expressly emphasize the complete absence of the enzyme. Again, Takamatsu<sup>4</sup>, and Kabat and Furth<sup>5</sup> failed to produce histochemical evidence for the presence of phosphatase in the pancreas of man. Gomori<sup>6</sup> reported that only in the pancreas of the dog are the smallest ducts strongly outlined in black (phosphatase-positive). I found<sup>7</sup> in histochemical tests, the epithelial cells, which are related to the duct system of the external secretion of the pancreas, entirely negative in the guinea pig and rat, but strongly positive in the dog (from the centro-acinar cells to the epithelium of large ducts; Fig. 1), thus confirming and extending Gomori's observation.

More recent studies on the rabbit showed that in this species, too, the duct system gives a definitely positive reaction, though somewhat less extensively than in the dog, the centro-acinar cells and smallest ducts being mainly affected (Fig. 2).

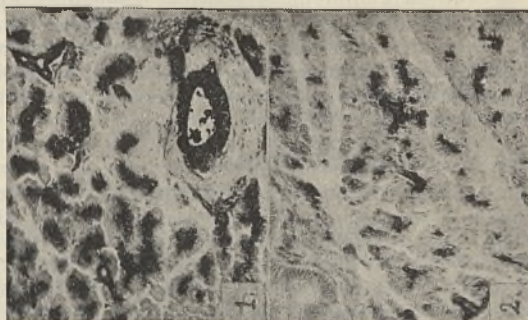


Fig. 1

Fig. 2

FIG. 1. FROM PANCREAS OF DOG. CENTRO-ACINAR CELLS, SMALL DUCTS AND A LARGER DUCT HEAVILY PHOSPHATASE-POSITIVE (BLACK). × 100

FIG. 2. FROM PANCREAS OF RABBIT. MAINLY CENTRO-ACINAR CELLS POSITIVE. IN BOTTOM-LEFT CORNER IS PART OF A LARGER DUCT THE EPITHELIUM OF WHICH IS NEGATIVE. × 100

Nothman's interesting discovery<sup>2</sup> of the presence of phosphatase in the pancreatic juice of dogs and its increase after ligation of the duct with subsequent rise of the level of serum phosphatase is, therefore, in full accord with the histochemical distribution of the enzyme in the pancreas of that species. Similar behaviour can be predicted for the rabbit. But caution is necessary in applying such results from animal experiments to clinical tests, and Nothman's suggestion that the level of serum phosphatase might be used as a diagnostic aid in pancreatic diseases (for example, duct occlusion) seems to be based on the erroneous assumption that a state of affairs exists in the human pancreas similar to that of the dog.

The cells of the acini themselves are histochemically negative with regard to phosphatase in all the species examined. It would thus appear that in the two 'positive' species (dog and rabbit) the epithelial cells of the duct system, particularly its finest ramifications, are responsible for the secretion of the enzyme. This interpretation would rest on the assumption that the site of the heaviest histochemical reaction for phosphatase is also the site of its formation. It is, however, conceivable that the enzyme, in these two species, is actually secreted by the cells of the acini and only becomes activated when present in the duct system (including the lumina between the centro-acinar cells), and that on applying the histochemical test, the adjacent epithelial cells and their nuclei supply suitable and perhaps necessary surfaces and interfaces for the reaction to take place, which then brings about the heavy salt precipitation in these cells.

Finally, it may be added that I found the islet cells strongly positive only in the dog; in the rat the peripheral cells of the islets sometimes show a weak (brownish) and doubtful reaction.

Further details of these and other comparative histochemical studies on the distribution of phosphatase will be published elsewhere.

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### Demonstration of Phosphatase in Decalcified Bone

As the decalcifying fluids commonly used in histology destroy alkaline phosphatase, it has so far only been possible to demonstrate the enzyme in undecalcified bone. The disadvantages of current methods are threefold: (1) Only bones from embryos or very young animals can give sections sufficiently thin to enable localization of phosphatase to be established satisfactorily by the method of Gomori<sup>1</sup> or of Menten, Junge and Green.<sup>2</sup> (2) If the Gomori method for bone is employed, the preformed phosphatase is stained black and the site of phosphatase purple. Controls only show the black bone salt. It is extremely difficult to decide whether there are areas in which both phosphatase and bone salt occur concurrently. (3) The Gomori method suffers from the obvious disadvantage of requiring treatment of the phosphatase-containing tissue with ammonium sulphide (which is an inhibitor of the enzyme<sup>3</sup>) before and during incubation of the sections.

The present method permits bones of adult rats and mice to be decalcified without adverse effects on the enzyme. It is based on the facts, established by Cloetens<sup>4,5</sup>, that alkaline phosphatase is reversibly inactivated by acid solutions having a pH greater than 4.5, and that it can be reactivated afterwards by alkaline solutions. Inactivation is retarded by the addition of Zn<sup>++</sup> to the acid medium, and reactivation is aided by glycine.

It was found that kidney sections kept in acetate or citrate buffer at pH 4.4-4.6 in the presence of Zn<sup>++</sup> (10<sup>-3</sup>M) can be completely reactivated even after 14 days by treatment with 0.075 per cent glycine in 1 per cent sodium barbitone. (The glycine must be washed out before incubation as it interferes with the precipitation of calcium phosphate<sup>6</sup>.)

Small pieces of bone fixed in 80 per cent alcohol and brought to water were left in the buffers until decalcified, the liquids being changed daily and kept at 10° C. The time taken for decalcification varied from three to fourteen days according to the size and consistency of the bone. The tissues were then washed in water, 'reactivated' for two hours in glycine-barbitone at 37° C., washed thoroughly in running water, dehydrated and embedded in paraffin (58° m.p.). Sections were cut at 8μ and the phosphatase demonstrated by the original Gomori-Takamatsu method<sup>1,7</sup>.

The distribution thus found agrees essentially with that described by other workers<sup>8</sup>. The ground substance of bony trabeculae or compact bone contains no phosphatase. Superficially placed osteocytes with their processes, and Sharpey's fibres, stand out black against the colourless matrix.

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### Vitamin Storage and Utilization in the Organism

DR. T. K. WITH's suggestion<sup>1</sup> that carotenoids, such as cryptoxanthin and β-carotene, are vitamins in their own right commands considerable sympathy, but we do not think that the data advanced in that communication settle the point. The efficiency of utilization and the storage of vitamin A in the liver of the rat and the chick are affected by many factors which control the growth response or quantity found. These include the amount and kind of vitamin A fed<sup>2</sup>, the amount of sparing agents, more particularly the tocopherols fed at the same time<sup>3</sup>, and the idiosyncrasies of the animal<sup>4</sup>, which is another way of saying that we do not yet know the complete physiology of vitamin utilization and liver storage.

We believe that the high value of utilization of cryptoxanthin by the chick may be explained completely by the large quantities of γ-tocopherol and other covitamins and sparing agents which are present in yellow corn. At least Dr. With's contentions would be considerably strengthened if the exact contribution made by the sparing agents could be measured.

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### Effect of Röntgen Irradiation on the Serum Content of Hæmagglutinins in Human Blood

THE behaviour of the natural antibodies present in the blood of normal individuals, under irradiation with Röntgen rays, has not been much investigated. The object of our present study was the behaviour of natural anti-sheep agglutinins in men who had been subjected to röntgenotherapy.

We have chosen as the indicator of the effect of irradiation the anti-sheep agglutinins, since in recent years this normal antibody has been the subject of extensive studies. Their standard titre in normal individuals is generally equal to the dilutions 1:4-1:8 of the serum. In our own investigations, on some hundreds of normal individuals, we have found in normal men only exceptionally a titre as high as 1:16. It is well known from clinical observations that the titre of anti-sheep agglutinins may rise considerably in some definite conditions, particularly in infectious mononucleosis and after injections of horse serum (normal or immune). In the first condition we have seen the titre in one case as high as 1:2,800.

The interpretation of this rise is relatively easy in serum sickness, as horse serum belongs to Forsman's antigens. In the case of infectious mononucleosis, the rise of the titre may be due to an unknown etiological agent, which is acting as Forsman's antigen, or to some unspecific stimulation of the reticulo-endothelial system. The clinical and experimental work of this Institute has shown that X-rays in small doses act as a powerful stimulant of this system. In our observations we therefore studied the possible influence of radiological stimulation of the reticulo-endothelial system on the titre of anti-sheep agglutinins.

In all we have had under observation thirty-two persons, who received röntgenotherapy for different causes: cancer, leucæmia, inflammatory states, and so on. Dosage varied from 50 r. to 6,000 r. In no case did the titre of sheep agglutinins after irradiation rise above the dilution of 1:10; it therefore remained normal.

These observations show that X-rays do not influence the behaviour of normal anti-sheep agglutinins; hence the rise of the titre in some conditions probably does not depend on the stimulation of the reticulo-endothelial system, but on active immunization.

The first appearance of hæmagglutinins in infants at the age of four to six months (earlier on artificial than on breast feeding) is probably due to changes of the intestinal flora at this period, some intestinal micro-organisms acting as Forsman's antigen.

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### Nutritional Studies on Blood-sucking Arthropods

A GREAT deal of study has been devoted in recent years to the nutritional requirements of insects, particularly those of economic importance. Blood-sucking insects, however, have suffered neglect, although they present problems of unusual interest. We have undertaken investigations on the rate of development of nymphs of the bed-bug, *Cimex lectularius* L., and of the fertility of the resulting adults, by feeding them directly on a number of different hosts or *in vitro* through a membrane.

It was found possible to rear first instar bugs to the adult stage by feeding them on defibrinated hæmolyzed blood through a mouse skin membrane. Attempts to vary the nature of the diets fed through the membrane were hampered by the refusal of the bugs to consume many of the diets offered them. Moreover, slight changes in the composition of the blood, such as slight dilution with isotonic saline solution, resulted in the death of all the nymphs by the time the third instar was reached. In spite of these difficulties, it was possible

to establish that growth, survival and fertility were impaired in varying degrees by using the freshly drawn defibrinated haemolysed blood of various animals. Restoration of the fibrin to the blood, the use of stirred unhemolysed defibrinated blood or storage of defibrinated haemolysed blood at  $-5^{\circ}\text{C}$ . increased its toxicity to the bugs. Separated blood fractions such as cells and serum were inadequate for growth and proved highly toxic.

When the nymphs were fed directly on a rabbit, even drastic blood changes brought about by the injection of dicoumarol or heparin had only a slight effect on the rate of growth of the bugs, but increased the mortality. There is thus a remarkable contrast between the ease with which media are rendered unsuitable for bugs *in vitro*, and the difficulty of affecting growth by changes in the blood of the host *in vivo*. This difference was most clearly shown by injecting rabbits with large doses of penicillin and then feeding bugs on the blood *in vivo* and through a membrane. Bugs fed directly on the rabbit grew normally, but when fed *in vitro* on the rabbit's blood they died. This effect could not be attributed to the penicillin, since tests carried out an hour after feeding revealed no trace of penicillin in the bugs; the dietary blood still showed penicillin activity. Furthermore, no effect on the symbionts of the bugs was apparent. Direct injection of penicillin into the haemocoel of fifth stage nymphs did not prevent them from moulting in the same time as controls injected with saline solution. The adults from such nymphs treated with penicillin contained what were apparently normal symbionts. It has been reported by Brues and Dunn<sup>1</sup> that in the cockroach the injection of penicillin serves to eliminate the symbionts.

It was thought possible to study dietary deficiency in the bug by inducing deficiency in the host. The bugs were fed on two groups of rats, which were given diets containing succinylsulphathiazole; in one group the diet was composed of purified ingredients, in the other case it was unpurified. Despite the severe leucopenia and agranulocytosis which developed in the rats on the purified diet, the rate of growth of the nymphs was not affected. However, in both groups there was a reduction in the number of eggs laid per female bug. When nymphs were fed on thiamin-deficient rats (in the blood of which no thiamin could be detected on assay) the rate of development of the bugs was not affected; but, as can be seen from the accompanying table, egg-laying was drastically reduced. Moreover, a large proportion of the eggs were sterile and of the 'taub' variety<sup>2</sup>. One subsequent feed on a normal rat resulted in the production, by the same adult bugs, of only two 'taub' eggs and a much higher proportion of fertile eggs.

Deficiency induced in rat	Number of first instar nymphs	Percentage reaching adult stage	Number of pairs	Mean and S.D. of number of eggs laid per female
None (normal diet)	96	67	21	10.4 ± 2.5
Folic acid	65	23	5	6.0 ± 3.3
Thiamin	45	33	7	1.3 ± 0.45
Thiamin	62	34	8	1.4 ± 1.0
Adults reared on thiamin-deficient rat given one feed on a normal rat			7	5.0 ± 4.0

Thiamin has been shown to be a dietary essential of every insect so far investigated. We have demonstrated<sup>3</sup> that folic acid is necessary for the mosquito larva and, more recently, Fraenkel and Blewett<sup>4</sup> have done the same in the case of *Tenebrio molitor* and *Ephesia kuehniella*. It is highly probable that in the experiments quoted in the table, the rat's blood contained little or no folic acid in one case and no thiamin in the other. The ability of the bedbug to develop so well under these conditions may be attributed to synthesis of folic acid and thiamin by its symbionts.

In the bedbug, the symbionts are situated in mycetocytes connected with the gonads and the fat body<sup>5</sup>. In order to throw more light on the function of the symbionts in deficiency, the arthropod *Ornithodoros moubata* Murray was studied. In this tick the symbionts are present in the Malpighian tubes<sup>6,7</sup>, and might therefore be expected to serve a different purpose from those in the bedbug.

When *Ornithodoros* was fed on thiamin-deficient rats, there was a striking decrease in the rate of growth and in the size of the nymphs, even in the early stages of development. While it is too early as yet to say whether the ticks will reach maturity and if so whether they will prove fertile, there is already sufficient evidence to show that thiamin deficiency affects this arthropod far more severely than it does *Cimex*. In both instances the activity of the host was not a complicating factor.

It is of interest to mention also that the bite of *Ornithodoros* produced a much more pronounced haemorrhagic reaction in the thiamin-deficient rat than it does in normal rats.

Our thanks are due to Miss L. O'C. Black and Miss J. P. Bradley for technical assistance and to Dr. D. Ordman for a supply of *O. moubata*.

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## Application of the Paper Partition Chromatogram to the Qualitative Analysis of Reducing Sugars

GORDON, MARTIN AND SYNGE<sup>1</sup> and Consden, Gordon and Martin<sup>2</sup> have shown that good separations of amino-acids can be obtained on filter paper by allowing a suitable solvent, which has previously been saturated with water, to flow over the paper in a closed container, the air in which is saturated with the vapours of water and the solvent. Filter paper contains 20-25 per cent water under these conditions, and separation depends upon the differences in partition coefficient of the amino-acids between the stationary water phase and the moving solvent. It has further been shown<sup>3</sup> that for any individual amino-acid the value

$$R_F = \frac{\text{distance moved by the band}}{\text{distance moved by the advancing front of liquid}}$$

is directly related to the partition coefficient, true adsorption by the cellulose playing little part. In the present preliminary investigation, which was undertaken as a result of a discussion with Dr. A. J. P. Martin and his colleagues, the behaviour of reducing sugars on the paper chromatogram has been examined.

In general, the experimental conditions that allow of separation of the amino-acids are also suitable for the qualitative analysis of reducing sugars. The apparatus used is similar to that described by Consden *et al.*<sup>3</sup> for work with narrow strips of paper, except that the glass trough was replaced by one of similar pattern made from stainless steel. Whatman No. 1 filter paper was used and was cut into strips 43 cm. × 12 cm. For use with phenol or collidine, the sugar solutions used were roughly 1 per cent wt./vol. with respect to each individual sugar, and about 2-3 μl. containing about 20-30 μgm. of each sugar was introduced as a circular spot on a horizontal line ruled 7.5 cm. from the top of the paper strip. When a number of different sugar solutions were run in the same strip of paper, the spots were introduced at intervals of 1.5 cm. along the horizontal line. When *n*-butanol or *n*-butanol-ethanol mixtures were used, the sugars did not travel so far and diffusion was less marked. For this reason considerably smaller amounts (0.5-1 μl. containing 5-10 μgm.) could be employed, and this assisted the observation of separation between closely neighbouring spots.

The strips were usually run 18 hours overnight. The solvent was then dried off in an oven at 105°C. the position of the solvent boundary being marked in ink before transfer to the oven. In order to reveal the positions of the sugars, the paper was sprayed rapidly and evenly with a mixture containing equal parts of silver nitrate (*N*/10) and ammonia solution (5*N*) and the strip replaced in the oven (105°C.) for 5-10 min.; the sugars appeared as dark brown spots on a white or light brown ground. In runs carried out in phenol, the lower part of the paper was usually uniformly coloured light brown, the upper part being white. This was presumably due to a reducing substance present in the paper as an impurity. The reaction with ammoniacal silver nitrate was given by all the reducing sugars tested, including maltose and lactose which gave spots of a rather lighter shade; but under the conditions employed the colour was not given by amino-acids, cysteine or creatine. The developed strips began to darken owing to the presence of silver salts a few hours after they had been removed from the oven, and if a permanent record was desired, the strips were washed first in distilled water and afterwards in running tap water for a few hours, followed by drying.

### R<sub>F</sub> VALUES OF REDUCING SUGARS IN VARIOUS SOLVENTS AT ROOM TEMPERATURE (WHATMAN NO. 1 PAPER)

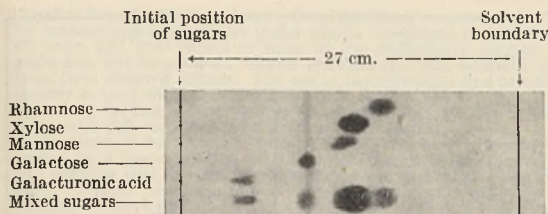
Solvent	Phenol	<i>n</i> -Butanol	<i>n</i> -Butanol 45% ethanol 5% water 50%*	<i>n</i> -Butanol 40% ethanol 10% water 50%†	<i>s</i> -Colli- dine
Addition	NH <sub>3</sub> *, HCN	NH <sub>3</sub> *	NH <sub>3</sub> *	NH <sub>3</sub> *	
Glucose	0.30	0.070	0.105	0.185	0.39
Galactose	0.44	0.060	0.090	0.170	0.34
Mannose	0.45	0.100	0.130	0.220	0.46
Sorbose	0.41	0.085	0.120	0.200	0.40
Fructose	0.51	0.100	0.135	0.215	0.42
Xylose	0.44	0.125	0.170	0.245	0.50
Arabinose	0.54	0.100	0.145	0.215	0.43
Ribose	0.59	0.180	0.210	0.285	0.56
Rhamnose	0.59	0.220	0.285	0.345	0.59
Galacturonic acid	0.13	0.00	0.00	0.065	0.14
Glucosamine hydrochloride	0.62	0.105	0.150	0.225	0.30
Lactose	0.38	0.00	0.00	0.075	0.24
Maltose	0.36	0.010	0.015	0.100	0.32

\* Ammonia was added to a concentration of about 1 per cent in the aqueous liquid at the bottom of the chamber.

† The solvents were mixed in the proportions given: the lower aqueous layer was run into the bottom of the chamber and the upper organic layer placed in the bath feeding the strip.

The accompanying table shows average *R<sub>F</sub>* values obtained for a number of solvents and solvent mixtures. Temperatures varied from 16° to 23°C.; the variation in *R<sub>F</sub>* value due to temperature changes was slight when phenol was used, but was more considerable with collidine or butanol-ethanol mixtures. The runs in phenol and butanol were carried out in the presence of ammonia in order to liberate the free base from glucosamine hydrochloride. In addition, a few crystals of potassium cyanide were added to the aqueous liquid in the bottom of the chamber when phenol was used, in order to suppress the catalytic oxidation of the solvent due to the presence of copper in the filter paper<sup>3</sup>.





FILTER PAPER CHROMATOGRAM OF FIVE MONOSACCHARIDES SHOWING THE SEPARATION OF THE MIXTURE. SOLVENT, COLLIDINE. PAPER, WHATMAN No. 1. TEMP. 21-23° C.

The photograph shows the separation of a number of sugars in *s*-collidine. The difference in *R<sub>F</sub>* value between xylose and mannose is not great enough to result in separation between these two sugars. With phenol as the moving phase, three groups of sugars could not be separated; these were: rhamnose, ribose, glucosamine (*R<sub>F</sub>* 0.59-0.62); galactose, mannose, xylose (*R<sub>F</sub>* 0.44-0.45); sorbose, glucose (*R<sub>F</sub>* 0.39-0.41). The use of collidine or butanol-ethanol mixtures permitted the separation of the first and second groups, provided the amount of sugar taken was not too large. Sorbose and glucose could not be separated in any of the three solvents investigated, although small differences in *R<sub>F</sub>* values could be demonstrated by use of the individual sugars.

This work forms part of the programme of the Food Investigation Board, of the Department of Scientific and Industrial Research.

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<sup>1</sup> Gordon, A. H., Martin, A. J. P., and Synge, R. L. M., *Biochem. J.*, **37**, Proc. xiii (1943).

<sup>2</sup> Consden, R., Gordon, A. H., and Martin, A. J. P., *Biochem. J.*, **38**, 224 (1944).

### Alginate Acid-acetate

VARIOUS attempts have been described<sup>1</sup> to acetylate alginate acid by means of acetic anhydride or acetic acid, without or with catalysts, for example, pyridine, acids, etc. Some of the products thus obtained were probably degraded, and it appeared of interest, therefore, to find out whether the acetylation of alginate acid can be done by a relatively mild method; for this reason the interaction with ketene was studied.

Alginate acid fully swollen with acetone reacts with ketene at room temperature to form a colourless insoluble ester acid which can be converted into a sodium and calcium salt. These derivatives could also be prepared by direct reaction of sodium or calcium alginate and ketene. The analysis of the various products indicates that approximately one acetyl grouping has been introduced into each repeating unit of these chain polymers. Viscosity determinations were made with solutions containing sodium alginate obtained by hydrolysis of the acetyl derivatives, and these tests led to the following conclusions.

During the acetylation of calcium alginate, no substantial degradation appears to occur; but during the reaction with sodium alginate and particularly with free alginate acid, some degradation takes place. The viscosity of solutions containing the 'recovered' sodium alginate is in all cases far higher, however, than that of solutions of salts of low molecular uronic acids. The following polymers were tested with regard to their swelling in water:

	Moles of water × 10 <sup>-2</sup> bound at 20° by 1 gm.-equivalent
Alginate acid .. .. .	7
Sodium alginate .. .. .	∞
Calcium alginate .. .. .	6
Alginate acid-acetate .. .. .	5
Sodium salt of alginate acid-acetate .. .. .	25
Calcium salt of alginate acid-acetate .. .. .	12

It should be noted that, in contrast to sodium alginate, which is soluble in water, the sodium salt of alginate acid-acetate swells to a limited extent only. If the free ester-acid is dried and the sodium salt is made by adding, at room temperature, an equivalent amount of sodium hydroxide solution, a non-transparent gel is obtained which binds only ~8 × 10<sup>2</sup> mol. water per gm.-equivalent; if, on the other hand, the sodium hydroxide solution and the fully swollen ester acid are mixed at about 60°, a colourless, transparent jelly is obtained, with a high degree of swelling (see table). An equally highly swollen transparent jelly can be made by dispersing the moderately swollen modification of the sodium salt in glycerol and adding excess water to the dispersion.

It has been found that alginate acid-acetate and its sodium salt are cation-exchange materials, that is, these colourless gels can be used either to remove certain cations, such as calcium, from dilute solutions, or as adsorption materials for inorganic chromatography.

A full account of these experiments will be published elsewhere.

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<sup>1</sup> Barry, Dillon and O'Muineachain, *Proc. Roy. Soc. Dublin*, **21**, 283 (1933-33). Cunningham, Chamberlain and Speakman, British Patent 573,591 (Application 1942).

### Influence of Glucose in the Assay of Streptomycin

DURING the course of our investigations into the production and properties of streptomycin, we have confirmed the majority of the observations recorded by Waksman *et al.*<sup>1,2</sup>, Denkewater *et al.*<sup>3</sup>, and by Abraham and Duthie<sup>4</sup>. These confirmations cover thermal stability, pH at which optimum activity is apparent, stability in solutions on storage, and methods of inactivation; but we have obtained results which suggest that the effect of glucose, to which attention has been directed, may be more complex than has hitherto been thought.

In their work on the properties of streptomycin, Waksman *et al.*<sup>1</sup> indicated that two methods of assay were used: (a) a serial dilution method using *B. coli* as the test organism; and (b) a cup-plate method using spores of *B. subtilis*; and they showed that in the latter test the addition of 2 mgm. of glucose to 10 ml. of agar reduced the potency of streptomycin by one half. The suggestion put forward for this reduction was that "This may be due to the reducing properties of glucose or to the production of some acid by the test organism". In this laboratory we have used mainly a ring-plate method of assay with *B. coli* as the test organism and a bile-salt-lactose agar medium. We have preferred to use *B. coli* instead of a spore-bearing bacterium, such as *B. subtilis*, because our original interest in streptomycin arose from the claims that it was active against Gram-negative bacteria. We use bile-salt-lactose agar because it gives a better defined zone of inhibition than ordinary nutrient agar made from tryptic digest broth.

Under our conditions of assay, the addition of glucose to the medium did not result in any apparent change in potency of the streptomycin. When, however, nutrient agar was substituted for bile-salt-lactose, a decline in potency was observed, the decline being dependent on the amount of glucose added to the medium. On the other hand, when *B. subtilis* was used in nutrient agar, a reduction in apparent potency, similar to that obtained by Waksman, was found (see table).

### EFFECT OF GLUCOSE ON THE PLATE ASSAY OF STREPTOMYCIN USING VARIOUS MEDIA AND ORGANISMS

Glucose added (mgm.) per plate (15 ml. agar)	Assay (u./ml.) using <i>B. coli</i>		Assay (u./ml.) using <i>B. subtilis</i>		Quoted by Waksman <sup>1</sup>
	Nutrient agar	Bile-salt-lactose agar	Nutrient agar		
			Sample A	Sample B	
0 (Control)	60	60	82	80	1200
2	56	62	43	—	—
3	—	—	—	—	600
10	36	63	35	51	—
15	—	—	35	—	620
20	17	61	38	54	—
40	8	55	—	35	—

In addition to the above tests, a series of assays was carried out in which glucose was added to solutions of streptomycin (70-80 u./ml.) instead of to the culture medium. The results showed that the activity was reduced when assayed against *B. subtilis*, the activity falling from 85 u./ml. with glucose absent to 46 u./ml. when 20 mgm. glucose per 10 ml. solution were added. In the tests with *B. coli*, however, no reduction was observed in either nutrient agar or in bile-salt-lactose agar.

From these results it is evident that the effect of glucose on the apparent potency of streptomycin depends on the organism and the culture medium used in the assay. It seems doubtful, therefore, that acid production by the organism or reducing action is solely responsible for the phenomena encountered.

We have pleasure in acknowledging the active interest of Sir Jack Drummond, and the help given by Mr. C. E. Coulthard.

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<sup>1</sup> Waksman, Bugie and Schatz, *Proc. Staff. Meet. Mayo Clin.*, **19** (1944).

<sup>2</sup> Waksman and Schatz, *Amer. Pharm. J. (Sci. Ed.)*, **34**, 310 (1945).

<sup>3</sup> Denkewater, Cook and Tishler, *Science*, **102**, 12 (1945).

<sup>4</sup> Abraham and Duthie, *Lancet*, **i**, 455 (1946).

### Strong Magnetic Fields

It is well known that with strong electromagnets one can produce unlimited magnetic fields, since the field increases with the logarithm of the dimensions of the polepieces; but in reality the field obtainable is limited by the enormous expense involved by the building of big electromagnets.

In the case of solenoids, the limit of the field is determined by the way in which the heat developed is carried away, and by the cost of the energy source; the experiments of Deslandres and Pérot have shown the order of magnitude of the strongest fields obtainable in this way.

In 1924 Kapitza succeeded in producing in an original way very strong fields of short duration by short-circuiting a battery by a small solenoid during a fraction of a second; in 1927 he improved his method by using, instead of a battery, a generator which could stand the enormous shock caused by the short-circuiting. In these experiments the small solenoid had to be reinforced, as without this precaution it tended to explode. In this way fields of short duration (about 1/100 sec.) could be produced.

By connecting a small copper coil, immersed in a bath of liquid hydrogen, during 0.1 sec. with the terminals of a very big battery, we have been able to produce magnetic fields up to about 250,000 gauss in a cylindrical space of 8 mm. diameter; the duration of one discharge is thus about ten times as long as in Kapitza's experiments. The heat developed causes the evaporation of a quantity of hydrogen, but as the resistance of the copper coil at the temperatures of liquid hydrogen is very small, and the heat of vaporization of liquid hydrogen relatively great, the amount of hydrogen required is not very big, which means that the experiments can be made in an ordinary cryostat.

The electrical equipment at our disposal did not permit us to push this method as far as possible, but the results indicate that with relatively small improvements much stronger fields can be obtained than in these very preliminary experiments.

Similar experiments have been carried out in baths of liquid helium at temperatures below the  $\lambda$  point. Although the development of heat was smaller in this case, the heat of vaporization of helium is also small and the fields produced were therefore not as strong as in liquid hydrogen; but an improved apparatus will certainly also yield much better results.

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### Fission Fragment Tracks in Photographic Plates

THE observation of tracks due to fission fragments in photographic emulsions has been reported by a number of authors<sup>1,2</sup>. In the course of similar work with photographic plates, we have obtained abundant

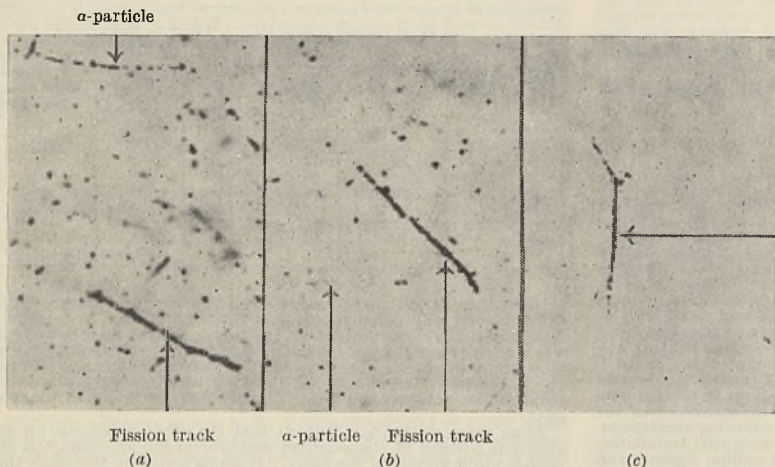


Fig. 1

and easily recognizable fission fragment tracks in specially concentrated emulsions supplied by Ilford, Ltd. The advantages of these new emulsions for the investigation of nuclear processes have already been described<sup>3</sup>.

The concentrated plates were prepared for exposure by immersing them in ammonium uranate dissolved in dilute acetic acid. The plates were then thoroughly dried, enclosed in thin brass boxes and irradiated for three hours with slow neutrons in the Cavendish High Tension Laboratory using a lithium-deuteron neutron source surrounded by paraffin wax.

The plates were examined under the microscope in the usual way and numerous examples of fission tracks were found (see Fig. 1, a, b, c). In most of the plates  $\alpha$ -particle tracks from the disintegration of uranium are also visible, but tracks due to the recoils of fast neutrons are almost completely absent. This is due to the desensitizing action of the uranyl ion on the emulsion, which also improves the differentiation between the tracks of various types of nuclear particles. At a strength of 10 gm. uranyl ion per litre, proton tracks are almost completely inhibited,  $\alpha$ -particle tracks are weakened, but fission tracks are still prominent. Fig. 1a shows the marked difference of grain density between a fission track and an  $\alpha$ -particle track at this stage of desensitization, and the considerable background of single grains present. Further increase in the strength of the uranium solution reduces the background considerably, completely prevents the formation of proton tracks, and greatly weakens the traces of  $\alpha$ -particles. Fission tracks, however, are still prominent, as shown in Fig. 1b, which was taken in a plate immersed in a solution containing 40 gm. uranyl ion per litre. Measurements made of the track-lengths in a plate similar to Fig. 1a are plotted in Fig. 2, from which it is clear that the combined range of the two fission fragments exceeds that of the  $\alpha$ -particle groups from uranium by a considerable margin, and this feature, together with the higher grain density of fission tracks, makes identification immediate.

A similar technique was utilized in the production of fission fragment tracks by fast lithium-deuteron neutrons in thorium. In this case the proton recoil background would normally be exceedingly dense, but this background was eliminated by soaking the plates in a 2 per

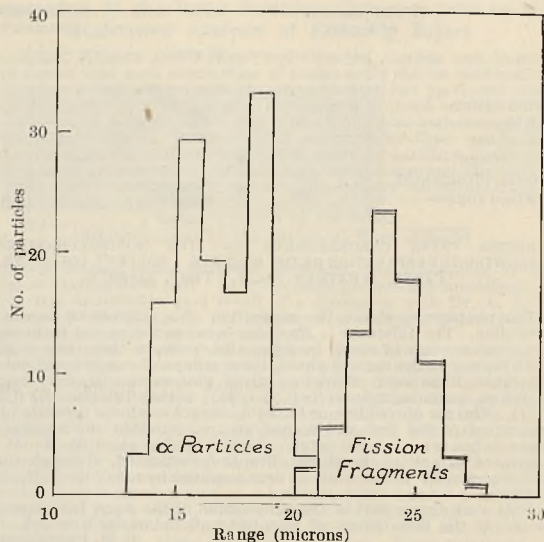


Fig. 2

cent solution of chromic acid and drying before impregnating with thorium acetate.

The fission fragment tracks exhibit several characteristic features which have been observed already<sup>4</sup>. There are frequent light and heavy nuclear recoils, giving forked and branched tracks, an example of which is shown in Fig. 1c. The grain density in the tracks decreases with decreasing energy of the fission fragment, unlike the well-known Bragg curves for protons and  $\alpha$ -particles. This effect causes the total range to be reduced in highly desensitized plates, because the last portions of the actual range are not recorded. The abundance of fission tracks varies with the strength of the impregnating solution and the conditions of irradiation, but a typical figure of three tracks per sq. mm. per gm. of uranyl ion per litre is readily obtainable. In a highly loaded plate, therefore, it is possible to examine rapidly large numbers of fission events. The method in general has obvious advantages where it

is desired to inspect the entire path of the fission tracks or to obtain information about rare fission events.

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- <sup>1</sup> Lark-Horovitz and Miller, *Phys. Rev.*, **59**, 941 (1941).
- <sup>2</sup> Guer, Morand and Cotton, *Cahiers de Physique.*, **22**, 70 (1946).
- <sup>3</sup> Powell, Occhialini, Livesey and Chilton, *J. Sci. Instr.*, **23**, 102 (1946).
- <sup>4</sup> Broström, Bøggild and Lauritsen, *Phys. Rev.*, **58**, 651 (1940).

### Linear 'Curves of Best Fit' and Regression Lines

IN a recent communication, Austen and Pelzer<sup>1</sup> have discussed the problem of fitting a straight line when both the variables  $x$ ,  $y$  are subject to error: their solution first seems to have been derived by Kummell<sup>2</sup> without the restriction that the standard deviations be constant throughout the range; he only assumed the ratio of the standard error of one variable to that of the other was the same for all pairs of readings. Kummell's paper does not seem to be obtainable in England, but this particular result is quoted by Deming<sup>3</sup>. The same solution was given later by K. Pearson and again by Gini, and there is a bibliography of work related to the subject in a paper by Roos<sup>4</sup>. Attention may also be directed to a recent paper by Wald<sup>5</sup>.

It is important to distinguish between the line of 'best fit' and the regression lines. The former serves as the estimate of the constant of proportionality holding between true values; for example, the slope of the line of best fit of mass against volume is an estimate of the density. The regression lines, however, provide an answer to the problem: How can one variable (mass, say) be estimated from the other (volume, say)? To answer this, one takes a preliminary sample of several pairs of observations under the same conditions as will be encountered later in measuring the volume, and estimates the re-

gression line of mass on volume: from this line the mass can be found by measurements of volume under similar conditions of distributions of errors and true values to those in the preliminary sample. The regression line of mass on volume provides the best estimate of true mass from observed volume. The use of the regression line to estimate density is only valid if measurements of volume are free from error: the use of the line of best fit to estimate mass from volume or volume from mass will, in general, lead to biased estimates.

Of course, it by no means follows that if the true values are connected by a linear relation then the regression of measured value of one variable (the dependent variable) on the measured value of the other variable (the independent variable) is linear. However, it is possible to prove that under this condition the necessary and sufficient condition for linearity is that the cumulant generating function of the distribution of errors of the independent variable be a constant multiple of the cumulant generating function of the distribution of true values of the independent variable.

The estimate of Kummell's involves a knowledge of the ratio of the standard deviations  $\beta$ : Austen and Pelzer have suggested that, if  $\beta$  is unknown, one should assume  $\beta = \rho$ , the slope of the line, leading to the estimate

$$\rho = \{\sum w^2 / \sum v^2\}^{1/2} \dots \dots \dots (1)$$

It should be noticed that this estimate is, in general, inconsistent, that is, as the sample size increases indefinitely the estimate, instead of tending to the true slope, tends to another value. It is the minimum requirement of any estimate that it be consistent, and hence the use of (1) is not satisfactory: it has previously been proposed by Dent<sup>6</sup>. Least squares methods do not enable the slope to be estimated without a knowledge of  $\beta$ , and if the distribution of errors and true values are normal, then no consistent estimate of  $\rho$  can be found.

Seares's solution

$$\rho = \left\{ \frac{\overline{w^2} - \sigma_w^2}{\overline{v^2} - \sigma_v^2} \right\}^{1/2} \dots \dots \dots (2)$$

requires a knowledge of  $\sigma_w$ ,  $\sigma_v$  and not merely their ratio, so that as it assumes more known, I should have expected it to have given a better estimate of  $\rho$  than Kummell's.

It is hoped to publish a fuller discussion of these points elsewhere, together with a proof of the above theorem and some generalizations of it: the work has been carried out as part of the research programme of the National Physical Laboratory, and this letter is published by permission of the Director.

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<sup>1</sup> *Nature*, 157, 693 (1946).  
<sup>2</sup> *Analyst* (Des Moines), 6, 97 (1879).  
<sup>3</sup> "Statistical Adjustment of Data" (Wiley, 1944), 184.  
<sup>4</sup> *Metron*, 13, 3 (1937).  
<sup>5</sup> *Ann. Math. Stat.*, 11, 284 (1940).  
<sup>6</sup> *Proc. Phys. Soc.*, 47, 92 (1935).

### Elimination of Certain Divergencies in Quantum Electrodynamics

THE 'A-limiting process', given by Wentzel and improved by Dirac, gives a finite classical theory for the interaction of a point-charge with its own field. A new mathematical method due to M. Riesz<sup>1,2</sup> of solving the wave equation by means of analytical continuation gives the same finite equation of motion for a point-charge as this 'A-limiting process'.

In previous papers we have applied these mathematical methods to quantum electrodynamics and to meson theory, solving the ordinary and the meson wave equation respectively by analytical continuation. In the following we will generalize these calculations.

We consider the interaction of an electron field  $\psi$  satisfying Dirac's equation, and an electromagnetic field  $A$ . When second quantization is used,  $\psi$ , too, becomes a matrix wave function. We work with the Heisenberg picture, with matrices varying with  $t$  and the state vector constant. The equations are

$$\left[ \frac{i\hbar}{c} \frac{\partial}{\partial t} - i\hbar\alpha^i \frac{\partial}{\partial x^i} - \beta mc \right] \psi = \frac{e}{c} A_\mu \alpha^\mu \psi.$$

$$\square A_\mu = 4\pi e \psi^* \alpha_\mu \psi.$$

We assume the usual commutation relations. The self-energy terms are, in the second approximation,

$$W = W_1 + W_2 = \frac{e^2}{2} \iiint dV \left[ \psi^{*0} \psi^0 A_0^1 - \frac{1}{c} \psi^{*0} \alpha^0 \psi^0 \vec{A}^1 \right] - \frac{e^2}{2c} \iiint \left[ \psi^{*1} \alpha^1 \psi^0 + \psi^{*0} \alpha^1 \psi^1 \right] \vec{A}^0.$$

We<sup>3</sup> have obtained  $A^1$  by analytical continuation with respect to a parameter  $\alpha$  for a certain value  $\alpha = 2$ . Physical expressions containing  $A^1$  can be defined as functions of  $\alpha$  and calculated by analytical continuation. When we apply these methods in quantum theory, some formerly divergent expressions become finite (for example,  $W_1 = 0$ ), but other divergencies still remain, for example, the second self-energy term  $W_2$ . Introducing in addition to the 'A-limiting process' the hypothesis of positive- and negative-energy photons, Dirac has eliminated these divergencies also.

Hitherto, we have solved the wave equation by analytical continuation and the Dirac equation in the ordinary way. The Dirac

equation is also, however, a hyperbolic equation, the solution of which, and thereby the corresponding energy expressions, can be given by analytical continuation. We will calculate  $W_2$  by this method, which has no counterpart in classical theory.

Introducing

$$x^0 = ct, e^0 = \beta, e^i = -\beta\alpha^i, \nabla = \Sigma e^\nu \frac{\partial}{\partial x^\nu}, \mu = mc/\hbar.$$

we write the Dirac equation

$$(\nabla + i\mu) \psi = -\frac{ie}{\hbar c} A_\mu \beta \alpha^\mu \psi.$$

As  $\nabla^2 = \square$ , we have  $(\nabla - i\mu)(\nabla + i\mu) = \square + \mu^2$ .

The solution of  $(\square + \mu^2) \varphi = f(P)$  is the analytical continuation to  $\alpha = 2$  of

$$V_\alpha f(P) = \frac{1}{2\alpha^{1/2} 2\pi \Gamma\left(\frac{\alpha}{2}\right)} \iiint\limits_{D_S^4} f(Q) \left(\frac{\tau PQ}{\mu}\right)^{\alpha-4} \frac{J_{\alpha-4}(\mu\tau PQ) dQ}{2},$$

where  $\tau PQ$  is the Lorentz distance between  $P$  and  $Q$ , and  $D_S^4$  is the four-dimensional domain bounded by the retrograde light-cone with its top in  $P$  and by the space  $S$ . Riesz<sup>2</sup> has obtained the  $\alpha$ -function corresponding to the operator  $\nabla$ . We now seek the functions  $L_\alpha$  and  $L_\alpha^*$  corresponding to the operators  $\nabla + i\mu$  and  $\nabla - i\mu$  respectively. We find

$$L_\alpha f(P) = \exp\left(\frac{i\pi\alpha}{2}\right) \left[ \cos \frac{\pi\alpha}{2} V_\alpha f(P) - i \sin \frac{\pi\alpha}{2} (\nabla - i\mu) V_{\alpha+1} f(P) \right],$$

$L_\alpha^* f(P)$  is obtained from  $L_\alpha f(P)$  by substituting  $\nabla + i\mu$  for  $\nabla - i\mu$ . As  $(\nabla + i\mu) L_\alpha f(P) = L_{\alpha-1} f(P)$  and  $L_\alpha^* f(P) = f(P)$ , the solution of the Dirac equation is obtained by analytical continuation to  $\alpha = 1$ .

We will now, assuming positive-energy photons only, calculate  $W_2$  by analytical continuation. Inserting

$$\psi^{1\alpha} = (\nabla - i\mu) V_{\alpha+1} \left[ \left( -\frac{i}{\hbar c} \right) A_\mu \beta \alpha^\mu \psi^0 \right] + (\text{terms}$$

vanishing for  $\alpha = 1$ ) for  $\psi^1$  in  $W_2$ , we get an expression  $W_2^\alpha$ . Owing to  $\Delta^0$ , the matrix wave function for the electromagnetic field in empty space, we get sums over all photons. In the one-electron case,  $\psi^0$  contains only one term which is not zero. We perform the operation

$$\nabla - i\mu. \text{ For an electron at rest the terms containing } \beta \alpha^i \frac{\partial}{\partial x^i} \text{ are zero.}$$

After further calculation we get for the other terms, when neglecting the retardation, an integrand which contains a sum over all photons

$$\sum_\lambda \exp\left(\frac{i}{\hbar} k_\lambda (X_Q - X_P)\right) = \delta(X_Q - X_P).$$

A calculation analogous to that for  $W_2^\alpha$  gives<sup>4,5</sup> for  $W_2^\alpha$  an expression convergent for  $2 < \alpha < 4$ , which can be continued analytically to all  $\alpha$ 's. As  $\psi$  has to be a solution of the Dirac equation, we have to find the analytical continuation to  $\alpha = 1$ . We find  $W_2 = -\frac{e^2 \mu}{8}$ .

Thus solving both the wave equation and the Dirac equation by analytical continuation, we find without further hypotheses finite expressions for the second approximation of the interaction energy.

A fuller account of this work will be presented in the *Arkiv. f. Mat. Astr. o. Fys.*, Stockholm.

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<sup>1</sup> Riesz, M., Congrès Internat. Math. Oslo, 2, 44 (1936).  
<sup>2</sup> Riesz, M., Confér. a la Réunion internat. d. Math. à Paris, 1937 (1939).  
<sup>3</sup> Gustafson, T., *Lunds Fysicgr. S. Förh.*, 15, 28 (1945).  
<sup>4</sup> Gustafson, T., *Lunds Fysicgr. S. Förh.*, 16, 2 (1946).  
<sup>5</sup> Gustafson, T., *Nature*, 157, 734 (1946).

### Practical Control of Wireworm with 'Gammexane'

In *Nature* of June 8, Messrs. Golightly and Hogg refer to our statement in an earlier issue that wireworm populations had been reduced by as much as 65 per cent following the application of 'Gammexane'. In view of a misconception that has evidently arisen, we would state that this 65 per cent measured the difference between the populations of treated and untreated plots when sampled at the same time, and had no connexion with the well-known natural fall in population that occurs after ploughing out.

We realize that the spectacular effect of 'Gammexane' treatment may not be due solely to reduction of the wireworm population, and also that other pests may sometimes be affected by these applications. It is hoped to publish a full account of our trials shortly.

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## RESEARCH ITEMS

## Caddis Flies of Illinois

A WELL-PRODUCED monograph on the Trichoptera of Illinois forms the subject of Article 1 of Vol. 23 of the *Bulletin of the Illinois Natural History Survey*. The author, Herbert H. Ross, mentions that some 184 species of these insects are known from the State of Illinois, and that the immature stages of no fewer than a hundred and twenty of the species are treated in this work. A considerable number of the species are described as new, and it is estimated that about three-quarters of a million specimens were actually collected and examined. Many of them were either females or larvæ, and consequently could not be identified any further than their genera. Keys are given for the identification of the larvæ, pupæ and adults of the seventeen families of caddis flies that are represented in North America. The monograph is very fully illustrated by more than a thousand separate figures of structural details which are clearly represented and greatly enhance the value of the work for purposes of identification. At the end of the monograph there is a useful check list of the Trichoptera of the nearctic zoological region. The whole treatise forms an admirable introduction to the study of these insects in North America, and is also likely to be useful to students of the European species.

## Colour Changes in Feathers of Hens

THE  $F_1$  males of barred Rock and Brown Leghorn fowls have feathers which are barred at the apex and Leghorn-like at the base. Mary Juhn (*J. Hered.*, 36, 355; 1945) has shown that when males were raised with thiouracil in their diet the shape of the feather, the pattern and especially the proportion of barring and Leghorn patterns on the feather were altered. In some cases there was a complete reversal of pattern—Leghorn apex and barring at the base. Phenotypic alterations may be brought about in the colour of feathers by depressing the metabolic level as by thiouracil. This is held by the author to support her hypothesis that patterns of genetic origin were affected by morphogenetic levels.

## Interpretation of the Golgi Apparatus

NEARLY fifty years have elapsed since the cytoplasmic structure, known by the above name, was first recognized; but a generally acceptable conception of it is still lacking. L. G. Worley has published a useful critical review of the whole subject (*Ann. New York Acad. Sci.*, 47, 1; 1946). The reason for much of the uncertainty regarding the interpretation of the nature of the Golgi apparatus appears to lie, to a high degree, in over-emphasis being given to the study of fixed, stained material, and inadequate examination of the living cells. During the past few years, it has come to be realized that the Golgi bodies are to be found in most, if not all, living animal cells. The apparatus is to be regarded as a series of intracellular, sponge-like structures which on account of their peculiar chemical nature and behaviour are continually engaged in mobilizing the protein and fat reserves of the cell, some of which are transformed into specialized secretory products. It is claimed that great opportunities await the cytologist who can bring himself to realize that the Golgi apparatus is something more important than a phenomenon that can be observed chiefly in dead tissue. There is, for example, the almost com-

pletely unexplored question of the structure and activities of Golgi bodies in diseased, as compared with living, cells. Also, little is known of the effects of the presence or absence of various hormones, vitamins and combinations of amino- and fatty-acids on the Golgi apparatus in different organs and tissues. Finally, there is the problem of the difference in character and behaviour of the Golgi system in young, as compared with ageing, tissues for all the body organs.

## Specific Time of Action of a Gene

R. W. SHOFFNER (*J. Hered.*, 36, 375; 1945) describes a recessive mutation affecting the toes of hens. It is of considerable and general importance since this recessive gene appears only to affect a short period of the chick's life and yet may have a lasting or even a lethal effect. At about one week old the chick, which is homozygous for the gene, develops sclerosed areas in the foot. These at this period do not heal and may lead to loss of toes. If the chick is given care, healing will take place later and the bird will appear normal except for possible lack of toes. Pathological conditions due to ergot, to dermatitis and to lack of vitamins show some similarity to the condition caused by this dactylosis gene. As the author points out, to guard against deleterious genes which only affect the organism for a short period raises more difficulties for the breeder.

## Chromosome Numbers in Iris

L. F. RANDOLPH (*Bull. Amer. Iris Soc.*, 95, 37; 1944) provides a comprehensive list of chromosome numbers in the cultivated bearded irises. As well as providing useful information for breeders, it is seen that most of the 420 varieties listed of the modern irises are tetraploids. Before 1910, most of the horticultural varieties were diploid. It is significant that the chromosome number and therefore the potentialities for the breeder cannot be recognized by external characteristics. The tetraploids are usually larger in flower, and of stronger texture of petal, but there are exceptions.

## Mutations in Bacteria

M. DEMEREC (*Proc. Nat. Acad. Sci.*, 32, 36; 1946) shows that both ultra-violet radiation and X-rays increase the mutation-rate of the susceptibility to T1. bacteriophage in *Escherichia coli*. The increase in mutation-rate is comparable to that found in higher organisms after irradiation. A most interesting discovery is that the mutation-rate remains high for several generations after irradiation. Various hypotheses to account for this delayed effect are discussed by the author.

## Solid Diffusion and Petrogenesis

A DISCUSSION by J. A. W. Bugge of the geological importance of diffusion through solids (*Norske Videnskaps-Akad. Oslo*, 1, 1945, No. 13; 1946) is of great interest in connexion with current investigations of granitization. The driving forces of all diffusion processes are related to differences in the chemical potentials ( $\mu$ ) of the elements concerned, and the variation of  $\mu$  with composition, external pressure and temperature is given detailed description. From theoretical considerations it is supposed that the rates of migration are greater under the thermodynamic conditions of the deeper zones of the earth's crust than those found in laboratory experiments. It is suggested that the migrations responsible for metasomatism occur partly by ionic diffusion through the

crystal lattices and partly by molecular and/or ionic diffusion through the interstices ('intergranular film' of Wegmann) between the minerals. Large ions, such as O, OH and F, will usually diffuse in the 'film', while small ions, such as Si, Al and Na, may migrate almost as quickly through the crystals themselves. The melting phenomena met with in granitized rocks are ascribed to a preponderance of exothermic reactions and to energy supplied from the depths by the primary diffusing particles. Geological consequences are illustrated by examples (showing increasing distances of diffusion) from the Archæan rocks of southern Norway: (a) exsolution processes in feldspars and other mix-crystals; (b) isomorphous substitution in feldspars, etc.; (c) reaction zones between minerals, for example, coronas around olivine in hyperites; (d) reaction zones between rocks, for example, skarn formation and the development of cordierite-anthophyllite-rocks; and (e) metablastic and paligenetic rocks, for example, granites and pegmatites.

#### Capacitors for Measurement Purposes

A PAPER read before the Institution of Electrical Engineers in London by C. G. Garton deals with the variations of capacitance and loss-angle occurring in precision capacitors used for measurement purposes. The degree of accuracy required in current practice is discussed and compared with the performance of available instruments. It is shown that improvements in stability are required in some cases, and could be achieved. The causes of variation are reviewed with relation to time, humidity, temperature, frequency, voltage and screening, and the properties of materials used in capacitor construction are discussed in the same relation. Special attention is given to the less well-known causes of change in capacitance and loss-angle, and also to experimental difficulties which lead to errors in the measurement of these quantities. In particular, attention is directed in an appendix to an apparently unrealized source of error in loss-angle measurements on samples with a guard ring.

#### Solar Rotation and Shift Towards the Red Measured in Prominence Spectra

J. EVERSHED has continued measurements of the shifts of the *H* and *K* lines in prominence spectra from April 1935 to March 1939 (*Mon. Not. Roy. Ast. Soc.*, 105, 4, 204; 1945). The auto-collimating spectrograph consists of solid glass prisms of 6-in. aperture (*Mon. Not. Roy. Ast. Soc.*, 95, 504; 1935), and the comparison spectrum is formed by a carbon arc containing traces of calcium, and giving the *H* and *K* lines of approximately the same width and intensity as the prominence lines. Previous measures showed that the prominences gave values of the angular speed of rotation in different zones of latitude greatly in excess of values derived from spectra of the reversing layer, or from the motions of sunspots, and the present results confirm this. The equatorial speed of the reversing layer is  $14.5^\circ$ , according to Adams, and Evershed finds that the speed in the prominences is  $16.9^\circ$ . The general shift of the *H* and *K* lines towards the red in this series of measures exceeds the relativity shift by only 0.0081 Å. On comparing the results with previous measures it appears that the rotation values were about  $2^\circ$  a day greater at times of maximum solar activity than they were near the minimum of 1933. There seems to have been a decrease in the general shift from 0.015 Å.

to 0.009 Å. in the period 1926-39, and the general mean of all the measures is 0.012 Å., which is 0.004 Å. in excess of the relativity shift.

#### Determination of Pentoses in Nucleotides and Nucleosides

A METHOD developed by Wanda Mejbaum in Prof. Parnas' laboratory in Lwow and published in 1939 (*Z. physiol. Chem.*, 258, 117; 1939) enables determinations to be made of free purines, purin nucleotides and nucleosides in microgram quantities: the method, in the original form or with modifications, is widely used. Miss Mejbaum has investigated the value of this method for other nucleotides, for it was found with a preparation of cozymase and phosphocozymase received from Prof. Otto Warburg that only one pentose was found for two phosphorus atoms. This was interpreted by Parnas ('Hdbk. der Enzymologie', 908; Nord-Weidenhagen, 1940; American photoprint, 1943) as indicating that only one of the mononucleotides in the cozymases is a pentose; this interpretation was wrong. Miss Mejbaum has found (*Biochimica*, Moscow, 10, 359; 1945) that the pentose contained in pyrimidine nucleotides (uridylic acid and cytidylic acid) and nucleosides (uridine) are not determined by her method; they give no coloration with the orcinol-reagent. Dihydrouridine behaves like free pentose or like purin nucleotides. The same holds for the determination of pentoses in nucleic acids, where only about one half of the pentoses is determined, namely, those linked with purines, and not those linked to pyrimidines. The same applies probably to the nicotinic part of the cozymases.

#### Determination of Fluorides in Water

THE importance of the fluoride content of a drinking water in relation to the production of mottled teeth is well known, and methods for the determination of small amounts of fluoride in water are thus important. O. J. Walker and G. C. Gainer (*Canad. J. Res.*, 23B, 275; 1945) describe a method using a photo-electric colorimeter. It is based on the bleaching of the lake from a zirconyl salt and sodium alizarin sulphonate by the fluoride ion. The photo-electric colorimeter is direct reading, the light passing through a long vertical absorption cell, and the apparatus is calibrated with solutions containing known amounts in parts per million of fluoride. The method is not suitable when more than 1.5 parts per million of fluoride is present, and in such cases dilution is necessary.

#### Oxides of Lead

SOME years ago, LeBlanc and Eberius reported that in the decomposition of lead dioxide,  $PbO_2$ , a range of homogeneous oxides of non-stoichiometric formulæ was formed. A. Byström (*Arkiv. f. Kemi, Min. Geol.*, 20, No. 11; 1945) has made a careful X-ray study of the system and has shown that the oxygen content of  $PbO_2$  cannot be below  $PbO_{1.95}$ , that it gives on decomposition an oxide  $\alpha$ - $PbO_x$  which has a range of homogeneity close to the formulæ  $Pb_3O_5$  and  $Pb_2O_3$ , and  $\beta$ - $PbO_x$  with a composition very close to  $Pb_2O_3$  and probably no range of homogeneity; and that the range of homogeneity of  $Pb_3O_4$  is very narrow. The modifications of  $PbO$  have no or very narrow ranges of homogeneity. The cell dimensions of all the compounds were determined. It appears that the oxides of lead do not present an example of non-stoichiometric compounds, and more careful investigations of other systems would probably diminish further the examples quoted.

## AGEING IN MAN AND OTHER ANIMALS

ON July 16 at the Imperial College of Science and Technology, London, a conference was held by the British Branch of the Club for Research on Ageing. Delegates of European branches of the Club and some other guests interested in the subject were also present. Lord Nuffield was elected honorary president of the conference, and Sir Francis Fraser, chairman of the conference.

Sir Francis Fraser introduced the delegates from other countries. He then proceeded to describe the role of clinical research on old age. Clinical research is the most difficult of all fields of research as there are always so many uncontrolled factors to consider. Quick results are not to be expected; one must think in terms of long-continued and laborious research. Pathological conditions are generally present in addition to old age, and it is difficult to differentiate between them. He concluded that clinical research on physiological ageing is practically impossible, and that it is better for clinicians to concentrate on studying primarily the pathological conditions.

Prof. F. A. E. Crew gave an account of recent work in Scotland on the sociological problems of an ageing population. The current figures for births, deaths and marriages appear satisfactory on the surface, but when looked into more carefully the present population trend shows a most disquieting increase in the proportion older than sixty-five. Since industrial capacity diminishes after the age of thirty-five there is a danger of the old becoming a burden on the younger members of the community. He went on to analyse the statistical figures of the causes of death, and he urged the need for closer collaboration between clinical investigators and those working on population research. The real problem of gerontology is "not how to give years to life, but life to years".

Dr. M. Critchley urged the need for further research on the nervous system in the study of normal ageing as well as the associated pathological conditions. He outlined in detail a number of possible schemes of research of importance for neuro-gerontology.

Dr. V. Korenchevsky expressed the aim of gerontology as not merely to achieve a longer life, but a stronger one. Since ageing starts at a very early age, we must include the study of the whole life-span and even the development of the fetus. Attempts that had been made at rejuvenation by such methods as Voronoff's glandular grafts, treatment with hormones or Bogomolets' serum, have proved unsatisfactory, since they achieve only a temporary stimulation: the aim must be to discover and remove the causes of premature ageing and not merely to stimulate degenerated tissues. He outlined five conditions required for international and local organisation, if research on ageing is to progress at a reasonable rate.

Prof. F. C. Bartlett believed that the effects of ageing on psychological performance can be compared with the effects of other factors such as extremes of heat, humidity and noise. Each of these factors produces an increased liability to fatigue, which can be measured in a number of ways. New methods developed for the study of skill and fatigue in air pilots during the War may be applicable.

In the discussion which followed these papers, Prof. G. R. Cameron emphasized the need for quantitative research on the effects of ageing on the blood

vessels of the brain: there is scope for the employment of many new techniques on this problem. Lord Nuffield said he could not understand how ageing could begin in early childhood, since the athletic performance of a child goes on improving up to the age of fifteen. Dr. Korenchevsky and Dr. J. Hammond pointed out in reply that different organs develop at different ages: brain and bone have priority at an early age, and muscle develops only later. Prof. M. J. Stewart would like research to be carried out on changes in the blood in old age: it is a striking fact that many old people die of pneumonia because their blood fails to respond as vigorously as that of young people to the toxins of the pneumococcus. Dr. D. Richter urged the need for more accurate statistics of the causation of death. The present figures are unreliable, as permission for a post-mortem is often refused. The public must be educated into a realization of the importance and value of post-mortem examinations. The development of gerontology as a science can be seen in the two editions of Cowdry's book on ageing. The first edition was made up largely of speculation and poetry: the second edition contained less poetry, but more facts, figures, tables and measurements. Clinical science can help in the same direction by obtaining greater precision in defining and measuring the factors concerned. Dr. L. Fairfield deplored the way in which the chronic sick and aged are despised by the teaching hospitals and thrust on the public authorities. Medical science has relieved many of the worst miseries of old age, such as the bladder and prostate troubles; but senile dementia is a social problem of increasing urgency. Is it right that healthy young women, who should be bringing up children in their own homes, are now engaged in washing the dirty linen in wards of senile demented?

The guests from Sweden, Denmark, Holland and France then reviewed the work on ageing that is in progress in their respective countries. Dr. B. Purchase, who gave the point of view of a coroner, agreed as to the unreliability of the present statistics, and said he could provide reliable figures for some two thousand cases a year on which post-mortems have been carried out. Prof. Crew said he is anxious to close with Dr. Purchase's offer, as he has been trying to obtain experimental material of this kind. Dr. Fairfield considers that the apparent conspiracy among general practitioners to avoid putting cancer on death certificates might be sufficient to make a significant error in the figures.

The morning session was closed by the passing of five resolutions proposed by Dr. Korenchevsky and expressing the views of the conference as to the requirements for the further rapid advance of gerontology. These included international co-operation between those interested in the subject (for which purpose the Club was founded), establishment of permanent institutes for research on ageing and the provision of ample funds necessary to secure these facilities.

At the afternoon session Dr. P. C. Williams read a paper for Prof. E. C. Dodds on the significance of androgen and oestrogen excretion in the urine in relation to ageing. The tendency to cancer of the prostate is considerably affected by the sex hormone balance, as shown by experiments on castration and by the effects of administering stilbestrol in the male. There is a need for further quantitative data on all age groups.

Prof. Crew pointed out that the male infant has a

much poorer chance of survival than the female. A male infant with broncho-pneumonia is thus suffering from two conditions: (a) broncho-pneumonia and (b) maleness. Could we use sex hormone preparations to effect a temporary transformation of a male infant into a female to get over this disadvantage?

Dr. Hammond described recent work at Cambridge on the ageing of the foetus in rabbits and sheep. The chronological age must be differentiated from the physiological age, as measured by the size, the ossification of the bones and development of the heat-regulating centres. The physiological ageing of the fetus can be varied experimentally by controlling the size of the litter and the nutrition of the mother. He suggested that similar factors may operate in the return to an infantile condition in old age.

Prof. J. B. Duguid put forward a new theory of the thickening of the arteries in atherosclerosis. He believes that we have been misled by the teachings of the Virchows. The thickening does not come from within the artery walls: it is due to the organisation of successive layers of fibrin deposited on the intima. The difference is fundamental, since in his view the primary cause of the disease is in the blood rather than in the vessels. Prof. Cameron asked how this view could account for lipoids in atheromatous plaques. If the arterial narrowing is due to encrustation with fibrin from without, why do not the veins get narrowed in the same way? Prof. Duguid replied that the relation of lipid changes to atheroma is not fully understood. The veins do not get narrowed, because when they are thrombosed the whole vein becomes blocked, while in an artery, the vessel is cleared by the rapid flow of the blood.

Dr. Korenchevsky gave an account of experiments on the artificial premature 'climacteric' and its effects on the process of ageing in female rats, and the influence on this process of androgenic, oestrogenic and thyroid hormones. Ovariectomy hastens the ageing of rats. The combination of androgenic, oestrogenic and thyroid hormones together produces an apparent 'anti-ageing' effect, as judged by the organ weights and histological appearances of some vital organs; but this may be merely a temporary stimulation of ageing organs. Prolonged treatment may be followed by collapse, since the stimulants do not remove the causes of ageing.

Dr. W. Stephenson read a paper for Dr. P. E. Vernon on the psychological conclusions from an investigation of the effects of vitamins on senile patients at Tooting Bec Hospital. It was concluded that large amounts of vitamins exert little effect on psychological ageing, when the diet is adequate in these compounds. Dr. Stephenson described also some work of his own in which an increased amount of vitamins in a diet previously deficient in these substances was followed by an improvement in the mental capacity of senile subjects. Prof. Bartlett criticized the use of psychometric tests in these experiments, as he holds that the performance of such a test is not characteristic of senile subjects. It would be better to measure the kind of things that old people normally enjoy doing.

Dr. Richter described an investigation on the biochemical changes in ageing. The results indicate that the mental and physical deterioration in ageing are different processes that can be defined by their biochemical accompaniments. Biochemical changes are found in the blood in advanced physical senility which are distinct from the changes normally occurring in old age: the changes associated with senile

dementia are different again. Senility is not a simple entity, but is made up of a series of pathological processes, which should be more clearly defined by further work. Our ignorance of the biochemical changes in the tissues in ageing is a big gap in our knowledge. Much public money is now being spent on palliative measures in providing homes for old people: there is an urgent need that more should be spent on preventive measures, which means research.

Dr. J. H. Smyly gave an account of the methods developed by him for assessing physical fitness in old men. These included exercise tolerance tests as measured by pulse-rate and oxygen consumption. The usual methods may be dangerous for old people.

Prof. Crew, in summing up, said that the proportion of old people in the population is increasing, and gerontology is therefore a science of increasing social importance. Geriatrics must also come to occupy a part not less important in medicine than pediatrics to-day. He recommended the formation of a permanent international congress committee to organise international gerontological congresses.

## MIMETIC POLYMORPHISM

By PROF. G. D. HALE CARPENTER, M.B.E.

University Museum, Oxford

DR. RICHARD B. GOLDSCHMIDT has discussed the origin of mimicry in a paper entitled "Mimetic Polymorphism, a Controversial Chapter of Darwinism" (*Quart. Rev. Biol.*, 20; June and Sept., 1945). As he rightly says, most field naturalists accept the facts of mimicry. He returns to the theory of production of a mimetic resemblance by saltations, but the discussion, being mainly on the genetical basis, ignores the fact that mimicry is essentially a phenomenon of life, and that far-reaching conclusions drawn from the study of the colour and pattern of a few dried butterflies do not cope with a vast number of cases among other creatures. Indeed, he remarks that in view of conflicting evidence as to habits, etc., of mimetic butterflies, it is better to mark this group of doubtful adaptations as *non liquet*. Were Goldschmidt more familiar with at least the records of field entomology, he would have found very many observations from naturalists of experience who have been deceived against their better judgment. The resemblance of an ant-like spider to its model is notorious for the part played by special movements and attitude, both foreign to the generality of spiders. The deceptive resemblance of longicorn beetles to Hymenopterous models (Braconidæ) is so great that experienced collectors have recorded their inability to distinguish them in flight. A black fossorial wasp in tropical America has the habit, while very actively running about on the ground, of vigorously flicking its wings. This characteristic is copied by two other insects far removed in relationship, a Reduviid (Hemiptera) and a Tettigoniid grasshopper which, agreeing in their wholly black coloration with the wasp, have the same habit, completely foreign to their congeners. Quite recently I was told by a leading Brazilian naturalist of how he was warned by an entomological companion not to touch a certain black insect as it stung very badly: the insect was the mimetic grasshopper.

The fact that mimicry sometimes does not deceive is of little importance beside the fact that sometimes

it does. The natural enemies of insects are not studying the patterns of dead specimens in a cabinet, at leisure. In the field, if a hunter, in the midst of the abundant life of the tropics where mimicry flourishes, hesitates over a doubtful specimen and turns to one of unequivocal appearance, the doubtful one escapes with its life.

Every field naturalist has been momentarily deceived by an insect which seemed other than what it really was. An experienced student and collector of British butterflies told me that every year when the 'wall' butterfly (*Dira megera* L.) appears he is occasionally puzzled by a specimen which, for a moment, seemed to be something else. The difficulty of 'the first step' is much less of a difficulty to a naturalist than to a geneticist. The following incident is illuminating. When in Africa I had a young monkey which one day played around as I sat on a chair mending some clothes; suddenly the monkey made the warning noise for 'snake'. Puzzled at first, I eventually found out, when he repeated the warning, that he was afraid of the thimble on my finger, and would not come near it. Apparently the bright surface, pitted, and the shape, evoked the response to a snake. Had this appearance been on the anterior extremity of a Sphingid or other large caterpillar among leaves, suddenly seen for a moment, one cannot doubt that the caterpillar would probably have been left alone. This would have been an early step in the production of snake-mimicry.

Goldschmidt says that the decisive part of the mimicry under consideration is the wing-pattern. But this does not mean that wing-pattern is the whole of mimicry. Exception must be taken to the statement that for a discussion of this topic we ought to distinguish between different types of mimicry. By this the critic does not mean between Batesian and Mullerian resemblances, but between resemblance to a dead leaf and resemblance to another living animal. I see no necessity for supposing that these two cases are differently produced; indeed, they grade into one another so that a definite line between them is impossible.

Ant-like spiders have already been mentioned. But Hingston described a spider which, found on the rubbish-heap outside the entrance to an ant's nest, when alarmed tucked its limbs beneath the body and closely resembled a common object on such a rubbish-heap, namely, the chitinous skeleton of the head of a dead ant. Is resemblance to part of a dead ant to be sharply separated from resemblance to a whole, living ant? To a Darwinian, one is an example of special procrystis, while the other is pseudoposematic; both are cases of resemblance to some object of little or no food value.

Another general point calls for comment. Goldschmidt classes Mantids among the predators which, at least, sustain mimetic resemblance. But that is not the view of supporters of the Darwinian theory which he is combating. It is known that not only do predacious arthropods devour 'warningly coloured' prey but also that in some cases they show preference for it. In general, mimicry is not directed against predacious arthropods, though it is possible that the resemblance of spiders to ants is such a case. Arachnologists have stated that hunting spiders are extremely important enemies of other spiders, and that spiders are usually afraid of ants. The quick, ant-like movements of mimetic spiders, which live among ants, have in some tests been shown to be protective against attack by other spiders.

Much use is made of parallel mutation to explain the cases of mimicry which are mentioned by Goldschmidt. It is stated that widely different models of different mimetic females of a species are related among themselves. The case of *Papilio dardanus* at once comes to mind; while Danaidæ serve as models for most of the female forms, a species of Acreidæ is the model for another. If we consider different members of a genus we often find widely different models. In the butterfly genus *Euphaedra*, two species mimic Agaristidæ, another an *Aletis*, these being day-flying moths widely separated from each other and from the mimics. The study of geographical distribution provides examples which do not seem to tally with the facile explanation by parallel mutation. *Acrea johnstoni* Godm. resembles, in most of its forms, Danaid models: it is widespread throughout less densely forested parts of Africa. In the mountainous country of western Uganda it occurs in only one form, mimicking, not a Danaid, but the Acreid *Bematistes* (= *Planema*) *quadricolor* Rogenhofer, a species with very unusual and peculiar purplish-brown colouring, which is found again, hundreds of miles to the east, on the mountains of Kenya and Tanganyika Territory. *Acrea johnstoni*, however, on the eastern mountains, does not mimic the *Bematistes*, but, as in all the intervening country, mimics the predominant Danaids of its locality. Danaid models occur in western Uganda, but there is no parallelism between them and the *Acrea*.

Again, *Papilio cynorta* F. has a female always different from its male. In West Africa it is mimetic of the black and white female of *Bematistes epæa* Cr., the male of which has the white replaced by orange-brown. In Abyssinia both sexes of the *Bematistes* are like the western male, but the female *P. cynorta* does not agree with this and resembles the black and white local race of the Danaid, *Amauris niavius* L., which occurs abundantly also in West Africa. It may be asked how does parallel mutation serve as an explanation of cases in which there is mimicry on the upper surface of the wings but another appearance on the under surface? Thus, in the Oriental and Ethiopian regions, species of Danainæ and Euploeinæ are mimicked by Elymniinæ on the upper surface, which are cryptically coloured below. The South American Nymphaline *Protogonius* are very like dead leaves on the under surface, but above they mimic the prevailing type of Ithomiine coloration. Some African Papilionidæ resemble spotted Danainæ above but have a warning colour of their own, entirely different, on the under surface. The remarkable African Lycaenidæ of genus *Telipna* are like species of *Acrea* above, but have a characteristic warning coloration of their own beneath.

A general point that does not seem to have struck critics may be thus stated. It is surely very strange that parallel mutation seems to concern itself with producing only conspicuous coloration. Why does it not produce similarly deceitful resemblances among cryptic species? Innumerable butterflies and moths resemble dead leaves, but although they resemble the same things (syncrystis), they do not resemble each other, as mimics resemble models.

All the arguments from parallel mutation are concerned with colour and pattern in butterflies only. The mimicry of the Australian wasp *Abispa ephippium* F., red-brown with a transverse black abdominal band, by two similarly coloured longicorn beetles is most instructive. One, *Tragocerus formosus* Pascoe,



has the normal elytra with the black band across them. As they are kept closed over the abdomen in flight, in this species, the resemblance to the wasp is the same whether the beetle flies or is at rest. The second beetle, *Esthesis ferrugineus* Macleay, has extremely truncated elytra which do not reach the position of the black abdominal band in the wasp. The black band is, in this beetle, across the abdomen itself. So, in this set of examples, the black band is placed on the abdomen in the wasp and one mimic, on a thoracic appendage in the other mimic. The effect is the same, however. This is only one example of the production of the same effect by different means, a phenomenon treated very lightly by Goldschmidt, rather as an inconvenience. Arguments about mimicry based on the statement that the pattern systems of different families of butterflies are in reality not very different are useless for dealing with a wider aspect of mimicry.

Goldschmidt quotes with approval Punnett's statement that cases of mimicry tend to run in series; for example, the African Papilionid species of *Graphium* tend to resemble Danaidæ and Acræidæ. But, it may be asked, What else is there for them to mimic? For this argument to be valid, it would have to be shown that there also exists in Africa a group of conspicuous distasteful butterflies (such as *Euplœa* in the East) which are *not* mimicked because the parallelism between Papilionidæ, Danaidæ, and Acræidæ keeps the former to these models. It may be confidently stated that should *Euplœas* find their way to Africa, they would be mimicked.

Finally, exception must be taken to a statement made by Goldschmidt in his discussion of seasonal dimorphism, which is compared with mimicry. He says "The mutant must be such as to effect the primary patterning processes, it can change the pattern thoroughly because the proper developmental system is already available", and then continues (the italics are mine) "Small wonder therefore that *mimetism is about as rare as extreme seasonal dimorphism*, and that it is *confined to a few nearly related members of a few systematic groups*". This most extraordinary statement is presumably due to lack of knowledge, for a glance through such a work as Seitz's "Macrolepidoptera of the World" would have dispelled the illusion. Particularly in the case of the tropical American butterflies is the statement untrue, for in the great humid forests there can be little seasonal change of appearance. I have some experience of African species, and have used volume 13 of Seitz's work on the African Rhopalocera. In order not to seem biased, I have taken none of the examples of mimicry of *Mylothris* by other Pierids as being nearly related, and none of the rather elementary cases of mimicry to be found among forest Nymphalines. I have also omitted resemblances of *Acrœa* to their larger relatives *Bematistes*, and resemblances among species of the genus *Charaxes* to each other. On the other hand, the comparatively slight seasonal differences in Satyrinæ have been discounted.

The cases of "extreme seasonal dimorphism" in Africa comprise *Charaxes zoolina* Westw. and six species of *Precis*: total, seven. Against these can be set the following very definite cases of mimicry by species. Papilionidæ, 10; Satyridæ (Elymniinæ), possibly all one species, 1; *Euxanthes* and *Charaxes*, 5; various Nymphalines, 7; *Pseudacrœa*, 8 species, of which one, *curytus*, has a great number of forms; *Hypolimnas*, 5. Among Lycænidæ, one can easily

find 40 mimetic species, and a few Hesperiidæ are known with Acræoid under-sides.

The other statement, that mimetism is confined to a few nearly related members of a few systematic groups, is almost as untrue, and becomes quite ridiculous if a little wider view of the subject is taken: the enormous, complex association of mimics of Lycid beetles at once calls for consideration.

## THE BRITISH INSTITUTE OF PHILOSOPHY

ON April 6 of this year the British Institute of Philosophy (University Hall, 14 Gordon Square, London, W.C.1) completed the first twenty-one years of its existence. The occasion was marked by a letter to *The Times* from Lord Samuel, president, Sir David Ross, chairman, and Lord Lindsay, vice-chairman of the Institute. A leading article in the same issue, "The Sovereign Mind", dealing with the work of the Institute, stressed the need for the pursuit of abstract truth and the scrutiny of ideas offered to the people as springs of action. Founded "to serve as a link between philosophers and the everyday world", the Institute has fulfilled this aim in many ways. It has organised courses of philosophical lectures as well as popular addresses in London. It has founded branches in Bangor, Cardiff, Liverpool, Manchester, Newcastle and Durham, and Sheffield under the auspices of the Universities in those centres, and usually under the direct guidance of the head or some member of their departments of philosophy giving his services free. Its journal *Philosophy*, which ranks with professional journals in philosophy and draws contributions from the leading philosophers in Britain, has performed the feat of compelling philosophers to write so as to be understood by laymen, and has achieved as a result the unique distinction of being read with enjoyment and profit by laymen and philosophers alike. All this has been done with a membership of only a little more than a thousand.

At the reception held on July 23 to celebrate the Institute's coming of age, Lord Samuel was able to announce a fifty per cent increase in membership as a result of the anniversary appeal. The reception was followed by addresses on "The Need for Moral and Intellectual Leadership" by Lord Samuel, Prof. A. V. Hill, Canon Hodgson and Prof. E. R. Dodds. Lord Samuel saw the ultimate sovereignty as residing not in governments but in the people, and the people as needing the leadership of ideas. Such ideas would have to come from religion, science or philosophy, three ways of thought that have frequently beckoned in different directions. He deplored the small influence philosophy commands in the world to-day, due to its absorption in scholastic disputes and its alleged rule of method: "Take no hair and split it", and recalled it to its traditional task—to interpret the human situation.

Prof. Hill saw the question as a problem of finding in a democracy men who combine reasoned ideas with the power of persuading people to adopt them. Science is not enough. The Hippocratic oath is as important as the Hippocratic method: and the necessary and rightful exclusion of moral considerations from the weighing of scientific truth should not be allowed to result in the extrusion of moral values as irrelevant to the wider situation in which the

pursuit of truth is one value among others and commands the devotion of men.

Canon Hodgson spoke of the creeds, or philosophies of life, by which men live, as needing to be at once rational and empirical. The Christian faith has its empirical side, as matter for theology; its rational side, as matter for philosophical criticism. It must hold fast to one, if it is to benefit from the other.

Prof. Dodds focused more narrowly upon the universities as the growing points of an educated democracy. Leadership must carry no suggestion of indoctrination. To train men with an educated intellectual conscience is the function of the universities, which are the very model of the 'open society'.

Prof. Dodds would presumably welcome the disorder in our beliefs to-day as at least a sign of the right of the individual conscience. Yet there may be some middle path. What we have to-day is not divergence within a pattern but divergence of patterns. The intellectual conscience is a fine conception, but it is only one side of man, who cannot be thus dissevered. It is man as indissolubly rational and moral that is the final test of all theories. Some theories are ruled out by this test; but experimentation must go on, because only in this way can they be ruled out. Modern thought has gone too far in proclaiming the irrationality of man, owing to the too narrow conception of reason with which it has operated. As Prof. Hill pointed out in his address, 'reasonable', in English, has a moral as well as an intellectual connotation. On linguistic grounds alone there must be something wrong with a conception of reason which does not do justice to this fact. It is the philosopher's duty to articulate those realms of reason which lie outside science, and it is time for him to take his courage in both hands and set about this task.

The reception was held in the rooms of the Royal Society. The venue was appropriate, if one remembers the wider aims which the founders of the Royal Society had in mind. There must to-day be many men of science who feel the need to discuss the wider philosophical issues of their work, which recent developments have forced into the forefront of the scientific consciousness. Certainly the Institute needs scientific men among its members. In this connexion it is worth noting that its journal has included a large number of philosophical articles by men of science.

It is interesting to compare the breadth of philosophic vision the Institute has shown in its twenty-one years career with the tendency in purely professional philosophy during the same period to contract into a highly specialized study of a narrow range of linguistic problems with the esoteric jargon and parochial pride of the typical sect. While eminent men of science like Jeans and Eddington were being driven into metaphysics by science, some professional philosophers were claiming that a true understanding of scientific inquiry showed that no other kind of inquiry was possible. There are signs that this period, valuable as its results have been, is drawing to a close. The joint session of the Aristotelian Society and the Mind Association, held in Manchester during July 5-7, showed that broader conceptions of philosophy are returning. Unofficial visits by members of the session to the University of Manchester to see the Bush differential analyser and the bust of Samuel Alexander by Epstein revealed an equal reverence for the machine and the metaphysician; and one philosopher was heard saying, as he left a group surrounding the bust, "Never have so many

positivists revered such a metaphysician". If these hopes are to be fulfilled, philosophy needs to be fertilized by contact with other subjects. Now that psychology is a grown-up science, it has no longer that close connexion with philosophy which afforded the latter continual stimulus, not to say provocation. A closer contact with all the sciences must take its place. If, as a result, the conception of philosophy as an activity of the sovereign mind—not in any spirit of dominating or controlling other activities of mind but simply as taking a broad and reflective view of the world as a whole—recovers its proper status, no small thanks will be due to the British Institute of Philosophy, whose lamp has burned boldly and brightly when other philosophical lamps were trimmed almost to extinction.

WINSTON H. F. BARNES

## PRODUCTION AND ANNIHILATION OF NEGATIVE PROTONS

THE only one known equation to describe particles of spin  $\frac{1}{2}$  is that derived by Dirac in his treatment of the electron. It must therefore be employed in any theoretical discussion of nucleons (protons or neutrons), and since Dirac's treatment was able to predict the existence of the positron it is to be expected that anti-nucleons, produced by removing nucleons from negative energy states, also exist.

Experimentally, anti-protons, that is, particles with the mass of a proton but with negative electrical charge, are the more interesting. They have not as yet been observed. The Rev. J. McConnell (*Proc. Roy. Irish Acad.*, A, 50, No. 12, 189; 1945), in a mathematical discussion of the problem of the production and annihilation of negative protons, has shown that the rate of production of such particles is so small that it is not surprising that the negative protons have not been observed in experiments so far performed. With more suitable experimental arrangements, the negative proton could most probably be detected.

Negative protons arise through the formation of nucleon pairs. These pairs could be produced, like electron pairs, from light quanta, but the effect would be extremely small. Alternatively, the pairs could be produced by the collision of cosmic ray mesons with nuclear particles in the atmosphere. The simplest process is that in which two charged mesons collide; and it is shown that if the approximation method due to Dirac is applied to the field, the cross-section for the process increases steadily with the energy—an unreasonable result. It is necessary to make use of the Heitler-Peng theory of radiation damping, and the cross-section for extremely small values of the momentum  $p$  is then proportional to  $p$ , rapidly reaches its maximum value of  $2.2 \times 10^{-27}$  cm.<sup>2</sup> and finally decreases as  $p^{-6}$ . The process in which a meson collides with a neutron or proton at rest is also considered. By means of a Lorentz transformation the meson is brought to rest and the nucleon allowed to move, and applying the Weizsäcker-Williams method the field of the moving nucleon is replaced by a field of mesons.

The calculation is admittedly very approximate, but the results are claimed by Mr. McConnell to be of the correct order of magnitude. It is found that pair production does not occur unless the energy of the primary meson is greater than  $4 \times 10^9$  eV. The cross-section then starts from zero, reaches a maxi-

of  $7 \times 10^{-29}$  cm.<sup>2</sup> at  $8 \times 10^9$  eV. and afterwards falls slowly to zero. This corresponds to a mean free path of not less than 40 metres in lead.

Neglecting damping, the annihilation of nucleon pairs would, in the Dirac approximation, have the same probability for occurrence as the production, apart from a simple factor arising from the different density functions of the final states, and thus the anti-nucleons on being produced would be immediately annihilated. That this is not so is shown by the further application of the radiation damping theory. It is found that the probability that a high-energy negative proton will be annihilated into mesons on passing through lead is less than 20 per cent, and that on being brought to rest the negative proton is annihilated with emission of light quanta with a mean life-time of about  $10^{-4}$  sec.

Thus, although the negative proton has not yet been observed, the above figures lead to the estimation that for every 1,000 cosmic ray particles observed at sea-level about 0.6 should be negative protons. Williams found that of two thousand particles observed, eight were protons, so that it is to be expected that of the number of detectable protons about 10 per cent are negative protons. It is suggested that experiments on showers of two particles, similar to those of J. G. Wilson (*Nature*, 142, 73; 1938) but with ten times the number of photographs, be performed in order to determine the charge on the particles and to verify the theoretical results.

## POPULATION POLICY FOR GREAT BRITAIN

A SERIES of broadsheets issued by Political and Economic Planning during the last few months are of considerable interest in relation to the proposed national health service in Great Britain. The first of them, "Vital Statistics" (No. 241), is concerned with the probable population trends. It points out that although there is scope for further reductions in total mortality, their effect on population growth could only be small compared with last century, when the rapid increase in population was entirely due to the reduction of mortality. Lower fertility within marriage is the main reason why the population has failed to replace itself for the last twenty-four years, and in the long run the declining trend can only be checked by increasing the average number of children per married couple. There are, however, clear signs that it is the deliberate limitation of families by methods of birth control which is mainly responsible for the present decline in fertility. Analysing various possible trends, *Planning* concludes that in no circumstances would it be realistic to expect an expansion of population in England and Wales comparable to that of the last century. The most that can be expected in the long run is a small increase, and this can only be achieved by reversing present trends.

In broadsheet No. 242, "Retreat from Parenthood", *Planning* examines the nature of the human impulses and attitudes responsible for this decline in population, and endeavours to set the most important of these factors in their correct historical perspective. Although there is evidence in all ages of some desire to avoid excessive fertility, there does not appear to have been in Europe any widespread desire severely to limit the size of families until the

transformation of life by the industrial revolution was far advanced. Thereafter the growth of financial penalties on parenthood as well as the state of public opinion encouraged the small family pattern. Children to-day are the cause of relative rather than absolute poverty, and limitation of the family is an obvious economy of energy as well as of money. The new awareness of insecurity was a further adverse factor, and the neo-Malthusian movement diffused the idea of family limitation far more widely than it succeeded in spreading actual knowledge of contraception. Again, the enjoyment of leisure, like the attainment of security, is apt to conflict with rearing a family, and the growth of sex equality and sexual knowledge have tended to reduce children from an integral part of the happy marriage to a welcome but not indispensable addition to it, if circumstances make a family appear worth while without too much sacrifice.

The broadsheet concludes by pointing out that the new freedom of parenthood in advanced societies marks the end of the epoch of automatic replacement of human numbers, and the institution of voluntary parenthood obliges society to adopt a population policy. Such a policy must take into account prevailing attitudes to marriage and parenthood, and seek to modify them in socially desirable directions. Simultaneously, it must recognize all the disabilities and obstacles to parenthood, and take action to abate or remove them.

One such line of action is discussed in a subsequent major broadsheet (No. 244. "A Complete Maternity Service"), in which the present condition of maternity services in Great Britain is outlined and the main deficiencies are indicated. Further, a full maternity service is outlined and the proper place of the midwife, the health visitor, the general practitioner, the clinic officer and the hospital are discussed and the functions which the health centre can perform in uniting these individuals in a team. The main, and much the most important, emphasis is laid in *Planning* on team-work and continuity of attention. The second point made in the broadsheet is the development of a more uniform service so that without rigid rules applicable through the whole of Britain for every detail of maternity care, the essential services should be readily available to the woman in a country district as well as to the town dweller and to all income groups. Thirdly, the need of simplifying the administrative structure behind maternity services is stressed. If the target is established and each move is made with that target clearly in view, the achievement of a really marked improvement should not be so difficult as it appears at present, when each section of the services concerned is apt to over-emphasize its importance. Lastly, there is the need for public education. First-rate administration and first-rate services could founder completely on the rock of ignorance or prejudice; the essential facts of the situation must be known and understood by the public for whose comfort and health maternity services are designed.

These three broadsheets belong to a series to be embodied in the PEP report on population policies, but the group responsible for this study has found itself unable to deal with the subject satisfactorily without entering on a wider and more difficult inquiry. Population policy must be seen in the context of a democratic society, and belief in the future of society, education in parenthood, and a higher valuation of parenthood by society are three vital factors making for a sound population policy.

## APPOINTMENTS VACANT

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

**DIRECTOR**—The Secretary, British Pottery Research Association, Federation House, Stoke-on-Trent (August 31).

**ASSISTANT LECTURER (temporary) IN BOTANY**—The Registrar, The University, Sheffield (August 31).

**ASSISTANT LECTURER IN THE AGRICULTURAL BOTANY DEPARTMENT**—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (August 31).

**ZOOLOGISTS** to sail in whaling factory ships during the Antarctic season of 1946-47—The Director of Research, Discovery Committee, 52 Queen Anne's Chambers, London, S.W.1 (August 31).

**LECTURER IN ELECTRICAL ENGINEERING** at the Municipal Technical College and School of Art—The Director of Education, Education Offices, Library Street, Blackburn (August 31).

**BIOCHEMIST** in the Ministry of Health Area Laboratory—The Medical Superintendent, City Hospital, Hucknall Road, Nottingham (September 1).

**PROFESSOR OF STRUCTURAL ENGINEERING AND FOUNDATIONS**, an **ASSISTANT PROFESSOR OF ELECTRICAL TESTING AND MEASURING INSTRUMENTS**, an **ASSISTANT PROFESSOR OF IRRIGATION AND IRRIGATION DESIGN**, and a **PROFESSOR OF GEOLOGY**, at the Farouk I University, Alexandria—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (September 3).

**ASSISTANT LECTURER AND DEMONSTRATOR IN CHEMISTRY**—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8 (September 6).

**ASSISTANT LECTURER (or LECTURER) IN CHEMISTRY**, and an **ASSISTANT LECTURER IN PHYSICS**—The Registrar, University College, Southampton (September 7).

**AGRICULTURAL ASSISTANT**, and a **HORTICULTURAL ASSISTANT**—The Chief Education Officer, Shire Hall, Cambridge (September 7).

**PRINCIPAL OF THE BARNSELY MINING AND TECHNICAL COLLEGE**—The Director of Education, Education Office, Town Hall, Barnsley (September 7).

**HEAD OF THE CHEMISTRY DEPARTMENT**—The Principal, Municipal Technical College, Hopwood Lane, Halifax (September 9).

**SENIOR ENGINEER**, an **ENGINEER**, and an **ASSISTANT ENGINEER**, in the Television Section, Research Department of the B.B.C.—Engineering Establishment Officer, Broadcasting House, London, W.1 (September 9).

**PRINCIPAL OF THE COVENTRY TECHNICAL COLLEGE**—The Director of Education, Council House, Coventry (September 14).

**LECTURER (Grade III) IN THE DEPARTMENT OF GEOGRAPHY**—The Clerk, Birkbeck College, Breams Buildings, London, E.C.4 (September 14).

**LECTURER IN MATHEMATICS** in the United College, St. Andrews—The Secretary, The University, St. Andrews (September 15).

**DIRECTOR OF RESEARCH**—The Secretary, Federation of Dyers and Cleaners, 7 Laurence Pountney Hill, Cannon Street, London, E.C.4 (September 21).

**LECTURERS (2) IN ZOOLOGY** (one to assist in the teaching of Vertebrate Zoology, the other of Invertebrate Zoology), and a **MUSEUM ASSISTANT** (experienced)—The Secretary to the University, Old College, Edinburgh 8 (September 25).

**DEPUTY PUBLIC ANALYST** in the Public Health Department—The Town Clerk, Town Hall, Manchester 2, endorsed 'Deputy Public Analyst' (September 28).

**MEDICAL GRADUATE** as Assistant to the Director—The Director, Wellcome Museum of Medical Science, 183-193 Euston Road, London, N.W.1 (October 1).

**LECTURER IN BIOCHEMISTRY**—The Secretary, Queen's University, Belfast (October 5).

**LECTURER IN PHARMACOLOGY**, and a **RESEARCH ASSISTANT IN THERAPEUTICS**—The Registrar, The University, Sheffield (October 14).

**LIVSEY CHAIR OF COAL GAS AND FUEL INDUSTRIES**—The Registrar, The University, Leeds 2 (October 15).

**CHAIR OF CHEMICAL ENGINEERING**—The Registrar, The University, Sydney (December 31).

**LECTURER IN MECHANICAL ENGINEERING**—The Registrar, King's College, Newcastle-upon-Tyne.

**LECTURER IN THE SCHOOL OF PHYSICS AND APPLIED SCIENCE**, a **LECTURER IN MATHEMATICS**, and a **LECTURER IN MATHEMATICS AND PHYSICS**—The Principal, Leicester College of Technology and Commerce, Leicester.

**RESEARCH ASSISTANT** to the Professor of Physiology—The Secretary, Medical School, Middlesex Hospital, London, W.1.

**LECTURERS IN MATHEMATICS, APPLIED MECHANICS (2), and PHYSICS**, at the Royal Naval College, Greenwich—The Director, Education Department, Admiralty, London, S.W.1.

**GRADUATES** of Universities of recognized standing in the fields of Electrical Precision Measurements, General Physics, Metrology, Heat, Acoustics, Atomic Physics, Electrical Engineering, Radio, Optics, Radiology—The Director, Division of Physics and Electrical Engineering, National Research Council, Ottawa, Canada.

**TEACHER (full-time) IN THE ENGINEERING DEPARTMENT** to take the following Higher National Certificate subjects: Metrology, Machine Shop Technology, Workshop Technology and Workshop Practice—The Principal, Stockport College for Further Education, Stockport.

**LECTURER IN AGRICULTURE**—The Secretary and Registrar, University College of North Wales, Bangor.

Stonyhurst College Observatory. Results of Geophysical and Solar Observations, 1939, with Report and Notes of the Director, Rev. J. P. Rowland. Pp. xviii+40. Results of Geophysical and Solar Observations, 1940, with Report and Notes of the Director, Rev. J. P. Rowland. Pp. xviii+40. Results of Geophysical and Solar Observations, 1941, with Report and Notes of the Director, Rev. J. P. Rowland. Pp. xvi+40. Results of Geophysical and Solar Observations, 1942, with Report and Notes of the Director, Rev. J. P. Rowland. Pp. xiv+40. Results of Geophysical and Solar Observations, 1943, with Report and Notes of the Director, Rev. J. P. Rowland. Pp. xv+40. (Blackburn: Stonyhurst College Observatory, 1939-1943.) [193

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(not included in the monthly Books Supplement)

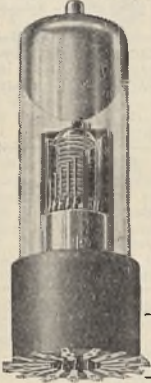
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## REASON

Human society is not maintained by the conjectures of theology . . . but by those sympathies and sentiments, and that faculty of Reason, which have raised man above the animals. Reason, and sentiment refined by Reason, are man's most precious possessions. Without them man could not survive as a social being. Reason has contributed more to the cultivation and refinement of social sentiment and to ideas of right and wrong than all the dogmas of religion. For as, by using his Reason, man becomes more enlightened, he sees more and more clearly that the welfare of every individual is dependent upon the welfare of society; and the welfare of society depends upon the welfare of each individual.



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**The London Scientific Film Society** re-organized and enlarged starting Ninth Season in Sept. invites applications for membership. Write Secretary, 34 Soho Square, W.1.

**University College, Southampton.—** Technician required for Zoology Laboratory. Good experience in section-cutting and preparation of zoological material required. Salary £5 10 to £7 per week according to qualifications. Further particulars may be obtained from the Registrar, with whom applications must be lodged by September 14, 1946.

**University College, Southampton.—** Applications are invited for the post of Lecturer or Assistant Lecturer in Zoology, duties to commence as soon as possible. Candidates, preferably with special knowledge of Vertebrate Zoology, will be required to undertake senior and junior teaching, and to engage in research. Further particulars may be obtained from the Registrar, with whom applications must be lodged by September 14, 1946.

**University College, Southampton,** invite applications for the post of Lecturer in Organic Chemistry, to date from January 1, 1947. Candidates of exceptional qualifications may be considered for appointment to the grade of Senior Lecturer. Further particulars may be obtained from the Registrar, with whom applications must be lodged by September 14, 1946.

**University College, Southampton,** invite applications for the post of Assistant Lecturer in Physics to date from October 1, 1946. Salary £350. Further particulars may be obtained from the Registrar, with whom applications must be lodged by September 7, 1946.

**University College, Southampton,** invite applications for the post of Assistant Lecturer (or Lecturer) in Chemistry, to date from October 1, 1946. Further particulars may be obtained from the Registrar, with whom applications must be lodged by September 7, 1946.

**University of London.—The Senate** invite applications for the Chair of Theoretical Physics tenable at King's College (salary £1,500 per annum). Applications must be received not later than September 16, 1946, by the Academic Registrar, University of London, Senate House, W.C.1, from whom further particulars should be obtained.

**Large Lancashire Chemical Company** require experienced Works Manager, age 35/40. Chemical engineering background essential. Salary £1,200 per annum. Reply to Box 670, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

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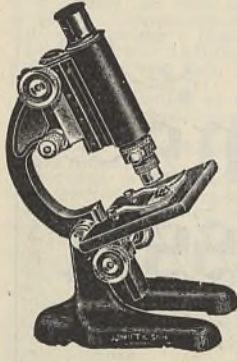
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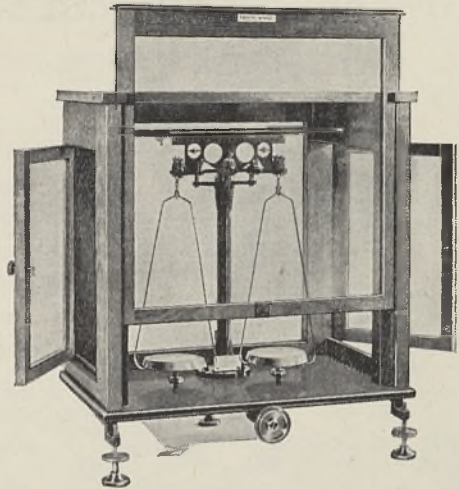
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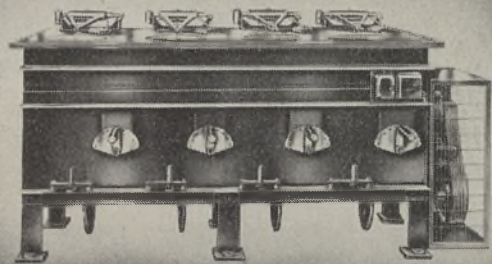
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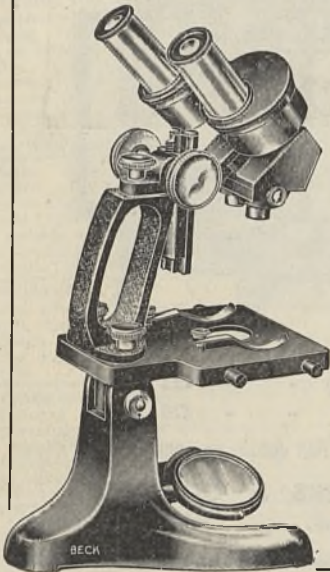


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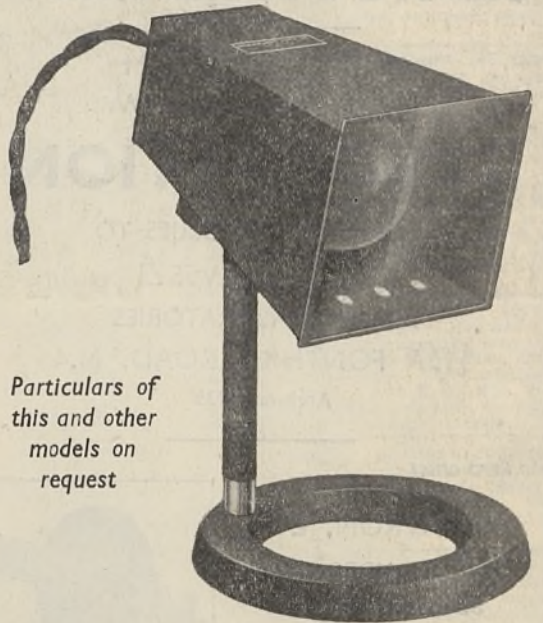
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